

30 December 2004

SUBJECT: SUPPLEMENTAL DETERMINATION OF THE SUITABILITY OF SEDIMENTS TO BE DREDGED FOR MANKE LUMBER COMPANY (2004-01400) FOR UNCONFINED OPEN-WATER DISPOSAL AT THE COMMENCEMENT BAY DISPOSAL SITE, AS EVALUATED UNDER SECTION 404 OF THE CLEAN WATER ACT.

1. The following summary reflects a consensus determination of the Agencies that comprise the regional Dredged Material Management Program (DMMP) for the State of Washington. The Agencies include the U.S. Army Corps of Engineers, Department of Ecology, Department of Natural Resources, and the Environmental Protection Agency. The Agencies are charged with determining the suitability of dredged material for in-water disposal and have evaluated the proposed dredging of an estimated 23,000 cubic yards of sediment from the head of the Hylebos Waterway at Manke Lumber Company. This high concern area falls within the Commencement Bay MTCA cleanup effort known as the Hylebos Wood Debris Site (HWDS).
2. **Background.** The area outlined in this DMMP evaluation was subject to an earlier DMMP characterization and suitability determination dated 10 October 2000, which indicated that 10 of 27 DMMUs evaluated were suitable for unconfined open-water disposal. Dredging of all surface suitable DMMUs from the 2000 SDM have been completed. Approximately 31,500 cy of material from 13 DMMUs remains to be addressed under the requirements of the MTCA Consent Decree, and are the focus of the DMMP characterization summarized below.

Table 1. Regulatory Tracking Dates

SAP Submittal date:	August 4, 2004
SAP Approval date:	August 24, 2004
Initial Sampling date(s):	September 21-23, 2004
Resampling of DMMU A-6:	November 6, 2004
Data report submittal date:	December 20, 2004
Total Volume Characterized:	23,000 cy
Total number of DMMU's:	2 DMMU's for Chemistry 10 DMMU's for Bioassays
DAIS Tracking Number:	MLUMB-1-B-F-204
Recency Determination Date: High Concern (2 years)	September 2006

3. This determination of suitability is based on the acceptability of the sampling data, as well as all relevant test data contained in the Data Letter Summary Report submitted by the Manke Lumber contractor (Anchor Environmental) to the DMMP on December 20, 2004. A pre-DMMP sampling effort was necessary to evaluate the surface sediments relative to Ecology's cleanup

Total Volatile Solids (TVS) cleanup objective (e.g., 15 %). Surface samples were collected on September 13, 2004 at 11 of 13 DMMUs in the DMMP approved SAP with a van Veen grab sampler prior to the DMMP sampling exercise (Figures 1 and 2). DMMP sampling was conducted on September 21-23, 2004 with a vibracorer sampler. Supplemental vibracorer sampling took place at DMMU A-6 on November 6, 2004 to collect additional material necessary for a retest of the sediment larval bioassay due to insufficient material.

4. Relevant dates for regulatory tracking purposes are included in Table 1. The DMMP approved SAP included a combined initial proposed dredging footprint estimated at 31,500 cubic yards representing thirteen DMMUs (see Figure 2). However, the pre-DMMP TVS surface screening sampling effort indicated that DMMU's A-1 and A-2 were already at or below the required TVS Cleanup level of 15 %, and, therefore, no additional cleanup dredging was needed at these two locations. During the DMMP vibracorer sampling effort at A-7, only about one foot of soft sediment remained above the native sediment contact layer, and the TVS level of 19 % showed only slight exceedance of Ecology's cleanup objective of 15 %. Because of the relatively small volume remaining at this location, the applicant elected not to pursue DMMP testing at this location¹. Eliminating these three DMMUs reduced the DMMP DMMU's from 13 to 10 and the volume to 23,000 cy. Of the 10 remaining DMMUs only two underwent DMMP chemical characterizations (AML-9 and AML-10), whereas all 10 DMMUs evaluated underwent concurrent bioassay testing.
5. Appendix 1 provides a summary of the sediment conventional parameters, chemical testing results, and bioassay testing results for the 10 DMMUs.
6. The results of the chemical analyses of the two DMMUs are summarized in Appendix 1 and indicated that only one chemical, mercury, exceeded the DMMP SL. Both were quantitated at 0.6 ppm, below the bioaccumulation trigger. Appendix 2 contains the full chemical characterization results for DMMU's AML-A9 and AML-A10.
7. DMMP QA/QC Performance guidelines for the three required DMMP bioassays are provided in Table 2. Concurrent bioassay testing was conducted on all 10 DMMUs, and the results of all analyses conducted are summarized in Table 3, and Appendix 3. The three Carr Inlet reference samples (wet sieving estimates for fines: 17%, 48%, and 80%) were run concurrently with the test sediment, and met the performance objective for both amphipod mortality (*Eohaustorius estuaries*) and *Neanthes* growth bioassays.
8. However, in conducting the standard PSEP protocol for the bivalve larval bioassay (*Mytilus galloprovincialis*), all three reference sediments failed the quality control performance standard for reference sediment (Table 3, Appendix 3c). Examination of the water quality parameters

¹ Subsequent to the draft letter report submittal, Ecology (Russ McMillan) indicated that the criteria for TVS for the Manke Lumber cleanup is 15% absolute. As such, A-7 is over the cleanup standard and fails the Ecology cleanup criteria. Ecology wants this material removed to complete the cleanup prior to initiating the required mitigation of the bank adjacent to A-7. The applicant decided to evaluate A-7 further relative to the cleanup TVS standard and DMMP chemicals of concern, including TBT at three locations within the DMMU. The results of these analyses will be evaluated separately as an addendum to this suitability determination.

associated with this test indicated that ammonia and sulfide did not appear to be responsible for the apparent reference sediment performance problems. After consultation, the DMMP agencies agreed to allow a retest using a screen tube inserted into the test beakers to keep the larvae off of the soft sediments (Appendix 4). The first retest with the screen tubes used a mesh size of 37 millimicrons and the reference sediments again failed to meet the performance QA standard (Appendix 3d). In evaluating the reasons for the performance standard Bill Gardiner (see Appendix 4) felt the larvae were smaller than the screen mesh of 37 millimicrons and were passing through the screen. He indicated that the problems with the test could be remedied by rerunning the test with a screen tube mesh size of 25 millimicrons. The recommended DMMP holding time for conducting bioassays (56 days) was exceeded by 20 days for the second retest with the smaller mesh size. The holding time exceedance was acknowledged by the DMMO as a serious concern and issue, but David Kendall indicated that because the primary chemical constituent being evaluated was TVS and not likely to be affected by the extended holding time, the retest could proceed. The retest results would be evaluated with best-professional-judgment (BPJ). The results of the second retest with the smaller mesh size indicated that two of the three reference samples met the performance standard and that these results were deemed valid for decision making using BPJ (Table 3, Appendix 3e).

- a) **Amphipod Bioassay (*Eohaustorius estuarius*).** Amphipod bioassays were conducted during the initial testing on 10 DMMUs, as noted in Table 3, Appendix 1, Appendix 3a. The results indicate that for the amphipod bioassay, all ten DMMUs exhibited no-hit responses and passed the nondispersive disposal site guidelines.
- b) ***Neanthes* 20-day Growth Bioassay (*Neanthes arenaceodentata*).** For the *Neanthes* growth bioassay nine of the ten DMMUs passed the nondispersive open-water disposal guidelines, whereas one DMMU (AML-A9) scored a 2-hit response (Table 3, Appendix 1, Appendix 3b).
- c) **Bivalve Larval Bioassay (*Mytilus galloprovincialis*).** The results of the PSEP protocol failing reference performance guidelines are summarized in Table 3, and provided in Appendix 3c. The results of the first test with the screen tubes, which also failed the reference performance guidelines are summarized in Table 3, and provided in Appendix 3d. The results of the second test with the screen tubes using the smaller (25 millimicron) mesh size are summarized in Table 3, and Appendix 3e. The bivalve larval bioassay results for the second screen tube test indicated that six of ten DMMUs passed the nondispersive disposal guidelines, whereas one DMMU (AML-9) scored a 2-hit response, whereas, three DMMUs (A-4, A-21, and A-22) scored 1-hit responses for this bioassay (Appendix 1, Table 3, Appendix 3e). Therefore, collectively DMMU AML-A9 had two bioassay responses scoring 2-hit responses (e.g., *Neanthes* and Bivalve larval bioassay), resulting in a failure to pass the nondispersive disposal guidelines. The three 1-hit responses for DMMU's A-4, A-21, and A-22 failed the nondispersive disposal guidelines.
- d) **DMMP Bioassay Determination.** Overall, interpretation of the ten DMMU's characterized, six DMMUs exhibited bioassay responses that were suitable for unconfined open-water disposal (UOWD) and 4 exhibited responses that were unsuitable for UCOWD (Table 3, Appendix 1, Appendix 3).

9. Based upon the results of all testing, the agencies concluded that six of the ten DMMUs evaluated at the Manke Lumber Company site, representing 16,800 cubic yards of dredged material, were suitable for unconfined open-water disposal at the Commencement Bay disposal site. The testing results confirmed that four DMMUs (A-4, AML-A9, A-21, A-22), comprising 6,200 cubic yards of dredged material from the Manke Lumber Company site, were unsuitable for unconfined open-water disposal. The material associated with DMMU A-7 is undergoing testing by the applicant and will be subject to a supplemental suitability determination after the results are reviewed and assessed within the DMMP. Refer to Appendix 1 for a complete inventory of suitable and unsuitable DMMUs.

10. This memorandum documents the suitability of the dredged material characterized at the Manke Lumber Company site located at the head of Hylebos Waterway for disposal at the Commencement Bay non-dispersive open-water disposal site. However, this suitability determination does not constitute final agency approval of the project. A dredging plan for this project must be completed as part of the final project approval process. A final decision will be made after full consideration of agency input, and after an alternatives analysis is done under Section 404(b)(1) of the Clean Water Act.

Concur:

1/6/2005

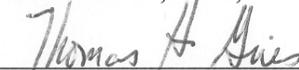
Date



David Kendall, Ph.D., Seattle District Corps of Engineers

1/6/05

Date



Tom Gries, Washington Department of Ecology

1/6/05

Date



Jonathan Freedman, Environmental Protection Agency

1/6/2005

Date



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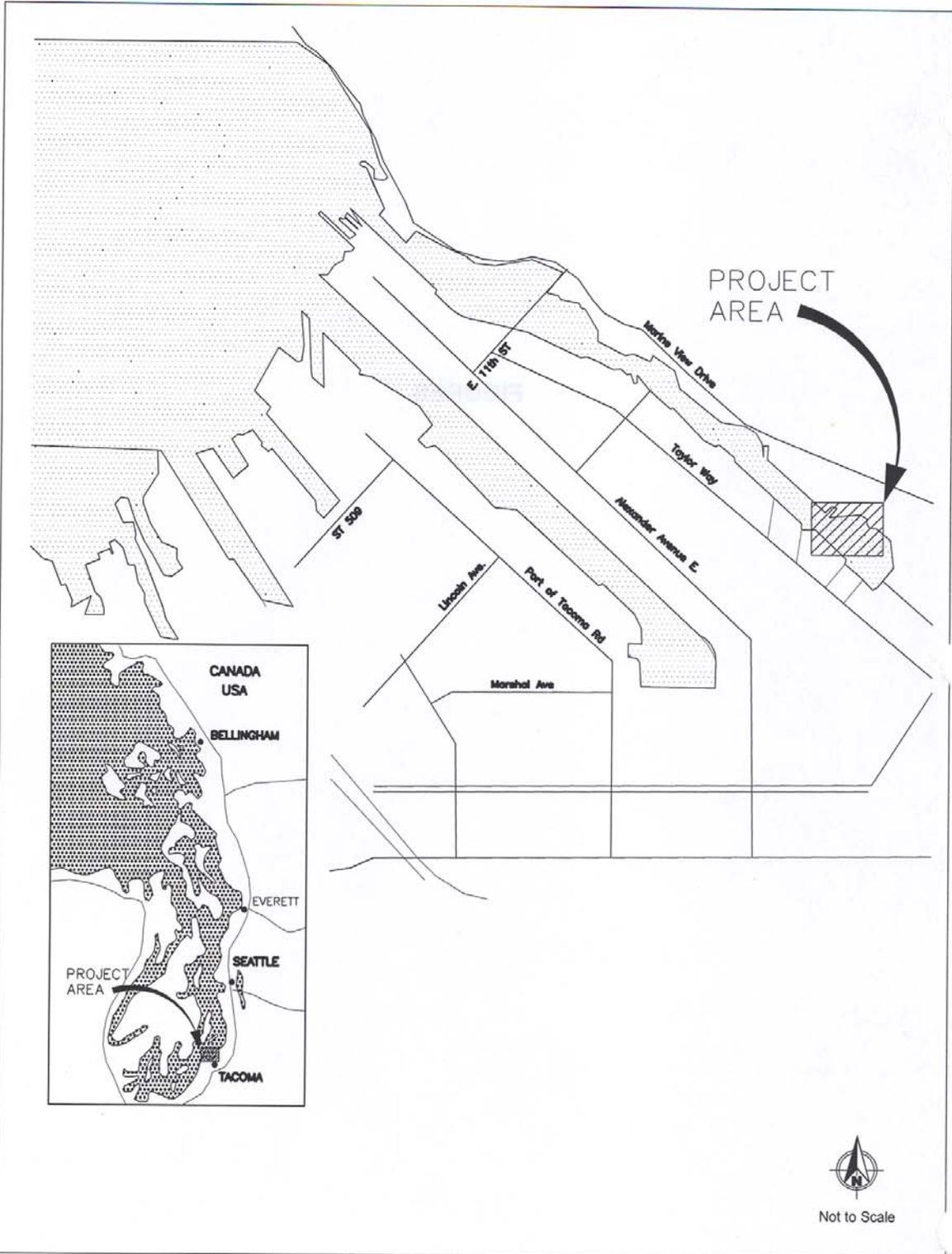


Figure 1
Vicinity Map
Manke Lumber

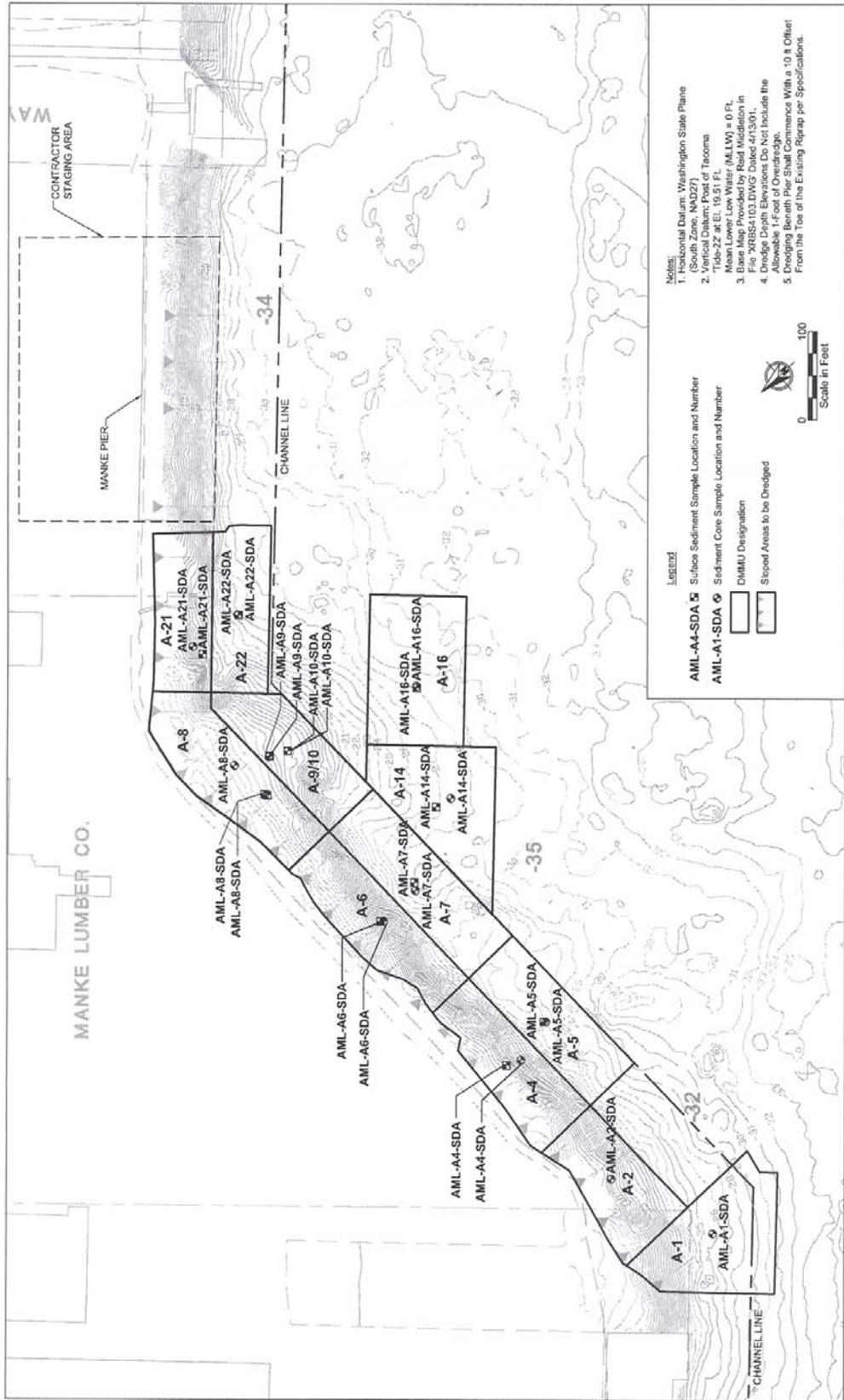


Figure 2
September 2004 Sediment Sampling Locations
Manke Lumber



NOV 11, 2004 11:20am 039m 039m N:\5204\040185-MANKE\04018501104018501_01.dwg FIG 1

Table 2 – DMMP EVALUATION GUIDELINES (BIOASSAYS)

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 SD ($p=.05$) and		$M_T - M_C > 20\%$ and M_T vs M_R SD ($p=.05$) and	
			$M_T - M_R > 10\%$	NOCN	$M_T - M_R > 30\%$	NOCN
Sediment 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 SD ($p=.10$) and		$N_T \div N_C < 0.80$ and N_T/N_C vs N_R/N_C SD ($p=.10$) and	
			$N_R/N_C - N_T/N_C > 0.15$	NOCN	$N_R/N_C - N_T/N_C > 0.30$	NOCN
<i>Neanthes</i> growth	$M_C \leq 10\%$ $MIG \geq 0.38$ mg/ind/day	$MIG_R \div MIG_C \geq 0.80$	$MIG_T \div MIG_C < 0.80$ and MIG_T vs MIG_R SD ($p=.05$) and		$MIG_T \div MIG_C < 0.80$ and MIG_T vs MIG_R SD ($p=.05$) and	
			$MIG_T/MIG_R < 0.70$	NOCN	$MIG_T/MIG_R < 0.50$	$MIG_T/MIG_R < 0.70$

M = mortality, N = normals, I = initial count, MIG = mean individual growth rate, BLD = blank-corrected light decrease
 SD = statistically different, NOCN = no other conditions necessary, N/A = not applicable
 Subscripts: R = reference sediment, C = negative control, T = test sediment

**Table 3
Summary of Bioassay Test Data**

Station	Surface Sediment TVS (% dry wt)	Dredge Prism TVS (% dry wt)	Amphipod Survival (percent)	Neanthes Growth Rate (mg/ind/d)	PSEP Larval Combined Mortality	Screen Tube Larval Retest #1 Combined Mortality	Screen Tube Larval Retest #2 Combined Mortality
Laboratory Control	-	-	100%	0.81	23%	3%	5%
Reference Stations (all reference stations are matched to all site stations):							
REF-17	-	-	96%	0.62	33%	89%	98%
REF-48	-	-	97%	0.69	31%	54%	17%
REF-80	-	-	94%	0.83	36%	-	-
REF-80-Retest	-	-	-	-	3%	40%	11%
DMMU Site Stations (generally in order of increasing distance from log lift):							
A-21	-	43%	87%	0.73	77%	100%	98%
A-22	32%	-	90%	0.61	68%	58%	97%
A-08	-	64%	94%	0.81	66%	92%	25%
A-09	26%	39%	85%	0.53	68%	94%	30%
A-10	20%	43%	90%	0.83	79%	82%	13%
A-06	18%	12%	90%	0.78	62%	-	-
A-06-Retest	-	12%	-	-	79%	63%	12%
A-07	19%	-	-	-	-	-	-
A-14	17%	27%	91%	0.73	62%	79%	11%
A-16	24%	21%	89%	0.71	85%	70%	3%
A-04	17%	-	95%	0.76	78%	66%	84%
A-05	16%	16%	83%	0.72	68%	38%	14%

NOTES:

Reference sample fails PSDDA acceptance criterion

Bioassay results pass two-hit PSDDA interpretive criterion, compared to acceptable reference samples

Bioassay results exceed two-hit, but pass one-hit PSDDA interpretive criteria, compared to acceptable reference samples

Bioassay results exceed one- and/or two-hit PSDDA interpretive criterion, compared to acceptable reference samples

Appendix I. DMMP characterization summary for Manke Lumber 2004 Retest

	DMMP Guidelines				A-4	A-5	A-6	A-7	A-8	AML-A9	AML-A10	A-14	A-16	A-21	A-22	REF-17	REF-48	REF-80
	Units	SL	BT	Rank: ML	H	H	H	H	H	H	H	H	H	H	H			
CHEMICAL NAME					Conc.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.			
Mercury	mg/kg	0.41	1.5	2.3	NT	NT	NT	NT	NT	0.6	0.6							
Total Solids	%									26.7	26.5							
Total Volatile Solids (dredged material prism)	%					16	12		64	38.7	42.9	27.0	21.0	43.0				
Total Volatile Solids (surface)					17	16	18	19		26.0	20.0	17.0	24.0		32.0			
Total Organic Carbon	%									9.7	9.5							
Total Ammonia	mg/kg									35.8	23.6							
Total Sulfides	mg/kg									4,600	6,700							
Gravel (percent)	%									18.7	18.5					0.1	0	0
Sand (percent)	%									44.4	37.2					76.9	54.2	19
Silt (percent)	%									23.0	28.5					19.3	39.3	71.6
Clay (percent)	%									13.8	15.7					3.8	6.7	9.4
Fines (percent silt + clay)	%									36.8	44.2					23	45.8	81
Eohaustorius Amphipod Survival hits:					NH	NH	NH			NH	NH	NH	NH	NH	NH			
Neanthes Growth					NH	NH	NH			NH	2H	NH	NH	NH	NH			
Mytilus galloprovincialis (PSEP Initial Test) hits:					F (QA)	F (QA)	F (QA)			F (QA)	F (QA)	F (QA)	F (QA)	F (QA)	F (QA)			
Mytilus galloprovincialis (Screen Tube Retest 1) hits:					F (QA)	F (QA)	F (QA)			F (QA)	F (QA)	F (QA)	F (QA)	F (QA)	F (QA)			
Mytilus galloprovincialis (Screen Tube Retest 2) hits:					1H	NH	NH			NH	2H	NH	NH	NH	1H	1H		
Bioassay Pass/Fail:					FAIL	PASS	PASS	NT		PASS	FAIL	PASS	PASS	PASS	FAIL	FAIL		
BTs exceeded:										no	no							
Bioaccumulation conducted:																		
Bioaccumulation Pass/Fail:																		
ML Rule exceeded:											no							
PSDDA Determination:					FAIL	PASS	PASS	NT		PASS	FAIL	PASS	PASS	PASS	FAIL	FAIL		
DMMU Volume:	cy				2,500	3,100	2,100	2,400	1,400	1,400	1,700	4,400	4,100	900	1,400			
DMMU ID:					A-4	A-5	A-6	A-7	A-8	AML-A9	AML-A10	A-14	A-16	A-21	A-22	REF-17	REF-48	REF-80

Legend:

NT = Not Tested

NA = Not Analyzed (bioassays)

F(QA) = Quality Assurance Failure

SL = Screening Level (lower chemical guideline)

NH = No Hit (nondispersive guidelines)

2H = two hit failure (nondispersive guidelines)

1H = one hit failure (nondispersive guidelines)

P = Pass (Suitable for UCOWD)

F = Failure (Unsuitable for UCOWD)

UCOWD = Unconfined open-water disposal

VQ = Validation Qualifier

Total Volume Tested

23,000 cy

6,200 cy Unsuitable = 27.0%

16,800 cy Suitable = 73.0%

Appendix 2
Summary of Analytical Results for the PSDDA Analyte List and Comparison with Criteria

Location ID Sample ID Sample Date	PSDDA Screening	Bio Trigger	PSDDA Max	AML-A9 AML-A9-01A 9/24/2004	AML-A9 AML-A9-01A-PW 9/29/2004	AML-A10 AML-A10-01A 9/24/2004	AML-A10 AML-A10-01A-PW 9/29/2004
Conventionals							
Ammonia (mg/kg)	--	--	--	35.8	--	23.6	--
Total Organic Matter (%)	--	--	--	--	--	--	--
Total Volatile Solids (%)	--	--	--	38.7	--	42.9	--
Preserved Total Solids (%)	--	--	--	27.20	--	24.70	--
Total Solids (%)	--	--	--	26.70	--	26.50	--
Sulfide (mg/kg)	--	--	--	4600	--	6700	--
Total Organic Carbon (%)	--	--	--	9.71	--	9.46	--
Grain Size (%)							
Gravel	--	--	--	18.7	--	18.5	--
Sand	--	--	--	44.4	--	37.2	--
Silt	--	--	--	23	--	28.5	--
Clay	--	--	--	13.8	--	15.7	--
Fines	--	--	--	36.8	--	44.2	--
Metals (mg/kg)							
Antimony	150	--	200	20 U	--	20 U	--
Arsenic	57	507.1	700	20 U	--	20 U	--
Cadmium	5.1	11.3	14	0.9	--	1.4	--
Chromium	--	267	--	41	--	46	--
Copper	390	1027	1300	81.7	--	94.2	--
Lead	450	975	1200	39	--	49	--
Mercury	0.41	1.5	2.3	0.6	--	0.6	--
Nickel	140	370	370	29	--	33	--
Selenium	--	3	--	20 U	--	20 U	--
Silver	6.1	6.1	8.4	1 U	--	1 U	--
Zinc	410	2783	3800	183	--	260	--
Butyltins (µg/L)							
Tributyltin ion	0.15	--	--	--	0.12	--	0.11
Tributyltin chloride	--	--	--	--	0.13	--	0.12
Pesticides (µg/kg)							
4,4'-DDT	--	50	--	a	--	2.0 U	--
Aldrin	10	--	--	a	--	1.0 U	--
Dieldrin	10	--	--	a	--	2.0 U	--
Endrin	--	--	--	a	--	2.0 U	--
alpha-BHC	--	--	--	a	--	a	--
alpha-BHC (mg/kg-OC)	--	10	--	a	--	a	--
gamma-BHC (Lindane)	10	--	--	a	--	1.0 U	--
Heptachlor	10	--	--	a	--	1.0 U	--
Hexachlorobenzene	22	168	230	1.1	--	1.6	--
Hexachlorobutadiene	29	--	270	0.98 UJ	--	1.0 UJ	--
PCBs (µg/kg)							
Aroclor 1016	--	--	--	7.9 U	--	4.0 U	--
Aroclor 1221	--	--	--	16 U	--	24 U	--
Aroclor 1232	--	--	--	3.9 U	--	4.0 U	--
Aroclor 1242	--	--	--	3.9 U	--	4.0 U	--
Aroclor 1248	--	--	--	11	--	10	--
Aroclor 1254	--	--	--	31	--	50	--
Aroclor 1260	--	--	--	24 U	--	40 U	--
Total PCBs	130	--	3100	42	--	60	--
Total PCBs (mg/kg-OC)	--	38	--	0.433	--	0.634	--

Appendix 2 (continued)
Summary of Analytical Results for the PSDDA Analyte List and Comparison with Criteria

Location ID Sample ID Sample Date	PSDDA Screening	Bio Trigger	PSDDA Max	AML-A9 AML-A9-01A 9/24/2004	AML-A9 AML-A9-01A-PW 9/29/2004	AML-A10 AML-A10-01A 9/24/2004	AML-A10 AML-A10-01A-PW 9/29/2004
SVOCs (µg/kg)							
1,2,4-Trichlorobenzene	31	--	64	14 UJ	--	11 UJ	--
1,2-Dichlorobenzene	35	--	110	2.8 UJ	--	2.2 UJ	--
1,3-Dichlorobenzene	170	--	--	2.8 UJ	--	2.2 UJ	--
1,4-Dichlorobenzene	110	--	120	2.8 UJ	--	2.2 UJ	--
2,4-Dimethylphenol	29	--	210	20 U	--	20 U	--
2-Methylnaphthalene	670	--	1900	20 U	--	20 U	--
2-Methylphenol	63	--	77	24	--	20 U	--
4-Methylphenol	670	--	3600	20 U	--	20 U	--
Acenaphthene	500	--	2000	20 U	--	20 U	--
Acenaphthylene	560	--	1300	20 U	--	20 U	--
Anthracene	960	--	13000	28	--	20 U	--
Benzo(a)anthracene	1300	--	5100	34	--	20 U	--
Benzo(a)pyrene	1600	--	3600	52 J	--	26 J	--
Benzo(b)fluoranthene	--	--	--	160 J	--	50 J	--
Benzo(g,h,i)perylene	670	--	3200	20 UJ	--	20 UJ	--
Benzo(k)fluoranthene	--	--	--	130 J	--	21 J	--
Total benzofluoranthenes	3200	--	9900	290 J	--	71 J	--
Benzoic acid	650	--	760	200 U	--	200 U	--
Benzyl Alcohol	57	--	870	20 U	--	20 U	--
bis(2-Ethylhexyl)phthalate	8300	--	--	120	--	77	--
Butylbenzylphthalate	970	--	--	84	--	20 U	--
Chrysene	1400	--	21000	58	--	39	--
Dibenzo(a,h)anthracene	230	--	1900	20 UJ	--	20 UJ	--
Dibenzofuran	540	--	1700	20 U	--	20 U	--
Diethylphthalate	1200	--	--	20 U	--	20 U	--
Dimethylphthalate	1400	--	--	20 U	--	20 U	--
Di-n-butylphthalate	5100	--	--	20 U	--	20 U	--
Di-n-octylphthalate	6200	--	--	20 UJ	--	20 UJ	--
Fluoranthene	1700	4600	30000	480	--	100	--
Fluorene	540	--	3600	20 U	--	20 U	--
Hexachloroethane	1400	--	14000	20 U	--	20 U	--
Indeno(1,2,3-cd)pyrene	600	--	4400	20 UJ	--	20 UJ	--
Naphthalene	2100	--	2400	20 U	--	20 U	--
N-Nitrosodiphenylamine	28	--	130	20 U	--	20 U	--
Pentachlorophenol	400	504	690	100 U	--	99 U	--
Phenanthrene	1500	--	21000	52	--	29	--
Phenol	420	--	1200	20 U	--	20 U	--
Pyrene	2600	11980	16000	190J	--	20 UJ	--
Total HPAHs	12000	--	69000	1104 J	--	236 J	--
Total LPAHs	5200	--	29000	80	--	29	--

Appendix 3a. Test Results for the 10-day Acute Test with *E. estuarius*, Manke Lumber

Sample	Replicate	Number Initiated	Number Surviving	Number Missing or Dead	Percentage Survival	Mean Percentage Survival	SD
Control	1	20	20	0	100.0	100.0	0.0
	2	20	20	0	100.0		
	3	20	20	0	100.0		
	4	20	20	0	100.0		
	5	20	20	0	100.0		
Ref-17	1	20	19	1	95.0	96.0	6.5
	2	20	17	3	85.0		
	3	20	20	0	100.0		
	4	20	20	0	100.0		
	5	20	20	0	100.0		
Ref-48	1	20	20	0	100.0	97.0	4.5
	2	20	20	0	100.0		
	3	20	18	2	90.0		
	4	20	19	1	95.0		
	5	20	20	0	100.0		
Ref-80	1	20	18	2	90.0	94.0	6.5
	2	20	17	3	85.0		
	3	20	20	0	100.0		
	4	20	19	1	95.0		
	5	20	20	0	100.0		
A-04	1	20	18	2	90.0	95.0	7.1
	2	20	20	0	100.0		
	3	20	17	3	85.0		
	4	20	20	0	100.0		
	5	20	20	0	100.0		
A-05	1	20	18	2	90.0	83.0	5.7
	2	20	17	3	85.0		
	3	20	17	3	85.0		
	4	20	16	4	80.0		
	5	20	15	5	75.0		
A-06	1	20	19	1	95.0	90.0	7.9
	2	20	18	2	90.0		
	3	20	20	0	100.0		
	4	20	16	4	80.0		
	5	20	17	3	85.0		
A-08	1	20	18	2	90.0	94.0	5.5
	2	20	20	0	100.0		
	3	20	18	2	90.0		
	4	20	18	2	90.0		
	5	20	20	0	100.0		
A-09	1	20	15	5	75.0	85.0	10.0
	2	20	19	1	95.0		
	3	20	19	1	95.0		
	4	20	17	3	85.0		
	5	20	15	5	75.0		

Appendix 3a (continued). Test Results for the 10-day Acute Test with *E. estuarius*, Manke Lumber

Sample	Replicate	Number Initiated	Number Surviving	Number Missing or Dead	Percentage Survival	Mean Percentage Survival	SD
A-10	1	20	18	2	90.0	90.0	3.5
	2	20	19	1	95.0		
	3	20	18	2	90.0		
	4	20	18	2	90.0		
	5	20	17	3	85.0		
A-14	1	20	19	1	95.0	91.0	4.2
	2	20	19	1	95.0		
	3	20	18	2	90.0		
	4	20	17	3	85.0		
	5	20	18	2	90.0		
A-16	1	20	18	2	90.0	89.0	4.2
	2	20	17	3	85.0		
	3	20	17	3	85.0		
	4	20	19	1	95.0		
	5	20	18	2	90.0		
A-21	1	20	17	3	85.0	87.0	5.7
	2	20	19	1	95.0		
	3	20	17	3	85.0		
	4	20	16	4	80.0		
	5	20	18	2	90.0		
A-22	1	20	20	0	100.0	90.0	6.1
	2	20	17	3	85.0		
	3	20	18	2	90.0		
	4	20	18	2	90.0		
	5	20	17	3	85.0		

Appendix 3b. Test Results for the 20-day Chronic Test with *N. arenaceodentata* , Manke Lumber

Sample	Replicate	Position	Number Surviving	Number Dead or Missing	Percentage Survival	Mean Percentage Survival	SD
Control	1	293	5	0	100	96.0	8.9
	2	281	4	1	80		
	3	298	5	0	100		
	4	238	5	0	100		
	5	263	5	0	100		
Ref-17	1	232	4	1	80	88.0	11.0
	2	295	4	1	80		
	3	266	5	0	100		
	4	248	5	0	100		
	5	296	4	1	80		
Ref-48	1	309	4	1	80	92.0	11.0
	2	302	4	1	80		
	3	255	5	0	100		
	4	269	5	0	100		
	5	272	5	0	100		
Ref-80	1	237	5	0	100	100.0	0.0
	2	242	5	0	100		
	3	287	5	0	100		
	4	289	5	0	100		
	5	236	5	0	100		
A-04	1	306	4	1	80	56.0	21.9
	2	285	3	2	60		
	3	313	1	4	20		
	4	258	3	2	60		
	5	239	3	2	60		
A-05	1	308	5	0	100	96.0	8.9
	2	231	5	0	100		
	3	291	5	0	100		
	4	284	5	0	100		
	5	279	4	1	80		
A-06	1	312	5	0	100	92.0	11.0
	2	276	4	1	80		
	3	260	4	1	80		
	4	244	5	0	100		
	5	270	5	0	100		
A-08	1	259	5	0	100	96.0	8.9
	2	257	5	0	100		
	3	261	5	0	100		
	4	253	4	1	80		
	5	265	5	0	100		
A-09	1	280	5	0	100	96.0	8.9
	2	292	4	1	80		
	3	307	5	0	100		
	4	273	5	0	100		
	5	274	5	0	100		

Appendix 3b. Continued

Sample	Replicate	Position	Number Surviving	Number Dead or Missing	Percentage Survival	Mean Percentage Survival	SD
A-10	1	305	5	0	100	72.0	22.8
	2	290	4	1	80		
	3	311	4	1	80		
	4	262	2	3	40		
	5	268	3	2	60		
A-14	1	250	5	0	100	100.0	0.0
	2	246	5	0	100		
	3	303	5	0	100		
	4	256	5	0	100		
	5	233	5	0	100		
A-16	1	299	5	0	100	96.0	8.9
	2	310	5	0	100		
	3	254	4	1	80		
	4	271	5	0	100		
	5	294	5	0	100		
A-21	1	245	3	2	60	88.0	17.9
	2	234	5	0	100		
	3	252	5	0	100		
	4	243	5	0	100		
	5	282	4	1	80		
A-22	1	283	4	1	80	92.0	11.0
	2	286	4	1	80		
	3	264	5	0	100		
	4	240	5	0	100		
	5	241	5	0	100		

Appendix 3b (continued)

Sample	Total biomass (mg)	Biomass per Individual (mg)	Individual Growth Rate (mg/ind/d)	Mean Total Biomass (mg)	SD	Mean Individual Biomass (mg)	SD	Mean Individual Growth Rate (mg/ind/d)	SD
Control	83.3	16.7	0.8	80.3	15.9	16.6	2.1	0.81	0.1
	53.0	13.3	0.6						
	82.0	16.4	0.8						
	92.5	18.5	0.9						
	90.6	18.1	0.9						
Ref-17	65.3	16.3	0.8	55.4	12.5	12.6	2.7	0.62	0.1
	35.2	8.8	0.4						
	58.6	11.7	0.6						
	65.3	13.1	0.6						
	52.8	13.2	0.6						
Ref-48	49.9	12.5	0.6	66.2	19.5	14.2	2.7	0.69	0.1
	41.4	10.4	0.5						
	84.2	16.8	0.8						
	82.4	16.5	0.8						
	73.1	14.6	0.7						
Ref-80	83.4	16.7	0.8	84.7	14.8	16.9	3.0	0.83	0.1
	80.8	16.2	0.8						
	89.3	17.9	0.9						
	105.6	21.1	1.0						
	64.6	12.9	0.6						
A-04	65.2	16.3	0.8	46.6	25.7	15.4	6.2	0.76	0.3
	41.8	13.9	0.7						
	7.2	7.2	0.3						
	45.4	15.1	0.7						
	73.4	24.5	1.2						
A-05	111.6	22.3	1.1	70.8	26.2	14.7	4.8	0.72	0.2
	46.8	9.4	0.5						
	72.8	14.6	0.7						
	74.5	14.9	0.7						
	48.5	12.1	0.6						
A-06	67.8	13.6	0.7	73.1	9.0	16.0	2.0	0.78	0.1
	60.9	15.2	0.7						
	75.7	18.9	0.9						
	76.5	15.3	0.7						
	84.6	16.9	0.8						
A-08	69.7	13.9	0.7	77.4	14.5	16.4	4.6	0.81	0.2
	66.8	13.4	0.7						
	92.2	18.4	0.9						
	94.2	23.6	1.2						
	64.3	12.9	0.6						
A-09	53.8	10.8	0.5	51.9	15.7	10.9	3.6	0.53	0.2
	56.7	14.2	0.7						
	25.1	5.0	0.2						
	65.8	13.2	0.6						
	58.1	11.6	0.6						

Appendix 3b. Continued

Sample	Total biomass (mg)	Biomass per Individual (mg)	Individual Growth Rate (mg/ind/d)	Mean Total Biomass (mg)	SD	Mean Individual Biomass (mg)	SD	Mean Individual Growth Rate (mg/ind/d)	SD
A-10	91.2	18.2	0.9						
	52.2	13.1	0.6						
	54.8	13.7	0.7						
	54.1	27.1	1.3						
	38.1	12.7	0.6	58.1	19.7	17.0	6.1	0.83	0.3
A-14	81.0	16.2	0.8						
	61.4	12.3	0.6						
	95.5	19.1	0.9						
	92.1	18.4	0.9						
	43.5	8.7	0.4	74.7	21.9	14.9	4.4	0.73	0.2
A-16	69.7	13.9	0.7						
	51.7	10.3	0.5						
	67.6	16.9	0.8						
	62.1	12.4	0.6						
	95.7	19.1	0.9	69.4	16.3	14.5	3.5	0.71	0.2
A-21	51.6	17.2	0.8						
	62.7	12.5	0.6						
	72.8	14.6	0.7						
	83.5	16.7	0.8						
	52.5	13.1	0.6	64.6	13.6	14.8	2.1	0.73	0.1
A-22	44.1	11.0	0.5						
	49.7	12.4	0.6						
	60.2	12.0	0.6						
	59.8	12.0	0.6						
	77.4	15.5	0.8	58.2	12.7	12.6	1.7	0.61	0.1

Appendix 3c. Test Results for the PSEP Larval Test with *M. galloprovincialis*, Manke Lumber

Treatment	Mean Percentage Combined Mortality	SD	Mean Percentage Mortality	SD	Mean Percentage Abnormal	SD
Control	23.4	18.4	NC	1.7	6.9	1.7
Ref-17	33.2	10.8	14.7	2.1	5.5	2.1
Ref-48	31.1	14.6	12.0	1.8	5.4	1.8
Ref-80	36.3	7.7	18.2	1.0	5.7	1.0
A-04	77.7	7.7	69.4	4.2	11.7	4.2
A-05	68.4	10.0	54.5	8.0	15.5	8.0
A-06	61.6	8.6	46.4	5.8	13.5	5.8
A-08	65.9	11.8	54.5	2.5	8.7	2.5
A-09	68.4	7.6	55.4	6.3	13.3	6.3
A-10	78.5	5.2	69.1	5.9	15.0	5.9
A-14	61.7	34.7	46.0	9.1	13.5	9.1
A-16	85.2	5.1	78.4	6.0	18.1	6.0
A-21	76.6	15.8	68.1	6.7	10.1	6.7
A-22	68.1	15.2	54.6	9.5	14.6	9.5

Appendix 3d. Test Results for SW1 Test 1 Larval Test with *M. galloprovincialis*, Manke Lumber

Test Results	Mean Percentage		Mean Percentage		Mean Percentage	
Treatment	Combined Mortality	SD	Mortality	SD	Abnormal	SD
Control	3.0	6.7	2.8	5.5	3.5	1.2
Ref-17	89.1	12.4	64.3	42.3	65.0	13.0
Ref-48	54.3	33.0	50.7	35.1	10.1	12.7
Ref-80	39.8	39.8	38.0	39.6	9.5	14.8
A-04	66.1	12.6	33.4	16.4	50.2	7.1
A-05	37.7	5.0	28.3	3.1	13.2	3.3
A-06	62.7	13.7	52.5	14.3	22.9	8.1
A-08	92.4	15.0	84.5	21.9	65.9	39.5
A-09	94.4	3.7	88.7	12.2	36.5	17.4
A-10	81.6	12.0	79.8	12.6	10.0	3.9
A-14	79.4	11.0	77.0	11.9	10.4	3.5
A-16	70.4	30.8	65.4	32.8	25.1	25.1
A-21	99.6	0.6	99.3	0.9	57.8	36.7
A-22	58.0	13.3	41.4	12.1	29.5	10.6
Ref-80 PSEP	2.5	2.8	1.0	1.4	3.0	1.9
A-06 PSEP	79.4	6.3	58.0	7.0	50.9	12.6

Appendix 3e. Test Results for SWI Test 2 with *M. galloprovincialis*, Manke Lumber

Treatment	Mean Percentage Combined Mortality	SD	Mean Percentage Mortality	SD	Mean Percentage Abnormal	SD
Control	4.7	6.8	2.8	5.0	4.1	1.0
Ref-17	97.6	3.0	75.5	22.6	93.5	7.3
Ref-48	17.5	11.5	12.5	9.9	7.3	7.3
Ref-80	10.6	7.7	5.3	7.4	5.0	1.5
A-04	83.9	11.9	76.4	15.8	33.9	9.3
A-05	13.9	15.3	4.4	7.9	14.0	8.7
A-06	12.1	15.6	4.9	6.9	11.6	7.3
A-08	25.0	21.9	7.7	7.5	24.0	17.8
A-09	30.2	19.3	11.5	7.5	22.5	16.6
A-10	13.4	13.7	0.2	0.5	15.6	8.9
A-14	11.2	10.7	6.8	9.1	6.3	2.1
A-16	2.6	1.8	0.7	1.5	5.2	3.5
A-21	98.2	2.8	84.2	12.7	82.9	33.1
A-22	97.1	3.6	55.5	14.3	94.8	5.4

Appendix 4.

From: Clay Patmont

Sent: Wednesday, December 8, 2004 (2:03 PM)

To: David Kendall

CC: Dan Hennessy; tgri461@ecy.wa.gov; johnm@mankelumber.com; rmc461@ecy.wa.gov; Gardiner, William

Subject: Status of Manke PSDDA Bioassays
David -

Following up on our discussion yesterday, provided below is a summary of the larval biological testing conducted to date for the Manke dredge material characterization. The purpose of this summary is to keep you up-to-date on the status of the testing in order to assist the DMMO's suitability determination and maintain the project dredging schedule.

As we have discussed, for the amphipod and Neanthes tests all samples met PSDDA criteria. However, all samples failed in the initial bivalve larval test conducted using PSEP methods. Following review of the initial larval test data, it was apparent that a physical impact to the embryos, associated with a pronounced floc in the test sediment chambers, was the most likely cause of the poor recovery of larvae (expressed as high mortality) that was observed. Following consultation with the DMMO, it was agreed to that a modification to the PSEP larval test method was appropriate. Specifically, the sediment-water interface (SWI) test was applied, which uses a screen tube that normally prevents the bivalve larvae from becoming entrapped or lost. In the SWI test, a screen tube (4.0 cm diameter acrylic tube, with a 37 um screen at the bottom) is placed into the test chamber to rest on the sediment surface. Once the screen tube is in place, 150 to 300 embryos are then added to the screen tube. At the end of the test, the screen tube is removed and all larvae recovered and counted.

On November 10th the SWI test was begun and the test ended on November 12th. We received the initial data on November 24th. The holding time for the samples was 56 days on November 19th. While the results from the SWI test provided better differentiation between test samples than the PSEP larval test, the overall recovery of larvae in both reference and test samples was poor (see attached Table 1). The likely mechanism resulting in the poor recovery appears to have been the loss of larvae through the screen tube mesh.

Given these results, and consistent with our discussion, a second SWI test will be conducted in an effort to obtain more consistent and acceptable reference sample results. The only modification will be using a smaller mesh size (25 um) to ensure that larvae are not lost through the screen tube mesh. The second SWI test will be started on December 9th, and preliminary results will be available on December 14th. The test will be run with sediments that are approximately 20 days past the recommended 8 week holding time. However, the sediments have been stored under nitrogen at 4°C and the holding time exceedence is not expected to result in significant changes to the toxicity of the samples. Wood debris is the primary contaminant of concern, not organic chemicals. Therefore, the breakdown of potentially toxic chemicals that could result in a false negative toxicity test result is of little concern. In fact, the long holding time would be expected to make the larval test more conservative (e.g., a higher

chance of a false positive) because of the greater potential to generate sulfides and ammonia over the longer storage time.

As always, please give me a call at (206) 903-3324 should you have any question on this material. We will transmit the results of the SWI re-test as soon as possible.

Clay