CENWS-OD-TS-DM
MEMORANDUM FOR RECORD 10 October 2000

SUBJECT: DETERMINATION OF THE SUITABILITY OF SEDIMENT TO BE DREDGED FOR MANKE LUMBER COMPANY AND LOUISIANA-PACIFIC CORPORATION (PN 1999-00694) 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 109,800 cubic yards of sediment from the head of the Hylebos Waterway at Manke Lumber and Louisiana-Pacific. These two locations fall under one of the larger Commencement Bay cleanup efforts known as the Hylebos Wood Debris Site (HWDS).

2. This determination of suitability is based on the acceptability of the sampling data, as well as all relevant test data contained in the Data Summary Report submitted by the Wood Debris Group's contractor (Pentec Environmental) to the DMMP on July 27, 2000. Sampling was conducted on May 6-7, 1999; July 26-30, 1999; and March 20-22, 2000.

   The initial sampling conducted on May 6-7, 1999 (referred to hereafter as Round 1) was done solely at the discretion of the project proponents and thus, was accomplished at the risk of not being acceptable for DMMP decision making.[1] On June 29, 1999, a Sampling and Analysis Plan (SAP) was submitted to the DMMP agencies and was approved on July 23, 1999. This sampling (referred hereafter as Round 2) was conducted between July 26-30, 1999, and generally followed the specifications in the approved SAP.

   After reviewing the initial bioassay testing results from Rounds 1 and 2, the DMMP agencies determined the need to rerun the bioassay tests on a subset of the dredged material management units (enclosures 2, 3 and 4). Subsequently, additional sampling was conducted between March 20-22, 2000 to conduct the bioassay retests. After reviewing the three rounds of testing data, the DMMP agencies determined that the data collected from all field-testing was deemed sufficient and acceptable for decision making by the Agencies based on best professional judgement.

[1] The project proponent's consultant was advised by the Dredged Material Management Office that any sampling/analyses conducted without concurrence of the DMMP process would be accomplished at the proponent's risk. However, the DMMP agencies acknowledged, in a letter to proponent's agent on July 23, 1999 (enclosure 1), that the DMMP would consider these testing results, along with the complete data testing submittal package, when evaluating the proposed project as part of the suitability determination evaluation process using best professional judgement.

3. Relevant dates for regulatory tracking purposes are included in Table 1.

Table 1. Regulatory Tracking Dates

SAP Submittal date:	June 29, 1999
SAP Approval date:	July 23, 1999
Sampling date(s): Round 1 Round 2 Round 3 (bioassay resampling/retesting)	May 6-7, 1999 July 26-30, 1999 March 20-22, 2000
Data report submittal date:	July 27, 2000[2]
Recency Determination Dates: High (2 years)	March 2002

The approved SAP included a combined dredging footprint with a total estimated volume of 109,800 cubic yards (see Figure 1). Sediment samples characterized in Round 1 included seven uncomposited surface samples, each representing one surface dredged material management unit (DMMU), and one core sample, representing one composited surface/subsurface DMMU. Eighteen sediment samples were characterized in Round 2, representing 18 surface DMMUs; however, one of the 18 DMMUs (A-8) was dropped from further consideration because the project proponents decided not to dredge it. Three other Round 2 DMMUs (A-9, A-10, A-24) could not be sampled because of the presence of surface logs and subsurface debris. Additional sediment sampling was conducted during Round 3 to do the bioassay retesting of 20 DMMUs from the Manke Lumber site.

Thus, a total of twenty-five DMMUs (8 + 17) were evaluated as a result of Rounds 1, 2, and 3. Twenty-four of the twenty-five DMMUs represent the Manke Lumber Company site. A single composited sample (C-1 = the core sample from Round 1) represents the Louisiana-Pacific Corporation site.

4. Appendix 1 provides a summary of the sediment conventional parameters for all 25 DMMUs that underwent testing, including grain size and total organic carbon. The conventional parameters varied widely; e.g., percent fines ranging from a low of 4.2 percent to a high of 91.4 percent. Seven of the twenty-five DMMUs had total volatile solids (TVS) concentrations exceeding twenty-five percent on a dry weight basis (26.2 – 62.3 %). The abnormally high concentrations of TVS are attributed to the presence of woody debris in the sediments, which also triggered bioassay testing on these seven DMMUs.

[2] The Data Report submitted covers only the testing results from the Manke Lumber and Louisiana-Pacific sites. It does not include results from the sediment characterization of the Weyerhaeuser dock site, where bioaccumulation testing was required and was ongoing at the time of the report submittal. On September 20, 2000, the project proponent's contractor requested that the DMMP Agencies complete a separate SDM for the Manke Lumber and Louisiana-Pacific portion of the HDWDG characterization rather than await the completion of all Weyerhaeuser site testing.

5. The results of the chemical analyses of the 25 DMMUs are summarized in Appendix 1; 21 of 25 samples had levels of (detected/undetected) chemicals exceeding the PSDDA screening level (SL) guidelines. The most frequently detected chemicals exceeding SL were total PCBs (17 DMMUs), Fluoranthene (8 DMMUs), Chrysene (8 DMMUs), and Arsenic (7 DMMUs). Tiered testing was conducted as a result of the high TVS and chemical exceedances, which triggered bioassay testing on 22 of the 25 DMMUs. The results of the bioassay testing are summarized below.

6. Standard bioassay testing was conducted on twenty-two DMMUs within the required 56-day biological holding time. Appendix 2 summarizes the solid phase bioassay Quality Control (QC) performance guidelines and also summarizes the solid phase bioassay interpretative guidelines for non-dispersive sites, which were used to evaluate the bioassay data discussed below. Appendix 3 summarizes the bioassay results for each specific Round (of sampling) and for each batch of bioassay organism as follows:

   Appendix 3a = amphipod (*Ampelisca abdita and Rhepoxynius abronius*) for Rounds 1-3
   Appendix 3b = echinoderm larval (*Dendraster excentricus*) for Round 2 and bivalve larval (*Mytilus galloprovincialis*) for Round 3.
   Appendix 3c = juvenile polychaete growth (*Neanthes arenaceodentata*) for Rounds 1 and 2.

   Reference sediment was collected from Carr Inlet to conduct DMMU-specific test-sediment comparisons for the three bioassays used during the three rounds of testing (see Appendix 1 and Appendix 3). Amphipod bioassays conducted during Round 1 using *Ampelisca abdita* failed to meet the performance standard for negative control sediment; however, the single DMMU bioassay using *Rhepoxynius abronius* met the performance standard for both the negative control and reference sediment. Similarly, the amphipod bioassays done for Round 2 (*Ampelisca abdita* and *Rhepoxynius abronius*) encountered problems in that performance standards failed for both reference and negative control sediments for both amphipod species, which resulted in a requirement to retest a subset of the DMMUs (see Appendices 1 and 3a). Using *Ampelisca abdita,* a subset of 15 DMMUs from Rounds 1 and 2 were retested in Round 3 with the result that all Round 3 bioassays met the performance standards for both the negative control and reference sediment.

   The Echinoderm larval bioassay (*Dendraster excentricus*) conducted in Round 1 encountered a problem in that the reference sediment did not meet performance standards ($\geq$ 65% normal larvae survival). As a result, all Round 1 DMMUs were retested in Round 3 using a bivalve, *Mytilus galloprovincialis*. Round 2 testing with the echinoderm and Round 3 testing with the bivalve sediment larval bioassay met the performance standards for both the negative control and reference sediments. In general, the *Neanthes* growth bioassay met the performance standards for the negative control and reference sediments during Rounds 1 and 2. A summary of the bioassay results for each DMMU are depicted in Appendix I relative to the DMMP non-dispersive interpretative guidelines. The results are discussed below for each of the bioassay tests:

   a) **Amphipod Bioassay (*Ampelisca abdita and/or Rhepoxynius abronius*).** Amphipod bioassays were conducted during the three testing rounds on 22 DMMUs, as noted in Appenidix 3a, Appendix I, Table 2. The results: 9 DMMUs with "no-hit" responses, 2 DMMUs with "2-hit" responses, and 10 DMMUs with "1-hit" responses.

b) **Bivalve Larval Bioassay (*Dendraster excentricus and/or Mytilus galloprovincialis).*** Of the twenty-two DMMU's tested, eight passed the DMMP guidelines for non-dispersive disposal sites, and twelve exhibited a 2-hit response and one exhibited a 1-hit response. Four of the eight suitable DMMUs exceeded the 2-hit response guidelines, but when compared statistically to the appropriate reference sediment responses, were found to be "not statistically different" ($p<0.1$), and thus are not scored as a "hit" for regulatory decision-making (e.g., "are deemed suitable").

c) ***Neanthes* 20-day Growth Bioassay (*Neanthes arenaceodentata*).** The results of the *Neanthes* growth bioassay (Appendix 3c and Appendix I, Table 2) showed no toxicity among the twenty-two DMMUs characterized, and all DMMU's met the guidelines for non-dispersive disposal sites.

d) **DMMP Bioassay Determination.** Overall, interpretation of the twenty-two DMMU's subjected to DMMP bioassays demonstrated that nine DMMUs exhibited bioassay responses that were suitable for unconfined open-water disposal (UOWD) and 13 exhibited responses that were unsuitable for UCOWD (Appendix 1, Table 2).

Table 2 Bioassay interpretation summary[3]

Amphipod bioassaay: (*Rhepoxynius abronius* & *Ampelisca abdita*)	**Pass**	**Two-Hit**	**One-Hit**	**Total:**
Manke Lumber/Louiisiana-Pacific DMMUs	9	2	10	21
Sediment Larval Bioassay: (*Dendraster excentricus* & *Mytilus galloprovincialis*)	**Pass**	**Two-Hit**	**One-Hit**	**Total:**
Manke Lumber/Louiisiana-Pacific DMMUs	8	12	1	21
Neanthes Growth Bioassay: (*Neanthes arenaceodentata*)	**Pass**	**Two-Hit**	**One-Hit**	**Total:**
Manke Lumber/Louiisiana-Pacific DMMUs	22	0	0	22
DMMP Bioassay Determination:	Number of Suitable DMMUs		Number of Unsuitable DMMUs	
Manke Lumber/Louiisiana-Pacific DMMUs	9		13	

[3] Although 22 DMMUs were subjected to bioassay testing during the three rounds of testing, the project proponent elected not to rerun the sediment larval bioassay for DMMU A-22 during the Round 3 retest due to a previous one-hit failure of the amphipod bioassay in Round 1. Likewise, the proponent elected not to rerun the amphipod bioassay for DMMU A-7 due to a one-hit failure of the sediment larval bioassay in Round 2 (see Appendix 1 and Appendix 3). Hence the total number of DMMUs with useable testing results for regulatory decision-making for the amphipod and sediment larval bioassays is 21 instead of 22.

7. Based upon the results of all testing, the agencies concluded that eleven of the twenty-four DMMUs evaluated at the Manke Lumber Company site, representing 48,200 cubic yards of dredged material, were suitable for unconfined open-water disposal at the Commencement Bay disposal site. The Louisiana-Pacific Corporation site, with one DMMU (C1) representing 3,900 cubic yards of dredged material, was also found suitable for disposal at Commencement Bay. Thus, the total volume of suitable dredged material is 52,100 cubic yards represented by twelve DMMUs. The testing results confirmed that thirteen DMMUs (A-1, A-2, A-4, A-5, A-6, A-7, A-11, A-12, A-14, A-16, A-19, A-21, A-22), comprising 57,700 cubic yards of dredged material from the Manke Lumber Company site, were unsuitable for unconfined open-water disposal. Refer to Appendix 1 for a complete inventory of suitable and unsuitable DMMUs.

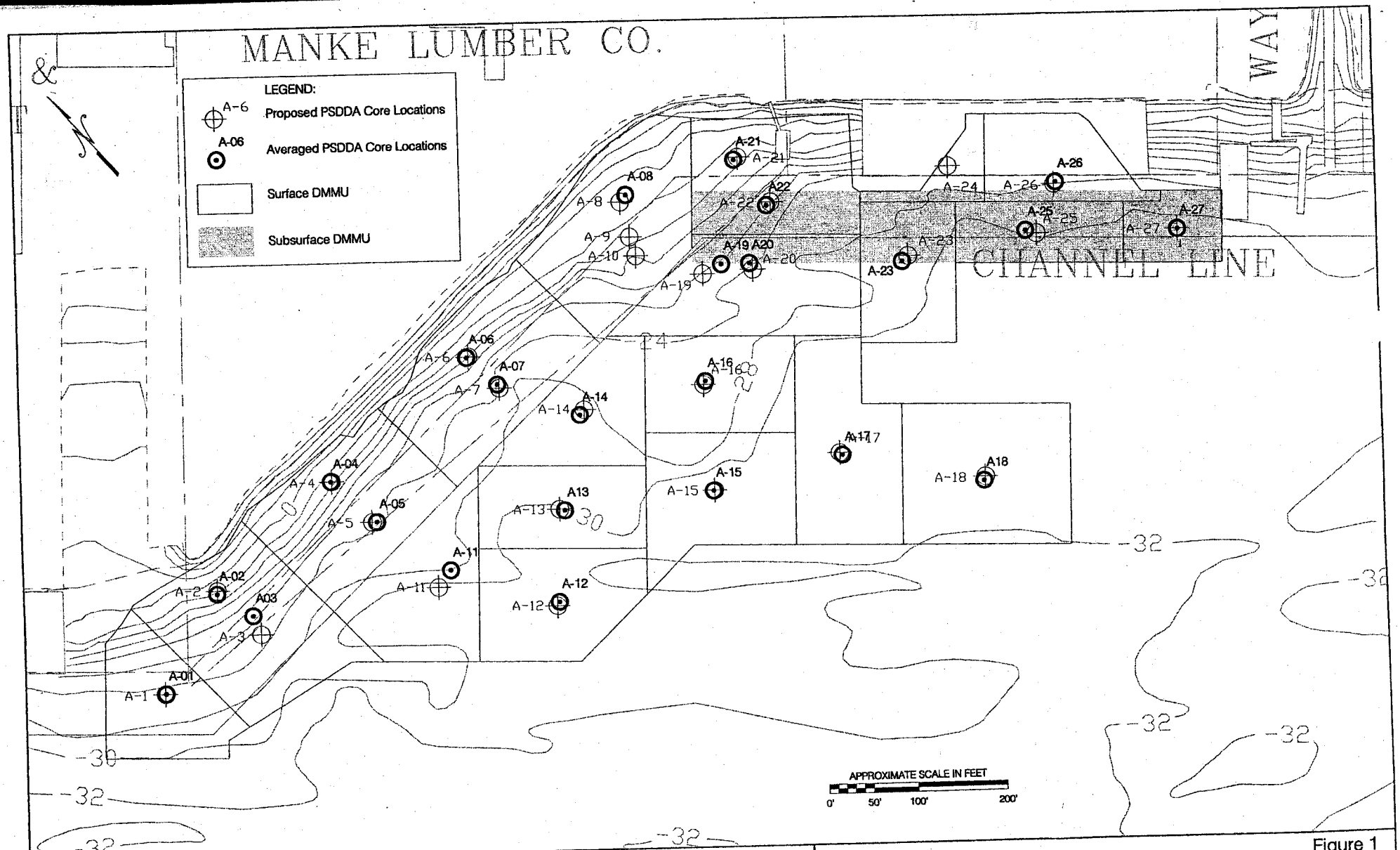
8. This memorandum documents the suitability of the dredged material characterized at the proposed Manke Lumber Company site and Louisiana-Pacific Company site located at the head of Hylebos Waterway for disposal at the Commencement Bay non-dispersive open-water disposal site. However, this suitability 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:

10/12/00	David R. Kendall
Date	David Kendall, Ph.D., Seattle District Corps of Engineers
10/12/00	Thomas H. Gries
Date	Tom Gries, Washington Department of Ecology
10/11/00	Erika Hoffman
Date	Erika Hoffman, Environmental Protection Agency
10/12/00	Richard L. Vining
Date	Rick Vining, Washington Department of Ecology
17 OCT 00	Ted A. Benson
Date	Ted Benson, Washington Department of Natural Resources

Copies Furnished:
Corps Regulatory Branch Project Manager
Erika Hoffman, EPA
Ted Benson, DNR
Tom Gries, Ecology
Rick Vining, Ecology
DMMO File

Figure 1a.



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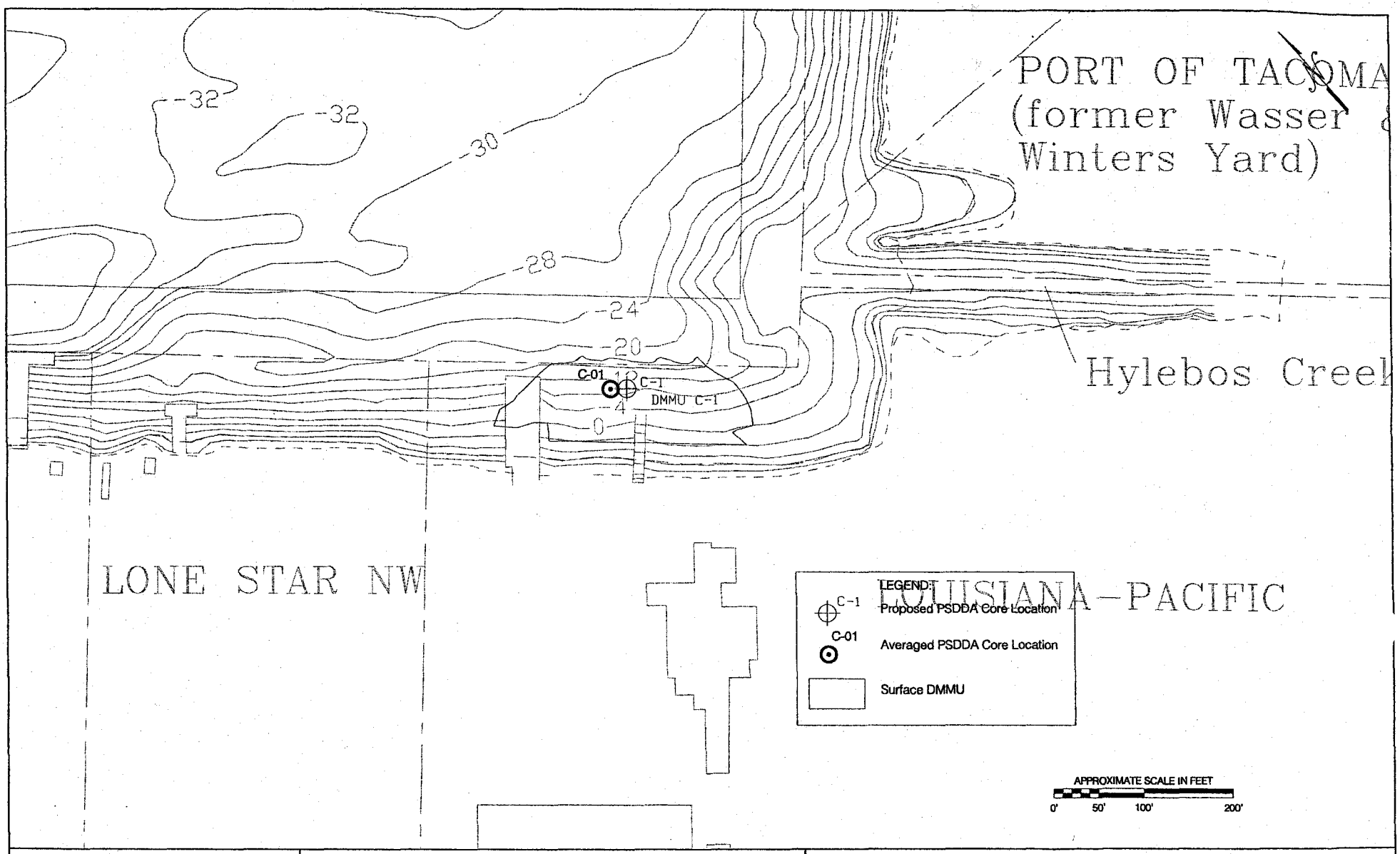
Consulting in the development of ports, waterways, and marine facilities

PSDDA Full Characterization
Tacoma, Washington
for Manke Lumber and Louisiana-Pacific

Figure 1
Proposed and averaged PSDDA core sample locations and DMMUs at the Manke Lumber facility.

06/07/2000 averaged psdda cores locations.dwg

Figure 1b.



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PSDDA Full Characterization
Tacoma, Washington
for Manke Lumber and Louisiana-Pacific

Figure 2
Proposed and averaged PSDDA core sample location and DMMU at the Louisiana-Pacific facility.

06/07/2000 averaged psdda core locations.dwg

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-2255

REPLY TO
ATTENTION OF

July 23, 1999

Operations Division/Technical Support Branch
Dredged Material Management Office

Teri Floyd, Ph.D.
Floyd and Snider Inc.
83 South King Street, Suite 614
Seattle, WA 98104

Dear Dr. Floyd:

This letter responds to your letter dated June 30, 1999 transmitting the sampling and analysis plan prepared by Pentec Environmental entitled: "Puget Sound Dredged Disposal Analysis Full Characterization for Hylebos Wood Debris Group" to the Dredged Material Management Program (DMMP) agencies for review. The following comments constitute the DMMP review of the sampling and analysis plan and our response to the questions you poised in your transmittal letter. The sampling and analysis plan is approved subject to making the changes detailed below.

DMMP Response to Transmittal Letter Questions:

1. The DMMP agencies are prepared to consider the sediment characterization data collected for the nine Dredged Material Management Units (DMMU) previously sampled on May 5-6, 1999 as part of the full characterization data submittal for the upper Hylebos Waterway. We expect that all analytical results and required QA/QC data for these nine samples will be submitted with the new data for the remaining 27 DMMUs to enable us to complete our data quality review and regulatory decision making process.

2. The DMMP agencies have carefully considered your request to allow the use of screen tubes to conduct the sediment larval bioassays. It is our consensus decision not to allow the use of screen tubes for the remaining 27 DMMUs. The DMMP agencies have a number of technical concerns with the use of screen tubes that we feel must be answered before making a formal DMMP protocol change, e.g, test standardization, equivalency of larval exposures, etc. We have previously discussed this protocol issue and decided to wait until all the technical questions are properly addressed through rigorous and scientifically defensible experiment(s). It would be precedent setting for the DMMP agencies to allow the use of a bioassay protocol that had not been fully peer reviewed and formally adopted for use in the DMMP through the sediment management annual review meeting (SMARM) process. We intend to conduct the technical studies necessary to adopt the potential screen tube protocol change as soon as time and resources allow.

3. We have a number of questions concerning the data you provided on the side-by-side sediment larval test results (e.g, with and without screen tubes). The data indicate that the unscreened Carr Inlet reference samples fail to meet the sediment larval reference performance standard ($\geq$ 65% normal larvae survival). The percent fines fractions of the two reference samples were 65.5% and 45.6% respectively. It has been our experience over ten years of DMMP implementation that Carr Inlet reference samples having even higher percent fines than those used in your tests generally have not experienced performance failures. Moreover, sediment larval testing conducted for two recent projects (East Waterway and USN Puget Sound Naval Shipyard), included testing of Carr Inlet reference samples with

enclosure 1

percent fines of 81% to 83%. Reference performance problems were not observed for either of these two projects, even though they were much higher in percent fines than the two reference samples used in your tests. Since we do not have the full data package available at this time to review, it is not possible to comment further on the possible reasons for the reference performance failures in your tests.

4. Given the larval reference performance history described above and unresolved technical issues, it is our consensus opinion that relaxing the performance standard for evaluating the results of the remaining testing without screen tubes is not warranted at this time. The DMMP agencies will use a weight of evidence approach and best professional judgement to review and interpret the full data package, and to make our regulatory determination on the 9 DMMUs with the reference sample performance problems.

Sampling and Analysis Plan Review Comments:

1. Page 13, last paragraph. Note that biological testing will be required for all samples where Total Volatile Solids (TVS) measurements exceed 25% dry weight (Kendall and Michelson 1997 Clarification paper on Management of Woodwaste), even in the absence of chemical screening level exceedances.

2. Page 23-24, Table 4-3. In addition to the TBT sample locations noted in Table 4-3, the DMMP agencies will require additional TBT analyses at DMMUs A-24, A-26, B-5, and C-1 to assess TBT at or near ship offloading facilities in areas with no previous or limited TBT testing. Subsamples for TBT analysis should be archived for all remaining DMMUs pending the analysis results for the DMMUs for initial TBT analysis. If these results indicate TBT is quantitated at or above the screening level, the DMMP agencies may require the analysis of some or all of the archived samples. All TBT analyses should follow the unfiltered sediment extraction protocol detailed in the 1998 clarification paper (Hoffman, 1998).

3. Page 50, larval sediment bioassay protocol. As noted above the proposed "screen tube" modification to the PSEP/DMMP protocol will not be acceptable for this characterization exercise for the reasons stated above. Samples collected for this characterization should follow the existing PSEP sediment larval bioassay protocol. Existing reference performance standards will apply. In the event reference performance standards are exceeded the dredged material management office should be contacted at the earliest opportunity to discuss potential courses of action.

Please call me at (206)764-3768 if you have any questions concerning the DMMP review of your sampling and analysis plan.

Sincerely,

David R. Kendall, Ph.D.
Chief, Dredged Material Management Office

Copies Furnished:
Erika Hoffman, EPA
Tom Gries/Rick Vining, Ecology
Ted Benson, DNR
Cliff Whitmus, Pentac Environmental
DMMO File

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83 South King Street Suite 614 Seattle, Washington 98104 206.292.2078 Fax 682.7867

June 30, 1999

Dr. David Kendall, Chief, DMMO
CENPS-OP-TS-DM
Department of the Army
Seattle District Corps of Engineers
PO Box 3755
Seattle, WA 98124-2255

SUBJECT: HYLEBOS WOOD DEBRIS GROUP PSDDA FULL CHARACTERIZATION SAMPLING AND ANALYSIS PLAN

Dear Dr. Kendall:

On behalf of the Hylebos Wood Debris Group (WDG) I am submitting, for your review and approval, the attached Sampling and Analysis Plan (SAP) for the Full Characterization (FC) of the Hylebos Wood Debris Site (HWDS). As you are aware, the WDG conducted a preliminary characterization on several DMMUs from within the HWDS on May 5 and 6, 1999. All work was conducted in accordance with the attached SAP, which was in draft form at the time the samples were collected. Samples were collected from nine of the 36 DMMUs required for the FC of the HWDS.

PSDDA chemical analyses were conducted on samples collected from all nine of the DMMUs (i.e., B-3, A-13, A-18, A-23, A-27, A-22, A-S1, A-3, and A-20); the PSDDA suite of laboratory bioassays was conducted on seven of the DMMUs (i.e., B-3, A-13, A-18, A-23, A-27, A-22, and A-3).

The WDG proposed to use screen tubes to conduct the sediment larval tests; however, during the discussions that you had with Cliff Whitmus of Pentec Environmental, Inc., prior to conducting the preliminary characterization, you indicated that the PSDDA agencies would need to approve the modification to the protocols. This modification to the Puget Sound Estuary Program (PSEP) Echinoderm Embryo Sediment Bioassay Protocol (PSEP 1995) was proposed because of WDG concerns that embryo/larval testing of very fine-grained sediment samples with debris may produce effects (i.e., larval mortality, abnormal development, or loss of embryos in the settling sediments) that are caused by the physical nature of the sediments and not by chemical contaminants or excessive concentrations of "natural toxicants" (e.g., ammonia and sulfide). Containment of the developing embryos in the screen tubes assures that no embryo is lost in the sediment at the bottom of the test beaker. Containment will allow more accurate estimates of sample mortalities and abnormalities and eliminate the uncertain dimension of unquantified embryo/larvae loss to the bottom sediment. The "embryo loss factor" may be especially critical when testing very fine-grained sediment containing wood debris such as the sediment in the HWDS. It should be noted that this modification was proposed to and approved by Ecology for the SMS characterization of the HWDS.

Because of time constraints on conducting the preliminary characterization and to ensure that the data collected during this preliminary characterization were suitable for a PSDDA suitability decision, the WDG decided not to seek formal PSDDA agency approval for the sediment larval test protocol modification. The WDG conducted side-by-side sediment larval tests with and without screens. The results of these tests are provided in the attached table.

It is readily apparent from the table that in the unscreened test the Carr Inlet reference sediment failed to meet the PSDDA performance criterion (i.e., NR/NC ≥ 0.65), while the same reference sediment in the screened test met the performance standards. The difference in performance of the reference sediment in the two tests is likely due to uncounted loss to the sediment in the unscreened test, since it is unlikely that there is any chemical contamination present that would cause a difference in mortality between the screened and unscreened tests.

The results of the screened and unscreened tests, compared to the PSDDA bioassay interpretive guidelines, are also shown in the table. The interpretation of the unscreened test was conducted ignoring the performance standards failure of the reference sediment. These results indicate that if the performance standards failure of the unscreened reference is ignored, the results of the screened and unscreened tests are essentially the same.

Attached is a letter from Dr. Paul Dinnel of Dinnel Marine Resources discussing the use of screens in the larval test. Based on the review of the above data and other relevant data, Dr. Dinnel recommends the use of screens for future testing. The WDG believes that, based on the data presented above and Dr. Dinnel's letter, it is likely that reference sediment performance standards will not be met without the use of screens. Therefore, the WDG requests that the PSDDA agencies accept the proposed modification (as presented in the SAP) to the sediment larval test protocols. If the use of the screens is not approved for use during the remainder of the characterization, the WDG requests that the PSDDA agencies set aside the reference sediment performance standards. In addition, the WDG requests that the data collected during the preliminary characterization be considered a part of the PSDDA full characterization of the HWDS and that the data be used for PSDDA suitability decision-making.

The WDG would like to begin the fieldwork for the PSDDA characterization of the HWDS the week of July 26, 1999. To facilitate the timely review of the SAP, I have sent copies directly to the other PSDDA agencies. If you have any questions or if I can be of any service, please contact me at (206) 292-2078 or terif@floyd-snider.com. Alternatively, you may contact Cliff Whitmus of Pentec at (425) 775-4682 or cliff@pentecenv.com.

Sincerely yours,
Floyd & Snider Inc.

FOR TERI FLOYD

Teri A. Floyd, Ph.D.
Principal

Attachments

Copies: Mr. Ted Benson, Washington Department of Natural Resources
Ms. Justine Barton, US Environmental Protection Agency
Mr. Rick Vining, Washington Department of Ecology

Results of sediment larval bioassay (normality endpoint).

Test	Test Species	Sample ID No.	Location/ DMMU	Replicate (Raw Counts of Normal Larvae) 1	2	3	4	5	Mean	Nondispersive Disposal Site Interpretation Guidelines: 1-hit rule $N_T/N_C < 0.80$ and N_T/N_C vs N_R/N_C SD (p=.10) and N_R/N_C-$N_T/N_C > 0.30$	2-hit rule $N_T/N_C < 0.80$ and N_T/N_C vs N_R/N_C SD (p=.10)
Sediment Larval (unscreened)	Dendraster		Control	153	118	150	132	121	134.80		
(Initial Count - 181 embryos)		312005213	Reference	91	91	76	63	81	80.4*		
		312005201	SA-13	71	63	95	113	49	78.20		NSD
		312005202	SA-18	99	107	121	78	100	101.00		NSD
		312005203	SA-23	110	117	119	84	118	109.60		
		312005205	SA-27	132	127	103	138	115	123.00		
		312005208	SA-3	119	63	62	69	106	83.80		NSD
		312005212	Reference	28	80	78	61	92	67.8*		
		312005200	SB-3	57	69	67	5	66	52.80		NSD
		312005206	SA-22	39	61	30	44	28	40.40		X
Sediment Larval (screened)	Dendraster		Control	125	115	137	97	146	124.00		
(Initial Count - 166 embryos)		312005213	Reference	101	104	155	126	117	120.60		
		312005201	SA-13	143	109	111	124	96	116.60		
		312005202	SA-18	140	152	91	144	107	126.80		
		312005203	SA-23	127	125	121	96	133	120.40		
		312005205	SA-27	123	111	133	88	102	111.40		
		312005208	SA-3	137	129	147	158	111	136.40		
		312005212	Reference	118	132	127	103	131	122.20		
		312005200	SB-3	143	109	111	124	96	116.60		
		312005206	SA-22	125	117	110	109	133	118.80		

* Reference sediment failed to meet performance criteria.
SD: Statistically different
NSD: Not statistically different
N: Counts of normal larvae
Subscripts: R = reference sediment, C = negative control, T = test sediment
X: Bioassay exceeds the criteria

DMR

Dinnel Marine Resources
2517 17th Street
Anacortes, WA 98221
Phone & Fax: 360-299-8468
E-mail: padinnel@aol.com

Dr. Teri Floyd
Floyd & Snider, Inc.
83 South King Street, Suite 614
Seattle, WA 98104

25 June 1999

Dear Dr. Floyd:

As per your request, I have prepared the following discussion on the use of a "screen tube" modification for larval sediment testing and provided my recommendation for their future use for testing Puget Sound sediments.

The essentials of the present Puget Sound Estuary Program (PSEP) sediment larval test protocol are based on a 1983 publication by Chapman and Morgan, which described a solid-phase sediment assay using Pacific oyster (*Crassostrea gigas*) developing embryos. The basics of the Chapman/Morgan test method were incorporated into the PSEP larval protocol (PSEP 1986, modified in 1995). Recently, the PSEP larval protocol served as the basis of the ASTM sediment testing Annexes to both mollusk (E724-94) and echinoderm (E1563-95) larval testing protocols (ASTM 1999).

However, use of the "Chapman/Morgan" method as the basis for larval sediment testing has not been accomplished without problems and criticism of the methodology. As you are aware, fertilized mollusk or echinoderm eggs are added to beakers containing homogenized sediments overlain by seawater, and the eggs develop into embryos and larvae in the direct presence of the sediments. Use of this procedure often results in high "mortality" of larvae at test termination. In this case, "mortality" is equal to those larvae *missing* at test termination, and the working assumption has been that "missing" larvae are dead or abnormal. However, past experience has shown that both normal and abnormal larvae can be lost to the bottom sediments, either as entrained larvae or as an artifact of the termination technique. The degree of larval retention in the sediments may be related to grain size (e.g., smothering by fine-grained sediments or infiltration of eggs/embryos into the matrices of coarse-grained sediments). Previous PSEP guidance required that investigators quantify the numbers/quality of larvae lost in the sediments, but this has proven to be completely unfeasible. The result is that even chemically clean reference sediments can cause substantial "mortality" that is not caused by "toxicants of concern."

The problem of "entrainment" and "grain-size effects" on eggs/larvae in the PSEP solid phase larval assay has been repeatedly discussed at sediment larval workshops

(PSDDA/PSEP 1989; DMMP 1998) and at various SMS/PSDDA Annual Review Meetings (ARMs) (e.g., see minutes of the 3rd and 6th ARMs and McCrone [1997] in the 9th ARM minutes). To date, actions to revise the larval sediment solid-phase test to ameliorate grain-size/entrainment effects have involved the following: 1) refinement of the test termination methodology, 2) allowance of a 4-hour sediment settling period to minimize fertilized egg entrainment, and 3) changing the reference sediment performance standard from 20% combined mortality/abnormality (normalized to the seawater control) to 35% combined mortality/abnormality. Thus, by present standards, combined mortality/abnormality for the reference sediments could be as high as 65% (absolute) and still be acceptable. Clearly, evidence to date indicates a substantial interaction between physical (non-chemical) factors and elevated "mortality" when using the present PSEP test protocol.

At the 1998 Larval Workshop (DMMP 1998), I proposed the use of "screen tubes" for future sediment larval testing. This proposal was based on the results of recent studies by Anderson & colleagues in California (Anderson et al. 1996, Phillips et al. 1997). They devised a method for testing sediment-water interface (SWI) toxicity to echinoderm larvae using a sediment core tube sealed with a bottom screen made of 37 µm polyethylene screen. This sediment core tube was then set on top of sediments in the bottom of a beaker containing sediments and seawater. Fertilized eggs were then added to the sediment core tubes (= screen tubes) and the larvae developed inside these tubes physically isolated from the bottom sediments. Anderson & colleagues reported good success with this "screen tube" methodology. They specifically reported that (Phillips et al. 1997):

- Results of tests where sea urchins [larvae] were exposed at the SWI were comparable in overall sensitivity to bulk sediment amphipod tests, but were generally less sensitive than tests with pore water. SWI toxicity generally tracked with porewater toxicity better than amphipod toxicity.

- Toxicity to embryo-larval stages tested at the SWI correlated with several chemicals in this data set. SWI toxicity appears to be associated with different chemicals than those correlating with amphipod mortality. SWI toxicity did not correlate with unionized ammonia concentrations, as porewater toxicity did.

Last year at a meeting between Washington State Sediment Management Standards (SMS) personnel and Hylebos Wood Debris Group (WDG) representatives, I proposed two possible modifications to the present PSEP larval protocol, especially when fine- or coarse-grained sediments were to be tested. My two recommendations were:

- Revise the initial sediment settling time from 4 to 24 hours (or "overnight"), which is identical to other protocols for amphipod and *Neanthes* testing, and

- Use screen tubes in the beakers (see the attached Proposed Modification).

SMS personnel accepted the provision for using screen tubes for the 1998 WDG testing, as well as for one other set of larval (mussel) tests conducted by the Hylebos Cleanup

Committee (HCC). Although the 1998 WDG testing was conducted using only the screen tube methodology, two subsequent tests (HCC in summer 1998 and WDG in spring 1999) have included side-by-side tests with and without screen tubes. Summary results for the reference sediments for these two side-by-side tests are presented in Table 1.

Table 1. Summary of reference sediment test results for two programs using side-by-side larval testing with and without screen tubes. The WDG testing used sand dollars and the HCC testing used mussels.

	WDG 1999		HCC 1998	
Parameter	w/o screens	with screens	w/o screens	with screens
# of reference sediments	2	2	3	3
SW control normal survival (%)	75.4	77.5	94.4	99.2
Ave. mortality (%)	54.4	17.3	20.7	-9.8
Ave. abnormal (%)	10.0	11.5	2.7	5.4
Ave. combined mort/abn (%)	59.0	26.7	22.9	-3.9

The summary in Table 1 shows that the reference sediment results of both tests were remarkably similar regarding the differences between the screen tube revision and the standard PSEP protocol (without screen tubes). Key conclusions are:

1. Average larval "mortality" was substantially higher in both tests when screen tubes were not used,
2. Average larval abnormality was similar for both methods, and
3. Average larval combined mortality/abnormality was substantially higher for the tests without the screen tubes (this was primarily driven by the mortality component).

Based, therefore, on the continuing problem with high reference sediment "mortalities," the pioneering work on "screen tube" testing by Anderson and colleagues, and on the results of side-by-side testing (Table 1), I recommend the continued use of the "screen tube" revision for conducting future PSEP larval tests of sediments.

Sincerely,

Paul A. Dinnel, Ph.D.
Principal Scientist

References Cited

Anderson, B. S., J. W. Hunt, M. Hester and B. M. Phillips. 1996. Assessment of sediment toxicity at the sediment-water interface. Chapter 33, pp. 609-624 *in*: Techniques in Aquatic Toxicology, G. K. Ostrander, editor. CRC Lewis Publishers, Boca Raton, FL.

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McCrone, L. 1997. Potential for grain-size effects on larval sediment bioassays. SMARM Issue Paper *in*: Sediment Management Annual Review Meeting Minutes, May 7, 1997.

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PSDDA/PSEP (Puget Sound Dredge Disposal Analysis/Puget Sound Estuary Program). 1989. Sediment Larval Workshop, June 15, 1989, Seattle, WA.

PSEP (Puget Sound Estuary Program). 1986, modified in 1995. Recommended guidelines for conducting laboratory bioassays on Puget Sound Sediments. Final Report by PTI Environmental Services for U. S. Environmental Protection Agency, Region 10, Office of Puget Sound, Seattle, WA.

Attachment 1.

Proposed Modification to the Puget Sound Estuary Program Echinoderm Larval Sediment Bioassay Protocol

The following modification to the Puget Sound Estuary Program (PSEP) Echinoderm Larval Sediment Bioassay Protocol (PSEP 1995) was proposed by technical contractors working with the Hylebos Wood Debris Group. This modification was proposed in response to concerns surrounding larval testing of very fine-grained sediment samples, which may cause effects (i.e., larval mortality, abnormal development, or loss of larvae in the settling sediments) that are caused by the physical nature of the sediments and not by chemical contaminants or excessive concentrations of "natural toxicants" (e.g., ammonia and sulfide).

The proposed modification adds the use of "screen tubes" in which the larvae develop. Containment of the developing larvae in the screen tubes assures that no larvae are lost in the sediments at the bottom of the test beaker. This factor will allow more accurate estimates of sample mortalities and abnormalities and eliminate the uncertain dimension of unquantified larval loss to the bottom sediments. The "larval loss factor" may be especially critical when testing very fine-grained sediments, such as the Wood Debris Group must contend with in the inner portions of the Hylebos Waterway.

The proposed modification is adapted from techniques tested and used by toxicologists in California (Anderson et al. 1996 and Phillips et al. 1997). While this proposed modification is being specifically written for project-specific testing of Hylebos Waterway sediments with echinoderm larvae, it should apply equally well to all PSEP sediment tests using larvae of echinoderms (sea urchins and sand dollars) and molluscs (oysters and mussels).

Proposed Protocol Modification:

Overview

Screen tubes will be constructed of all plastic materials. They will be designed to fit into the standard 1-liter glass beaker used for the larval tests. The tubes will be open at the top and sealed at the bottom with fine-mesh plastic screening. They will extend above the water surface of the beaker and sit on top of the bottom sediments. The tubes will be put into the beakers containing the sediments and seawater following the four-hour sediment settling period. Fertilized eggs will immediately be put into the screen tubes and the exposure period started. Aeration, which is optional, will be injected into the confines of the screen tube at a rate that does not exceed about 100 bubbles/min. At the conclusion of the test, the screen tubes are removed from the test beakers and the contents flushed into a clean beaker. This beaker is then filled to a standard volume with filtered seawater and appropriate subsamples collected as per the original protocol.

Screen Tube Construction (see Anderson et al. 1996)

The screen tubes will be constructed of 7.5 to 10-mm OD rigid polycarbonate tubing. They will be cut into about 15 cm lengths (or a length that assures that the tops extend beyond the water level in the test beakers). Polyethylene (preferred) or nylon (e.g., Nytex®) mesh screen, with a mesh size of ≤37 µm is glued on the bottom of the tubes with clear-thickened acrylic plastic glue. Excess screen material is then cut off once the glue has dried. To prevent toxicity due to the new plastics and glue used to construct the tubes, the following cleaning and aging process is used:

Rinse in warm tap water (soap and scrub if necessary)
Rinse three times with reagent-grade hexane
Rinse three times in deionized water
Rinse three times with 3 N HCl acid
Rinse three times in deionized water
Soak 48 hours in deionized water
Soak 48 hours in seawater
Rinse three times in milli Q water
Dry in drying oven at about 55 °C

References Cited

Anderson, B. S., J. W. Hunt, M. Hester and B. M. Phillips. 1996. Assessment of sediment toxicity at the sediment-water interface. Chapter 33, pp. 609-624 in: Techniques in Aquatic Toxicology, G. K. Ostrander, editor. CRC Lewis Publishers, Boca Raton, FL.

Phillips, B. M., B. S. Anderson, J. W. Hunt, R. Tjeerdema, R. Fairey, K Taberski and M. Puckett. 1997. Comparison of solid-phase, porewater, and sediment-water interface exposure systems in sediment toxicity assessments with marine invertebrates. Poster Presentation, 1997 meeting of Society of Environmental Toxicologists and Chemists (SETAC), San Francisco, CA.

PSEP (Puget Sound Estuary Program). 1995. Recommended guidelines for conducting laboratory bioassays on Puget Sound Sediments. Final Report by PTI Environmental Services for U. S. Environmental Protection Agency, Region 10, Office of Puget Sound, Seattle, WA.

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

REPLY TO
ATTENTION OF

December 17, 1999

Operations Division / Technical Support Branch
Dredged Material Management Office

Clifford J. Whitmus
Pentec Environmental, Inc.
120 Third Avenue South, Suite 110
Edmonds, WA 98020

Reference: Hylebos Wood Debris Group
Letter on Full PSDDA Characterization

Dear Mr. Whitmus:

This letter provides the Dredged Material Management Program (DMMP) response to the three requests stated in your October 29, 1999 letter.

1) "Approve the recalculated volumes for each of the DMMUs originally proposed in the SAP."
2) "Approve the layout and volume represented for each of the DMMUs, adjacent to the Weyerhaeuser pier, that were added during the July field activity (i.e., B-8, B-9, and B-10) and allow the chemical and biological tests results from these DMMUs to be used in the PSDDA suitability determinations."
3) "Approve the scope and methodology for TBT porewater chemistry and bioaccumulation testing."

1. In reference to the first request, the DMMP agencies approve the recalculated volumes for each of the DMMUs, and the total volume increase from 105,600 cy to 110,700 cy.
2. With respect to the second request, the DMMP agencies approve the general layout and volume represented for each of the DMMUs adjacent to the Weyerhaeuser pier added during the July field activity. The DMMP will allow the chemical and biological test results from these DMMUs to be used in the overall suitability determination for the Wood Debris Group Project.
3. Relative to the third request, the DMMP agencies approve the process outlined to collect TBT porewater samples. Those DMMUs, which exceed the PSDDA SL/BT (e.g., DMMUs B-1, B-5, etc.) and pass the PSDDA bioassays, will be subject to bioaccumulation testing. Bioaccumulation testing will utilize the protocol used for the recent Port of Seattle – East Waterway Stage II Project. Changes to the standard protocol include increasing the exposure time from 28 to 45 days to insure steady-state TBT concentrations in the tissues of the test species (*Macoma nasuta* and *Nephtys caecoides*). Other additions to the protocol will include performing wet weight biomass measurements at the beginning and end of the test to estimate net growth during the exposure period, as an additional metric to evaluate the health of the test animals. Moreover, to provide additional nutrients and to maintain contaminant

Enclosure 2

doses for the test animals during the longer exposure period, once weekly additions of 175-mL of test or control/reference sediment will be added to each of the test chambers.

4. Our review of the bioassay data for the Phase 1 testing indicated that the sediment larval bioassay results failed to meet the reference performance standard. These data are therefore unusable for regulatory decision making, and the sediment larval bioassay will have to be rerun in order to complete the data package for our regulatory review.
5. The DMMP agencies are still reviewing the Phase I and II chemical/biological data provided to help us in your October 29 and December 3, 1999 letters relative to the Phase II amphipod bioassay testing results. As discussed at the monthly DMMP meeting in which you participated, we will provide DMMP responses and recommendations in a separate letter to you as soon as we complete our review relative to the issues raised in your letters. Furthermore, we will provide our recommendations relative to amphipod bioassasy retesting of the Phase II DMMUs.
6. Please call me at 206/764-3768 if you have any questions about issues discussed in this letter.

Sincerely,

David R. Kendall, Ph.D.
Chief, Dredged Material Management Office

Copies Furnished:
Corps Regulatory Project Manager
Erika Hoffman, EPA
Tom Gries, Ecology
Rick Vining, Ecology
Ted Benson, DNR
DMMO File

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

REPLY TO
ATTENTION OF

December 29, 1999

Operations Division / Technical Support Branch
Dredged Material Management Office

Clifford J. Whitmus
Pentec Environmental, Inc.
120 Third Avenue South, Suite 110
Edmonds, WA 98020

Reference: Hylebos Wood Debris Group Letters on Amphipod Bioassay Results for the Full PSDDA Characterization

Dear Mr. Whitmus:

This letter provides the Dredged Material Management Program (DMMP) response to the issues raised in your two letters, dated October 29 and December 3, 1999, relative to the amphipod bioassay testing results. The DMMP response to the two requests stated below from your October 29 letter are provided below.

1) "Reject the results of the *Ampelisca* bioassays conducted in August 1999 and allow the PSDDA suitability determination to be based on the results of the sediment larval and juvenile polychaete tests."
2) "Reject the results of the *Rhepoxynius* bioassays conducted in August 1999 and allow the PSDDA suitability determination to be based on the results of the sediment larval and juvenile polychaete tests."

1. In response to both requests, the DMMP agencies, after carefully reviewing the arguments supporting your view that the results of the *Ampelisca* and *Rhepoxynius* bioassay tests should be set aside for decision-making, have determined that a retest of the amphipod bioassay will be required to complete our suitability determination. We believe the *Ampelisca* data is unuseable for regulatory decision-making because of the negative control performance failure, and because of the apparently stressed condition of the amphipods as noted in Dr. Dinnel's letter attached to your October 29, 1999 letter. We have concluded that while ammonia may be a covarying factor contributing to the observed amphipod (*Ampelisca* and *Rhepoxynius*) responses, we remain unconvinced that it is a significant or a primary factor contributing to the observed toxicity responses for the following reasons. LC50 values from the literature for *Ampelisca* and *Rhepoxynius* in both overlying water (*Ampelisca*: 49.8 mg/liter total ammonia; *Rhepoxynius*: 78.7 mg/liter total ammonia)[1] and in interstitial water

[1] Kohn, N.P., J.Q. Word, D.K. Niyogi, L.T. Ross, T. Dillon, and D.W.Moore. 1994. Acute toxicity of ammonia to four species of marine amphipods. Marine Environmental Research. 38: 1-15.

(*Ampelisca*: 66.5 mg/liter total ammonia; 0.95 mg/liter unionized ammonia)[2] are an order of magnitude higher than the total ammonia concentrations observed in both the overlying water and in interstitial/porewater during the Phase II testing (< 5 mg/liter total ammonia). Therefore, we do not feel there is sufficient demonstration of ammonia toxicity to amphipods to set aside these test results .

2. Moreover, the data provided in your letter demonstrating apparent Rhepoxynius sensitivity to percent fines (less than 60%), although intriguing, runs counter to all our past experience with this species. Furthermore, there appears to be variability in the responses observed relative to percent fines, with two of the lowest mortalities (SA-6 = 16% mortality, and SA-21 = 17% mortality) observed in DMMUs having relatively high percent fines (42.8 and 44.6 %, respectively). Therefore, we conclude that the *Rhepoxynius* Phase II results are generally equivocal for regulatory decision-making, and a retest will be required.
3. For the amphipod retest, we recommend using *Eohaustorius estuarius* instead of *Ampelisca* and *Rhepoxynius*, because *Eohaustorius* is much less sensitive to ammonia and fine grain size than are *Ampelisca* and *Rhepoxynius*. Note, however, results of recent testing have suggested that *Eohaustorius may be somewhat* t sensitive to sediments with higher clay contents (> 30 %). We have reviewed the sediment conventional (grain size) information for the Phase II DMMUs, and have concluded *Eohaustorius estuarius* should be a suitable amphipod species for retesting those DMMUs with clay content less than 30%.
4. If you elect to retest with *Ampelisca* and *Rhepoxynius*, we would strongly recommend running an ammonia LC50 for each species to verify their sensitivity to ammonia. Test methods and guidelines for interpreting LC50 data should be arranged in consultation with the DMMP agencies prior to the initiation of any testing.
5. Please call me at 206/764-3768 if you have any questions about the DMMP response to your letters.

Sincerely,

David R. Kendall, Ph.D.
Chief, Dredged Material Management Office

Copies Furnished:
Erika Hoffman, EPA
Tom Gries, Ecology
Rick Vining, Ecology
Ted Benson, DNR
Corps, Project Manager
DMMO File

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[2] SAIC. 1992. Role of ammonia in toxicity tests used in evaluation of dredged material. Prepared for EPA, Naragansett, Rhode Island under EPA Contract No. 68-C1-005, Work Assignment 13, Task 3 (SAIC Project No. 2263).

Pentec
ENVIRONMENTAL

October 29, 1999

Dr. David Kendall, Chief, DMMO
CENPS-OP-TS-DM
Department of the Army
Seattle District Corps of Engineers
PO Box 3755
Seattle, WA 98124-2255

PSDDA Full Characterization for the Hylebos Wood Debris Group

Dear Dr. ~~Kendall~~ Dave:

This letter discusses issues that have arisen during the implementation of the PSDDA characterization for the Hylebos Wood Debris Group (WDG). Presented below is a discussion of each of the issues that will require a decision from the DMMO. In summary, these are: (1) volume changes in existing DMMUs, (2) addition of new DMMUs, and (3) TBT bioaccumulation testing.

Volume Changes in Existing DMMUs

As described in the Sampling and Analysis Plan (SAP; Pentec and FSI 1999), the material to be dredged is a mixture of logs, large wood debris, and smaller wood debris mixed with sediments. Below this layer are native Puyallup River delta silts and clayey silts that overlay coarse native sands. The thickness of wood debris and sediment accumulations range from 1 ft to greater than 15 ft. In high accumulation areas, results from the WDG Pilot Study (FSI and Evans-Hamilton 1999) indicated the presence of logs and other materials larger than 2 ft-square. For these areas, it was assumed in the SAP that a portion of the recovered material would be larger than 2-ft square and thus would be unsuitable for PSDDA open-water disposal. In order to account for the volume of material greater than 2-ft square, the estimated volume of each DMMU was calculated using the following rules:

1. If the thickness of accumulated wood debris and sediment was greater than or equal to 8 ft, it was assumed that 50 percent of the volume was less than 2-ft square.

2. If the thickness of accumulated wood debris and sediment was greater than 4 ft but less than 8 ft, it was assumed that 4 ft of the material was less than 2-ft square.

3. If the thickness of the accumulated wood debris and sediment was less than 4 ft, it was assumed that all the material was less than 2-ft square.

Based on the results of the coring effort, it appears that we may have overestimated the volume of large wood debris and logs. Approximately 89 attempts were required to collect 77 acceptable cores for the PSDDA characterization of the Hylebos Wood Debris Site (HWDS). The 12 unsuccessful attempts were caused by subsurface obstructions (presumably large debris and logs). This contrasts with the number of logs that were encountered during the PSDDA characterization at the Port of Everett Barge Berth site. At that site, approximately 36 attempts were required to collect 18 acceptable cores. A considerable number (and volume) of subsurface logs were removed during the dredging operation at the Port of Everett, which confirmed what the coring had suggested. Since we did not encounter nearly as many logs during the characterization of the HWDS, this would suggest that the amount of subsurface large debris and logs is potentially considerably less than at the Port of Everett.

Because we may have overestimated the volume of logs and large debris, and therefore underestimated the volume of small wood debris and sediment (i.e., material less that 2-ft square), the WDG proposes to recalculate the volume of the DMMUs. The new volume includes all of the material within the boundaries of each DMMU, without any reduction to account for material greater than 2-ft square. The original volumes presented in the SAP and the new proposed DMMU volumes are shown in Table 1. As can be seen in this table, the proposed volume represented by each DMMU is, in some cases, greater than the 4,000 cy allowed under PSDDA guidance. It is important to note that the proposed volume is conservative, and that actual volumes disposed to a PSDDA open-water site will be less because of the volume of large debris and logs segregated from the material prior to disposal. Current assumptions being used for project design estimate that logs and large debris will comprise approximately 10 percent of the material to be dredged from the HWDS.

Table 1 Original DMMU volumes presented in the SAP and new proposed DMMU volumes.

DMMU	Original DMMU Volumes Presented in SAP (cy)	New Proposed DMMU Volumes (cy)	Comments
A-12	3,400	3,400	
A-15	3,400	3,400	
A-17	3,500	3,500	
A-18	3,600	3,600	DMMUs with Little or no Large
A-25	3,600	3,600	Wood Debris or Logs
A-26	3,300	3,300	Average Volume = 3,500 cy
A-27	3,700	3,700	(Excepting A-S1)
A-S1	10,600	10,600	
A-1	3,400	3,800	DMMUs with Moderate Accumulations
A-11	3,500	3,600	of Large Wood Debris and Logs
A-13	3,600	3,800	Average Volume = 3,700 cy
A-23	3,500	3,600	(Including Large Material)
A-2	3,600	4,800	
A-3	3,400	4,600	
A-4	3,400	4,500	
A-5	3,500	4,800	
A-6	3,600	4,900	DMMUs with Potentially
A-7	3,500	4,800	Significant Volume of Large
A-14	3,600	5,200	Wood Debris and Logs
A-16	3,600	4,300	Average Volume = 4,666 cy
A-19	3,600	4,100	(Including Large Material)
A-20	3,500	4,500	
A-21	3,700	4,800	
A-22	3,700	4,700	
A-8	3,500	N/A[1]	
A-9	3,600	N/A[2]	
A-10	3,300	N/A[2]	
A-24	3,400	N/A[2]	
Total Volume	105,600	110,700	Average Total Volume for all Surface DMMUs, (not including A-8, A-9, A-10, and A-24) = 4,140 cy[3]

Notes:

1. Material at this location was 100% wood, therefore DMMU unsuitable for PSDDA disposal.
2. Unable to collect sample at this location because of core refusal (likely attributable to the presence of logs), therefore DMMU unsuitable for PSDDA disposal.
3. Assuming a conservative 10% logs and large debris, this number is 3,726 cy.

The proposed project at the HWDS is not typical of PSDDA dredging projects. In typical projects, the depth of dredging is usually defined by navigation depth requirements plus some allowable overdepth. In the case of this project, dredging depths are defined by the estimated depth of the wood deposition. Since little coring had been conducted in the project area, there was some uncertainty as to the depth to which the wood debris would need to be removed (discussed below) and the volume of large debris and logs that would be dredged but not suitable for PSDDA disposal. The DMMO acknowledged during early discussions that this project was unique and that certain allowances might need to be made based on the results of the field investigation. The WDG therefore respectfully requests that the DMMO approve the new proposed volumes shown in Table 1 for each of the DMMUs. ok ✓

Addition of New DMMUs

The depth of proposed dredge-cuts adjacent to the Weyerhaeuser pier was based on the elevation of the deepest historical dredging (native contact) and the current mudline elevation. During field sampling activities it was determined that the woody sediments may be deeper than the elevation of the deepest historical dredging at several locations (i.e., B-1, B-2, and B-5). Deeper accumulations at these locations are assumed to be the result of in-filling of depressions caused by prop-scour from ships docked at the Weyerhaeuser pier. New DMMUs were added in the field to represent the additional volumes of sediment. These DMMUs were designated B-8, B-9, and B-10, which underlie B-1, B-2, and B-5, respectively. PSDDA chemical and biological analyses were conducted at each of these DMMUs. Figure 1 shows the layout of DMMUs B-8, B-9, and B-10 and Table 2 shows the volume of each of the DMMUs.

Table 2 Designation and volume of DMMUs added during the field study.

DMMU	Vertical Delineation (ft MLLW; +1 ft overdredge)	Volume (cy)
B-8	-41 to –46	3,200
B-9	-41 to –46	4,900
B-10	-44 to –46	5,900

The WDG requests that the DMMO approve the layout and the volume represented by each of the DMMUs added in the field and allow the results of the chemical and biological testing to be used in PSDDA suitability determinations. ok ✓

TBT Bioaccumulation Testing

The DMMO approved six DMMUs for which TBT porewater chemistry data were collected. The results of the porewater analysis are shown in Table 3.

As shown in the table, the TBT bioaccumulation trigger was exceeded for two of the DMMUs located adjacent to the Weyerhaeuser pier. As detailed in our response to the DMMO's comments on the PSDDA SAP (letter dated July 26, 1999), the WDG agreed to additional TBT porewater analyses if the results from the initial porewater analysis indicated that TBT may be a constituent of concern. Based on the above results, the WDG proposes to conduct TBT porewater analyses at all DMMUs adjacent to the Weyerhaeuser pier (i.e., DMMUs B-1 through B-10). All DMMUs that satisfy the PSDDA suite of bioassays and exceed the TBT bioaccumulation trigger will be subjected to bioaccumulation testing. The field and laboratory methods for conducting the bioaccumulation tests are detailed below.

Table 3 TBT porewater concentrations (µg/l).

Location	DMMU	TBT Porewater Concentration (µg/l)[1]
Manke	A-1	0.09
	A-26	0.07M[2]
	A-24	DMMU not sampled
	A-27	0.05M[2]
Weyerhaeuser	B-1	0.20
	B-5	0.76
Louisiana-Pacific	C-1	0.07M[2]

Notes:

1. PSDDA bioaccumulation trigger for TBT is 0.15 µg/l.
2. The "M" qualifier is used in cases where the mass spectra generated by the sample do not exactly match those in the NBS library. When the "M" is used, the analyst judges that there is enough of a spectral match to report the analyte as detected.

Field Collection Procedures For TBT Porewater Sampling

Sediment for Round 3 TBT porewater testing will be collected from material composited from multiple cores. Sediment from up to eleven cores will be composited to provide sufficient sample volume to conduct the TBT porewater testing, and the TBT bioaccumulation testing. Polycarbonate sample containers for the TBT porewater samples will be decontaminated following the steps outlined for TBT sampling in Section 4.3.6 of the approved SAP submitted June 29, 1999. Sediment collection

and handling equipment (e.g., aluminum and stainless steel samplers, stainless steel spoons, bowls, and mixing containers) will be decontaminated using the techniques presented in Section 4.3.6 of the SAP

Field Collection Procedures For TBT Bioaccumulation Testing

Sediment collection for TBT bioaccumulation testing will follow the procedures specified for bioassay sediment collection outlined in Sections 4.3.6 and 4.3.8.11 of the SAP. General decontamination procedures will be used for all sediment collection and handling equipment. Each sample will require the collection of multiple cores to obtain sufficient sample volume. A minimum of 20 liters of sediment will be required for each test. After compositing, sediment for each bioaccumulation test will be placed equally into two 5-gallon low-density polyethylene (LDPE) pails lined with high-density polyethylene (HDPE) bags. Each bag will be purged with nitrogen before closing. Samples will be stored in the dark at 4°C.

Laboratory Procedures For Conducting TBT Bioaccumulation Testing 45 day exposures?

Bioaccumulation testing for TBT will be conducted by EVS Environment Consultants in Vancouver, British Columbia, Canada. The test is a 28-day test using the facultative deposit/suspension feeding bivalve *Macoma nasuta* and the deposit feeding polychaete *Nephtys caecoides*. Co-testing of the two species in the same aquaria (Battelle 1992) is used to reduce sediment volumes and setup costs. Test containers are 20-liter glass aquaria (5 per test plus 1 for monitoring steady state conditions). A maximum of 4 cm of sediment (~3.3 l volume) is placed in each aquarium. Twenty *Macoma* (2-4 years in age, 28-45 mm shell length) and 25 adult *Nephtys* (~1 g in weight) are added to each test container. Tests are conducted at 15° C and at a salinity of 28 ppt. The animals are placed on a 16:8 light/dark photoperiod. The test is run either as a static renewal test with replacement of the overlying water occurring 3 times each week or as a flow-through test with a complete volume change occurring every 24 hours. Dilution water is collected from Burrard Inlet, North Vancouver, British Columbia. Aeration is by a trickle-flow (< 100 bubbles per minute).

On conclusion of the test, the organisms are removed from the sediment by sieving, gently cleaned, and held in clean aquaria for 24 hours to allow time for their systems to clear any ingested sediment. The bivalves are placed in aquaria with flowing seawater and the polychaetes are placed in aquaria with seawater and clean sediments. The organisms are then collected, drained, and frozen in new Whirlpack™ bags. The polychaetes are frozen whole and sent intact to the analytical laboratory for

homogenization and extraction. The bivalves undergo additional processing to remove the soft body tissues from the shells prior to being sent to the analytical lab.

Tissue Removal From Bivalves For TBT Tissue Analysis

Cleaned and frozen *Macoma* are opened by inserting a scalpel or other suitable instrument into the opening of the shell and cutting the adductor mussels. All instruments used to open or handle the soft body tissues are stainless steel. Instruments are decontaminated using a 10-percent nitric acid wash with a distilled water rinse. All tissue is handled frozen. The soft body tissues and any body fluids are placed in new Whirlpack™ bags and sent to the analytical lab for homogenization and extraction.

Tissue Analysis For TBT

Laboratory analysis of tissue samples will be consistent with current PSDDA/DMMP guidance and PSEP.

Summary of Requests to DMMO

1. Approve the recalculated volumes for each of the DMMUs originally proposed in the SAP.

2. Approve the layout and volume represented for each of the DMMUs, adjacent to the Weyerhaeuser pier, that were added during the July field activity (i.e., B-8, B-9, and B-10) and allow the chemical and biological tests results from these DMMUs to be used in PSDDA suitability determinations.

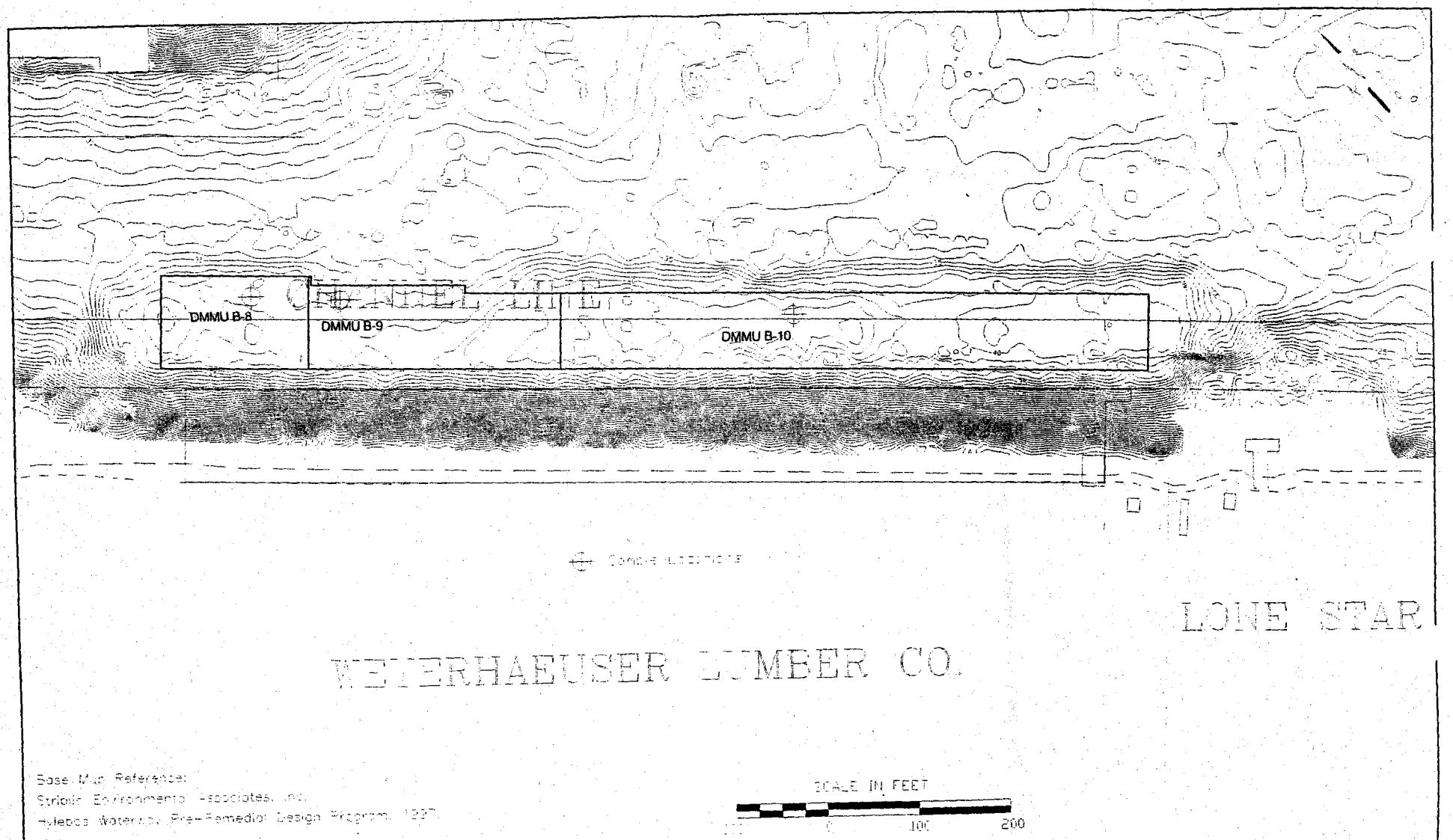
3. Approve the scope and methodology for TBT porewater chemistry and bioaccumulation testing.

Thank you in advance for your timely review and response to these requests. If you have any questions, please call me at (425) 775-4682.

Sincerely,
Pentec Environmental, Inc.

Clifford J. Whitmus
Senior Fisheries Biologist/Sediment Specialist
cliff@pentecenv.com

Attachment



Base Map Reference:
Striplin Environmental Associates, Inc.
Hylebos Waterway, Pre-Remedial Design Program, 1997

Floyd & Snider Inc.	Ogden Beeman & Associates, Inc. Consulting in the development of ports, waterways, and marine facilities	HYLEBOS WATERWAY WOOD DEBRIS PROGRAM Tacoma, Washington	Figure 1 DMMU layout adjacent to the Weyerhaeuser pier

CADR REVIEW DRAFT

10-6-99 FILENAME G:\1997\97004\WO-16\DWG\B2B-SUB.DWG

Reference List

Battelle. 1992. Ecological evaluation of proposed discharge of dredged material from Oakland Harbor into ocean waters (Phase IIIA of -42 foot project). Volume 1: Analyses and discussion. Prepared by Ward, J.A., J.Q. Word, M.R. Pinza, H.L. Mayhew, E.S. Barrows, and L.F. Lefkovitz. Pacific Northwest Laboratory for US Army Corps of Engineers under Contract DE-AC06-76RL, 1830.

FSI and Evans-Hamilton (Floyd & Snider Inc. and Evans-Hamilton, Inc.). 1999. Hylebos Waterway Wood Debris Program pilot study technical memorandum (agency draft). Appendix A *in* Cleanup Action Design Report. Prepared for the Hylebos Wood Debris Group. Floyd & Snider Inc., Seattle, Washington.

FSI and Ogden Beeman (Floyd & Snider Inc. and Ogden Beeman Associates). 1999. Hylebos Waterway Wood Debris Program cleanup action design report (agency draft). Prepared for the Hylebos Wood Debris Group. Floyd & Snider Inc., Seattle, Washington.

Pentec and FSI (Pentec Environmental, Inc., and Floyd & Snider Inc.). 1999. Puget Sound Dredged Disposal Analysis, full characterization for Hylebos Wood Debris Group: Sampling and analysis plan. Prepared for the Dredge Material Management Office, Department of the Army, Seattle District, Corps of Engineers, Seattle, Washington.

Pentec
ENVIRONMENTAL

December 3, 1999

Dr. David Kendall, Chief, DMMO
CENPS-OP-TS-DM
Department of the Army
Seattle District Corps of Engineers
PO Box 3755
Seattle, WA 98124-2255

Amphipod Bioassay Results
PSDDA Full Characterization for the Hylebos Wood Debris Group

Dear Dr. Kendall:

The purpose of this letter is to address your comments regarding the letter dated October 29, 1999, and to provide additional supporting documentation that the amphipod tests, conducted as part of the Puget Sound Dredged Disposal Analysis (PSDDA) characterization of the Hylebos Wood Debris Site (HWDS), do not represent the true nature of the test sediments. In support of this contention we have also included the results of the other bioassays conducted in May and August of this year.

All references to ammonia or NH_3 presented in the letter dated October 29, 1999, and in the data submittals provided with the letter should be changed to total ammonia expressed as milligrams of nitrogen per liter (mg N/L). Revised and expanded versions of the original tables are provided as attachments to this document. Total ammonia values for interstitial waters and for overlying water are presented in mg N/liter. The total ammonia values were determined at the bioassay testing laboratory using a colormetric test kit. Ammonia levels were determined on 1:5 or 1:25 dilutions of the test water to the nearest 0.1 mg N/L. A reading error of 0.1 mg N/L total ammonia may result in a final calculated concentration that is in error by up to 2.5 mg N/L. The concentration of un-ionized ammonia present in solution was calculated using the total ammonia concentration (in mg N/L), the pH (if available) of the solution, and the dissociation constant for ammonia. An error of 2.5 mg N/L in the total ammonia concentration may result in a significant error in the calculated concentration of the un-ionized ammonia portion, especially at the higher pH values (7.5 and above) where more of the total ammonia exists in its un-ionized form. Where

ammonia levels were below the method detection limit, a value of one-half the detection limit was used in calculations and statistical tests.

Round 1

Initially during the Round 1 testing, six test sediments with a single reference sediment were run using *Ampelisca* as the test species. In addition, two test sediments with a single reference sediment were run using *Rhepoxynius*. The two test sediments run using *Rhepoxynius* were thought to have coarser-grained sediments based on the results of a rapid grain-size analysis. The results of the standard grain-size analysis showed that the sediments were substantially finer-grained than first thought and the sediments were retested using *Ampelisca* as the test species. For all the amphipod bioassays conducted during Round 1 the total ammonia concentrations in the interstitial water ranged from < 2.5 mg N/L to 37.5 mg N/L (Table 1). The total ammonia level of 37.5 mg N/L is above the general acceptability range for *Ampelisca* bioassays provided by the Inland Testing Manual (EPA and Corps 1998). This high ammonia level was measured in the reference sediment used in the *Ampelisca* retest. The concentration was substantially higher than the total ammonia level measured in the same reference sediment during the initial bioassay test with *Rhepoxynius*. The elevated level may reflect a buildup of ammonia with increased holding time; however, the test sediments failed to show as dramatic an increase in total ammonia concentration over the same period of time. For the Round 1 bioassays total ammonia concentrations in the overlying water ranged from < 0.5 mg N/L to 5.0 mg N/L (Table 1). The un-ionized ammonia concentration in the overlying water ranged from 0.0 mg NH_3/L to 0.3 mg NH_3/L (Table 1). In general, ammonia concentrations were higher on Day 0 and lower by Day 10. A plot of the mean concentration of total ammonia (mg N/L measured at the initiation and the termination of the bioassay) in the overlying water of the test sediments versus *Ampelisca* mortality showed little correlation (Figure 1, Table 2; $r^2 = 0.24$, $P = 0.32$). In addition, a plot of the mean calculated concentration of un-ionized ammonia (mg NH_3/L at the initiation and the termination of the bioassay) in the overlying water of the test sediments versus amphipod mortality showed little correlation (Figure 2, Table 3; $r^2 = 0.18$, $P = 0.41$). All available ammonia data for the Round 1 amphipod bioassays is presented in Table A-1 as an attachment to this letter. A comparison of all the bioassay results (amphipod, sediment larval, and juvenile polychaete) for the Round 1 sediments with the PSDDA criteria is presented in Table A-2 as an attachment to this letter.

Table 1 Total ammonia and un-ionized ammonia ranges for Round 1 and Round 2 amphipod bioassays.

	Interstitial Water		Overlying Water	
	Total Ammonia	NH_3	Total Ammonia	NH_3
Round 1	1.0 to 37.5 (mg N/L)	Not available	< 0.5 to 5 (mg N/L)	0.0 to 0.3 (mg NH_3/L)
Round 2	< 2.5 to 20 (mg N/L)	0.0 to 2.8 (mg NH_3/L)	< 0.5 to 7.5 (mg N/L)	0.0 to 0.7 (mg NH_3/L)

Table 2 Regression for mean total ammonia concentration in the overlying water versus *Ampelisca* mortality (Round 1 data).

Regression Statistics	
Multiple R	0.493550188
R Square	0.243591788
Adjusted R Square	0.054489735
Standard Error	19.33695407
Observations	6

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	481.6621622	481.6621622	1.288149886	0.319787105
Residual	4	1495.671171	373.9177928		
Total	5	1977.333333			

		Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept		9.882882883	13.04284296	0.757724594	0.490803217	-26.32992963	46.09569539	-26.32992963	46.09569539
	2	11.78378378	10.38249105	1.13496691	0.319787105	-17.04269238	40.61025995	-17.04269238	40.61025995

Table 3 Regression for mean un-ionized ammonia concentration in the overlying water versus *Ampelisca* mortality (Round 1 data).

Regression Statistics	
Multiple R	0.418361892
R Square	0.175026673
Adjusted R Square	-0.031216659
Standard Error	0.049574115
Observations	6

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.002085616	0.002085616	0.848641607	0.409069407
Residual	4	0.009830372	0.002457593		
Total	5	0.011915987			

		Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept		0.046024431	0.031512903	1.460494788	0.217942007	-0.041469596	0.133518459	-0.041469596	0.133518459
	18	0.001027016	0.001114846	0.921217459	0.409069407	-0.0020683	0.004122332	-0.0020683	0.004122332

Figure 1 Ampelisca mortality vs. total ammonia.

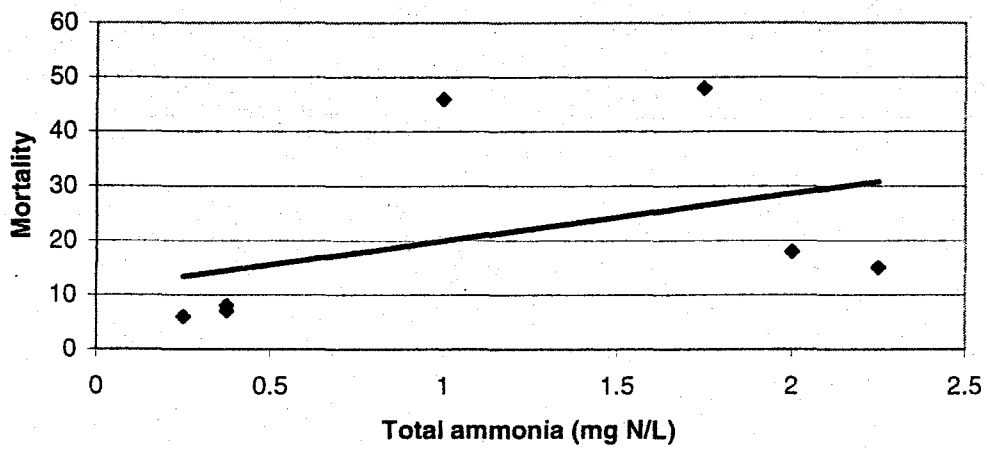
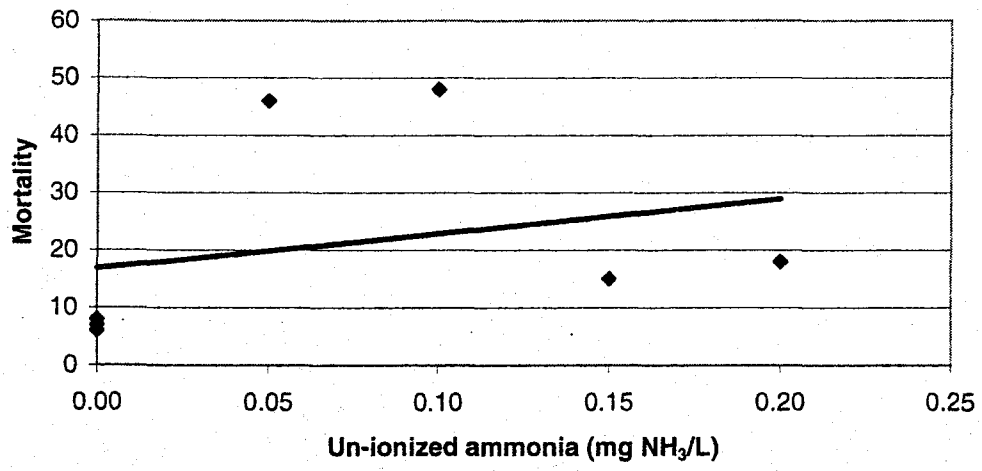


Figure 2 Ampelisca mortality vs. un-ionized ammonia.



Round 2

During Round 2 bioassay testing 13 test sediments and 2 reference sediments were tested using *Ampelisca* as the test species. In addition, 14 test sediments and 2 reference sediments were tested using *Rhepoxynius* as the test species. Total ammonia concentrations in the interstitial water ranged from < 2.5 mg N/L to 20 mg N/L (Table 1). Total ammonia concentrations in the overlying water ranged from < 0.5 mg N/L to 7.5 mg N/L (Table 1). The un-ionized ammonia concentration in the interstitial water ranged from 0.0 mg NH_3/L to 2.8 mg NH_3/L (Table 1). The two highest un-ionized ammonia values should be used with caution. The highest un-ionized ammonia value (2.8 mg NH_3/L) was calculated using a recorded pH of 9.2, a value well above the other recorded interstitial pHs. The second-highest un-ionized ammonia value (1.3 mg NH_3/L) was calculated using an estimated pH value of 8.0 (total ammonia concentration was 20 mg N/L). For the *Ampelisca* bioassays several of the un-ionized ammonia concentrations in the interstitial water at the start of the bioassay approached or exceeded the 0.4 mg/L criteria presented in the Inland Testing Manual. In addition, several of the un-ionized ammonia concentrations in the overlying water approached or exceeded the 0.4 mg/L at the conclusion of the bioassay. A plot of the mean concentration (at the start and the end of the bioassay) of un-ionized ammonia (mg NH_3/L) in the overlying water versus mortality shows a high correlation (Figure 3, Table 4; $r^2 = 0.86$, $P = 0.00002$). All available ammonia data for the Round 2 amphipod bioassays is presented in Table A-3 as an attachment to this letter. A comparison of all the bioassay results (amphipod, sediment larval, and juvenile polychaete) for the Round 2 sediments with the PSDDA criteria is presented in Table A-4 as an attachment to this letter.

The additional ammonia data provided continues to support our contention that the Round 2 amphipod bioassays were adversely affected by ammonia toxicity. A majority of the levels of un-ionized ammonia found in the interstitial and overlying water were below the guidance criteria of 0.4 mg NH_3/L found in the Inland Testing Manual (EPA and Corps 1998). However, there remains a strong correlation between the mean concentration of un-ionized ammonia in the overlying water (measured in mg NH_3/L) and *Ampelisca* mortality (Figure 2). We continue to request that the results of the *Ampelisca* and *Rhepoxynius* bioassays conducted in August 1999 (Round 2) be set aside on the basis of the results presented in this letter and the letter dated October 29, 1999, and that the PSDDA suitability determination be based on the results of the sediment larval and juvenile polychaete tests.

Figure 3 Ampelisca mortality vs. un-ionized ammonia.

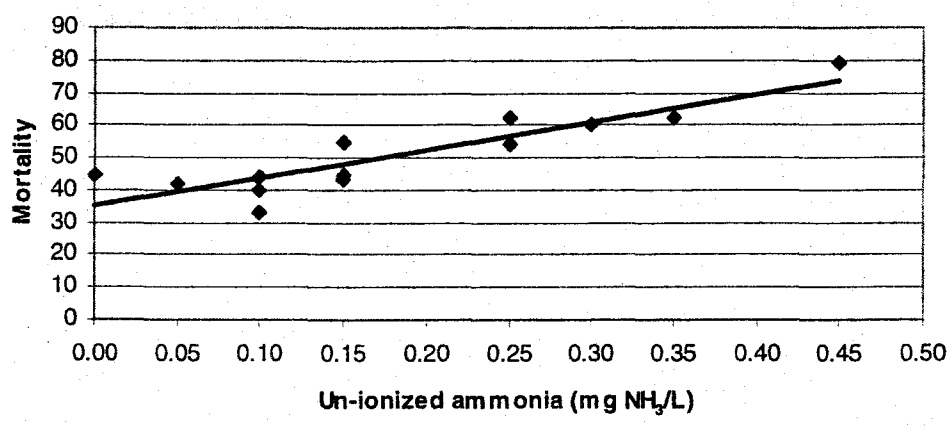


Table 4 Regression for mean un-ionized ammonia concentration in the overlying water versus *Ampelisca* mortality (Round 2 data).

Regression Statistics	
Multiple R	0.924846658
R Square	0.855341341
Adjusted R Square	0.840875475
Standard Error	0.054805233
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.177598411	0.177598411	59.12825023	1.66266E-05
Residual	10	0.030036135	0.003003614		
Total	11	0.207634546			

		Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept		-0.314399336	0.066955461	-4.695648883	0.00084714	-0.463585426	-0.165213246	-0.463585426	-0.165213246
	54	0.009841456	0.001279858	7.689489595	1.66266E-05	0.006989754	0.012693158	0.006989754	0.012693158

Thank you in advance for your review and response to this additional information. If you have any questions, please call me at (425) 775-4682.

Sincerely,
Pentec Environmental, Inc.

Robert Gilmour

Robert H Gilmour
Marine Biologist
rob@pentecenv.com

RHG/agm
Attachments

Reference List

EPA and Corps (US Environmental Protection Agency and US Army Corps of Engineers). 1998. Evaluation of dredged material proposed for discharge in waters of the US: Testing manual. US Environmental Protection Agency, Office of Water, EPA 823-B-98-004, Washington, DC.

Table A-1 Round 1 ammonia data for amphipod bioassays.

				Ammonia Interstitial (before)		Ammonia Interstitial (after)		Ammonia Overlying (before)		Ammonia Overlying (after)		Mean Overlying			
Sample ID	DMMU	Species	Initial Interstitial Salinity	Total mg N/L	Un-Ionized mg NH_3/L	Total mg N/L	Un-Ionized mg NH_3/L	Total mg N/L	Un-Ionized mg NH_3/L	Total mg N/L	Un-Ionized mg NH_3/L	Total mg N/L	Un-Ionized mg NH_3/L	Mortality	Fines
201	A13	Ampelisca	12.5	13	(no pH)	1.25	(no pH)	2	0.2	2	0.2	2	0.20	18	65.8
202	A18	Ampelisca	14	3	(no pH)	-	(no pH)	0.5	0.0	0.25	0.0	0.375	0.00	8	80.2
203	A23	Ampelisca	11	5	(no pH)	1.25	(no pH)	0.5	0.0	0.25	0.0	0.375	0.00	7	91.4
205	A27	Ampelisca	9	5	(no pH)	1.25	(no pH)	0.25	0.0	0.25	0.0	0.25	0.00	6	71.2
208	A3	Ampelisca	18	10	(no pH)	1.25	(no pH)	2	0.1	2.5	0.2	2.25	0.15	15	72.8
200	B3	Ampelisca	6	8	(no pH)	1.25	(no pH)	0.5	0.0	1.5	0.1	1	0.05	46	63.1
206	A22	Ampelisca	9	8.5	(no pH)	2.5	(no pH)	1	0.0	2.5	0.2	1.75	0.10	48	61.6
213	Reference	Ampelisca	27	10	(no pH)	1.25	(no pH)	0.25	0.0	0.25	0.0	0.25	0.00	6	65.5
212	Reference	Ampelisca	27	37.5	(no pH)	5	(no pH)	1	0.0	1	0.2	1	0.10	10	45.6
212	Reference	Rhepoxynius	27	3	(no pH)	4	(no pH)	1	0.0	0.5	0.1	0.75	0.05	10	45.6
200	B3	Rhepoxynius	6	1	(no pH)	4.5	(no pH)	4	0.2	3	0.2	3.5	0.20	45	63.1
206	A22	Rhepoxynius	9	1.5	(no pH)	4.5	(no pH)	5	0.3	4	0.3	4.5	0.30	43	61.6

Table A-2 Round 1 sediment bioassay results.

Amphipod Sediment Bioassay (percent mortality endpoint)													
					Replicate (percent mortality)						Nondispersive Disposal Site Interpretation Guidelines		
Test		Test Species	Sample ID No.	% Fines	Location/ DMMU	1	2	3	4	5	Mean	1-hit rule M_T-M_C > 20% and M_T vs M_R SD (p=.05) and M_T-M_R > 30%	2-hit rule M_T-M_C > 20% and M_T vs M_R SD (p=.05)
Amphipod		Ampelisca			Control	0	30	5	5	25	13*		
			312005213	65.5	Reference	15	0	5	0	10	6		
			312005201	65.8	SA-13	10	15	40	10	15	18		
			312005202	80.2	SA-18	15	10	0	0	15	8		
			312005203	91.4	SA-23	10	10	5	5	5	7		
			312005205	71.2	SA-27	10	0	0	5	15	6		
			312005208	72.8	SA-3	10	15	30	10	10	15		
		Rhepoxynius			Control	5	5	0	0	0	2		
			312005212	45.6	Reference	10	10	20	10	0	10		
			312005200	63.1	SB-3	80	10	30	35	70	45	X	
			312005206	61.6	SA-22	65	30	50	20	50	43	X	
	Retest	Ampelisca			Control	10	10	15	5	20	12*		
			312005212	45.6	Reference	15	5	15	10	5	10		
			312005200	63.1	SB-3	60	55	50	25	40	46	X	
			312005206	61.6	SA-22	50	65	75	25	25	48	X	

continued

* Control sediment failed to meet performance criteria.
SD: Statistically different
M: Percent mortality
Subscripts: R = reference sediment, C = negative control, T = test sediment
X: Bioassay exceeds the criteria

Table A-2 (continued).

Sediment Larval Bioassay (normality endpoint)												
					Replicate (raw counts of normal larvae)						Nondispersive Disposal Site Interpretation Guidelines	
Test	Test Species	Sample ID No.	% Fines	Location/ DMMU	1	2	3	4	5	Mean	1-hit rule $N_T/N_C < 0.80$ and N_T/N_C vs N_R/N_C SD (p=.10) and N_R/N_C-$N_T/N_C > 0.30$	2-hit rule $N_T/N_C < 0.80$ and N_T/N_C vs N_R/N_C SD (p=.10)
Sediment Larval (unscreened)	Dendraster			Control	153	119	156	132	121	136.20		
(Initial Count - 181 embryos)		312005213	65.5	Reference	91	91	76	63	81	80.4*		
		312005201	65.8	SA-13	71	63	95	113	49	78.20		NSD
		312005202	80.2	SA-18	99	107	121	78	100	101.00		NSD
		312005203	91.4	SA-23	110	117	119	84	118	109.60		
		312005205	71.2	SA-27	132	127	103	139	115	123.20		
		312005208	72.8	SA-3	119	63	62	69	108	84.20		NSD
		312005212	45.6	Reference	28	80	78	61	92	67.8*		
		312005200	63.1	SB-3	57	69	67	5	65	52.60		NSD
		312005206	61.6	SA-22	39	61	30	44	26	40.00		X

continued

* Reference sediment failed to meet performance criteria.
SD: Statistically different
NSD: Not statistically different
N: Counts of normal larvae
Subscripts: R = reference sediment, C = negative control, T = test sediment
X: Bioassay exceeds the criteria

Table A-2 (continued).

Juvenile Polychaete Sediment Bioassay (mean individual growth rate endpoint)													
					Replicate (mean individual growth rate [mg/ind/d])						Nondispersive Disposal Site Interpretation Guidelines	
Test	Test Species	Sample ID No.	% Fines	Location/ DMMU	1	2	3	4	5	Mean	1-hit rule $MIG_T/MIG_C < 0.80$ and MIG_T vs MIG_R SD (p=.05) and $MIG_T/MIG_R < 0.50$	2-hit rule $MIG_T/MIG_C < 0.80$ and MIG_T vs MIG_R SD (p=.05) and $MIG_T/MIG_R < 0.70$
Juvenile Polychaete	Neanthes			Control	1.17	1.02	0.92	1.03	1.03	1.03		
		312005213	65.5	Reference	0.75	0.84	0.84	0.71	0.65	0.76*		
		312005201	65.8	SA-13	0.78	1.14	1.06	0.99	1.00	0.99		
		312005202	80.2	SA-18	0.79	0.80	0.89	0.91	1.01	0.88		
		312005203	91.4	SA-23	0.82	0.93	0.76	0.91	1.06	0.90		
		312005205	71.2	SA-27	0.95	0.85	0.69	0.85	0.91	0.85		
		312005208	72.8	SA-3	1.11	0.94	0.92	0.90	0.87	0.95		
		312005212	45.6	Reference	1.06	1.08	0.91	0.70	0.97	0.94		
		312005200	63.1	SB-3	0.77	0.63	0.59	0.76	1.16	0.78		NSD
		312005206	61.6	SA-22	0.90	0.86	1.13	1.19	0.87	0.99		

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* Reference sediment failed to meet performance criteria.
SD: Statistically different
NSD: Not statistically different
MIG: Mean individual growth rate (mg/individual/day)
Subscripts: R = reference sediment, C = negative control, T = test sediment

Table A-3 Round 2 ammonia data for amphipod bioassays.

				Ammonia Interstitial (before)		Ammonia Interstitial (after)		Ammonia Overlying (before)		Ammonia Overlying (after)		Mean Overlying			
Sample ID	DMMU	Species	Salinity	Total mg N/L	Un-Ionized mg NH_3/L	Total mg N/L	Un-Ionized mg NH_3/L	Total mg N/L	Un-Ionized mg NH_3/L	Total mg N/L	Un-Ionized mg NH_3/L	Total mg N/L	Un-Ionized mg NH_3/L	Mortality	Fines
350	A1	Ampelisca	15.5	7.5	0.2	2.5	0.0	1.5	0.1	2	0.4	1.75	0.25	54	67.4
360	A5	Ampelisca	20	17.5	0.4	5	0.2	4	0.2	6	0.7	5	0.45	79	73.3
363	A11	Ampelisca	19.5	15	0.4	5	0.1	3.5	0.3	3	0.4	3.25	0.35	62	80.9
364	A12	Ampelisca	23.5	10	0.4	2.5	0.0	1.5	0.1	1	0.1	1.25	0.10	40	70.2
361	A14	Ampelisca	11.5	10	0.1	2.5	0.0	2	0.1	2.5	0.2	2.25	0.15	55	66.6
367	A17	Ampelisca	14	2.5	0.0	1.25	0.0	1	0.1	1	0.1	1	0.10	33	75.5
358	A19	Ampelisca	17.5	10	0.2	2.5	0.1	2.5	0.2	3	0.3	2.75	0.25	62	69.8
355	B1	Ampelisca	25	7.5	0.2	1.25	0.0	1.5	0.1	0.25	0.0	0.875	0.05	42	65.4
370	B2	Ampelisca	10	10	0.3	2.5	0.0	2.5	0.2	1	0.1	1.75	0.15	45	66.3
377	B5	Ampelisca	5.5	5	0.1	1.25	0.0	1	0.0	0.25	0.0	0.625	0.00	45	70.6
371	B9	Ampelisca	0.5	15	0.1	5	0.0	1.5	0.1	5	0.1	3.25	0.10	44	61.27
378	B10	Ampelisca	1	7.5	0.2	5	2.8[1]	1	0.1	2	0.2	1.5	0.15	43	65
374	C1	Ampelisca	28	17.5	0.4	2.5	0.0	3.5	0.3	2	0.3	2.75	0.30	60	61.4
382	Reference (CR-23)	Ampelisca	27.5	7.5	0.2	2.5	0.0	1	0.1	0.25	0.0	0.625	0.05	21	55.5
383	Reference (CR-20)	Ampelisca	29.5	17.5	0.4	2.5	0.0	3	0.2	0.25	0.0	1.625	0.10	28	78.1
368	A2	Rhepoxynius	25	2.5	0.0	1.25	0.1	0.5	0.0	0.25	0.0	0.375	0.00	12	10.3
369	A4	Rhepoxynius	26.5	2.5	0.1	1.25	0.2	0.5	0.0	1	0.0	0.75	0.00	12	4.2
372	A6	Rhepoxynius	25	5	0.1	2.5	0.1	1	0.1	1	0.0	1	0.05	16	42.8
359	A7	Rhepoxynius	1.5	7.5	0.0	5	0.0	7	0.1	7	0.0	7	0.05	85	57.6
373	A8	Rhepoxynius	16.5	2.5	0.0	1.25	0.1	1	0.1	2	0.1	1.5	0.10	74	30.2
366	A15	Rhepoxynius	9.5	2.5	0.1	2.5	0.1	4	0.2	3	0.2	3.5	0.20	65	56.3
353	A16	Rhepoxynius	12	5	0.1	5	0.2	5	0.3	5	0.1	5	0.20	59	57.8
379	A21	Rhepoxynius	12	5	0.0	2.5	0.1	3.5	0.2	2.5	0.1	3	0.15	17	39.7
365	A25	Rhepoxynius	8	2.5	0.0	2.5	0.1	2.5	0.1	3	0.1	2.75	0.10	62	45
362	A26	Rhepoxynius	16	2.5	0.1	2.5	0.1	3	0.2	2	0.1	2.5	0.15	74	48.7
380	B4	Rhepoxynius	27.5	2.5	0.1	1.25	0.1	1.5	0.1	2	0.1	1.75	0.10	66	38.8
376	B6	Rhepoxynius	5	5	0.1	5	0.1	4	0.2	4	0.1	4	0.15	82	58.1
375	B7	Rhepoxynius	9.5	2.5	0.0	1.25	0.0	1	0.1	1.5	0.0	1.25	0.05	35	51.3
356	B8	Rhepoxynius	8	5	0.2	2.5	0.1	5	0.3	5	0.1	5	0.20	76	44.4
382	Reference (CR-23)	Rhepoxynius	27.5	7.5	0.2	2.5	0.1	0.5	0.0	0.5	0.0	0.5	0.00	13	55.5
384	Reference (CR-23W&22 S)	Rhepoxynius	28	20	1.3[2]	10	0.8	2.5	0.2	7.5	0.4	5	0.30	63	30.1

1: Recorded pH of 9.2. May be in error. Use with caution.

2: pH measurement not available , un-ionized ammonia concentration calculated using a pH of 8. Use with caution.

Table A-4 Round 2 sediment bioassay results.

Amphipod Sediment Bioassay (percent mortality endpoint)													
					Replicate (percent mortality)						Nondispersive Disposal Site Interpretation Guidelines	
Test	Test Species	Sample ID No.	% Fines	Location/ DMMU	1	2	3	4	5	Mean	1-hit rule M_T-M_C > 20% and M_T vs M_R SD (p=.05) and M_T-M_R > 30%	2-hit rule M_T-M_C > 20% and M_T vs M_R SD (p=.05)
Amphipod	Ampelisca		NA	Control	35	10	10	0	10	13*		
		312005383	78.1	Reference (CR-20)	35	45	20	40	0	28		
		312005360	73.3	SA-5	60	95	65	85	90	79	X	
		312005363	80.9	SA-11	50	75	55	70	60	62	X	
		312005364	70.2	SA-12	65	40	40	20	35	40		NSD
		312005367	75.5	SA-17	50	10	35	25	45	33		
		312005377	70.6	SB-5	50	45	40	35	55	45		NSD
		312005350	67.4	SA-1	85	60	60	35	30	54		X
		312005361	66.6	SA-14	60	75	65	25	50	55		X
		312005358	69.8	SA-19	60	55	45	70	80	62	X	
		312005370	66.3	SB-2	30	60	40	45	50	45		NSD
		312005355	65.4	SB-1	30	40	55	15	70	42		NSD
		312005378	65	SB-10	50	25	50	70	20	43		NSD
		312005382	55.5	Reference (CR-23)	30	10	30	20	15	21		
		312005371	61.3	SB-9	60	25	55	60	20	44		X
		312005374	61.4	SC-1	40	50	65	90	55	60	X	
	Rhepoxynius		NA	Control (West Beach)	0	5	5	0	0	2		
		312005368	10.3	SA-2[1]	0	20	15	20	5	12		
		312005369	4.2	SA-4[1]	5	25	15	0	15	12		
		312005382	55.5	Reference (CR-23)	0	50	10	0	5	13		
		312005372	42.8	SA-6	10	15	5	30	20	16		
		312005359	57.1	SA-7	85	75	90	95	80	85	X	
		312005366	56.3	SA-15	55	55	55	70	90	65	X	
		312005353	57.8	SA-16	60	60	70	70	35	59	X	
		312005379	44.6	SA-21	15	20	10	10	30	17		
		312005365	45	SA-25	65	70	70	40	65	62	X	
		312005362	48.7	SA-26	70	95	80	50	75	74	X	
		312005356	44.4	SB-8	75	90	85	90	40	76	X	
		312005376	58.1	SB-6	85	80	70	95	80	82	X	
		312005375	51.3	SB-7	40	40	35	40	20	35		
		312005373	30.2	SA-8	55	85	85	70	75	74	X	
		312005380	38.8	SB-4	50	80	90		45	66.25	X	
		312005384	30.1	Reference (CR-23W&22 S)	40	60	30	95	90	63*		

continued

* Control or reference sediment failed to meet performance criteria.
SD: Statistically different
M: Percent mortality
Subscripts: R = reference sediment, C = negative control, T = test sediment
X: Bioassay exceeds the criteria
1: West Beach sand used as reference sediment

Table A-4 (continued).

Sediment Larval Bioassay (normality endpoint)													
					Replicate (raw counts of normal larvae)						Nondispersive Disposal Site Interpretation Guidelines	
Test	Test Species	Sample ID No.	% Fines	Location/ DMMU	1	2	3	4	5	Mean	1-hit rule $N_T/N_C < 0.80$ and N_T/N_C vs N_R/N_C SD (p=.10) and N_R/N_C- $N_T/N_C > 0.30$	2-hit rule $N_T/N_C < 0.80$ and N_T/N_C vs N_R/N_C SD (p=.10)
Sediment Larval (unscreened)	Dendraster		seawater	Control	204	243	188	225	251	222.20		
(Initial Count - 250 embryos)		312005383	78.1	Reference (CR-20)	188	200	182	191	225	197.20		
		312005383	78.1	Reference (CR-20)	118	186	213	198	157	174.40		
		312005363	80.9	SA-11	131	101	205	141	87	133.00		X
		312005367	75.5	SA-17	126	191	152	219	188	175.20		NSD
		312005360	73.3	SA-5	53	200	169	108	200	146.00		X
		312005377	70.6	SB-5	197	137	173	159	182	169.60		NSD
		312005364	70.2	SA-12	221	148	117	117	197	160.00		NSD
		312005358	69.8	SA-19	155	143	87	119	169	134.60		X
		312005350	67.4	SA-1	131	145	141	196	125	147.60		X
		312005361	66.6	SA-14	119	159	140	168	186	154.40		X
		312005370	66.3	SB-2	108	99	127	153	151	127.60		X
		312005355	65.4	SB-1	143	111	149	117	182	140.40		X
		312005378	65	SB-10	178	112	177	110	143	144.00		X
		312005382	55.5	Reference (CR-23)	216	170	202	212	179	195.80		
		312005382	55.5	Reference (CR-23)	213	180	203	167	199	192.40		
		312005371	61.3	SB-9	119	151	113	193	168	148.80		X
		312005376	58.1	SB-6	170	221	201	129	203	184.80		
		312005353	57.8	SA-16	143	180	173	205	158	171.80		X
		312005359	57.1	SA-7	84	60	60	29	135	73.60	X	
		312005366	56.3	SA-15	109	149	214	208	207	177.40		NSD
		312005375	51.3	SB-7	155	203	149	190	207	180.80		
		312005362	48.7	SA-26	187	193	146	222	191	187.80		
		312005365	45	SA-25	121	154	184	201	191	170.20		X
		312005379	44.6	SA-21	208	116	82	152	155	142.60		X
		312005356	44.4	SB-8	167	154	113	142	101	135.40		X
		312005372	42.8	SA-6	188	89	160	105	214	151.20		X
			NA	Reference (West Beach)	201	227	203	148	165	188.80		
			NA	Reference (West Beach)	107	155	195	174	209	168.00		
		312005368	10.3	SA-2[1]	171	156	177	140	178	164.40		NSD
		312005369	4.2	SA-4[1]	105	146	176	139	188	150.80		X
		312005384	30.1	Reference (CR-23W&22 S)	185	196	202	185	162	186.00		
		312005384	30.1	Reference (CR-23W&22 S)	228	193	200	197	184	200.40		

continued

* Reference sediment failed to meet performance criteria.
SD: Statistically different NSD: Not statistically different
N: Counts of normal larvae
Subscripts: R = reference sediment, C = negative control, T = test sediment
X: Bioassay exceeds the criteria
1: West Beach sand used as reference sediment

Table A-4 (continued).

Juvenile Polychaete Sediment Bioassay (mean individual growth rate endpoint)												
					Replicate (mean individual growth rate [mg/ind/d])						Nondispersive Disposal Site Interpretation Guidelines	
Test	Test Species	Sample ID No.	% Fines	Location/ DMMU	1	2	3	4	5	Mean	1-hit rule $MIG_T/MIG_C < 0.80$ and MIG_T vs MIG_R SD (p=.05) and $MIG_T/MIG_R < 0.50$	2-hit rule $MIG_T/MIG_C < 0.80$ and MIG_T vs MIG_R SD (p=.05) and $MIG_T/MIG_R < 0.70$
Juvenile Polychaete	Neanthes			Control	0.80	1.16	1.06	0.71	0.87	0.92		
		312005383	78.1	Reference (CR-20)	1.47	1.69	0.91	1.21	1.17	1.29		
		312005350	67.4	SA-1	1.06	1.14	1.27	0.91	1.02	1.08		
		312005355	65.4	SB-1	0.68	0.49	0.82	0.75	0.99	0.75		
		312005358	69.8	SA-19	0.77	1.16	0.80	0.91	1.15	0.96		
		312005360	73.3	SA-5	0.68	0.91	0.91	1.13	0.73	0.87		
		312005361	66.6	SA-14	0.65	0.70	0.69	1.55	0.70	0.86		
		312005363	80.9	SA-11	1.04	0.96	1.36	1.10	1.01	1.09		
		312005364	70.2	SA-12	1.14	1.45	1.00	0.69	1.19	1.09		
		312005367	75.5	SA-17	1.16	1.00	0.83	0.94	0.92	0.97		
		312005370	66.3	SB-2	0.92	0.74	1.17	0.99	1.28	1.02		
		312005377	70.6	SB-5	0.71	0.81	1.08	0.72	0.82	0.83		
		312005378	65	SB-10	0.76	1.10	0.98	1.02	0.86	0.94		
		312005382	55.5	Reference (CR-23)	0.82	0.60	0.61	0.77	0.89	0.74		
		312005353	57.8	SA-16	0.71	0.93	0.87	0.92	1.07	0.90		
		312005356	44.4	SB-8	0.97	1.41	1.07	0.96	0.87	1.06		
		312005359	57.1	SA-7	0.76	0.84	0.89	1.04	0.90	0.89		
		312005362	48.7	SA-26	0.97	0.90	0.89	1.10	0.85	0.94		
		312005365	45	SA-25	1.09	1.16	1.26	1.12	0.93	1.11		
		312005366	56.3	SA-15	0.95	0.93	1.18	0.88	0.83	0.95		
		312005371	61.3	SB-9	0.88	0.86	1.18	0.69	1.01	0.92		
		312005372	42.8	SA-6	1.20	1.09	0.71	1.02	1.06	1.02		
		312005375	51.3	SB-7	1.10	1.03	1.08	0.89	0.90	1.00		
		312005376	58.1	SB-6	1.00	0.91	0.91	0.90	1.08	0.96		
		312005379	44.6	SA-21	0.97	0.70	1.06	0.75	0.45	0.79		
				Reference (West Beach)	0.69	0.95	1.04	0.53	1.15	0.87		
		312005368	10.3	SA-2[1]	1.00	0.89	1.08	0.83	0.93	0.95		
		312005369	4.2	SA-4[1]	1.05	0.72	0.85	1.03	0.97	0.92		
		312005384	30.1	Reference (CR-23W&22 S)	1.38	1.01	1.28	1.07	1.02	1.15		

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* Reference sediment failed to meet performance criteria.
SD: Statistically different
NSD: Not statistically different
MIG: Mean individual growth rate (mg/individual/day)
Subscripts: R = reference sediment, C = negative control, T = test sediment
1: West Beach sand used as reference sediment

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

REPLY TO
ATTENTION OF

March 7, 2000

Operations Division / Technical Support Branch
Dredged Material Management Office

Clifford J. Whitmus
Pentec Environmental, Inc.
120 Third Avenue South, Suite 110
Edmonds, WA 98020

Reference: Hylebos Wood Debris Group PSDDA
Characterization Letter

Dear Mr. Whitmus:

This letter provides the Dredged Material Management Program (DMMP) response to the issues raised in your February 28, 2000 letter relative to PSDDA characterization. In response to the scope of activities outlined in your letter the DMMP agencies have the following responses.

1. We accept the proposed sediment larval retest utilizing the Blue Mussel (*Mytilus galloprovincialis*).
2. Relative to the proposed amphipod bioassay re-tests, the DMMP agencies have the following comments:
   a) Results of recent testing with *Eohaustorius estuarius* have further demonstrated an apparent sensitivity of this species to sediments with high clay fractions (20 – 40%). As a result, the DMMP agencies now support an upper threshold of 20% clay for testing with *Eohaustorius*, rather than the 30% noted in our December 29, 1999 letter to you. As such, DMMUs with clay contents less than 20% can be retested using either *Eohaustorius* and/or *Ampelisca.*
   b) Those DMMU's containing greater than 20% clay should be re-tested using only *Ampelisca spp.*.
   c) Acknowledging the applicant's concern about the potential for ammonia in these sediments to be toxic to *Ampelisca*, we suggest that a water-only ammonia LC50 experiment be conducted to quantify the sensitivity of the *Ampelisca* population being used to ammonia levels occurring in the DMMUs. The Agencies will considering using information from the water-only tests to make adjustments to the retesting results to account for any toxicity that may be attributable to ammonia.
   d) In conducting ammonia LC50 tests, test methods and guidelines for interpreting LC50 data should be arranged in consultation with the DMMP agencies prior to the initiation of any testing.
   e) Ammonia reduction procedures should not be used in *Ampelisca* retesting unless interstitial ammonia concentrations exceed 30 mg/l (@ pH 7.7) total ammonia or 0.4 mg/L (@pH 7.7) unionized ammonia.

enclosure 4

f) Ammonia reduction procedures should not be used in DMMUs tested with *Eohaustorius*, unless interstitial ammonia measurements exceed 60 mg/l (@ pH 7.7) or 0.8 mg/l (@ pH 7.7) unionized ammonia.

3. The DMMP agencies concur with the bioaccumulation testing protocol outlined in your letter for testing TBT bioaccumulation potential in the bent nose clam, *Macoma nasuta*, and the polychaete, *Nephtys caecoides*.

4. Please call me at 206/764-3768 if you have any questions about the DMMP comments/response to your letter.

Sincerely,

David R. Kendall, Ph.D.
Chief, Dredged Material Management Office

Copies Furnished:
Erika Hoffman, EPA
Tom Gries, Ecology
Rick Vining, Ecology
Ted Benson, DNR
Corps, Project Manager
DMMO File

Pentec
ENVIRONMENTAL

February 28, 2000

Dr. David Kendall, Chief, DMMO
CENPS-OP-TS-DM
Department of the Army
Seattle District Corps of Engineers
PO Box 3755
Seattle, WA 98124-2255

Hylebos Wood Debris Group PSDDA Characterization

Dear Dr. Kendall:

This letter details additional testing to be conducted for the Hylebos Wood Debris Group (WDG) at the Hylebos Wood Debris Site (HWDS). Discussed below is the scope of the activities to be conducted to complete the PSDDA full characterization of the HWDS, which includes the following tests:

- Sediment larval bioassay re-tests
- Amphipod bioassay re-tests
- TBT pore water analyses and bioaccumulation testing

Presented in Table 1 are the tests to be conducted for each of the DMMUs in the HWDS characterization.

Sediment Larval Bioassay Re-Tests

This table shows that for each DMMU sampled in May 1999, the sediment larval tests have been rejected as per the DMMO letter (dated December 29, 1999). DMMUs sampled in May 1999 that failed the PSDDA biological criteria for open-water disposal based on the two valid tests (i.e., the amphipod and juvenile polychaete tests) will not be re-tested using the sediment larval

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bioassay. The sediment larval test will be conducted using the blue mussel. The test will be conducted in accordance with PSEP and PSDDA guidelines.

Amphipod Bioassay Re-Tests

The table also shows the amphipod data for the DMMUs sampled in July 1999 has been rejected (as per the DMMO letter) and all DMMUs for which bioassays are required for the PSDDA suitability decision will be re-tested.

Our previous letter to the DMMO, presenting the results of statistical analyses, suggested that ammonia may have contributed to amphipod mortality in the tests that were previously conducted. The DMMO did not accept this argument, partially on the basis that the ammonia levels in the test sediments were an order of magnitude below published LC50s for the test species. We are still concerned about the potential for ammonia toxicity in the test sediments since mortality below the LC50 can influence PSDDA suitability decisions. Even an ammonia LC10 can mean the difference between passing or failing a DMMU for open-water disposal.

Because of our ammonia toxicity concern, the DMMO has recommended that *Eohaustorius estuarius* be used in the amphipod re-test; *Eohaustorius* is known to have a higher ammonia tolerance than *Ampelisca*. This recommendation is based on the assumption that all test sediments will have clay contents of less than 30 percent. The results of a recent PSDDA characterization has suggested that amphipod test using *Eohaustorius* may be adversely affected when the clay content of the test sediments exceed approximately 30 percent. The clay content of the 23 sediments to be re-tested range from 0 to 29 percent with 7 having clay fractions over 25 percent. Because of the potential for trading a potential ammonia affect for a grain size affect when clay fraction approach 30 percent, the WDG may choose to use *Ampelisca* or to conduct side-by-side *Eohaustorius* and *Ampelisca* tests for test sediments that exceed 25 percent clay. The decision as to what species will be used in the tests will be made in consultation with the DMMO after the grain size data is available for the test sediments and prior to initiation of the tests.

In addition to using *Eohaustorius* to minimize potential ammonia effects, ammonia reduction procedures may be used to further reduce the potential for ammonia toxicity. The proposed experimental design for ammonia reduction procedures is described below. The testing will be conducted by Battelle's Marine Sciences Laboratory under the direction of Mr. Jeffrey Ward.

The 10-day acute amphipod toxicity test will be conducted in a manner consistent with Recommended Guidelines for Conducting Laboratory Bioassays on Puget Sound Sediments (PSEP 1995) and Methods for Assessing the Toxicity of Sediment-Associated Contaminants with Estuarine and Marine Amphipods (EPA 1994). The proposed experimental design is presented in Table 2. To ensure that the presence of interstitial water ammonia does not influence test results, the proposed experimental design includes measurements of interstitial water ammonia in bulk sediment upon arrival at the laboratory, and measurements during toxicity testing on Days 0 (test initiation), 3, 5, 7, and 10 (test termination). In addition to the five replicate containers per sediment for biological testing, five surrogate containers will be included for interstitial water measurements during the test. According to EPA (1994), the water-column total ammonia no-effect level for *Eohaustorius* and *Ampelisca* is 60 mg/l and 30 mg/l, respectively. The un-ionized ammonia no-effect level for *Eohaustorius* and *Ampelisca* is 0.8 mg/l and 0.4 mg/l, respectively. To ensure that interstitial water ammonia does not influence test results, we propose a 60 percent renewal of overlying water in all exposure containers associated with a sediment if total interstitial water ammonia levels exceed a trigger level of 20 mg/l or if interstitial water un-ionized ammonia concentrations exceed 0.4 mg/l. 30 mg/l

TBT Pore Water Analyses and Bioaccumulation Testing

Bioaccumulation tests will be conducted for all DMMUs located adjacent to the Weyerhaeuser dock (i.e., Stations B-1 through B-10) if the DMMU passes PSDDA open-water disposal chemical or biological criteria and the TBT BT is exceeded. The TBT bioaccumulation tests will be conducted by Battelle's Marine Sciences Laboratory as described below.

The 45-day bioaccumulation test will be conducted following PSDDA 45-Day Bioaccumulation protocols (EPA/PSWQA 1995). The proposed experimental design for this test is presented in Table 3. Bioaccumulation testing will involve two species: the bent nose clam, *Macoma nasuta*, and the polychaete annelid, *Nephtys caecoides*. Commercial suppliers will collect test organisms for this study. *M. nasuta* will be collected from Discovery Bay, Washington; *N. caecoides* will be collected from Tomales Bay, California. Organisms will be acclimated to laboratory conditions, and tested together in 10-gallon aquaria under the flow-through conditions described in Table 3. As required by PSDDA, 175 ml of sediment will be added to each aquaria at 7-day intervals. At the end of the exposure period, test organisms will be

depurated for 24 hours under flow-through conditions, and tissues will be placed in precleaned chemistry jars for TBT analysis.

Since it is expected that sediment samples from the DMMUs will be similar in grain size composition to the reference material available from the Sequim Bay reference site near the Battelle facility, we propose to use this sediment as both a reference sediment for bioaccumulation evaluations and a control sediment for *M. nasuta*. Control sediment for *N. caecoides* will be obtained from Tomales Bay and included with the test organisms.

Sampling will be conducted over two field events. The first event will be to reoccupy all stations for which bioassay re-tests will be conduced to collect sediment for the bioassays. In addition, sediment will be collected for TBT pore water analyses at all the stations located adjacent to the Weyerhaeuser dock excluding Stations B-1 and B-5; TBT pore water data has already been collected at these two stations. A second sampling event will be conducted to collect sediment at the Weyerhaeuser stations that require bioaccumulation testing.

Thank you in advance for your timely review and response to these requests. We plan on collecting the samples the week of March 13, 2000. If you have any questions, please call me at (425) 775-4682.

Sincerely,
Pentec Environmental
A Division of Hart Crowser, Inc.

Clifford J. Whitmus
Senior Fisheries Biologist/Sediment Specialist
cliff@pentecenv.com

CJW/ds
Attachments: Tables 1, 2, and 3

Table 1 Tests to be conducted for each of the DMMUs in the HWDS characterization.

DMMU	Date Initially Sampled	% Clay	PSDDA Chemical Exceedances	PSDDA Bioassay Results: Amphipod	Larval Test	Polychaete	PSDDA Suitability	Additional Bioassay Testing	TBT BT Exceedance	Additional TBT Pore Water Analysis	TBT Bioaccumulation Tests
A-20	July, 99		No				Suitable	None (no SL exceedances)			
A-S1	May, 99		No				Suitable	None (no SL exceedances)		No	No
C-1	July, 99		No	Rejected	Not Tested	Not Tested	Suitable	None (no SL exceedances)		No	
A-1	July, 99	23.2	SL	Rejected	2-Hit	Pass	Pending	Amphipod	No	No	No
A-2	July, 99	4.4	SL	Rejected	NSD	Pass	Pending	Amphipod		No	No
A-3	May, 99	24.1	SL	Pass	Rejected	Pass	Pending	Sediment Larval		No	No
A-4	July, 99	(No clay)	SL	Rejected	2-Hit	Pass	Pending	Amphipod		No	No
A-5	July, 99	27.6	SL	Rejected	2-Hit (negotiated w/ DMMO)	Pass	Pending	Amphipod		No	No
A-6	July, 99	19.2	SL	Rejected	2-Hit	Pass	Pending	Amphipod		No	No
A-11	July, 99	24.3	SL	Rejected	2-Hit	Pass	Pending	Amphipod		No	No
A-12	July, 99	16.9	SL	Rejected	NSD	Pass	Pending	Amphipod		No	No
A-13	May, 99	22.3	SL	Pass	Rejected	Pass	Pending	Sediment Larval		No	No
A-14	July, 99	28.7	SL	Rejected	2-Hit	Pass	Pending	Amphipod		No	No
A-15	July, 99	16.7	SL	Rejected	NSD	Pass	Pending	Amphipod		No	No
A-16	July, 99	19.8	SL	Rejected	2-Hit	Pass	Pending	Amphipod		No	No
A-17	July, 99	20.9	SL	Rejected	NSD	Pass	Pending	Amphipod		No	No
A-18	May, 99	19.2/18.4	SL/18.8	Pass	Rejected	Pass	Pending	Sediment Larval		No	No
A-19	July, 99	26.0	SL	Rejected	2-Hit	Pass	Pending	Amphipod		No	No
A-21	July, 99	9.7	SL	Rejected	2-Hit	Pass	Pending	Amphipod		No	No
A-23	May, 99	19.2	SL	Pass	Rejected	Pass	Pending	Sediment Larval		No	No
A-25	July, 99	10.2	SL	Rejected	2-Hit	Pass	Pending	Amphipod		No	No
A-26	July, 99	13.0	SL	Rejected	Pass	Pass	Pending	Amphipod	No	No	No
A-27	May, 99	15.3	SL	Pass	Rejected	Pass	Pending	Sediment Larval	No	No	No
B-1	July, 99	25.1	SL	Rejected	2-Hit	Pass	Pending	Amphipod	Yes	No	Yes if DMMU passes bioassays
B-2	July, 99	26.5	SL	Rejected	2-Hit	Pass	Pending	Amphipod	To Be Determined	Yes	Yes if DMMU passes bioassays and TBT BT is exceeded
B-4	July, 99	11.0	No	Rejected	Not Tested	Not Tested	Pending	None (no SL exceedances)	To Be Determined	Yes	Yes if DMMU passes bioassays and TBT BT is exceeded
B-5	July, 99	24.8	SL	Rejected	NSD	Pass	Pending	Amphipod	Yes	No	Yes if DMMU passes bioassays
B-6	July, 99	16.9	SL	Rejected	Pass	Pass	Pending	Amphipod	To Be Determined	Yes	Yes if DMMU passes bioassays and TBT BT is exceeded
B-7	July, 99	14.5	SL	Rejected	Pass	Pass	Pending	Amphipod	To Be Determined	Yes	Yes if DMMU passes bioassays and TBT BT is exceeded
B-8	July, 99	16.1	SL	Rejected	2-Hit	Pass	Pending	Amphipod	To Be Determined	Yes	Yes if DMMU passes bioassays and TBT BT is exceeded
B-9	July, 99	18.1/18/	SL/18.4	Rejected	2-Hit	Pass	Pending	Amphipod	To Be Determined	Yes	Yes if DMMU passes bioassays and TBT BT is exceeded
B-10	July, 99	12.1	SL	Rejected	2-Hit	Pass	Pending	Amphipod	To Be Determined	Yes	Yes if DMMU passes bioassays and TBT BT is exceeded
A-7	July, 99	20.1/20.8/20.2	SL	Rejected	1-Hit	Pass	Unsuitable	None (Sediment Larval 1-hit)		No	No
A-8	July, 99	12.9	SL	Rejected	Not Tested	Not Tested	Unsuitable	None (62% TVS)			
A-9	July, 99		No Sample Obtained Due to Logs				Unsuitable				
A-10	July, 99		No Sample Obtained Due to Logs				Unsuitable				
A-22	May, 99		SL	1 Hit	Rejected	Pass	Unsuitable	None (Amphipod 1-hit)			
A-24	July, 99		No Sample Obtained Due to Refusal				Unsuitable				
B-3	May, 99		SL	1 Hit	Rejected	NSD	Unsuitable	None (Amphipod 1-hit)		No	

Table 2 Experimental design for 10-day acute amphipod test.

Parameter	Condition
Test type	Static – whole sediment
Test sediments	23
Reference sediments	3
Control sediment	1
Replicates per sediment	5 for bioassay, 5 for interstitial water ammonia analysis
Exposure container	1-liter jar
Sediment volume	175 ml/container
Overlying water volume	800 ml/container
Organisms per container	20
Temperature	15.0 ± 1.0°C
Salinity	20‰ overlying, ambient interstitial
Dissolved oxygen	> 5.0 mg/l
pH	Ambient
Photoperiod	Continuous light
Interstitial water ammonia measurements	Bulk sediment upon arrival Days 0, 3, 5, 7, 10
Overlying water renewal	60% renewal and replacement in all jars associated with a sediment if interstitial water total ammonia is ≥ 20 mg/l or if interstitial un-ionized ammonia ≥ 0.4 mg/l
Reference toxicant exposures	Cadmium and ammonia: 6 concentrations x 3 replicates per concentration
Test validity	≥ 90% survival in control sediment

Table 3 Experimental design for 45-day TBT bioaccumulation test.

Parameter	Condition
Test type	Flow-through 45-day
Test organisms	*Macoma nasuta*; *Nephtys caecoides* tested together
Test sediments	Not determined
Reference sediments	1 – Sequim Bay Reference
Control sediment	Sequim Bay for *M. nasuta*; Tomales Bay for *N. caecoides*
Replicates per sediment	5
Exposure container	10-gal aquaria
Sediment volume	4 liters/container
Sediment addition	175 ml per container every 7 days
Organisms per container	25 *M. nasuta*, 50 *N. caecoides*
Temperature	15.0 ± 1.0°C
Salinity	~30‰ (Sequim Bay seawater)
Dissolved oxygen	> 5.0 mg/l
pH	Ambient
Flow rate	125 ± 10 ml/min
Photoperiod	16-L, 6-D
Test validity	≥ 70% survival in control sediment

Appendix I. DMMP characterization summary for Manke Lumber and Louisiana-Pacific Corporation

					A-1		A-2		A-3		A-4		A-5		A-6		A-7		A-8		A-11		A-12		A-13		A-14	
				Rank:	H		H		H		H		H		H		H		H		H		H		H		H	
CHEMICAL NAME	Units	SL	BT	ML	Conc.	VQ	Conc	VQ	Conc	VQ	Conc	VQ	Conc.	VQ	Conc.	VQ	Conc.	VQ	Conc.	VQ	Conc.	VQ	Conc.	VQ	Conc.	VQ	Conc.	VQ
Arsenic	mg/kg	57	507.1	700	220		71		65		207				62													
Mercury	mg/kg	0.41	1.5	2.3											0.540													
Zinc	mg/kg	410		3,800	738						419																	
Tributyltin ion (porewater)	ug/L	0.15	0.15	--	0.09																							
Total LPAH	ug/kg	5,200		29,000													12,300											
Acenaphthene	ug/kg	500		2,000													1,400											
Fluorene	ug/kg	540		3,600													1,500											
Phenanthrene	ug/kg	1,500		21,000													8,000										2,300	
Anthracene	ug/kg	960		13,000													1,400											
Fluoranthene	ug/kg	1,700	4,600	30,000	1,800				2,100				5,300				11,000		1,900								3,000	
Pyrene	ug/kg	2,600		16,000									3,000				4,500											
Benzo(a)anthracene	ug/kg	1,300		5,100									1,700				1,400											
Chrysene	ug/kg	1,400		21,000	1,900				2,800				3,200				3,200				2,700				1,400		2,000	
Benzofluoranthenes	ug/kg	3,200		9,900									3,500				3,200											
Dibenzo(a,h)anthracene	ug/kg	230		1,900															230	u								
Total HPAHs	ug/kg	12,000		69,000									18,610				25,150				12,430						12,410	
Hexaclorobenzene (HCB)	ug/kg	22	168	230			59	u	39	u	59	u	76	u	120	u	71	u	230	u	120	u	57	u	39	u	200	u
2,4-Dimethylphenol	ug/kg	29		210					39	u																		
Pentachlorophenol	ug/kg	400	504	690											580	u			1,200	u	590	u					990	u
Benzyl alcohol	ug/kg	57		870			59	u			59	u	76	u	120	u	71	u	230	u	120	u	57	u			200	u
Dibenzofuran	ug/kg	540		1,700													660											
Hexachlorobutadiene	ug/kg	29	212	270			59	u	39	u	59	u	76	u	120	u	71	u	230	u	120	u	57	u	39	u	200	u
N-Nitrosodiphenylamine	ug/kg	28	130	130			59	u	39	u	59	u	76	u	120	u	71	u	230	u	120	u	57	u	39	u	200	u
Lindane (gamma-BHC)	ug/kg	10																										
Dieldrin	ug/kg	10	37																		10	u						
Total DDT	ug/kg	6.9	50	69	9.6	u			13.0	uj			10.2	u	7.9	u	9.5	u			13.0	u			10.0	u	16.0	u
Total PCBs	ug/kg	130		3,100	330				400				260				220				370		170		250		200	
Total PCBs (TOC- normalized)	mg/kg		38		11.8				9.3				5.8				5.4				10.3		12.1		4.6		2.7	
Total Solids	%				51.1		64.0		46.8		38.6		44.8		35.5		50.8		27.4		45.1		63.4		41.8		34.6	
Total Volatile Solids	%				9.3		17.9		23.8		**27.0**		19.2		**38.6**		12.7		**62.3**		**35.1**		5.0		**27.9**		**33.1**	
Total Organic Carbon	%				2.8		6.5		4.3		11.0		4.5		11.0		4.1		14.0		3.6		1.4		5.4		7.5	
Total Ammonia	mg/kg				32.0		7.4		42.0		17.0		77.0		30.0		46.0		35.0		62.0		21.0		54.0		70.0	
Total Sulfides	mg/kg				9,100		370		2,000		1,400		2,100		980		1,900		2,100		3,000		200		3,000		2,800	
Gravel (percent)	%				2.0		46.9		13.3		50.6		5.0		2.0		1.3		22.0		3.2		0.4		4.7		8.9	
Sand (percent)	%				30.5		42.8		57.5		45.1		21.7		44.6		42.4		47.8		15.9		29.4		37.6		24.6	
Silt (percent)	%				44.3		5.9		19.8		4.2		45.7		38.4		36.3		17.2		51.6		53.3		35.6		37.8	
Clay (percent)	%				**23.1**		**4.3**		**9.4**		**-**		**27.7**		**15.1**		**20.1**		**12.9**		**29.3**		**16.8**		**22.3**		**28.7**	
Fines (percent silt + clay)	%				67.4		10.3		72.8		4.2		73.3		42.8		57.6		30.2		80.9		70.2		65.8		66.6	
Reference match (silt+clay):	%				66.0		7.0		65.5		7.0		66.0		47.0		55.5				81.0		66.0		65.5		66.0	
Ampelisca abdita (round 1) hits:									NH																NH			
Rhepoxynius abronius (round 1) hits:																												
Ampelisca abdita (round 1 retest) hits:																												
Ampelisca abdita (round 3) hits:					1-H		1-H				1-H		1-H		1-H		**NA**				2-H		1-H				1-H	
Dendraster excentricus (round 2) hits:					2-H		NSD				2-H		2-H		2-H		1-H				2-H		NSD				2-H	
Mytilus galloprovincialis (round 3) hits:									2-H																NH			
Neanthes arenaceodentata (round 1 and 2) hits:					NH		NH		NH		NH		NH		NH		NH				NH		NH		NH		NH	
Bioassay Pass/Fail:					**Fail**		**Fail**		**Pass**		**Fail**		**Fail**		**Fail**		**Fail**		**NA**		**Fail**		**Fail**		**Pass**		**Fail**	
BTs exceeded:					no		no		no		no		no		yes		yes		yes		yes		no		no		yes	
Bioaccumulation conducted:															no		no		no		no						no	
Bioaccumulation Pass/Fail:																												
ML Rule exceeded:					no		no		no		no		no		no		no		yes		no		no		no		yes	
PSDDA Determination:					**Fail**		**Fail**		**Pass**		**Fail**		**Fail**		**Fail**		**Fail**		**Fail (C)**		**Fail**		**Fail**		**Pass**		**Fail**	
DMMU Volume:	cy				3,800		4,800		4,600		4,500		4,800		4,900		4,800		no dredging		3,600		3,400		3,800		5,200	
DMMU ID:					A-1		A-2		A-3		A-4		A-5		A-6		A-7		A-8		A-11		A-12		A-13		A-14	
Failed:					3,800		4,800				4,500		4,800		4,900		4,800				3,600		3,400				5,200	
Passed:									4,600																3,800			

Legend:

NA = Not Analyzed (bioassays)
NSD = Not Significantly Different (No Hit)
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
U = Undetected
J = Positively identified; approximate concentration of the analyte in sample.
ML = Maximum Level (upper chemical guideline)
ML + BT = ML + BT exceedance
BT = Bioaccumulation Trigger
SL = Screening Level (lower chemical guideline)

Appendix I. DMMP characterization summary for Manke Lumber and Louisiana-Pacific Corporation

					A-15		A-16		A-17		A-18		A-19		A-20		A-21		A-22		A-23		A-25		A-26		A-27		A-S1		C-1		DMMU
				Rank:	H		H		H		H		H		H		H		H		H		H		H		H		H		H		SL
CHEMICAL NAME	Units	SL	BT	ML	Conc.	VQ	Conc.	VQ	Conc.	VQ	Conc.	VQ	Conc.	VQ	Conc.	VQ	Conc.	VQ	Conc.	VQ	Conc.	VQ	Conc.	VQ	Conc.	VQ	Conc.	VQ	Conc.	VQ	Conc.	VQ	exceed.
Arsenic	mg/kg	57	507.1	700																	123		215										7
Mercury	mg/kg	0.41	1.5	2.3																													1
Zinc	mg/kg	410		3,800																			555										3
Tributyltin ion (porewater)	ug/L	0.15	0.15	--																					0.07	m	0.05	m			0.10	m	-
Total LPAH	ug/kg	5,200		29,000									9,640																				2
Acenaphthene	ug/kg	500		2,000									1,400																				2
Fluorene	ug/kg	540		3,600									1,600																				2
Phenanthrene	ug/kg	1,500		21,000									4,900																				3
Anthracene	ug/kg	960		13,000									1,500																				2
Fluoranthene	ug/kg	1,700	4,600	30,000									2,200												1,900								8
Pyrene	ug/kg	2,600		16,000																													2
Benzo(a)anthracene	ug/kg	1,300		5,100																													2
Chrysene	ug/kg	1,400		21,000									1,800																				8
Benzofluoranthenes	ug/kg	3,200		9,900																													2
Dibenzo(a,h)anthracene	ug/kg	230		1,900																													1
Total HPAHs	ug/kg	12,000		69,000																													4
Hexachlorobenzene (HCB)	ug/kg	22	168	230	58	u	38	u	59	u			83	u											58	u							16
2,4-Dimethylphenol	ug/kg	29		210	58	u																											2
Pentachlorophenol	ug/kg	400	504	690									410	u																			5
Benzyl alcohol	ug/kg	57		870	58	u			59	u			83	u									58	u									4
Dibenzofuran	ug/kg	540		1,700									630	u																			2
Hexachlorobutadiene	ug/kg	29	212	270	58	u	38	u	59	u			83	u									58	u									16
N-Nitrosodiphenylamine	ug/kg	28	130	130	58	u	38	u	59	u			83	u									58	u									16
Lindane (gamma-BHC)	ug/kg	10											29	u																			1
Dieldrin	ug/kg	10	37																														1
Total DDT	ug/kg	6.9	50	69	8.2	u	7.4	u	7.5	u	7.4	u	11.0	u					8	uj													14
Total PCBs	ug/kg	130		3,100	220		190		210		220		270						240		200				170		140						17
Total PCBs (TOC- normalized)	mg/kg		38		8.8		4.0		12.4		14.7		4.2						9.6		8.3				7.1		11.7						
Total Solids	%				56.0		47.3		56.5		57.7		39.4		78.4		59.2		56.7		52.8		64.0		58.9		63.3		85.1		54.0		
Total Volatile Solids	%				6.4		14.1		9.0		4.2		**26.2**		1.5		10.1		7.2		7.2		4.4		4.8		3.0		0.38		11.8		
Total Organic Carbon	%				2.5		4.7		1.7		1.5		6.5		0.5		2.7		2.5		2.4		1.9		2.4		1.2		1.7		3.7		
Total Ammonia	mg/kg				22.0		47.0		15.0		13.0		73.0		9.2		28.0		32.0		17.0		14.0		18.0		11.0		4.5		44.0		
Total Sulfides	mg/kg				3,700		1,700		840		6,400		7,000		40		340		6,500		9,200		2,300		5,300		2,400		1.4		3,100		
Gravel (percent)	%				1.3		3.7		0.1		-		5.5		1.3		4.8		3.5		0.4		0.9		1.0		0.1		3.1		2.0		
Sand (percent)	%				42.4		38.6		24.4		41.6		24.8		79.1		50.5		45.7		40.8		54.2		50.2		39.8		83.6		36.5		
Silt (percent)	%				39.5		38.1		54.6		41.8		43.7		17.1		34.9		36.2		34.1		34.8		35.8		44.8		10.3		50.3		
Clay (percent)	%				**16.7**		**19.8**		**20.8**		**16.7**		**26.1**		**1.4**		**9.7**		**14.5**		**14.8**		**10.2**		**13.0**		**15.4**		**3.0**		**11.2**		
Fines (percent silt + clay)	%				56.3		57.8		75.5		80.2		69.8		36.5		39.7		61.6		91.4		45.0		48.7		71.2		19.4		61.4		
Reference match (silt+clay):	%				66.0		47.0		47.0		65.5						7.0		45.6		65.5		31.0		31.0		65.5						
Ampelisca abdita (round 1) hits:											NH										NH						NH						
Rhepoxynius abronius (round 1) hits:																			1-H														
Ampelisca abdita (round 1 retest) hits:																			1-H														
Ampelisca abdita (round 3) hits:					NH		1-H		NH				2-H				1-H						NH		NH								
Dendraster excentricus (round 2) hits:					NSD		2-H		NSD				2-H				2-H		NA				2-H		NH								
Mytilus galloprovincialis (round 3) hits:											NH										NH						2-H						
Neanthes arenaceodentata (round 1 and 2) hits:					NH		NH		NH		NH		NH				NH		NH		NH		NH		NH		NH						
Bioassay Pass/Fail:					**Pass**		**Fail**		**Pass**		**Pass**		**Fail**		**NA**		**Fail**		**Fail**		**Pass**		**Pass**		**Pass**		**Pass**		**NA**		**NA**		
BTs exceeded:					no		no		no		no		no		no		no		no		no		no		no		no		no		no		
Bioaccumulation conducted:																																	
Bioaccumulation Pass/Fail:																																	
ML Rule exceeded:					no		no		no		no		no		no		no		no		no		no		no		no		no		no		
PSDDA Determination:					**Pass**		**Fail**		**Pass**		**Pass**		**Fail**		**Pass**		**Fail**		**Fail**		**Pass**		**Pass**		**Pass**		**Pass**		**Pass**		**Pass**		
DMMU Volume:	cy				3,400		4,300		3,500		3,600		4,100		4,500		4,800		4,700		3,600		3,600		3,300		3,700		10,600		3,900		
DMMU ID:					A-15		A-16		A-17		A-18		A-19		A-20		A-21		A-22		A-23		A-25		A-26		A-27		A-S1		C1		
Failed:							4,300						4,100				4,800		4,700														
Passed:					3,400				3,500		3,600				4,500						3,600		3,600		3,300		3,700		10,600		3,900		

Legend:

NA = Not Analyzed (bioassays)
NSD = Not Significantly Different (No Hit)
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
U = Undetected
J = Positively identified; approximate concentration of the analyte in sample.
ML = Maximum Level (upper chemical guideline)
ML + BT = ML + BT exceedance
BT = Bioaccumulation Trigger
SL = Screening Level (lower chemical guideline)

Appendix I. DMMP characterization summary for Manke Lumber and Louisiana-Pacific Corporation

					CR-23	CR-23/24	CR-23	CR-20	CR-23W/22S	CR-02	CR-20/23	CR-23W/25	MSMP-43
				Rank:	REF	REF	REF	REF	REF	REF	REF	REF	REF
CHEMICAL NAME	Units	SL	BT	ML	Round 1	Round 1	Round 2	Round 2	Round 2	Round 3	Round 3	Round 3	Round 3
Arsenic	mg/kg	57	507.1	700									
Mercury	mg/kg	0.41	1.5	2.3									
Zinc	mg/kg	410		3,800									
Tributyltin ion (porewater)	ug/L	0.15	0.15	--									
Total LPAH	ug/kg	5,200		29,000									
Acenaphthene	ug/kg	500		2,000									
Fluorene	ug/kg	540		3,600									
Phenanthrene	ug/kg	1,500		21,000									
Anthracene	ug/kg	960		13,000									
Fluoranthene	ug/kg	1,700	4,600	30,000									
Pyrene	ug/kg	2,600		16,000									
Benzo(a)anthracene	ug/kg	1,300		5,100									
Chrysene	ug/kg	1,400		21,000									
Benzofluoranthenes	ug/kg	3,200		9,900									
Dibenzo(a,h)anthracene	ug/kg	230		1,900									
Total HPAHs	ug/kg	12,000		69,000									
Hexachlorobenzene (HCB)	ug/kg	22	168	230									
2,4-Dimethylphenol	ug/kg	29		210									
Pentachlorophenol	ug/kg	400	504	690									
Benzyl alcohol	ug/kg	57		870									
Dibenzofuran	ug/kg	540		1,700									
Hexachlorobutadiene	ug/kg	29	212	270									
N-Nitrosodiphenylamine	ug/kg	28	130	130									
Lindane (gamma-BHC)	ug/kg	10											
Dieldrin	ug/kg	10	37										
Total DDT	ug/kg	6.9	50	69									
Total PCBs	ug/kg	130		3,100									
Total PCBs (TOC- normalized)	mg/kg		38										
Total Solids	%				43.5	51							
Total Volatile Solids	%				1.81	2.38							
Total Organic Carbon	%												
Total Ammonia	mg/kg												
Total Sulfides	mg/kg												
Gravel (percent)	%				0.5	0	0	0	0	0.1	0	0	0
Sand (percent)	%				53.9	34.5	72.6	21.9	69.9	14.6	42.6	61.4	92.4
Silt (percent)	%				40.2	58.1	20.6	70.4	25.4	72.7	51	33.2	3.6
Clay (percent)	%				5.3	7.4	6.8	7.7	4.7	12.7	6.5	5.2	3.9
Fines (percent silt + clay)	%				45.5	65.5	27.4	78.1	30.1	85.4	57.5	38.4	7.5
Reference match (silt+clay):	%												
Ampelisca abdita (round 1) hits:													
Rhepoxynius abronius (round 1) hits:													
Ampelisca abdita (round 1 retest) hits:													
Ampelisca abdita (round 3) hits:													
Dendraster excentricus (round 2) hits:													
Mytilus galloprovincialis (round 3) hits:													
Neanthes arenaceodentata (round 1 and 2) hits:													
Bioassay Pass/Fail:													
BTs exceeded:													
Bioaccumulation conducted:													
Bioaccumulation Pass/Fail:													
ML Rule exceeded:													
PSDDA Determination:													
DMMU Volume:	cy												
DMMU ID:													

Total Volume Tested

109,800 cy

Failed:	57,700	cy Unsuitable
Passed:	52,100	cy Suitable

Legend:

NA = Not Analyzed (bioassays)
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