Operations Division
Dredged Material Management Office

7 April 1995

MEMORANDUM FOR RECORD

SUBJECT: DETERMINATION ON THE SUITABILITY OF DREDGED MATERIAL TESTED UNDER PSDDA GUIDELINES FOR IN BELLINGHAM HARBOR MAINTENANCE DREDGING AT SQUALICUM CREEK WATERWAY (CENPS-OP-NP-89 / 95-2-00323) FOR PLACEMENT AT EITHER THE BELLINGHAM BAY NONDISPERSIVE OR THE ROSARIO STRAIT DISPERSIVE OPEN WATER SITES

1. The following summary represents the suitability determination for Squalicum Creek Waterway characterization conducted during December, 1994. It reflects information on analyses gathered for and reviewed by the PSDDA agencies' (Corps, Departments of Ecology and Natural Resources, and the Environmental Protection Agency). The technical decision is based on a careful review of the sediment characterization results documented in March 20, 1995 report from Science Application International Corporation (SAIC) entitled: "Sediment Characterization at Squalicum Waterway, Bellingham, Washington". A determination of suitability has been made for the 258,000 cubic yards of dredged material proposed for maintenance dredging from the Squalicum Creek Waterway navigation channel and adjacent berthing areas. This final determination is made relative to suitability for unconfined open-water disposal (UCOWD) at either the PSDDA Bellingham Bay nondispersive site or the PSDDA Rosario Strait dispersive site. Relevant dates for regulatory tracking purposes are included in Table 1.

Table 1. Regulatory Tracking Dates

SAP Approval date	November 25, 1994
Sampling date(s)	November 28 - December 5, 1994
Data report submittal date	March 20, 1995
Recency Determination Dates: Moderate Concern DMMU (5-7 years) High Concern DMMU (2 years)	 Recency date = December 1999-2001 Recency date = December 1996

2. Most of the dredging area characterized in December 1994 was previously characterized in 1991/1992 and dredged during 1992 (see attached suitability determinations, enclosures 1-3) and found suitable for unconfined open water disposal. Therefore, the material characterized for the most part, reflects recently settled material from the Nooksack River and Squalicum Creek. Exceptions include material at the mouth (C1 and C2), which were outside the 1992 dredging prism, and the head of the navigation channel (C12-15), which was not dredged in 1992 because of incomplete biological characterization data. The 1994 field sample collection occurred between November 28 and December 5, 1994. Characterization included 57 samples composited into 20 analyses, of which twelve were ranked moderate and

eight were ranked high for characterization purposes (see Figure 1). The conventional parameters measured in the twenty composited dredged material management units (DMMU) analyzed are depicted in Table 2. As noted in Table 2, the initially high bulk sulfide levels were not confirmed on reanalysis.

3. The Agencies' approved sampling and testing plan (approved by PSDDA agencies on 25 November 1994) was followed, and quality assurance/quality control guidelines specified by PSEP and the PSDDA program were generally complied with. Chemical analysis results depicted in Table 3 demonstrated that the dredged material management units characterized were predominately free of chemicals of concern with twelve of twenty DMMU with no chemical exceedances of screening levels. The remaining eight DMMU showed minor exceedances of nickel, copper, mercury, and lead, with only two of the eight with organic chemical exceedances of chemical screening guidelines (ideno(1,2,3,c,d)pyrene and total DDT). The DMMU with nickel exceedances were reanalyzed to confirm the initial analysis results. The reanalysis results were marginally lower, but tended to confirm the initial results. Based on these exceedances biological testing was required for eight of twenty DMMU as shown in Table 3.

4. PSDDA biological testing performance guidelines for control and reference sediments are depicted in Table 4a for each of the PSDDA bioassays. Interpretative guidelines for nondispersive sites are summarized in Table 4b, whereas Table 4c summarizes interpretative guidelines for dispersive sites. The testing outcome summary for the eight DMMU undergoing biological testing are depicted in Table 5. In general, the control and reference performance standards were met for both the amphipod bioassay and the *Neanthes* growth bioassay. The analysis results for these two bioassays indicated that all eight DMMU were deemed suitable for nondispersive site disposal, whereas three DMMU (C1, C3, and C19) failed to pass the more stringent dispersive disposal site guidelines. The microtox bioassay results, although not currently being used for regulatory decisionmaking[1], also confirmed the amphipod and *Neanthes* bioassay results, where no toxicity was observed.

5. The sediment larval bioassay test results using the purple sea urchin (*Strongylocentrotus purpuratus*) were rejected for regulatory decisionmaking, because the laboratory failed to follow the PSDDA/PSEP temperature requirement of 15 $\pm$ 1°C. The test was run at 12 $\pm$ 1°C. Because the test was run at the lower temperature, development occurred at a slower rate and thus took a longer time until test termination (e.g., 4-arm pluteus larval stage). The lower temperature may have influenced abnormality observations, whereby organisms scored as abnormal may have been normal larvae, which had not yet reached the 4-arm pleuteus larval stage. Additionally the number surviving in the seawater control was unacceptable, thereby invalidating the results for decisionmaking. At the time DMMO was notified of the test performance problems, the holding time had been exceeded by some four weeks, thereby

[1] The PSDDA agencies agreed to set aside the saline microtox bioassay for regulatory decisionmaking at the May 1994 Annual Review Meeting, due to inconclusive results, questions about the protocol, and the apparent lack of test sensitivity compared to the remaining PSDDA bioassays.

making a retest infeasible. Given the low chemical exceedances noted within each of the DMMU tested, and the results of the remaining three bioassays, the agencies with jurisdiction over dredging and disposal elected to set aside the results of the sediment larval test for regulatory decision making and make a decision with the remaining bioassays based on best professional judgement.

6. The Agencies concluded based on the above discussion and summary of sediment chemical and biological testing results for the Bellingham Harbor maintenance dredging project, Bellingham, Washington, that all the material tested (258,000 cubic yards) is suitable for disposal at a PSDDA nondispersive site, whereas 214,000 cubic yards (all the material except C1 + C3 + C19 = 44,000 cubic yards, of which 32,000 cubic yards is federal and 12,000 cubic yards is nonfederal material) is suitable for dispersive site disposal. The material not suitable for dispersive site disposal would have to be placed at a PSDDA non-dispersive site. Table 6 summarizes the Federal and Nonfederal (Port of Bellingham) suitability partitioning for dispersive and nondispersive site disposal as denoted above.

7. This memorandum documents the suitability of proposed dredged sediments for disposal at a PSDDA open-water disposal site. This determination of suitability does not preclude the consideration of this material for an appropriate beneficial use. It does not constitute final agency approval of the project. During the public comment period which follows a public notice, the resource agencies will provide input on the overall project. 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. If a Section 404 permit is issued for this project, a dredging plan must be developed and submitted prior to dredging to the Corps' Regulatory Branch, Compliance Section in Operations Division at Seattle District.

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Table 2. Summary of DMMU Sediment Conventional Parameters and suitability for UCOWD[1].

Conventional Parameters	C1 (M)[2]	C2 (M)	C3 (M)	C4 (M)	C5 (M)	C6 (M)	C7 (M)	C8 (M)	C9 (M)	C10 (M)
DMMU Volume (cubic yards)	16,000	16,000	16,000	16,000	17,000	17,000	16,000	16,000	16,000	16,000
Grain Size (%):										
Gravel	0	0, 0, 0	0	2, 1, 0	0	0	0	0	0	0
Sand	0	0, 0, 1	1	7, 7, 7	5	14	5	7	11	4
Silt	46	76,76,74	67	67,68,69	57	63	68	68	58	66
Clay	52	23,23,23	30	16,16,16	24	22	28	26	32	30
Total Solids (%)	53.5	52.8	53.8	62.0	52.8	55.7	54.7	58.6	57.6	55.9
Total Volatile Solids (%)	2.5	2.7	3.5	12.9	3.3	3.6	3.4	7.1	6.4	6.3
Total Organic Carbon (%)	1.4	1.5	1.4	1.5	1.7	1.6	1.8	1.6	1.7	1.6
Bulk Ammonia (mg/Kg)	24	41	47	37	75	69	59	48	49	44
Total Sulfides (mg/Kg)	480 48	1,100 110	2,600 260	4,900 490	2,800 280	3,300 330	3,100 310	3,600 360	3,300 330	1,500 150

Conventional Parameters	C11 (M)	C12 (H)	C13 (H)	C14 (H)	C15 (H)	C16 (H)	C17 (H)	C18 (H)	C19 (H)	C20 (M)
DMMU Volume (cubic yards)	16,000	4,000	12,000 (sub)	4,000	12,000 (sub)	4,000	12,000 (sub)	4,000	12,000 (sub)	16,000
Grain Size (%):										
Gravel	8	52	36	49	43	7	1	1	2	1
Sand	26	36	22	50	45	62	60	6	30	23
Silt	42	8	33	0	10	25	26	60	41	49
Clay	24	2	10	0	3	6	15	33	25	27
Total Solids (%)	57.3	81.0	70.2	81.1	79.4	69.4	69.2	56.5	69.6	59.6
Total Volatile Solids (%)	3.7	2.2	4.2	3.2	3.7	7.1	5.5	3.7	3.0	3.7
Total Organic Carbon (%)	1.5	0.32	1.3	0.27	1.1	0.82	0.94	1.5	0.83	2.1
Bulk Ammonia (mg/Kg)	70	5.8	67	2.3	13	35	87	12	16	65
Total Sulfides (mg/Kg)	7,600 760	2,400 240	6,500 650	1.7 N.D.	2,200 800, 220	8,000 800	15,000 1,500	510 51	10,000 1,000	4,600 460

1/ UCOWD = unconfined open-water disposal; federal DMMU (C1-C15), nonfederal DMMU (C16-C20); C13, C15, C17, C19 = subsurface (sub) DMMU.

2/ Area Rank (M= Moderate; H= High)

Table 3. DMMU with screening level guideline exceedances[1].

Parameters	Chemical Guidelines			C1 (M)[2]	C3 (M)	C4 (M)	C5 (M)	C16 (H)	C17 (H)	C18 (H)	C19 (H)
	SL	BT	ML								
DMMU Volume (cubic yards)				16,000	16,000	16,000	16,000	4,000	12,000	4,000	12,000
Metals (ppm): Nickel	140		--	150 116	150 135	150 140	160 145				
Copper	81		810								86
Mercury	0.21	1.5	2.1						0.285	0.246	
Lead	66		660	120							
Organics (ppb): Ideno(123cd)pyrene	69		5,200					78			
Total DDT	6.9	50	69						12.7		

[1] All remaining DMMU with no exceedances of PSDDA chemical screening level guidelines.
[2] Area Rank (M= Moderate; H= High)

Table 4a. Solid Phase Bioassay Performance Standards.

PARAMETER	AMPHIPOD BIOASSAY	SEDIMENT LARVAL BIOASSAY	*NEANTHES* 20-DAY GROWTH TEST	SALINE MICROTOX TEST
Negative control performance	Mortality ≤ 10 %	CMA[1] ≤ 30 %	Mortality ≤ 10 % (≥ 0.72 mg-ind-day)[3]	None
Reference sediment performance	Reference mortality minus control mortality ≤ 20 %	NCMA[2] ≤ 35 % Seawater Control	Mean individual growth[4] ≥ 80 % of control	Blank-corrected light decrease ≤ 20%

[1] Combined mortality and abnormality.
[2] Normalized combined mortality and abnormality relative to Seawater control$_{(Fresh)}$
[3] Proposed control growth guideline (1995 SMARM)
[4] Expressed as mg-individual-day (dry weight)

Table 4b. Solid Phase Bioassay Interpretive Guidelines for Nondispersive sites.

BIOASSAY	NONDISPERSIVE INTERPRETATION GUIDELINES[1]	
	2-HIT	1-HIT
Amphipod (% Mortality)	Test mortality > 20% over Control mortality; Test mortality < 30% over Reference mortality, and statistically significant[2]	Test mortality > 20% over Control mortality; Test mortality > 30% over Reference mortality, and statistically significant[2]
Sediment Larval (%Combined Mort+Abnor)	Test CMA > 20% over Control CMA; Test CMA < 30% over Reference CMA, and statistically significant[2]	Test CMA > 20% over Control CMA; Test CMA > 30% over Reference CMA, and statistically significant[2]
Neanthes-20-day Growth (mg-individual-day)	Test growth < 80% or > 120% of Control growth; Test growth < 70 of Reference growth, and statistically significant[2]	Test growth < 80% or >120% of Control growth; Test growth < 50% of Reference growth, and statistically significant[2]
Saline Microtox (% light Δ)	Test light Δ > 20% over Control light Δ; Test light Δ <20% (absolute) over Reference light Δ, and statistically significant[2]	NA

1/ Test response ≤ 20% of Control response (test ≥ 80% or < 120% of control growth endpoint for *Neanthes* Bioassay) = No Hit.

2/ Statistically significant (t-test, $p<0.05$).

Table 4c. Solid Phase Bioassay Interpretive Guidelines for dispersive sites.

BIOASSAY	DISPERSIVE INTERPRETATION GUIDELINES[1]
	1-HIT
Amphipod (% Mortality)	Test mortality > 20% over Control mortality; Test mortality > 10% over Reference mortality, and statistically significant[2]
Sediment Larval (%Combined Mort+Abnor)	Test CMA > 20% over Control CMA; Test CMA > 15% over Reference CMA, and statistically significant[2]
Neanthes-20-day Growth (mg-individual-day)	Test growth < 80% or > 120% of Control growth; Test growth < 70 of Reference growth, and statistically significant[2]

1/ Test response ≤ 20% of Control response (test ≥ 80% or < 120% of control growth endpoint for *Neanthes* Bioassay) = No Hit.

2/ Statistically significant (t-test, $p<0.05$).

Table 5. Solid Phase Bioassay Results Summary for eight DMMU undergoing testing.

Dredged Material Management Units (DMMU)	Amphipod Mortality, % (*Rhepoxynius*)	Amphipod Mortality, % (*Ampelisca*)	Sediment Larval Test[1] (Sea Urchin: *Strongylocentrotus purpuratus*)		20-day *Neanthes* growth, mg-ind-day (% reference), mortality %	Saline Microtox % light ▲ (reference)	DMMU Suitability	
			Mort+Abnor %	Abnormality %			ND	D
Control	5	2	83.5 QA/QC failure	8.9	initial wgt=0.6 mg-individual 1.00 (± 0.04 SD) mortality = 0%	–	NA	
Carr 04 (50% fines)	8	NT	28.0	7.2	0.96 (± 0.13 SD) mortality = 8%	-5.35 -0.13	NA	
Carr 80 (80% fines)	NT	16	81.3	16.1	0.98 (± 0.07 SD) mortality = 0%	-2.18 7.43 -9.21	NA	
C1 (99% fines)	NT	31[ND]	69.8	12.3	0.98 (100%)[B] mortality = 0%	4.2 (-2.18 ref)	yes	no
C3 (98% fines)	NT	30[ND]	63.0	10.6	0.89 (90.8%)[B] mortality = 0%	1.17 (7.43 ref)	yes	no
C4 (90-93% fines)	NT	17[B]	65.7	18.0	0.87 (88.8%)[B] mortality = 4%	23.05 (7.43 ref)	yes	yes
C5 (96% fines)	NT	24[B]	25.1	7.0	0.84 (85.7%)[B] mortality = 4%	12.98 (7.43 ref)	yes	yes
C16 (31% fines)	18[B]	NT	24.6	6.9	0.73 (76%)[B] mortality = 12%	-5.74 (-5.35 ref)	yes	yes
C17 (40% fines)	18[B]	NT	47.8	13.8	0.84 (87.5%)[B] mortality = 12%	0.05 (-0.13 ref)	yes	yes
C18 (92% fines)	NT	23[B]	65.0	28.2	0.91 (92.9%)[B] mortality = 4%	4.19 (-9.21 ref)	yes	yes
C19 (69% fines)	NT	28[ND]	33.7	13.4	0.95 (96.9%)[B] mortality = 0%	12.07 (-9.21 ref)	yes	no
Positive Control (LC50/EC50) TEST DAIS (Mean ± SD)	$CdCl_2$ 0.43 mg/L (0.79 ± 0.48 mg/L DAIS)	$CdCl_2$ 0.31 mg/L (0.49 ± 0.42 mg/L DAIS)	$CdCl_2$ 2.16 mg/L (10.1 ± 6.5 mg/L DAIS for *Dendraster*)	–	$CdCl_2$ 8.83 mg/L (12.5 ± 5.4 mg/L DAIS)	Phenol 19.9, 23, 19.1, 23 mg/L (20.1 ± 4.7 mg/L DAIS)		

1\ QA/QC failure (temperature outside control limits), data not useable for regulatory decisionmaking.

Legend: ND = Nondispersive site suitability; D = Dispersive site suitability; B = Suitable for either nodispersive or dispersive site disposal.
NA = not applicable; NT = not tested; SD = Standard Deviation

Table 6. Final Summary of Federal/Nonfederal Open-water Suitability for either the Bellingham nondispersive site or Rosario Straits dispersive site.

FEDERAL (CORPS) (Volumes, cubic yards)		PORT OF BELLINGHAM (Volumes, cubic yards)		TOTAL (Volumes, cubic yards)	
Nondispersive	Dispersive	Nondispersive	Dispersive	Nondispersive	Dispersive
32,000	178,000	12,000	36,000	44,000	214,000

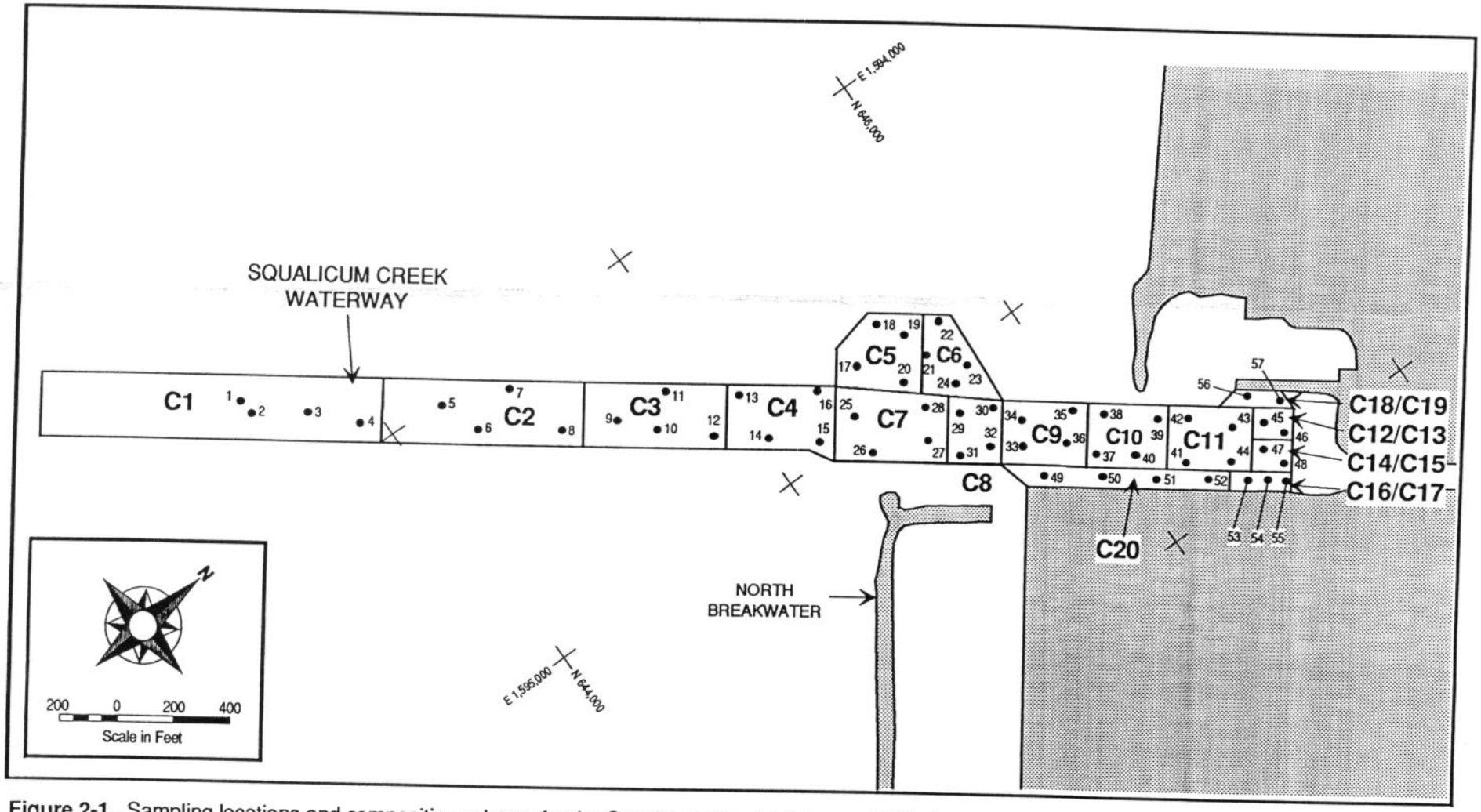

Figure 2-1. Sampling locations and compositing scheme for the Squalicum Creek Waterway, Bellingham, WA sediment characterization.