CENWS-OD-TS-DMMO

MEMORANDUM FOR: RECORD November 19, 2012

SUBJECT: DETERMINATION REGARDING THE SUITABILITY/UNSUITABILITY OF PROPOSED DREDGED MATERIAL FROM THE SALMON BAY MARINA FOR UNCONFINED OPEN-WATER DISPOSAL AT THE ELLIOTT BAY OPEN-WATER SITE.

1. Introduction. This memorandum reflects the consensus determination of the Dredged Material Management Program (DMMP) agencies (U.S. Army Corps of Engineers, Washington Departments of Ecology and Natural Resources, and the Environmental Protection Agency) regarding the suitability/unsuitability of 11,900 cubic yards (cy) of dredged material from the Salmon Bay Marina for disposal at the Elliott Bay open-water site.

2. Background. Salmon Bay Marina is a commercial/recreational marina located at 2100 West Commodore Way, on the Lake Washington Ship Canal west of Fisherman's Terminal (Figure 1). Dredging has been proposed to increase berthing depths at this industrial waterfront property to optimize use of the marina. Salmon Bay Marina proposes to dredge to a design depth of −17 feet, plus 1 foot of overdepth, for a total of −18 feet (USACE Lake Washington Ship Canal datum). The total maximum estimated quantity of dredged material is 11,900 cubic yards (cy), including side-slope and 1-foot overdepth allowances. Volume estimates are based on a bathymetric survey completed in May 2011 (Pentec, 2012a).

3. Project Summary. Table 1 includes project summary and tracking information.

Table 1. Project Summary

Project ranking	High
Dredging volume	11,900 cubic yards
Proposed dredging depth	-18 feet LWSC datum including one foot of overdepth
1st draft sampling and analysis plan (SAP) received	January 17, 2012
DMMP comments provided on 1st draft	January 26, 2012
2nd draft SAP received	February 21, 2012
DMMP comments provided on 2nd draft	February 23, 2012
Final SAP received	March 5, 2012
SAP approved	March 9, 2012
Sampling dates	March 16, 2012
Draft data report received	June 8, 2012
DMMP comments provided on draft report	June 15, 2012
Final data report received	November 16, 2012
DAIS Tracking number	SALMO-1-A-F-325

USACE Permit Application Number	NWS-2012-1261
Recency Determination (high rank = 2 years)	March 2014

4. Project Ranking and Sampling Requirements. The Salmon Bay Marina project was ranked "high" due to its location on the Lake Washington Ship Canal (DMMP, 2008a).

   In a high-ranked area the number of samples and analyses are calculated using the following guidelines (DMMP, 2008a):
   - Maximum volume of sediment represented by each field sample (typically a 4-foot core) = 4,000 cubic yards
   - Maximum volume of sediment represented by each analysis in the upper 4-feet of the dredging prism (surface sediment) = 4,000 cubic yards
   - Maximum volume of sediment represented by each analysis beyond the upper 4-feet of the dredging prism (subsurface sediment) = 12,000 cubic yards

   Figure 2a shows the bathymetry at Salmon Bay Marina, with the -18 foot contour in bold. As can be seen in the figure, the existing mudline elevation drops off steeply on the northeast side of the dredge prism. Rather than calculating the surface volume as the upper 4-feet of sediment across the entire project, as is done for the majority of DMMP projects, the contractor – at the direction of the DMMP agencies – defined the surface volume as everything above -12 feet (highlighted in Figure 2a). This modification in the definition of surface material was used in order to make the resulting dredged material management units (DMMUs) more dredgeable. Using this modified definition, the surface volume was calculated to be 4,600 cubic yards, while the subsurface volume was calculated to be 7,300 cubic yards. The DMMP agencies required the surface material to be split into two DMMUs (DMMUs 1 and 2), while the subsurface material was represented by a single DMMU (DMMU 3). Two sampling stations were required within each surface DMMU, for a total of four stations. Surface material (mudline to -12 feet) from the two stations within each surface DMMU was to be composited to represent that DMMU (as shown in Figure 2a). Subsurface material (-12 to -18 feet) was to be composited across all four stations to represent DMMU 3 (as highlighted in Figure 2b).

5. Sampling. Field sampling took place March 16, 2012 using a vibracore sampler. Table 2 includes the coring data, while Table 3 shows how the samples were composited for analysis. Figure 3 shows both the target and actual sampling locations.

   As can be seen from Figure 3, between two and five attempts were made at each sampling station. Stiff silt/clay was encountered at each station, resulting in refusal before the design depth could be reached. Only two samples representing subsurface DMMU 3 could be retrieved, both from station 2-1. None of the planned z-samples were able to be collected. However, samples of the stiff silt/clay were retrieved from the bottom of two of the cores at station 2-2 and archived for separate analysis. These two samples were ultimately used to characterize the native material and the sediment to be exposed by dredging.

6. Chemical Analysis. The approved SAP was followed and the resulting analytical data were deemed adequate to characterize the proposed dredged material. In addition to the analysis of composited samples representing the three DMMUs, the two samples of native material from station

2-2 were analyzed. The sediment conventional and chemistry results can be found in Table 4. The core logs clearly showed a soft, black, organic layer of silt overlying either dense sand or stiff inorganic silt/clay. But because the sediment was composited vertically over the entire depth of each DMMU, the grain-size data reflect the average characteristics of sediment in the DMMUs. All three DMMUs had sizable sand, silt and clay fractions. The samples of native material were also a mixture of sand, silt and clay, with a somewhat smaller silt component than found in the DMMUs. The total organic carbon content ranged from 0.26 to 0.88% for the DMMUs, and only 0.13 to 0.15% for the native material. The low organic-carbon concentrations for the DMMUs are indicative of the relatively thin layer of organic silt lying at the surface of the DMMUs compared to the larger bulk of deeper inorganic sediment.

The chemical testing results indicated that DMMU 1 was moderately contaminated – primarily polycyclic aromatic hydrocarbons (PAHs) – with multiple exceedances of DMMP screening levels (SLs). DMMU 1 also exceeded the bioaccumulation triggers (BTs) for porewater tributyltin (TBT) and fluoranthene. DMMU 2 had a single SL/BT exceedance – this being for porewater TBT. DMMU 3 and the two samples of native material had no SL exceedances, and TBT was undetected in all three of these samples.

The dioxin concentrations for DMMUs 1, 2 and 3 were 16.7, 3.4 and 0.16 parts per trillion (pptr) toxicity equivalents (TEQ, with nondetects = ½ estimated detection limit) respectively. The two samples of native material had concentrations of 0.95 and 0.20 pptr TEQ. Dioxin results with both laboratory and validation qualifiers are included in Table 5. TEQ calculations are shown in Table 6.

The organic data underwent Stage 4 validation. Other data were subjected to Stage 3 validation. All validation was conducted by Hart Crowser. There were numerous minor quality control issues with the chemistry data, but none that impacted the overall utility of the data in making this suitability determination. For example, the antimony data were rejected for all samples except DMMU 1 due to low matrix spike recovery, and oxychlordane (a component of total chlordane) results for two samples were rejected due to zero recovery in the standard reference material. In the case of antimony, the one sample for which the result was not rejected had a concentration of only 0.6 mg/kg – far below the SL of 150 mg/kg. This occurred in DMMU 1, the sample that otherwise had the highest chemistry, indicating that antimony is not an issue for this project. Similarly, with respect to oxychlordane, none of the other constituents of total chlordane were found in any of the samples, leading the DMMP agencies to conclude that the two rejected oxychlordane results are inconsequential for this project. Other quality control exceedances resulted in data being qualified, but not rejected, for use (Pentec, 2012b).

7. Sediment Exposed by Dredging. Sediment exposed by dredging must either meet the State of Washington Sediment Quality Standards (SQS) (Ecology, 1995) or the State's antidegradation standard (DMMP, 2008b). For this project, dredging will remove the layer of soft, black, organic silt that now blankets the site. What will be exposed is native material, represented by the two samples collected during sampling. Results from the analysis of these samples are compared to SQS in Table 7. The only detected chemicals in the native material were metals and phenol, all of which had concentrations far below SQS.

   Reporting limits for nondetects were also below SQS for most chemicals, with the exception of the carbon-normalized reporting limits for the dichlorobenzenes, trichlorobenzene and butylbenzyl

phthalate. However, the organic-carbon content for these samples was extremely low, thus driving up the carbon-normalized detection limits. The Department of Ecology does not recommend carbon-normalization when the total organic carbon concentration is below 0.5% (PSEP, 1997). The carbon content of the native material samples was well below this threshold. A comparison of the dry-weight concentrations for these compounds against the DMMP guidelines shows that the detection limits were far below the SLs. Based on the evidence, the agencies agreed that the carbon-normalized detection-limit exceedances of SQS are inconsequential.

In summary, there is no reason to believe that there are any chemicals of concern present above SQS in the sediment that will be exposed by dredging.

8. Suitability Determination. Based on the sampling and testing results, the DMMP agencies determined that the soft, black layer of silt that has accumulated over the entire project is unsuitable for open-water disposal. This material exceeded the BT for TBT in both DMMUs 1 and 2. Within DMMU 1, this layer of silt also exceeded the maximum concentration of dioxins/furans allowed for open-water disposal (10 pptr TEQ) without bioaccumulation testing. There were also numerous SL exceedances. The dredging proponent decided not to pursue bioassays or bioaccumulation testing for this material and accepted the finding that it is unsuitable for open-water disposal without further testing. The two samples of native material did not have any SL or BT exceedances and, therefore, did not require bioassays or bioaccumulation testing. The native material is suitable for open-water disposal.

As documented previously, sampling of the proposed dredged material could not be conducted as planned due to the presence of native material at shallow depths. The DMMP agencies determined that continued use of the dredged material management units, as originally conceived, would result in contaminated silt at the outer fringes of DMMU 3 being taken to the Elliott Bay site, while significant quantities of clean native material in the deeper portions of DMMUs 1 and 2 would be taken to an upland disposal facility. Therefore, in consultation with the DMMP agencies, Hart Crowser and PND Engineers developed an alternative plan to separate suitable from unsuitable material.

Based on a review of sampling and testing data collected for the present project, plus data from a 1999 study conducted for Marco Shipyard and Salmon Bay Marina (SAIC, 1999), Hart Crowser sketched cross-sections through the dredge prism to show the approximate depth of the contaminated silt layer overlying clean native material. These cross-sections are shown in Figures 4 and 5 (see Figure 3 for the location of these cross-sections). The white breaks in the sketch indicate areas where sampling data were not available. Based on this review, PND Engineers proposed removing the upper 1.5 feet of sediment over the entire project footprint and disposing of it in an upland disposal facility. The DMMP agencies independently verified the depth of the contaminated silt layer (see Table 8) by analyzing the core logs and estimating the maximum possible thickness of this layer. The analysis corroborated the estimated thickness of 1.5 feet.

To ensure that all the contaminated material is removed, the DMMP agencies will require an additional 1-foot vertical buffer to be included when separating suitable from unsuitable material. This means that 2.5 feet of material will need to be removed over the entire project footprint and taken to an upland disposal facility. The total volume of material in this top 2.5-foot dredge lift is 3,563 cubic yards. The remainder of the project material, a volume of 8,337 cubic yards, is native

material and may be disposed of at the Elliott Bay open-water disposal site. This is contingent upon approval of a dredging quality control plan, as follows.

A pre-dredge meeting with DNR, Ecology, EPA and the Corps of Engineers is required at least 7 days prior to dredging. A dredging quality control plan must be developed and submitted to the Regulatory Branch of the Seattle District Corps of Engineers at least 7 days prior to the pre-dredge meeting. The dredging quality control plan must clearly show how the top 2.5 feet of material will be dredged separately from the underlying native material. Dredging, positioning, de-watering, transloading and disposal will all need to be addressed with enough detail to provide assurance to the agencies that the dredge plan will be properly implemented. The unsuitable material must be completely dredged and removed before the native material may be dredged and taken to the Elliott Bay site. A bathymetric survey will be required after the top 2.5 feet of material have been dredged to verify that the unsuitable material has been completely removed. The dredging plan should also include a contingency in the event that more of the soft black silt is encountered during dredging of the suitable material.

A DNR site-use authorization must be acquired for open-water disposal. Disposal at the Elliott Bay site must be by bottom-dump barge.

This suitability determination does ***not*** constitute final agency approval of the project. During the public comment period that 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.

9. References.

DMMP, 2008a. *Dredged Material Evaluation and Disposal Procedures (Users Manual)*. Prepared by the Seattle District Dredged Material Management Office for the Dredged Material Management Program, July 2008.

DMMP, 2008b. *Quality of Post-Dredge Sediment Surfaces (Updated).* A Clarification Paper Prepared by David Fox (USACE), Erika Hoffman (EPA) and Tom Gries (Ecology) for the Dredged Material Management Program, June 2008.

DMMP, 2010. *Dredged Material Management Program – New Interim Guidelines for Dioxin.* DMMP agencies, December 2010.

Ecology, 1995. *Sediment Management Standards – Chapter 173-204 WAC*. Washington State Department of Ecology, December 1995.

Pentec, 2012a. *Sampling and Analysis Plan, Salmon Bay Marina, 2100 West Commodore Way Seattle, Washington.* Prepared by Pentec Environmental for PND Engineers, March 2012.

Pentec, 2012b. *Dredge Material Characterization, Salmon Bay Marina, 2100 West Commodore Way, Seattle, Washington.* Prepared by Pentec Environmental for PND Engineers, November 2012.

PSEP, 2007. *Recommended Guidelines for Measuring Organic Compounds in Puget Sound Water, Sediment and Tissue Samples – Appendix D, Organic Carbon Normalization of Sediment Data.* Based on work by Teresa Michelsen and Kathryn Bragdon-Cook. Published by the Puget Sound Water Quality Action Team for U.S. EPA, Region 10, April 2007.

SAIC , 1999. *Draft Sediment Characterization of Marco Shipyard and Salmon Bay Marina, Salmon Bay, Washington*. Prepared by Science Applications International Corporation for the Law Offices of Bruce W. Hilyer and Draper Machine Works, dba Salmon Bay Marina. July 15, 1999.

10. Agency Signatures.

The signed document is on file in the Dredged Material Management Office.

Concur:

_____ _____
Date David Fox, P.E. - Seattle District Corps of Engineers

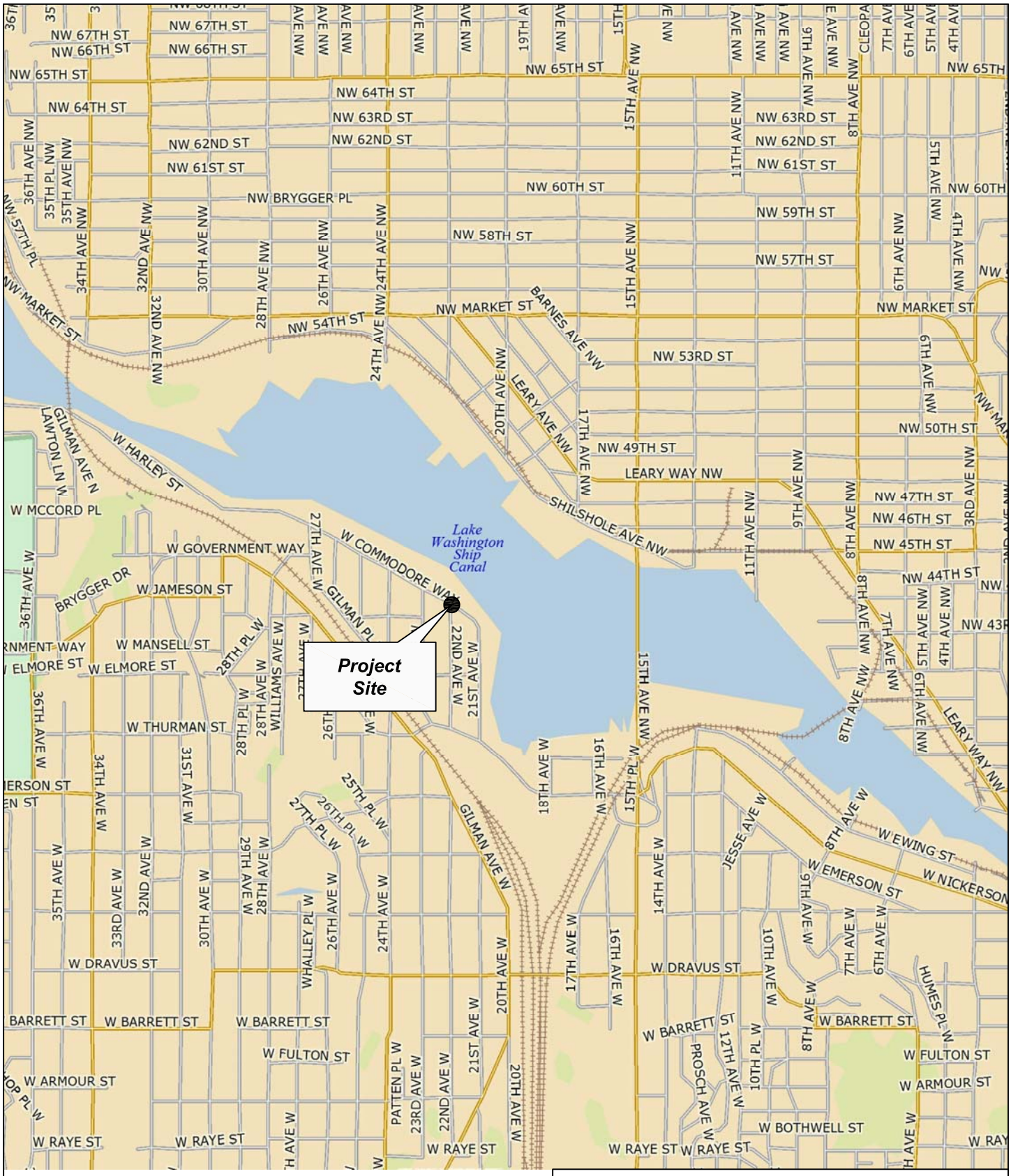
_____ _____
Date Justine Barton - Environmental Protection Agency

_____ _____
Date Laura Inouye, Ph.D. - Washington Department of Ecology

_____ _____
Date Celia Barton - Washington Department of Natural Resources

Copies furnished:

DMMP signatories
Jacalen Printz – Seattle District Regulatory
Roger McGinnis – Hart Crowser
Laura Gurley – PND Engineers



Source: Base map prepared from DeLorme Topo 7.0, 2007.

0 1500 3000

Scale in Feet

N

Salmon Bay Marina
Seattle, Washington

Vicinity Map

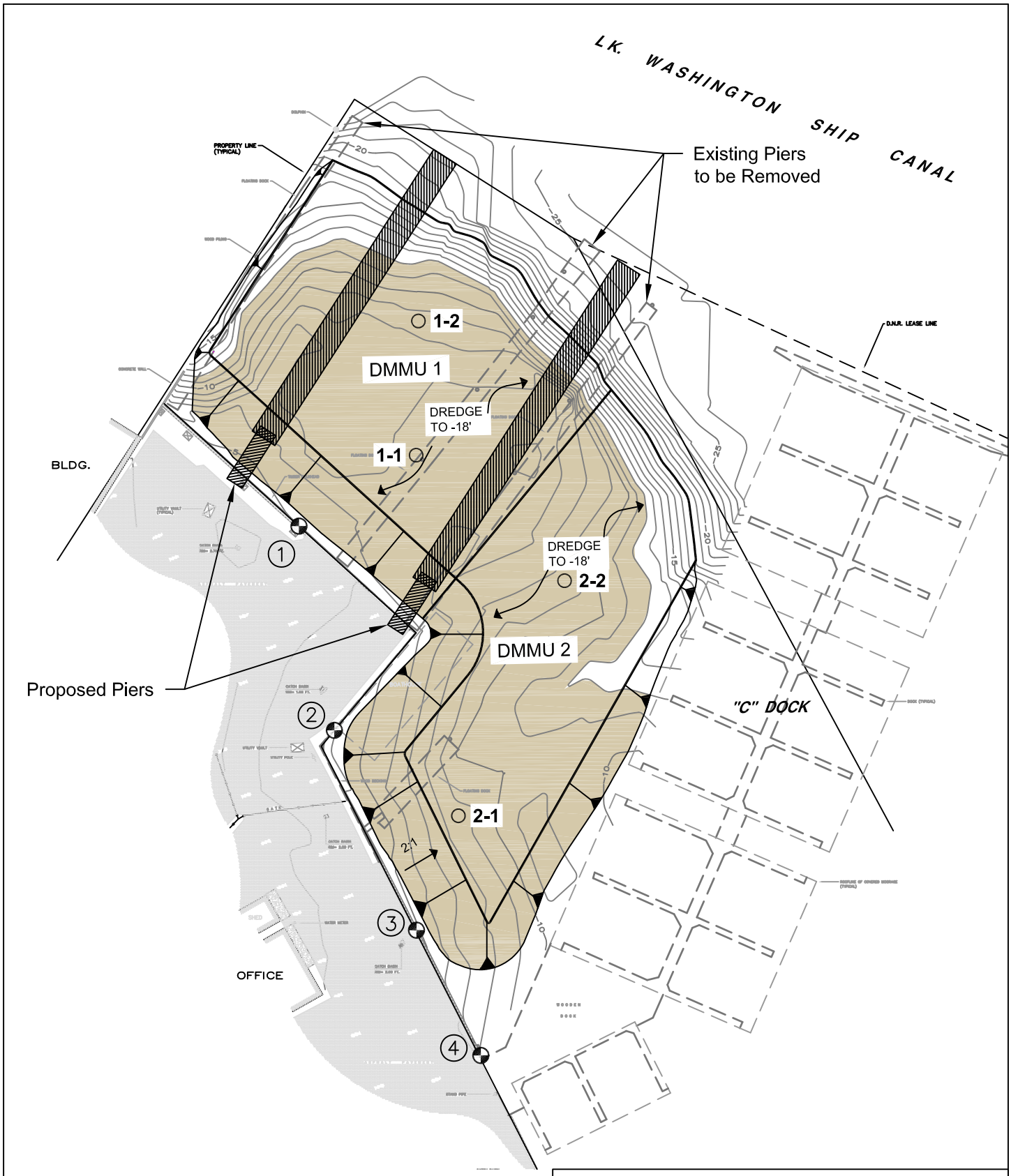
12132-26 9/11

HARTCROWSER

Figure

1

EAL 09/28/11 1213226-003.dwg



1-1 ○ Proposed Sample Location and Number

① Approximate Outfall Location and Number

0 60 120

Scale in Feet

N

Salmon Bay Marina
Seattle, Washington

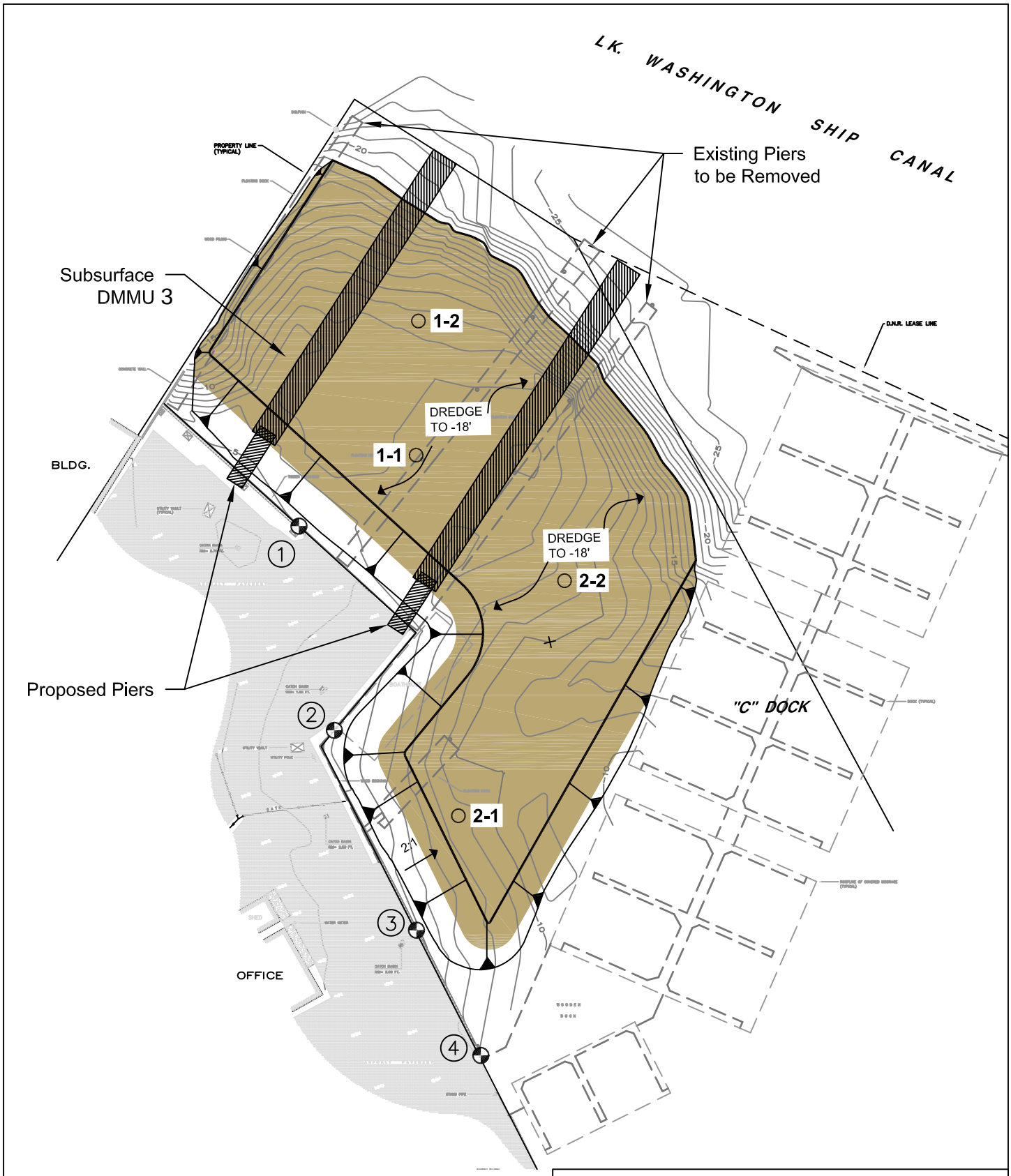
Site Plan - Surface DMMU
(from the sampling plan)

12132-26 3/12

HARTCROWSER

Figure
2a

EAL 03/5/12 1213226-005.dwg



1-1 ○ Proposed Sample Location and Number

① ⊕ Approximate Outfall Location and Number

0 60 120

Scale in Feet

N

Salmon Bay Marina
Seattle, Washington

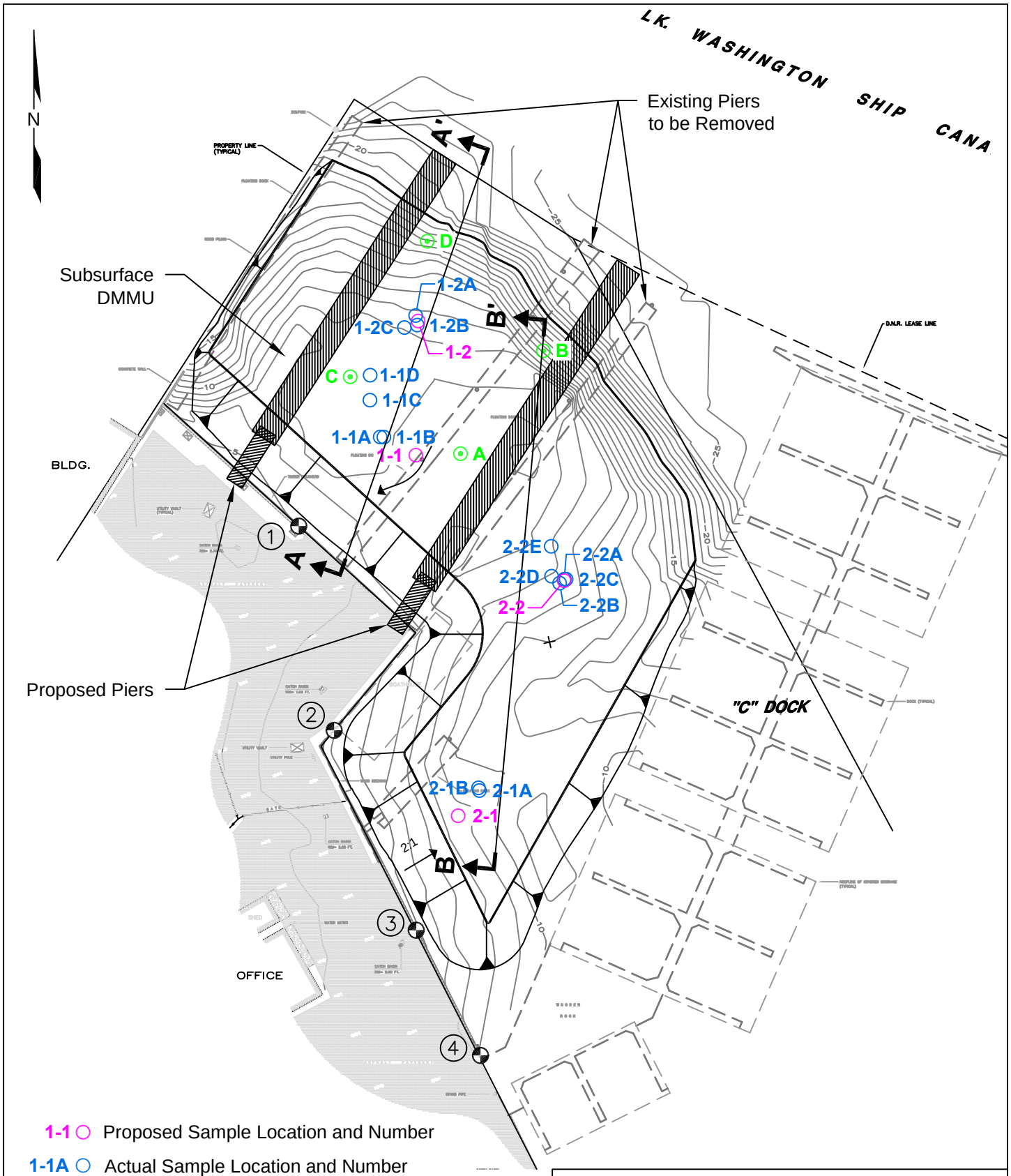
Site Plan - Subsurface DMMU
(from the sampling plan)

12132-26 3/12

HARTCROWSER

Figure
2b

EAL 03/5/12 1213226-007.dwg



1-1 ○ Proposed Sample Location and Number

1-1A ○ Actual Sample Location and Number

A ⊙ Marco Lease Core Sample Location and Designation

① Approximate Outfall Location and Number

A A' Cross Section Location and Designation

0 60 120

Scale in Feet

Salmon Bay Marina
Seattle, Washington

DMMU and Core Location Plan

12132-26 11/12

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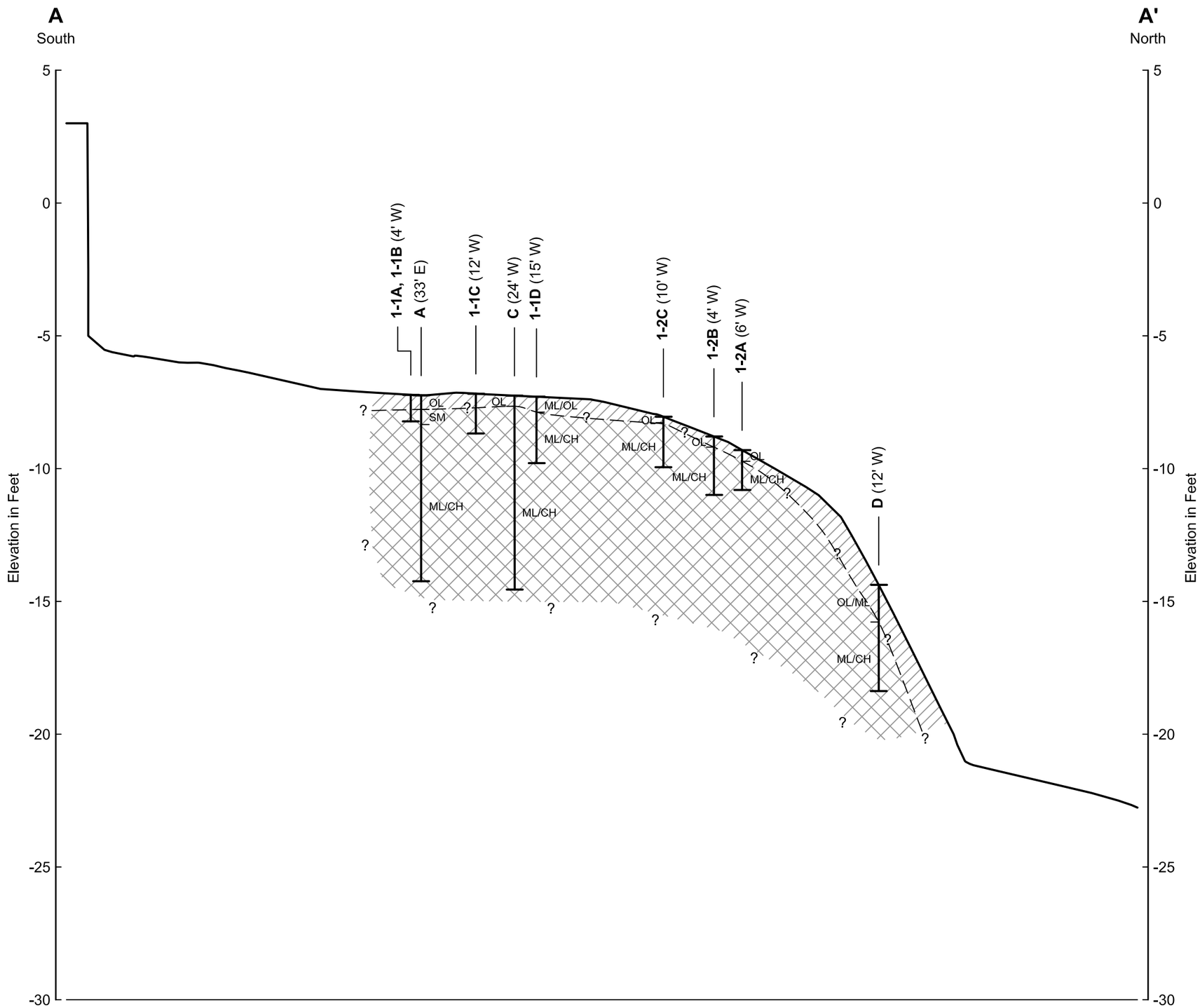
Figure
3

EAL 11/14/12 1213226-008.dwg



1-1D (15' W) Exploration Number (Offset Distance and Direction)

Exploration Location

Inorganic and Organic Silts with Varying Amounts of Wood and Plant Debris

Native Sandy Silt/Clay

Unified Soil Classification Symbols:

SM	Silty sands, sand-silt mixtures
OL	Organic silts and organic silty clays of low plasticity
ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity
CH	Inorganic clays of high plasticity

Notes:
1. Vibracore logs were corrected for compaction.
2. See Figure 3 for cross section location.

Horizontal Scale in Feet
0 20 40
0 4 8
Vertical Scale in Feet
Vertical Exaggeration x 5

Salmon Bay Marina
Seattle, Washington

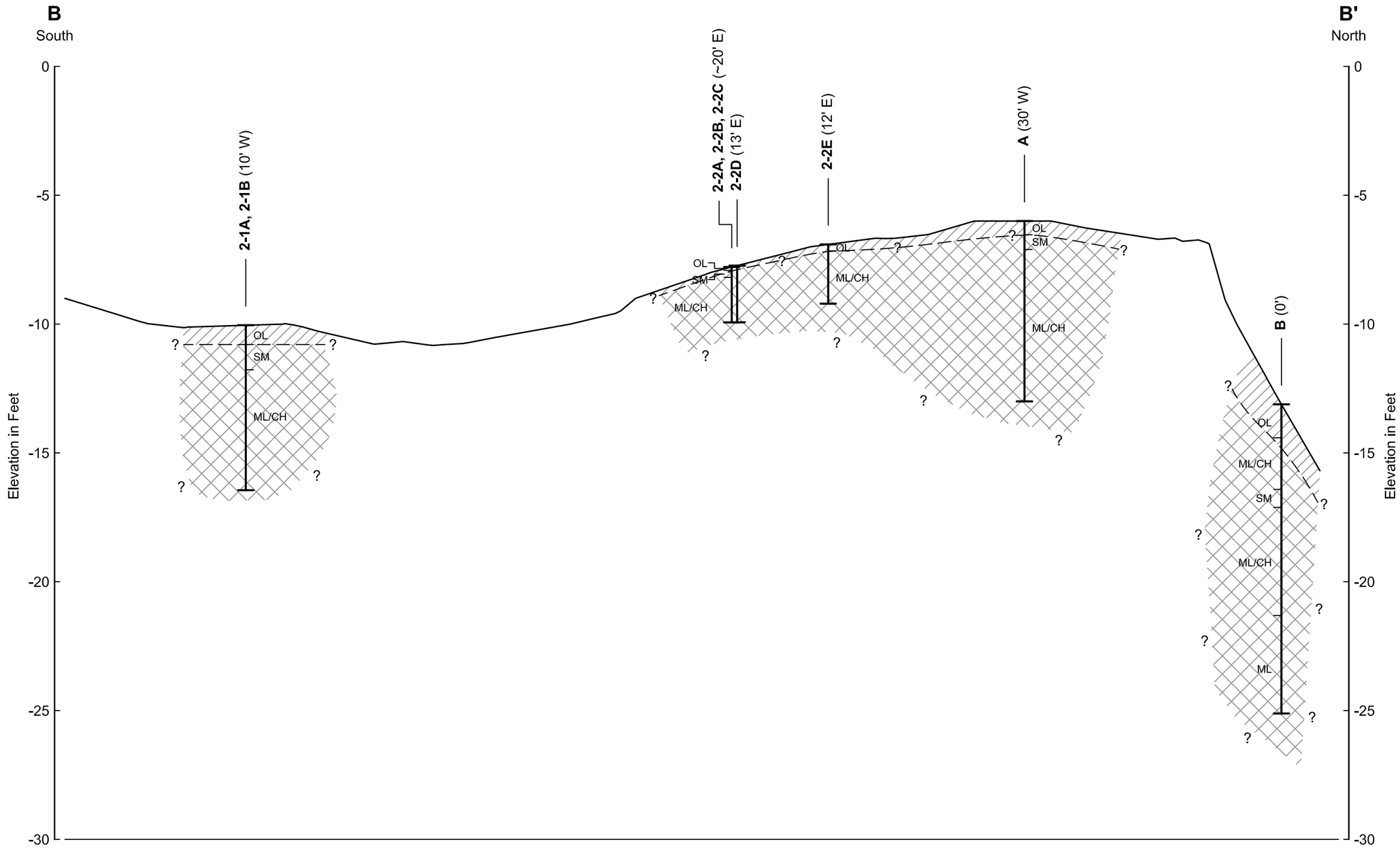
Generalized Cross Section A-A'

12132-26 7/12

HARTCROWSER

Figure **4**

EAL 07/9/12 1213226-009.dwg



2-2E (12' E) Exploration Number (Offset Distance and Direction)

Exploration Location

Inorganic and Organic Silts with Varying Amounts of Wood and Plant Debris

Native Sandy Silt/Clay with Silty Sand with Trace Gravel

Unified Soil Classification Symbols:

SM	Silty sands, sand-silt mixtures
OL	Organic silts and organic silty clays of low plasticity
ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands,or clayey silts with slight plasticity
CH	Inorganic clays of high plasticity

Notes:
1. Vibracore logs were corrected for compaction.
2. See Figure 3 for cross section location.

Horizontal Scale in Feet
0 20 40
0 4 8
Vertical Scale in Feet
Vertical Exaggeration x 5

Salmon Bay Marina
Seattle, Washington

Generalized Cross Section B-B'

12132-26 7/12

HARTCROWSER

Figure **5**

EAL 07/10/12 1213226-010.dwg

Table 2 - Coring Data

Sample Location	Sample Replicate	Latitude	Longitude	Mudline Elevation in Feet (LWSC)	Penetration Depth[a] (ft)	Recovered Core Length[b] (ft)
1-1	A	47.660870	122.383925	-7.65	0.50	---[c]
	B	47.660870	122.383918	-7.65	1.00	---[c]
	C	47.660915	122.383945	-7.65	1.50	---[d]
	D	*	*	-7.65	2.50	1.30
1-2	A	47.661020	122.383865	-8.35	1.50	1.10
	B	47.661008	122.383862	-8.00	2.20	1.70
	C	47.661005	122.383885	-7.95	1.90	1.70
2-1	A	47.660438	122.383732	-9.60	5.88	6.10
	B	47.660442	122.383733	-9.75	6.38	5.70
2-2	A	47.660700	122.383585	-8.25	2.15	1.60
	B	47.660695	122.383593	-8.15	2.00	2.20
	C	47.660700	122.383582	-8.15	2.50	---[e]
	D	47.660703	122.383608	-7.81	2.20	---[e]
	E	47.660740	122.383610	-7.63	2.30	2.80

Notes:

- horizontal datum = WGS84

- LWSC = Lake Washington Ship Canal vertical datum

a - Refusal was encountered at every sampling station due to native material.

b - from core logs

c - Insufficient sample volume was collected at replicates 1-1A and 1-1B to retain for analysis.

d - An intact core could not be collected; sediment from 1-1C was collected in an HDPE bucket, and no core log was created.

e - Sediment was lost from replicates 2-2C and 2-2D due to lack of core fingers in the core tube. Some sediment from 2-2C was retained in a container, but no core log was created.

*Station location was inaccurate. The DGPS antenna was displaced during coring operations. Approximate location is shown on Figure 3.

Table 3 - Compositing Plan

DMMU Number	Laboratory Sample Identification	Composite Core Sample Identification [a]	Sample Depths[b] (ft) (referenced to mudline)
DMMU-1 [c]	DMMU-1-C1	1-1C 1-1D 1-2A 1-2B 1-2C	0 - 1.5[g] 0 - 2.5 0 - 1.5 0 - 2.2 0 - 1.9
DMMU-2 [d, e]	DMMU-2-C2	2-1A 2-1B 2-2A 2-2B	0 - 1.9 0 - 2.2 0 - 2.15 0 - 1.8
DMMU-3	DMMU-3-C3	2-1A 2-1B	1.9 - 5.88 2.2 - 6.38
Native Material[f]	2-2B-Bottom 2-2C-Bottom	2-2B 2-2C[d]	1.8 - 2.0 2.3 - 2.5

Note:

a - See Figure 3 for sample locations.

b - Based on penetration depths.

c - Insufficient sample volume was collected at replicates 1-1A and 1-1B to include in the composite sample for DMMU-1.

d - Sediment was lost from replicates 2-2C and 2-2D due to lack of core fingers in the core tube. Some native sediment from the bottom of 2-2C was retained in a container, but no core log was created.

e - Sediment from replicate 2-2E was not included in the sample composite, as sufficient sediment was available in replicates 2-2A and 2-2B for the composite sample.

f - Very stiff to hard native silt/clay was analyzed from samples 2-2B Bottom and 2-2C Bottom.

g - An intact core could not be collected; sediment from 1-1C was collected in an HDPE bucket; no core log was created.

Table 4 - Dry-Weight Analytical Results for Sediment Samples

Sample ID		DMMP		DMMU-1-C1	DMMU-2-C2	DMMU-3-C3
Sampling Date	SL	BT	ML	3/21/2012	3/21/2012	3/21/2012
Conventionals in %						
Preserved Total Solids				52.2	21.9	79.4
Total Solids				59.1	71.2	77
Total Volatile Solids				3.97	2.98	2.49
Total Organic Carbon				0.884	0.602	0.261
Conventionals in mg/kg						
Ammonia (NH3) as Nitrogen (N)				13.4	5.3	23.6
Sulfide				234	725	1.22 U
Grain Size in %						
Particle/Grain Size, Gravel				15.6	6.5	1.7
Particle/Grain Size, Sand				42.9	37.3	32.5
Particle/Grain Size, Silt				24	27.8	34.5
Particle/Grain Size, Clay				17.8	28.4	31.3
METALS (mg/kg)						
Antimony	150	---	200	0.6 J	0.017 R	0.016 R
Arsenic	57	507.1	700	9.3	2.9	4.5
Cadmium	5.1	11.3	14	0.3	0.2	0.015 U
Chromium	260	260	---	32.4	48.1	43.2 J
Copper	390	1,027	1,300	93.5	36.9	31.9
Lead	450	975	1,200	40	14	4.0
Mercury	0.41	1.5	2.3	0.14	0.09	0.04
Selenium	--	3	--	0.17 U	0.13 U	0.12 U
Silver	6.1	6.1	8.4	0.014 U	0.01 U	0.01 U
Zinc	410	2,783	3,800	166	75	60
ORGANOMETALLIC COMPOUNDS						
Tributyltin Ion	0.15	0.15	--	0.76	0.46	0.005 U
Interstitual water (ug/L)						
TBT-Bulk (ug/kg)	73	73	--			
ORGANICS (ug/kg)						
PAHs						
Total LPAH [1]	5,200	---	29,000	11640 J	188 J	15 J
Naphthalene	2,100	---	2,400	590	39	2.5 U
Acenaphthylene	560	---	1,300	150 J	5.5 U	5.1 U
Acenaphthene	500	---	2,000	1300 J	16 JT	3.0 U
Fluorene	540	---	3,600	1600 J	24 J	3.9 U
Phenanthrene	1,500	---	21,000	5300 J	85 J	15 JT
Anthracene	960	---	13,000	2700 J	24 J	4.1 U
2-Methylnaphthalene[1]	670	---	1,900	300 J	15 JT	2.8 U
1-Methylnaphthalene				110	2.6 U	2.4 U
Total HPAH	12,000	---	69,000	31340 J	591 J	37.9 J
Fluoranthene	1,700	4,600	30,000	7900 J	130 J	14 JT
Pyrene	2,600	11,980	16,000	6700 J	120 J	14 JT
Benzo(a)anthracene	1,300	---	5,100	3800 J	44 J	3.0 U
Chrysene	1,400	---	21,000	3400 J	59 J	3.4 U
Total Benzofluoranthenes[3]	3,200	---	9,900	4800	95	9.9 T
Benzo(a)pyrene	1,600	---	3,600	2500 J	50 J	4.9 U
Indeno(1,2,3-cd)pyrene	600	---	4,400	930 J	34 J	4.2 U
Dibenz(a,h)anthracene	230	---	1,900	350 J	14 JT	3.9 U
Benzo(g,h,i)perylene	670	---	3,200	960 J	45 J	4.0 U

Table 4 - Dry-Weight Analytical Results for Sediment Samples

Sample ID		DMMP		DMMU-1-C1	DMMU-2-C2	DMMU-3-C3
Sampling Date	SL	BT	ML	3/21/2012	3/21/2012	3/21/2012
CHLORINATED HYDROCARBONS						
1,4-Dichlorobenzene	110	---	120	17 JT	2.7 U	2.6 U
1,2-Dichlorobenzene	35	---	110	2.4 U	2.4 U	2.3 U
1,2,4-Trichlorobenzene	31	---	64	3.4 U	3.3 U	3.1 U
Hexachlorobenzene	22	168	230	4.2 U	4.1 U	3.9 U
PHTHALATES (2)						
Dimethylphthalate	71	---	1,400	23	2.8 U	2.6 U
Diethylphthalate	200	---	1,200	36 U	35 U	33 U
Di-n-Butylphthalate	1,400	---	5,100	8.0 U	7.8 U	7.4 U
Butylbenzylphthalate	63	---	970	6.0 U	5.9 U	5.5 U
bis(2-Ethylhexyl)phthalate	1,300	---	8,300	330 J	120 J	45 J
Di-n-Octyl phthalate	6,200	---	6,200	74 J	5.6 U	5.3 U
ACID EXTRACTABLES						
Phenol	420	---	1,200	47 J	8.3 U	7.8 U
2-Methylphenol	63	---	77	11 T	5.0 U	4.7 U
4-Methylphenol	670	---	3,600	140	12 T	6.0 U
2,4-Dimethylphenol	29	---	210	12 JT	3.3 UJ	3.1 UJ
Pentachlorophenol	400	504	690	47 UJ	46 UJ	44 UJ
Benzyl Alcohol	57	---	870	5.9 U	5.8 U	5.5 U
Benzoic Acid	650	---	760	240 T	110 T	91 U
MISCELLANEOUS EXTRACTABLES						
Dibenzofuran	540	---	1700	420 J	18 JT	3.7 U
Hexachlorobutadiene	11	---	270	4.5 U	4.4 U	4.1 U
N-Nitrosodiphenylamine	28	---	130	50 J	5.2 U	4.9 U
PESTICIDES & PCBs (ug/kg)						
4,4'-DDE	9	---	---	0.12 U	0.11 U	0.12 U
4,4'-DDD	16	---	---	0.13 U	0.13 U	0.13 U
4,4'-DDT	12	---	---	0.18 U	0.18 U	0.18 U
Total DDT		50	69	0.18 U	0.18 U	0.18 U
Aldrin	9.5	---	---	0.053 U	0.051 U	0.051 U
Total Chlordane (3)	2.8	37	---	1.4 U	0.76 U	0.77 U
Dieldrin	1.9	---	1,700	0.096 U	0.093 U	0.093 U
gamma-BHC (Lindane)				0.046 U	0.045 U	0.045 U
Heptachlor	1.5	---	270	0.13 UJ	0.12 UJ	0.12 UJ
Hexachlorobenzene	22	160	230	0.09 U	0.087 U	0.088 U
Hexachlorobutadiene	11	---	270	0.13 U	0.13 U	0.13 U
Total PCBs	130	38	3,100	91 J	16 J	1.3 U

Table 4 - Dry-Weight Analytical Results for Sediment Samples

Sample ID		DMMP		2-2B-BOTTOM	2-2C-BOTTOM
Sampling Date	SL	BT	ML	3/21/2012	3/21/2012
Conventionals in %					
Preserved Total Solids					
Total Solids				84.1	85
Total Volatile Solids				2.17	1.74
Total Organic Carbon				0.133	0.154
Conventionals in mg/kg					
Ammonia (NH3) as Nitrogen (N)				1.44	1.32
Sulfide					
Grain Size in %					
Particle/Grain Size, Gravel				7.9 J	9.7 J
Particle/Grain Size, Sand				33.6 J	40.7 J
Particle/Grain Size, Silt				19.7 J	22.4 J
Particle/Grain Size, Clay				38.8 J	27.4 J
METALS (mg/kg)					
Antimony	150	---	200	0.2 R	0.2 R
Arsenic	57	507.1	700	6.4	2.8
Cadmium	5.1	11.3	14	0.1 U	0.1 U
Chromium	260	260	---	48.2	38.6
Copper	390	1,027	1,300	23.4	17.7
Lead	450	975	1,200	4.0	3.0
Mercury	0.41	1.5	2.3	0.04	0.03
Selenium	--	3	--	0.6 U	0.6 U
Silver	6.1	6.1	8.4	0.2 U	0.2 U
Zinc	410	2,783	3,800	43	38
ORGANOMETALLIC COMPOUNDS					
Tributyltin Ion	0.15	0.15	--		
Interstitual water (ug/L)					
TBT-Bulk (ug/kg)	73	73	--	3.1 UJ	3.8 UJ
ORGANICS (ug/kg)					
PAHs					
Total LPAH (1)	5,200	---	29,000	8.4 UJ	5.4 UJ
Naphthalene	2,100	---	2,400	4.1 UJ	2.6 UJ
Acenaphthylene	560	---	1,300	8.4 U	5.4 U
Acenaphthene	500	---	2,000	4.9 UJ	3.1 UJ
Fluorene	540	---	3,600	6.4 UJ	4.1 UJ
Phenanthrene	1,500	---	21,000	5.4 UJ	3.4 UJ
Anthracene	960	---	13,000	6.7 UJ	4.2 UJ
2-Methylnaphthalene(1)	670	---	1,900	4.5 UJ	2.9 UJ
1-Methylnaphthalene				4.0 UJ	2.5 UJ
Total HPAH	12,000	---	69,000	8.1 UJ	5.1 UJ
Fluoranthene	1,700	4,600	30,000	4.3 UJ	2.7 UJ
Pyrene	2,600	11,980	16,000	2.9 UJ	1.8 UJ
Benzo(a)anthracene	1,300	---	5,100	4.9 UJ	3.1 UJ
Chrysene	1,400	---	21,000	5.5 U	3.5 U
Total Benzofluoranthenes(3)	3,200	---	9,900	4.1 UJ	2.6 UJ
Benzo(a)pyrene	1,600	---	3,600	8.1 UJ	5.1 UJ
Indeno(1,2,3-cd)pyrene	600	---	4,400	6.9 UJ	4.4 UJ
Dibenz(a,h)anthracene	230	---	1,900	6.4 U	4.1 U
Benzo(g,h,i)perylene	670	---	3,200	6.5 UJ	4.2 UJ

Table 4 - Dry-Weight Analytical Results for Sediment Samples

Sample ID		DMMP		2-2B-BOTTOM	2-2C-BOTTOM
Sampling Date	SL	BT	ML	3/21/2012	3/21/2012
CHLORINATED HYDROCARBONS					
1,4-Dichlorobenzene	110	---	120	4.2 U	2.7 U
1,2-Dichlorobenzene	35	---	110	3.7 U	2.4 U
1,2,4-Trichlorobenzene	31	---	64	5.1 U	3.3 U
Hexachlorobenzene	22	168	230	6.3 U	4.0 U
PHTHALATES (2)					
Dimethylphthalate	71	---	1,400	4.3 UJ	2.7 UJ
Diethylphthalate	200	---	1,200	54 U	35 U
Di-n-Butylphthalate	1,400	---	5,100	12 U	7.7 U
Butylbenzylphthalate	63	---	970	9.1 UJ	5.8 UJ
bis(2-Ethylhexyl)phthalate	1,300	---	8,300	47 U	14 U
Di-n-Octyl phthalate	6,200	---	6,200	8.6 U	5.5 U
ACID EXTRACTABLES					
Phenol	420	---	1,200	84	39
2-Methylphenol	63	---	77	7.8 U	5.0 U
4-Methylphenol	670	---	3,600	9.8 U	6.3 U
2,4-Dimethylphenol	29	---	210	5.1 UJ	3.3 UJ
Pentachlorophenol	400	504	690	72 UJ	46 UJ
Benzyl Alcohol	57	---	870	9.0 U	5.7 U
Benzoic Acid	650	---	760	150 U	95 U
MISCELLANEOUS EXTRACTABLES					
Dibenzofuran	540	---	1700	6.1 U	3.9 U
Hexachlorobutadiene	11	---	270	6.8 U	4.3 U
N-Nitrosodiphenylamine	28	---	130	8.0 U	5.1 U
PESTICIDES & PCBs (ug/kg)					
4,4'-DDE	9	---	---	0.11 U	0.12 U
4,4'-DDD	16	---	---	0.12 U	0.13 U
4,4'-DDT	12	---	---	0.18 U	0.19 U
Total DDT		50	69	0.18 U	0.19 U
Aldrin	9.5	---	---	0.051 U	0.053 U
Total Chlordane (3)	2.8	37	---	0.76 UJ	0.8 UJ
Dieldrin	1.9	---	1,700	0.092 U	0.097 U
gamma-BHC (Lindane)				0.044 U	0.046 U
Heptachlor	1.5	---	270	0.12 U	0.13 U
Hexachlorobenzene	22	160	230	0.087 U	0.091 U
Hexachlorobutadiene	11	---	270	0.13 U	0.13 U
Total PCBs	130	38	3,100	1.2 U	1.3 U

(1) 2-Methylnaphthalene is not included in the summation for total LPAH.
(2) Based on 1998 LAETs; see
http://www.nws.usace.army.mil/PublicMenu/Doc_list.cfm?sitename=dmmo&pagename=17th_ARM_MAy_5_2004
(3) Components of benzofluoranthenes and chlordane were clarified at the 2007 SMARM.
U = Not detected at the reporting limit indicated.
J = Estimated value.
T = Value is between the EDL and RL, or the MDL and the RL.
K = Ion ratios do not meet identification criteria acceptance limits for positive identification.
R = Rejected value.
SL = Screening level.
BT = Bioaccumulation trigger.
ML = Maximum level.
Non-detected results are reported to the MDL.

Table 5. Dioxin/Furan Congener Results (pg/g) (from Pentec, 2012b)

Chemical	DMMU-1-C1			DMMU-2-C2			DMMU-3-C3			2-2B-BOTTOM			2-2C-BOTTOM		
	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ	Result	LQ	VQ
1,2,3,4,6,7,8-HpCDD	594			107			4.57			15.2		J	4.31		J
1,2,3,4,6,7,8-HpCDF	74			20.2			0.839	J	T	1.3	J	T	0.275	BJ	T
1,2,3,4,7,8,9-HpCDF	4.73			1.2	J	T	0.024	JEMPC	UK	0.102	J	T	0.0224	U	U
1,2,3,4,7,8-HxCDD	4.84			1.19	J	T	0.048	BJEMPC	UK	0.361	JEMPC	UK	0.11	BJEMPC	UK
1,2,3,4,7,8-HxCDF	4.64			1.01	J	T	0.0086	U	U	0.106	JEMPC	UK	0.0162	U	U
1,2,3,6,7,8-HxCDD	18.2			4.1			0.17	BJ	T	0.617	J	T	0.145	JEMPC	UK
1,2,3,6,7,8-HxCDF	3.41			1.06	J	T	0.0096	U	U	0.138	JEMPC	UK	0.0353	JEMPC	UK
1,2,3,7,8,9-HxCDD	10.8			2.69			0.17	JEMPC	UK	0.577	J	T	0.173	JEMPC	UK
1,2,3,7,8,9-HxCDF	1.5	J	T	0.354	J	T	0.0153	U	U	0.0259	U	U	0.015	U	U
1,2,3,7,8-PeCDD	2.69			0.752	JEMPC	UK	0.036	JEMPC	UK	0.515	J	T	0.155	JEMPC	UK
1,2,3,7,8-PeCDF	1.39	J	T	0.373	JEMPC	UK	0.0066	U	U	0.118	J	T	0.0182	U	U
2,3,4,6,7,8-HxCDF	2.17			0.756	J	T	0.0098	U	U	0.21	BJ	J	0.0177	U	U
2,3,4,7,8-PeCDF	1.81			0.513	J	T	0.0081	U	U	0.122	J	T	0.0111	U	U
2,3,7,8-TCDD	0.371	JEMPC	UK	0.175	BJEMPC	UK	0.0601	BJEMPC	UK	0.0539	BJEMPC	UK	0.0746	BJEMPC	UK
2,3,7,8-TCDF	2.36			0.892	JX	JT	0.0143	U	U	0.0479	JEMPC	UK	0.0097	U	U
OCDD	5600			886			51.3			93.3			41.2		
OCDF	233			46.8			2.35	J	T	2.44	J	T	0.495	BJEMPC	UK
Dioxin/Furan TEQ, nd = 0	16.5			2.9			0.09			0.89			0.06		
Dioxin/Furan TEQ, nd = SDL*0.5	16.7			3.4			0.16			0.95			0.20		

NOTE: EMPC qualified results are treated as non-detects.
dw = dry weight
LQ = laboratory qualifier
nd = nondetect
SDL = sample detection limit
TEQ = toxic equivalent
VQ = validation qualifier

EMPC = estimated maximum possible concentration
J = estimated value less than reporting limit and/or QC parameter out of control limits
U = undetected

Table 6. Dioxin/Furan Toxic Equivalency Calculations (pg/g) (from Pentec, 2012b)

Chemical		DMMU-1-C1		1/2	zero	DMMU-2-C2		1/2	zero	DMMU-3-C3		1/2	zero	2-2B-BOTTOM		1/2	zero	2-2C-BOTTOM		1/2	zero
	TEF	Result	VQ	TEC	TEC	Result	VQ	TEC	TEC	Result	VQ	TEC	TEC	Result	VQ	TEC	TEC	Result	VQ	TEC	TEC
1,2,3,4,6,7,8-HpCDD	0.01	594		5.94	5.94	107		1.07	1.07	4.57		0.046	0.046	15.2	J	0.152	0.152	4.31	J	0.043	0.043
1,2,3,4,6,7,8-HpCDF	0.01	74		0.74	0.74	20.2		0.20	0.20	0.839	T	0.008	0.008	1.3	T	0.013	0.013	0.275	T	0.003	0.003
1,2,3,4,7,8,9-HpCDF	0.01	4.73		0.0473	0.0473	1.2	T	0.01	0.01	0.024	UK	0.000	0.000	0.102	T	0.001	0.001	0.0224	U	0.000	0.000
1,2,3,4,7,8-HxCDD	0.1	4.84		0.484	0.484	1.19	T	0.12	0.12	0.048	UK	0.002	0.000	0.361	UK	0.018	0.000	0.11	UK	0.006	0.000
1,2,3,4,7,8-HxCDF	0.1	4.64		0.464	0.464	1.01	T	0.10	0.10	0.0086	U	0.000	0.000	0.106	UK	0.005	0.000	0.0162	U	0.001	0.000
1,2,3,6,7,8-HxCDD	0.1	18.2		1.82	1.82	4.1		0.41	0.41	0.17	T	0.017	0.017	0.617	T	0.062	0.062	0.145	UK	0.007	0.000
1,2,3,6,7,8-HxCDF	0.1	3.41		0.341	0.341	1.06	T	0.11	0.11	0.0096	U	0.000	0.000	0.138	UK	0.007	0.000	0.0353	UK	0.002	0.000
1,2,3,7,8,9-HxCDD	0.1	10.8		1.08	1.08	2.69		0.27	0.27	0.17	UK	0.017	0.000	0.577	T	0.058	0.058	0.173	UK	0.009	0.000
1,2,3,7,8,9-HxCDF	0.1	1.5	T	0.15	0.15	0.354	T	0.04	0.04	0.0153	U	0.001	0.000	0.0259	U	0.001	0.000	0.015	U	0.001	0.000
1,2,3,7,8-PeCDD	1	2.69		2.69	2.69	0.752	UK	0.38	0.00	0.036	UK	0.018	0.000	0.515	T	0.515	0.515	0.155	UK	0.078	0.000
1,2,3,7,8-PeCDF	0.03	1.39	T	0.0417	0.0417	0.373	UK	0.01	0.00	0.0066	U	0.000	0.000	0.118	T	0.004	0.004	0.0182	U	0.000	0.000
2,3,4,6,7,8-HxCDF	0.1	2.17		0.217	0.217	0.756	T	0.08	0.08	0.0098	U	0.000	0.000	0.21	J	0.021	0.021	0.0177	U	0.001	0.000
2,3,4,7,8-PeCDF	0.3	1.81		0.543	0.543	0.513	T	0.15	0.15	0.0081	U	0.001	0.000	0.122	T	0.037	0.037	0.0111	U	0.002	0.000
2,3,7,8-TCDD	1	0.371	UK	0.19	0	0.175	UK	0.09	0.00	0.0601	UK	0.030	0.000	0.0539	UK	0.027	0.000	0.0746	UK	0.037	0.000
2,3,7,8-TCDF	0.1	2.36		0.236	0.236	0.892	JT	0.09	0.09	0.0143	U	0.001	0.000	0.0479	UK	0.002	0.000	0.0097	U	0.000	0.000
OCDD	0.0003	5600		1.68	1.68	886		0.27	0.27	51.3		0.015	0.015	93.3		0.028	0.028	41.2		0.012	0.012
OCDF	0.0003	233		0.0699	0.0699	46.8		0.01	0.01	2.35	T	0.001	0.001	2.44	T	0.001	0.001	0.495	UK	0.000	0.000
Dioxin/Furan TEQ, nd = 0					16.54				2.92				0.09				0.89				0.06
Dioxin/Furan TEQ, nd = SDL*0.5				16.7				3.4				0.16				0.95				0.20	

NOTE: EMPC qualified results are treated as non-detects.
dw = dry weight
LQ = laboratory qualifier
nd = nondetect
SDL = sample detection limit
TEQ = toxic equivalent
VQ = validation qualifier

EMPC = estimated maximum possible concentration
J = estimated value less than reporting limit and/or QC parameter out of control limits
U = undetected

Table 7 - Analytical Results Compared to SMS

Sample ID	SMS		2-2B-BOTTOM	2-2C-BOTTOM
Sampling Date	SQS	CSL	3/21/2012	3/21/2012
METALS (mg/kg dw)				
Arsenic	57	93	6.4	2.8
Cadmium	5.1	6.7	0.1 U	0.1 U
Chromium	260	270	48.2	38.6
Copper	390	390	23.4	17.7
Lead	450	530	4.0	3.0
Mercury	0.41	0.59	0.04	0.03
Silver	6.1	6.1	0.2 U	0.2 U
Zinc	410	960	43	38
ORGANICS				
PAHs (mg/kg oc)				
Total LPAH [1]	370	780	6.3 UJ	3.5 UJ
Naphthalene	99	170	3.1 UJ	1.7 UJ
Acenaphthylene	66	66	6.3 U	3.5 U
Acenaphthene	16	57	3.7 UJ	2.0 UJ
Fluorene	23	79	4.8 UJ	2.7 UJ
Phenanthrene	100	480	4.1 UJ	2.2 UJ
Anthracene	220	1200	5.0 UJ	2.7 UJ
2-Methylnaphthalene[1]	38	64	3.4 UJ	1.9 UJ
Total HPAH	960	5,300	6.1 UJ	3.3 UJ
Fluoranthene	160	1,200	3.2 UJ	1.8 UJ
Pyrene	1,000	1,400	2.2 UJ	1.2 UJ
Benzo(a)anthracene	100	270	3.7 UJ	2.0 UJ
Chrysene	110	460	4.1 U	2.3 U
Total Benzofluoranthenes[3]	230	450	3.1 UJ	1.7 UJ
Benzo(a)pyrene	99	210	6.1 UJ	3.3 UJ
Indeno(1,2,3-cd)pyrene	34	88	5.2 UJ	2.9 UJ
Dibenz(a,h)anthracene	12	33	4.8 U	2.7 U
Benzo(g,h,i)perylene	31	78	4.9 UJ	2.7 UJ
CHLORINATED HYDROCARBONS (mg/kg oc)				
1,4-Dichlorobenzene	3.1	9	3.2 U	1.8 U
1,2-Dichlorobenzene	2.3	2.3	2.8 U	1.6 U
1,2,4-Trichlorobenzene	0.81	1.8	3.83 U	2.14 U
Hexachlorobenzene	0.38	2.3	0.07 U	0.06 U
PHTHALATES [2] (mg/kg oc)				
Dimethylphthalate	53	53	3.2 UJ	1.8 UJ
Diethylphthalate	61	110	40.6 U	22.7 U
Di-n-Butylphthalate	220	1,700	9.0 U	5.0 U
Butylbenzylphthalate	4.9	64	6.8 UJ	3.8 UJ
bis(2-Ethylhexyl)phthalate	47	78	35.3 U	9.1 U
Di-n-Octyl phthalate	58	4,500	6.5 U	3.6 U
ACID EXTRACTABLES (mg/kg dw)				
Phenol	420	1,200	84	39
2-Methylphenol	63	63	7.8 U	5.0 U
4-Methylphenol	670	670	9.8 U	6.3 U
2,4-Dimethylphenol	29	29	5.1 UJ	3.3 UJ
Pentachlorophenol	360	690	72 UJ	46 UJ
Benzyl Alcohol	57	73	9.0 U	5.7 U
Benzoic Acid	650	650	150 U	95 U
MISCELLANEOUS EXTRACTABLES (mg/kg oc)				
Dibenzofuran	15	58	4.6 U	2.5 U
Hexachlorobutadiene	3.9	6.2	0.1 U	0.1 U
N-Nitrosodiphenylamine	11	11	6.0 U	3.3 U
PCBs (mg/kg oc)				
Total PCBs	12	65	0.9 U	0.8 U

dw = dry-weight normalized
oc = organic-carbon normalized

Table 8 - Analysis of Core Logs

Core	penetration (ft)	recovered core length (ft)	measured thickness of overlying silt in recovered core (ft)	measured thickness of underlying material in recovered core[a] (ft)	maximum possible thickness of overlying silt[b] (ft)
1-1A	0.50	ND	ND	ND	ND
1-1B	1.00	ND	ND	ND	ND
1-1C	1.50	ND	ND	ND	ND
1-1D	2.50	1.30	0.3	1.0	1.50
1-2A	1.50	1.10	0.3	0.8	0.70
1-2B	2.20	1.70	0.3	1.4	0.80
1-2C	1.90	1.70	0.2	1.5	0.40
2-1A	5.88	6.10	0.8	5.3	0.80
2-1B	6.38	5.70	0.3	5.4	0.98
2-2A	2.15	1.60	0.1	1.5	0.65
2-2B	2.00	2.20	0.2	2.0	0.20
2-2C	2.50	ND	ND	ND	ND
2-2D	2.20	ND	ND	ND	ND
2-2E	2.30	2.80	0.3	2.5	0.30

ND = no data

a - Underlying material included medium dense to dense silty sand, and medium stiff to hard silt/clay

b - This is the larger of the following: 1) measured thickness of overlying silt in the recovered core; or 2) penetration minus the measured thickness of underlying material. The 2nd scenario assumes that recovery of the underlying material was 100% and any loss of sediment during sampling was from the overlying silt layer.

Example 1: For Core 1-D, the core penetrated 2.5 feet below the mudline, but only 1.3 feet of sediment was collected in the core tube. The overlying layer was soft organic silt, so it is possible that the core barrel - if equipped with a core catcher with fingers - could have pushed through this soft layer with little recovery. Alternatively, some of the soft material could have been lost from the top of the tube after retrievel when the overlying water was drained. Assuming that recovery was 100% after the soft silt layer was penetrated, the maximum possible thickness of the overlying silt equals the penetration (2.5 ft) minus the measured length of underlying sediment (1.0 ft).

Example 2: For Core 2-1A, the recovered core length was greater than the penetration depth, meaning that the core expanded upon recovery. In this case it is much less likely that core-loss occurred. Assuming that all expansion occurred in the underlying material, the maximum possible thickness of the overlying silt simply equals its measured thickness in the recovered core, or 0.80 ft in this example.

Appendix 1

Core Logs

Key to Exploration Logs

Sample Description

Classification of soils in this report is based on visual field and laboratory observations which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field nor laboratory testing unless presented herein. Visual-manual classification methods of ASTM D 2488 were used as an identification guide.

Soil descriptions consist of the following:
Density/consistency, moisture, color, minor constituents, MAJOR CONSTITUENT, additional remarks.

Density/Consistency

Soil density/consistency in borings is related primarily to the Standard Penetration Resistance. Soil density/consistency in test pits and probes is estimated based on visual observation and is presented parenthetically on the logs.

SAND or GRAVEL Density	Standard Penetration Resistance (N) in Blows/Foot	SILT or CLAY Consistency	Standard Penetration Resistance (N) in Blows/Foot	Approximate Shear Strength in TSF
Very loose	0 to 4	Very soft	0 to 2	<0.125
Loose	4 to 10	Soft	2 to 4	0.125 to 0.25
Medium dense	10 to 30	Medium stiff	4 to 8	0.25 to 0.5
Dense	30 to 50	Stiff	8 to 15	0.5 to 1.0
Very dense	>50	Very stiff	15 to 30	1.0 to 2.0
		Hard	>30	>2.0

Sampling Test Symbols

- 1.5" I.D. Split Spoon
- Grab (Jar)
- 3.0" I.D. Split Spoon
- Shelby Tube (Pushed)
- Bag
- Cuttings
- Core Run

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

Moisture

Dry	Little perceptible moisture
Damp	Some perceptible moisture, likely below optimum
Moist	Likely near optimum moisture content
Wet	Much perceptible moisture, likely above optimum

Minor Constituents

Minor Constituents	Estimated Percentage
Trace	<5
Slightly (clayey, silty, etc.)	5 - 12
Clayey, silty, sandy, gravelly	12 - 30
Very (clayey, silty, etc.)	30 - 50

Laboratory Test Symbols

GS	Grain Size Classification
CN	Consolidation
UU	Unconsolidated Undrained Triaxial
CU	Consolidated Undrained Triaxial
CD	Consolidated Drained Triaxial
QU	Unconfined Compression
DS	Direct Shear
K	Permeability
PP	Pocket Penetrometer Approximate Compressive Strength in TSF
TV	Torvane Approximate Shear Strength in TSF
CBR	California Bearing Ratio
MD	Moisture Density Relationship
AL	Atterberg Limits

Water Content in Percent
Liquid Limit
Natural
Plastic Limit

PID	Photoionization Detector Reading
CA	Chemical Analysis
DT	In Situ Density in PCF
OT	Tests by Others

Groundwater Indicators

- Groundwater Level on Date or (ATD) At Time of Drilling
- Groundwater Seepage (Test Pits)

Sample Key

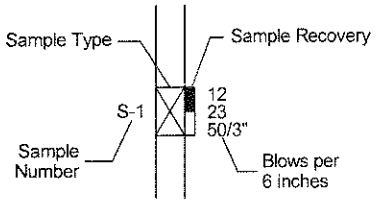


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Figure A-1

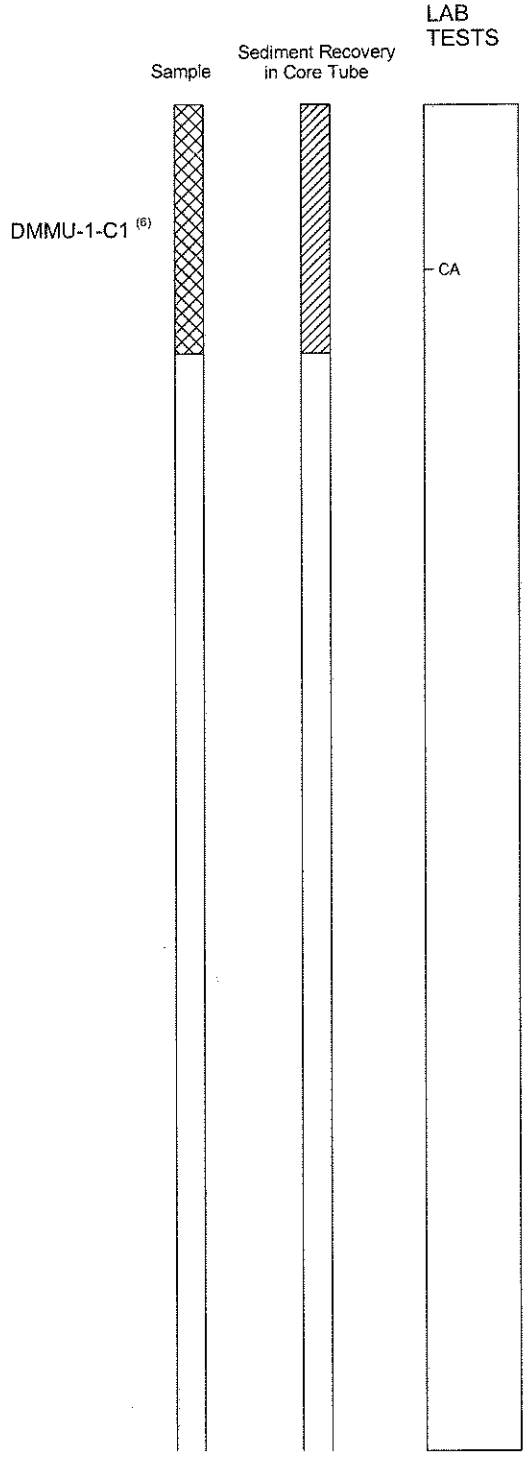
KEY SHEET 1213226-VC.GPJ HC_CORP.GDT 6/6/12

Vibracore Log DMMU-1-1D

Location: Salmon Bay Marina
Water Depth in Feet: 6.45 Feet

Type of Sample: Vibracore
Core Diameter: 3.5 inches
Northing: 245015.036
Easting: 1258324.699
Logged By: E. Duncanson Reviewed By: P. Cordell

USCS Class	Graphic Log	Soil Descriptions (based on Recovered Core)	Depth in Feet
ML OL		(Soft), wet, black, organic SILT with trace wood/plant debris.	0
ML CH		(Medium stiff to stiff), wet, dark gray, sandy SILT/CLAY. Becomes (very stiff to hard), wet, gray, slightly gravelly, sandy SILT/CLAY, medium to high plasticity.	
		Bottom of Sediment in Core Tube at 1.3 Feet. Drive length: ~2.5 feet, Lab Recovery Length: 1.3 feet. Lab recovery: ~52%	5



VIBROCORE LOG 1213226-VC.GPJ HC_CORP.GDT 6/6/12

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Sediment descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Vibracore not corrected for compaction.
5. Core diameter shown is the inner diameter.
6. Sample is a composite consisting of DMMU-1-1 and DMMU-1-2 cores.
7. Mudline Elevation: -7.75 feet

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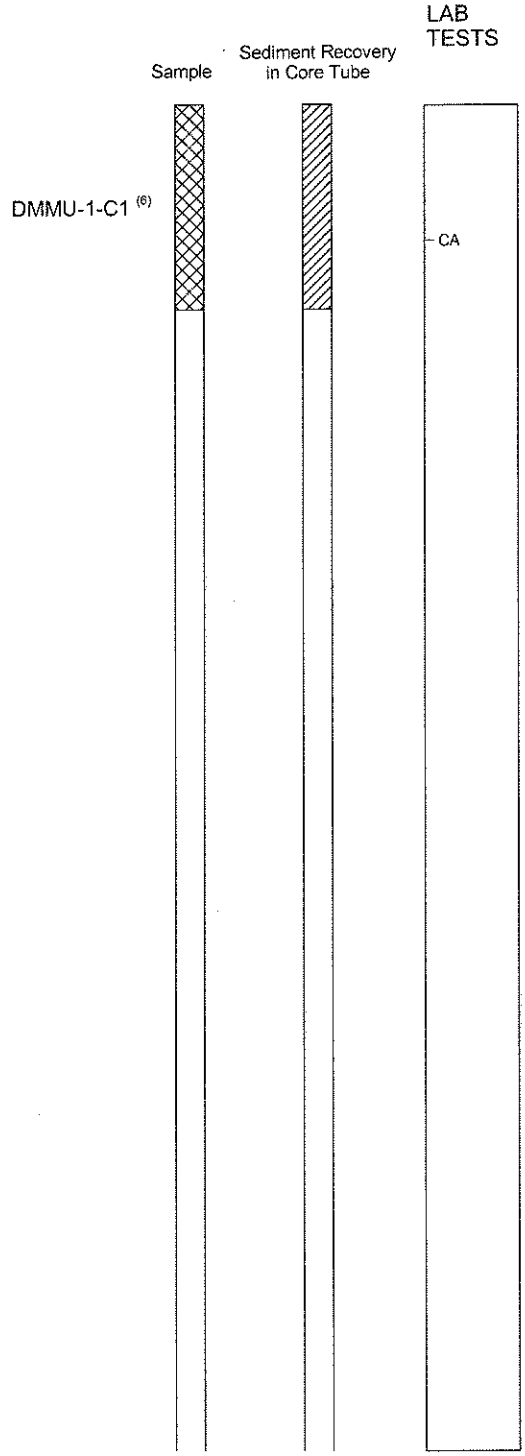
Figure A-2

Vibracore Log DMMU-1-2A

Location: Salmon Bay Marina
Water Depth in Feet: 7.15 Feet

Type of Sample: Vibracore
Core Diameter: 3.5 inches
Northing: 244969.519
Easting: 1258350.483
Logged By: E. Duncanson Reviewed By: P. Cordell

USCS Class	Graphic Log	Soil Descriptions (based on Recovered Core)	Depth in Feet
OL		(Soft), wet, black, organic SILT with plant material and fine wood fibers.	0
ML CH		(Medium stiff to stiff), wet, gray-black, sandy SILT/CLAY with trace organic debris, mild sulfur-like odor. Becomes (very stiff to hard), wet, gray, sandy SILT/CLAY with trace gravel.	
		Bottom of Sediment in Core Tube at 1.1 Feet.	
		Drive length: ~1.5 feet, Lab Recovery Length: 1.1 feet. Lab recovery: ~71%	5



VIBROCORE LOG 1213226-VC.GPJ HC_CORP.GDT 6/6/12

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Sediment descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Vibracore not corrected for compaction.
5. Core diameter shown is the inner diameter.
6. Sample is a composite consisting of DMMU-1-1 and DMMU-1-2 cores.
7. Mudline Elevation: -8.45 feet

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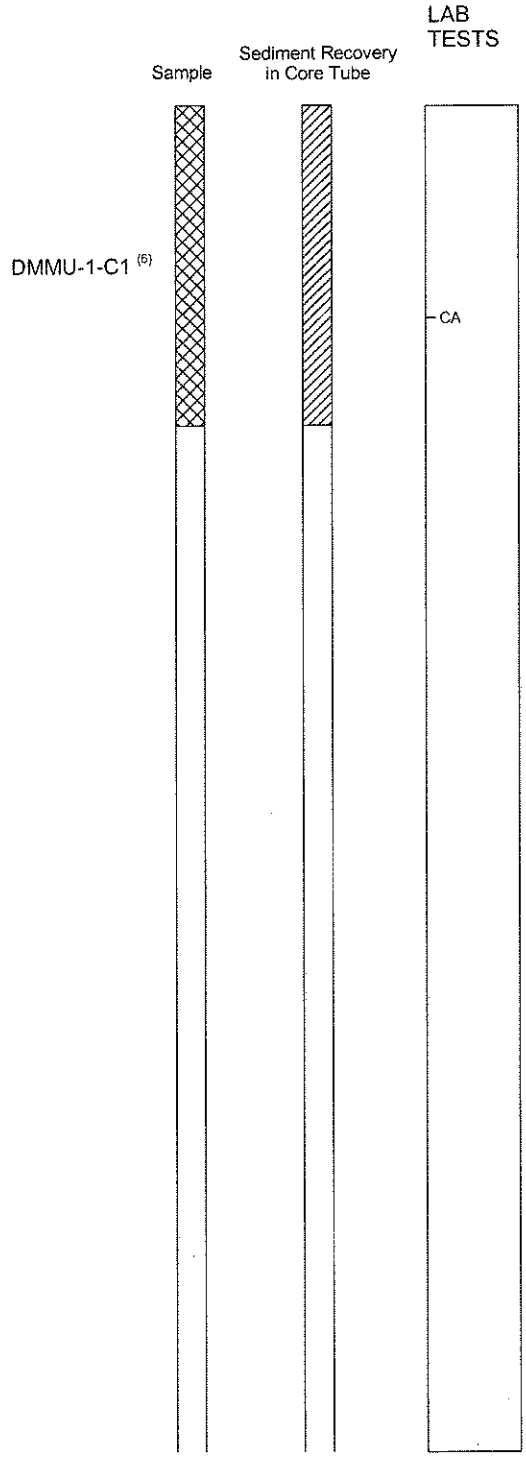
Figure A-3

Vibracore Log DMMU-1-2B

Location: Salmon Bay Marina
Water Depth in Feet: 6.8 Feet

Type of Sample: Vibracore
Core Diameter: 3.5 inches
Northing: 244965.248
Easting: 1258351.219
Logged By: E. Duncanson Reviewed By: P. Cordell

USCS Class	Graphic Log	Soil Descriptions (based on Recovered Core)	Depth in Feet
OL		(Soft), wet, black, organic SILT.	0
ML CH		(Medium stiff), wet, dark brown/black, sandy SILT/CLAY with trace gravel and trace organic debris, slight sheen.	
		Becomes (very stiff to hard), wet, gray, gravelly, sandy SILT/CLAY with trace organic debris.	
		Bottom of Sediment in Core Tube at 1.7 Feet.	
		Drive length: 2.2 feet, Lab Recovery Length: 1.7 feet. Lab recovery: 76%	5



VIBROCORE LOG 1213226-VC.GPJ HC_CORP.GDT 6/6/12

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Sediment descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Vibracore not corrected for compaction.
5. Core diameter shown is the inner diameter.
6. Sample is a composite consisting of DMMU-1-1 and DMMU-1-2 cores.
7. Mudline Elevation: -8.1 feet

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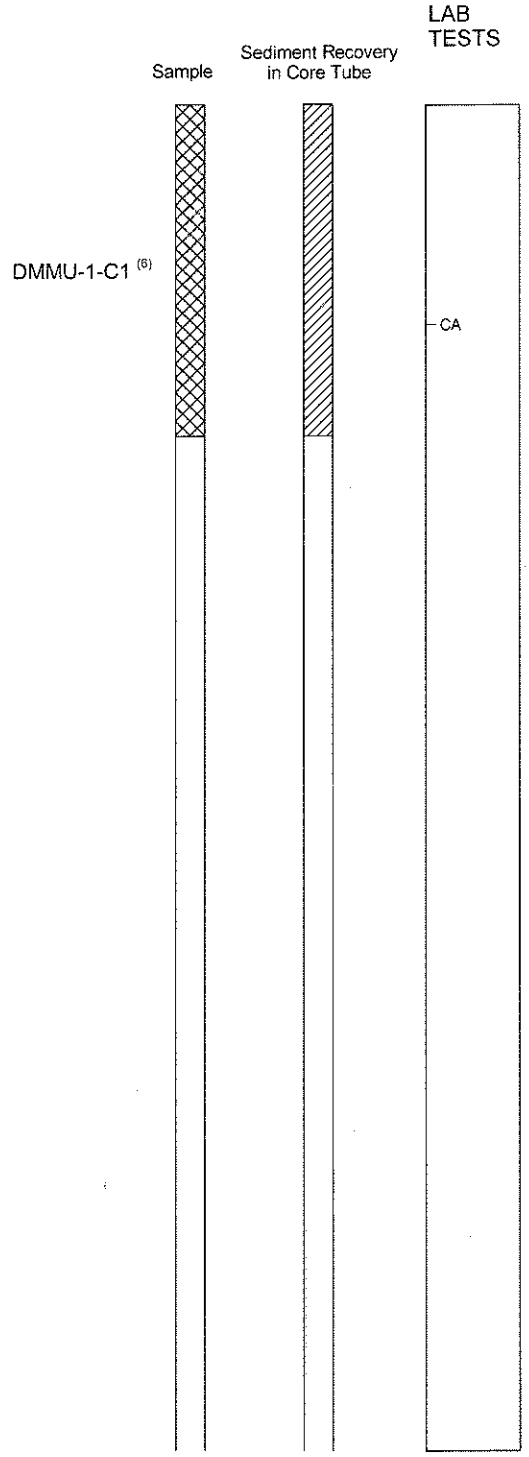
Figure A-4

Vibracore Log DMMU-1-2C

Location: Salmon Bay Marina
Water Depth in Feet: 6.75 Feet

Type of Sample: Vibracore
Core Diameter: 3.5 inches
Northing: 244964.148
Easting: 1258345.445
Logged By: E. Duncanson Reviewed By: P. Cordell

USCS Class	Graphic Log	Soil Descriptions (based on Recovered Core)	Depth in Feet
OL		(Soft), wet, black, organic SILT.	0
ML CH		(Medium stiff), wet, dark gray, slightly sandy SILT/CLAY with trace organic debris.	
		Becomes (very stiff to hard), wet, gray, sandy SILT/CLAY with high plasticity, trace gravel, and trace organic debris.	
		Bottom of Sediment in Core Tube at 1.7 Feet.	
		Drive length: ~1.9 feet, Lab Recovery Length: 1.7 feet. Lab recovery: ~91%	5



VIBROCORE LOG 1213226-VC.GPJ HC_CORP.GDT 6/6/12

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Sediment descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Vibracore not corrected for compaction.
5. Core diameter shown is the inner diameter.
6. Sample is a composite consisting of DMMU-1-1 and DMMU-1-2 cores.
7. Mudline Elevation: -8.05 feet

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Figure A-5

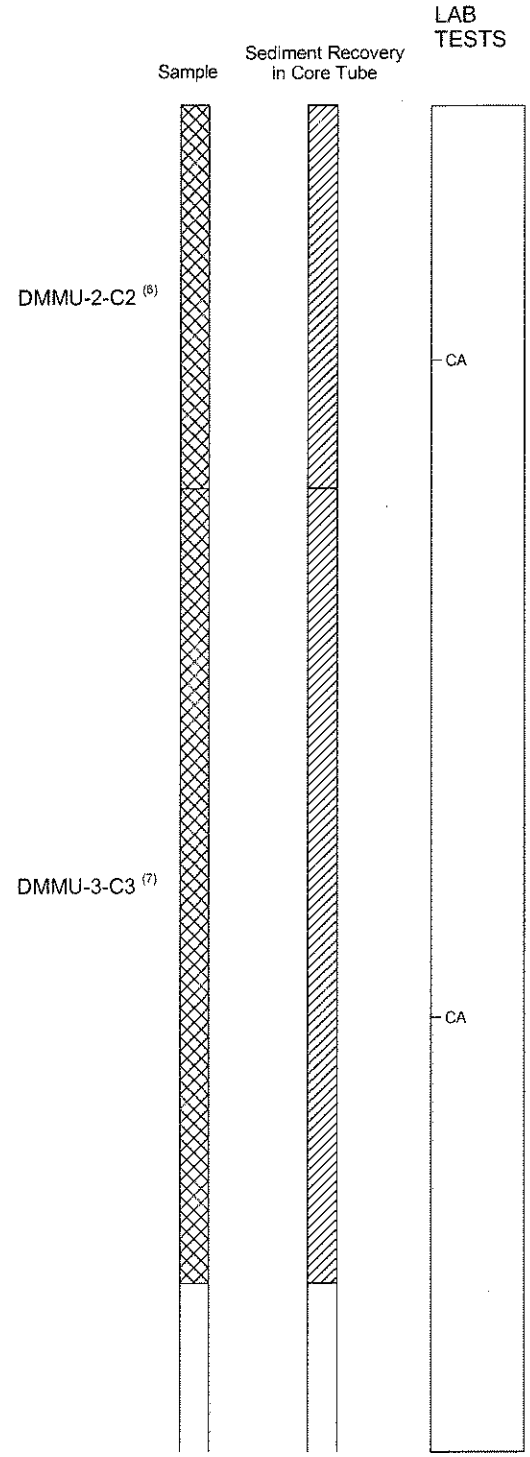
Vibracore Log DMMU-2-1A

Location: Salmon Bay Marina
Water Depth in Feet: 8.4 Feet

Type of Sample: Vibracore
Core Diameter: 3.5 inches
Northing: 244756.728
Easting: 1258379.059
Logged By: E. Duncanson Reviewed By: P. Cordell

USCS Class	Soil Descriptions (based on Recovered Core)	Depth in Feet
OL	(Soft), wet, black, organic SILT with trace organic material (twigs, millefoil).	0
SM	(Medium dense), wet, dark gray, silty SAND with trace gravel.	
ML CH	(Medium stiff to stiff), wet, gray, very sandy SILT/CLAY.	5
	Bottom of Sediment in Core Tube at 6.1 Feet.	

Drive length: ~5.88 feet, Lab Recovery Length: 6.1 feet. Lab recovery: ~104%



VIBROCORE LOG 1213226-VC.GPJ HC_CORP.GDT 6/6/12

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Sediment descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Vibracore not corrected for compaction.
5. Core diameter shown is the inner diameter.
6. Sample is a composite consisting of DMMU-2-1 and DMMU-2-2 cores.
7. Mudline Elevation: -9.7 feet; Sample is a composite consisting of DMMU-2-1A and DMMU-2-1B cores.

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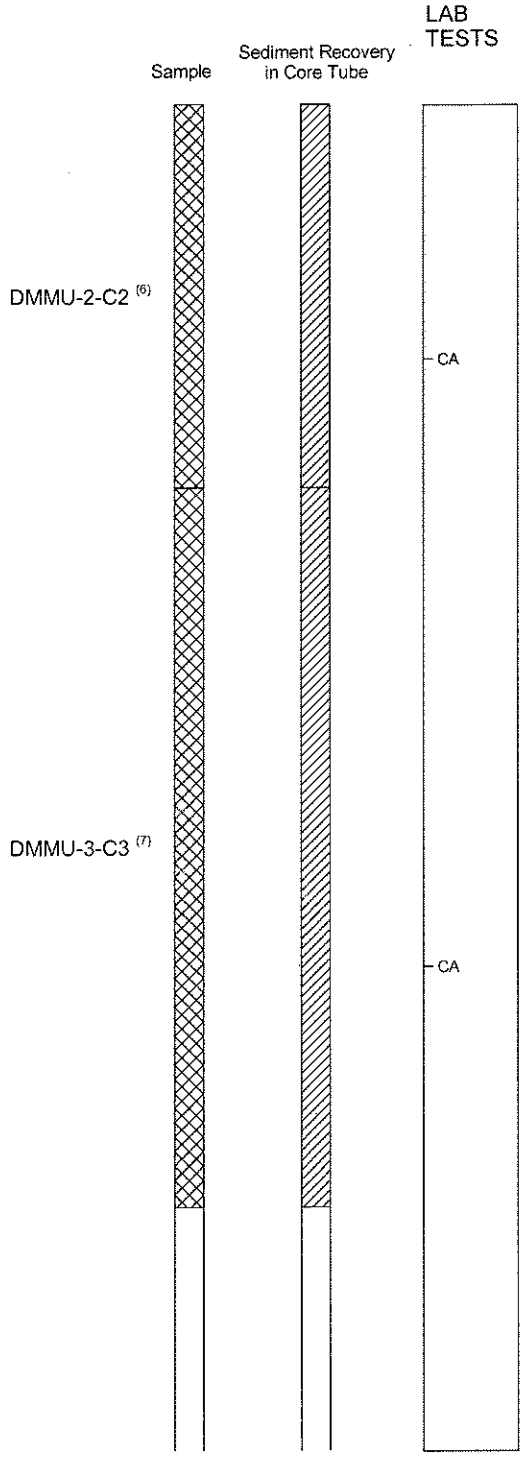
Figure A-6

Vibracore Log DMMU-2-1B

Location: Salmon Bay Marina
Water Depth in Feet: 8.55 Feet

Type of Sample: Vibracore
Core Diameter: 3.5 inches
Northing: 244757.952
Easting: 1258378.673
Logged By: E. Duncanson Reviewed By: P. Cordell

USCS Class	Graphic Log	Soil Descriptions (based on Recovered Core)	Depth in Feet
OL		(Soft), wet, black, organic SILT, some biota observed on sediment surface.	0
SM		(Medium dense), wet, dark gray, silty SAND with trace gravel.	
ML CH		(Medium stiff to stiff), wet, dark gray, gravelly, sandy SILT/CLAY.	5
		Bottom of Sediment in Core Tube at 5.7 Feet. Drive length: 6.38 feet, Lab Recovery Length: 5.7 feet. Lab recovery: 90%	



VIBROCORE.LOG 1213226-VC.GPJ HC_CORP.GDT 6/6/12

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Sediment descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Vibracore not corrected for compaction.
5. Core diameter shown is the inner diameter.
6. Sample is a composite consisting of DMMU-2-1 and DMMU-2-2 cores.
7. Mudline Elevation: - 9.85 feet; Sample is a composite consisting of DMMU-2-1A and DMMU-2-1B cores.

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Figure A-7

Vibracore Log DMMU-2-2A

Location: Salmon Bay Marina
Water Depth in Feet: 7.05 Feet

Type of Sample: Vibracore
Core Diameter: 3.5 inches
Northing: 244851.428
Easting: 1258417.117
Logged By: E. Duncanson Reviewed By: P. Cordell

USCS Class	Graphic Log	Soil Descriptions (based on Recovered Core)	Depth in Feet	Sample	Sediment Recovery in Core Tube	LAB TESTS
OL		(Soft), wet, black, organic SILT.	0			
SM		(Medium dense to dense), wet, dark gray, silty SAND with trace gravel and trace shell fragments.				
ML CH		(Very stiff to hard), wet, gray, sandy SILT/CLAY, with trace gravel and high plasticity.		DMMU-2-C2 (6)		CA
		Bottom of Sediment in Core Tube at 1.6 Feet. Drive length: ~2.15 feet, Lab Recovery Length: 1.6 feet. Lab recovery: ~76%				
			5			

VIBROCORE LOG 1213226-VC.GPJ HC_CORP.GDT 6/6/12

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Sediment descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Vibracore not corrected for compaction.
5. Core diameter shown is the inner diameter.
6. Sample is a composite consisting of DMMU-2-1 and DMMU-2-2 cores.
7. Mudline Elevation: -8.35 feet

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Figure A-8

Vibracore Log DMMU-2-2B

Location: Salmon Bay Marina
Water Depth in Feet: 6.95 Feet

Type of Sample: Vibracore
Core Diameter: 3.5 inches
Northing: 244849.646
Easting: 1258415.027
Logged By: E. Duncanson Reviewed By: P. Cordell

USCS Class	Graphic Log	Soil Descriptions (based on Recovered Core)	Depth in Feet	Sample	Sediment Recovery in Core Tube	LAB TESTS
OL		(Soft), wet, black, organic SILT.	0			
ML CH		(Very stiff to hard), wet, dark gray, gravelly, sandy SILT/CLAY.		DMMU-2-C2 (6)		CA
				2-2B-BOTTOM		CA
		Bottom of Sediment in Core Tube at 2.2 Feet. Drive length: ~2.0 feet, Lab Recovery Length: 2.2 feet. Lab recovery: ~111%				
			5			

VIBROCORE LOG 1213226-VC.GPJ HC_CORP.GDT 6/6/12

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Sediment descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Vibracore not corrected for compaction.
5. Core diameter shown is the inner diameter.
6. Sample is a composite consisting of DMMU-2-1 and DMMU-2-2 cores.
7. Mudline Elevation: -8.25 feet

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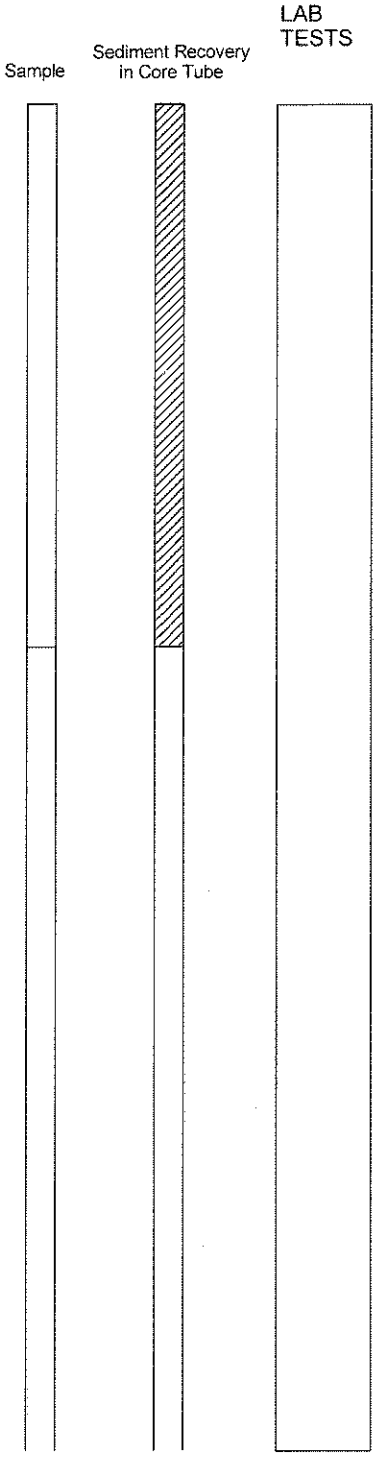
Figure A-9

Vibracore Log DMMU-2-2E

Location: Salmon Bay Marina
Water Depth in Feet: 6.43 Feet

Type of Sample: Vibracore
Core Diameter: 3.5 inches
Northing: 244866.14
Easting: 1258411.252
Logged By: E. Duncanson Reviewed By: P. Cordell

USCS Class	Graphic Log	Soil Descriptions (based on Recovered Core)	Depth in Feet
OL		(Soft), wet, black, organic SILT, with organic plant material.	0
ML CH		(Hard), wet, gray, gravelly, sandy SILT/CLAY.	
		Bottom of Sediment in Core Tube at 2.8 Feet. Drive length: ~2.3 feet, Lab Recovery Length: 2.8 feet. Lab recovery: ~123%	5



VIBROCORE LOG 1213226-VC.GPJ HC_CORP.GDT 6/6/12

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Sediment descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Vibracore not corrected for compaction.
5. Core diameter shown is the inner diameter.
7. Mudline Elevation: -7.73 feet

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Figure A-10