CENWS-OD-TS-DMMO

MEMORANDUM FOR: RECORD December 29, 2007

SUBJECT: DETERMINATION REGARDING THE SUITABILITY OF PROPOSED DREDGED MATERIAL FROM SEMIAHMOO MARINA, BLAINE, WASHINGTON, FOR UNCONFINED OPEN-WATER DISPOSAL AT THE ROSARIO STRAIT DISPERSIVE SITE OR BENEFICIAL USE.

1. Introduction. This memorandum reflects the consensus determination of the Dredged Material Management Program (DMMP) agencies (U.S. Army Corps of Engineers, Washington Departments of Ecology and Natural Resources, and the Environmental Protection Agency) regarding the suitability of 156,800 cubic yards (cy) of dredged material from the Semiahmoo Marina for beneficial use or for disposal at the Rosario Strait open-water dispersive site.

2. Background. Construction of the Semiahmoo Marina, with 296 boat berths and a dredged depth of -12 feet MLLW, was completed in 1981. Maintenance dredging has not occurred since that time. The Trillium Corporation proposes to construct an expanded marina facility within the undeveloped portion of the existing marina, adding 220 new berths. Dredging depths of -15.5 and -17 feet are proposed in two contiguous areas to accommodate larger vessels than the marina was originally designed to accommodate (Anchor, 2006). See Figure 1 for a vicinity map.

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

Table 1. Project Summary

Project ranking	Moderate
Proposed dredging volume	156,800 cubic yards
Proposed dredging depth	-15.5 and -17 feet MLLW
SAP received	August 30, 2006
SAP approved	September 20, 2006
Sampling dates	August 20-24, 2007
Data report received	December 26, 2007
DAIS Tracking number	SEMAR-1-A-F-230
USACE Permit Application Number	NWS-2005-883-NO
Recency Determination (moderate rank = 6 years)	August 2013

4. Project Ranking and Sampling Requirements. This project was ranked “moderate” by the DMMP agencies because it is a marina without a history of sediment characterization. In a moderate-ranked area the number of samples and analyses are calculated using the following guidelines (PSDDA, 1988):
   - Maximum volume of sediment represented by each field sample = 4,000 cubic yards
   - Maximum volume of sediment represented by each analysis in the upper 4-feet of the

dredging prism (surface sediment) = 16,000 cubic yards

- Maximum volume of sediment represented by each analysis in the subsurface portion of the dredging prism = 24,000 cubic yards

The total volume of material proposed for dredging is 156,800 cubic yards. The sampling and analysis plan (Anchor, 2006) split this material into two areas to accommodate two dredging depths:

- Area A: Dredging depth = -15.5 feet MLLW; dredged material volume = 83,100 cubic yards, including 1 foot of overdredge depth. All material was considered surface material. A minimum of 21 field samples and 5 dredged material management units (DMMUs) were required. The SAP called for 23 field samples and 6 DMMUs.
- Area B: Dredging depth = -17 feet MLLW; dredged material volume = 73,700 cubic yards, including 1 foot of overdredge depth. All material was considered surface material. A minimum of 18 field samples and 5 dredged material management units (DMMUs) were required. The SAP called for 20 field samples and 5 DMMUs.

5. Sampling. Sampling took place August 20-24, 2007. A vibracore sampler was used throughout. During field sampling activities, difficulties in achieving target core penetration and sediment recovery were encountered. The primary cause of the sampling difficulties was a layer of gravel and cobble that was present over much of the proposed dredging footprint, with consolidated low-moisture clayey or silty sand below. The gravel/cobble layer and underlying material are assumed to be undisturbed native sediment.

   Core collection was planned at 43 target locations (Figure 2). Where refusal was encountered, an additional core was attempted 20 to 25 feet from the target. In some cases 3 or 4 attempts were made, for a total of 65 coring attempts. Refusal was encountered during 57 of these attempts. The sampling crew tried several approaches to improve penetration and recovery, including use of both vibratory and rotary impact power heads, two types of core barrels and attempts with and without a core catcher (Anchor, 2007). Table 2 presents a synthesis of the numerous sampling attempts, along with compositing information.

   The DMMP agencies believe the contractor's attempts to achieve target penetration and recovery were adequate and that the acquired samples represent the material to be dredged. Further, the agencies believe that there is no reason to believe that the native material, consisting of the gravel/cobble layer and underlying sediments, contains concentrations of chemicals of concern greater than those found in the overlying sediment. This was borne out by DMMU SMB-5, which contained the largest portion of material from below the gravel/cobble layer. All organic chemicals in this DMMU were undetected and metals were well below screening levels.

6. Chemical Analysis. The approved sampling and analysis plan was followed and quality control guidelines specified by the PSEP and DMMP programs were generally met. The data were considered sufficient and acceptable for regulatory decision-making under the DMMP program.

   Sediment conventional results (Table 3) show that the proposed dredged material is predominantly sand and gravel/cobble. Total organic carbon ranged from 0.32 to 1.18 percent. The chemical results indicated that there were no exceedances of DMMP screening levels (Table 4). Consequently, bioassay testing was not required for this material. All 11 DMMUs met suitability

guidelines, based on chemistry alone, for open-water disposal at the Rosario Strait site.

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, 2001). Comparison of the proposed dredged material to SQS serves as a first-tier indicator for this purpose. Table 5 shows that there were no detected exceedances of SQS. However - while undetected - the reporting limit for 1,2,4-trichorobenzene exceeded SQS for 8 of the 11 DMMUs. The DMMP agencies believe the probability that this chemical is actually present at concentrations above SQS is low. Therefore, the reporting-limit exceedances were deemed insignificant and the agencies agreed that there was no need for analysis of Z-samples for this project. The sediment that will be exposed by dredging is not anticipated to have any exceedances of SQS.

8. Beneficial-Use Analysis. As indicated in the previous section, the proposed dredged material had no detected exceedances of SQS (and only a single undetected chemical with a reporting-limit exceedance, which was deemed insignificant). The Sediment Quality Standards pertain to marine sediment; therefore the dredged material is suitable for beneficial use in a marine environment.

   To assess the suitability for upland beneficial use, the chemical results were compared to the Model Toxics Control Act (MTCA) guidelines (Ecology, 2005). Table 6 indicates that, while undetected, the reporting limit for arsenic exceeds the Method B guideline for carcinogens for all 11 DMMUs. In the case of arsenic, a widely distributed and naturally occurring chemical in Puget Sound sediment, the reporting limits are high enough above the Method B guideline that no conclusion can be made regarding the potential for actual concentrations being above the guideline. Therefore, Ecology, DNR and the local health department should be consulted if upland beneficial use is contemplated. Also, while there is no MTCA Method A guideline for total chromium, the total chromium value exceeds the guideline for chromium VI for 5 DMMUs. Additional analysis may be required for upland beneficial use in order to determine the chromium VI content of the sediment.

9. Suitability Determination. This memorandum documents the evaluation of the suitability of sediment proposed for dredging from Semiahmoo Marina for beneficial use or open-water disposal. The approved sampling and analysis plan was followed with the exceptions noted above and in Table 2. The data gathered were deemed sufficient and acceptable for regulatory decision-making under the DMMP program.

   Based on the results of the previously described testing, the DMMP agencies conclude that **all 156,800 cubic yards are suitable** for open-water disposal at the Rosario Strait dispersive site. The dredged material is also suitable, from a chemical and toxicity standpoint, for beneficial use in a marine environment. Upland beneficial use would require additional consultation with Ecology, DNR and the local health department.

   This suitability determination does ***not*** constitute final agency approval of the expanded 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.

A pre-dredge meeting with DNR and the Corps of Engineers will be required. A dredging quality control plan must be developed and submitted to the Enforcement Section of the Regulatory Branch of the Seattle District Corps of Engineers at least 7 days prior to the pre-dredge meeting. A DNR site use authorization must also be acquired.

10. References.

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

Ecology, 2005. *Model Toxics Control Act – Chapter 70.105D RCW and Cleanup Regulation - Chapter 173-340 WAC*. Washington State Department of Ecology, October 2005.

Anchor, 2006. *Sampling and Analysis Plan, Sediment Characterization for the Semiahmoo Marina, Blaine, Washington*. Prepared by Anchor Environmental, Seattle, Washington for Trillium Corporation, Bellingham, Washington. August 2006.

Anchor, 2007. *Sediment Characterization Report - Semiahmoo Marina, Blaine, Washington*. Prepared by Anchor Environmental, Seattle, Washington for Trillium Corporation, Bellingham, Washington. December 2007.

PSDDA, 1988. *Evaluation Procedures Technical Appendix – Phase I – Central Puget Sound*. U.S. Army Corps of Engineers Seattle District, U.S. Environmental Protection Agency Region 10, Washington State Department of Ecology, Washington State of Natural Resources. June 1988.

11. Agency Signatures.

Concur:

12/29/07 David F. Fox
Date David Fox, P.E. - Seattle District Corps of Engineers

1/3/08 Erika Hoffman
Date Erika Hoffman - Environmental Protection Agency

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

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Table 2a. Sampling and Compositing - Area A (design depth = -15.5' MLLW; overdepth = -16.6').

		SMA-1	SMA-2	SMA-3	SMA-4	SMA-5	SMA-6
	Volume (CY):	14,600	15,400	15,600	10,900	13,400	13,200
Station	SMA-1-01	-12.0' to -15.5'					
	SMA-1-02	-11.1' to -14.0'					
	SMA-1-03	-10.7' to -14.3'					
	SMA-1-04	-11.7' to -14.3'					
	SMA-2-01		-11.6' to -15.0				
	SMA-2-02		-10.6' to -12.5'				
	SMA-2-03		-12.3' to -15.3'				
	SMA-2-04		-12.0' to -14.5'				
	SMA-3-01			-10.6' to -16.0'			
	SMA-3-02			-10.2' to -13.2'			
	SMA-3-03			-11.0' to -12.5'			
	SMA-3-04			-10.5' to -13.1'			
	SMA-4-01				-13.2' to -14.2'		
	SMA-4-02				-14.0' to -16.5'		
	SMA-4-03				-14.1' to -16.5'		
	SMA-5-01					-14.4' to -16.5'	
	SMA-5-02					-14.3' to -16.5'	
	SMA-5-03					-13.6' to -15.3'	
	SMA-5-04					-12.9' to -14.4'	
	SMA-6-01						-12.2' to -14.2'
	SMA-6-02						-12.4' to -16.5'
	SMA-6-03						-12.5' to -14.8'
	SMA-6-04						-13.2' to -16.5'

Table 2b. Sampling and Compositing - Area B (design depth = -17.0' MLLW; overdepth = -18.0').

		SMB-1	SMB-2	SMB-3	SMB-4	SMB-5
	Volume (CY):	13,600	15,000	13,200	15,500	16,400
Station	SMB-1-01	-10.1' to -16.0'				
	SMB-1-02	-10.0' to -16.2'				
	SMB-1-03	-10.0' to -15.0'				
	SMB-1-04	-11.0' to -16.7'				
	SMB-2-01		-12.2' to -16.1			
	SMB-2-02		-12.5' to -16.4'			
	SMB-2-03		-11.3' to -13.3'			
	SMB-2-04		-12.8' to -18.0'			
	SMB-3-01			-11.3' to -17.8'		
	SMB-3-02			-11.9' to -14.1'		
	SMB-3-03			-11.3' to -16.4'		
	SMB-3-04			-12.3' to -15.3'		
	SMB-4-01				-13.6' to -16.8'	
	SMB-4-02				no sample	
	SMB-4-03				-12.2' to -16.9'	
	SMB-4-04				-12.9' to -15.9'	
	SMB-5-01					-16.2' to -18.0'
	SMB-5-02					-14.4' to -17.9'
	SMB-5-03					no sample
	SMB-5-04					-14.7' to -18.0'

Table 3. Sediment Conventional Data.

	DMMU:	SMA-1	SMA-2	SMA-3	SMA-4	SMA-5	SMA-6	SMB-1	SMB-2	SMB-3	SMB-4	SMB-5
	DAIS ID:	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
GRAIN SIZE	% Gravel:	9.4	11.0	15.3	30.5	55.1	38.3	13.0	29.2	50.4	38.5	14.9
	% Sand:	52.4	51.5	63.6	56.9	27.2	54.4	69.6	58.2	42.5	50.7	56.5
	% Silt:	24.7	24.3	12.9	7.8	12.2	3.8	11.3	8.2	3.8	6.5	20.4
	% Clay:	13.4	13.3	8.2	4.7	5.5	3.4	5.9	4.6	3.2	4.3	8.3
	% Fines (clay+silt):	38.2	37.5	21.1	12.6	17.8	7.3	17.3	12.8	7.0	10.7	28.6
	Total Solids (%):	60.8	62.4	70.2	72.7	62.8	74.5	73.7	75.9	79.1	77.2	74.5
	Volatile Solids (%):	3.08	3.03	2.39	3.26	4.00	1.97	1.50	1.51	1.48	1.73	2.19
	Total Organic Carbon (%):	0.69	1.00	0.61	0.65	0.50	0.50	0.32	0.40	0.60	1.18	0.61
	Total Sulfides (mg/kg):	3.67	48.2	173	65.1	16.4	34	1.57	45.4	33.4	20.4	33.1
	Total Ammonia (mg N/kg):	21.9	14.5	6.19	3.67	21.3	16.1	3.67	9.60	14.5	19.5	24.1

Table 4. Chemical results compared to DMMP regulatory guidelines.

CHEMICAL	SL	BT	ML	SMA-1		SMA-2		SMA-3		SMA-4		SMA-5		SMA-6		SMB-1		SMB-2		SMB-3		SMB-4		SMB-5	
				conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL
METALS (mg/kg dry)																									
Antimony	150	---	200	0.3	UJ	0.3	J	0.3	UJ	0.3	UJ	0.3	UJ	0.3	UJ	0.3	UJ	0.3	UJ	0.3	UJ	0.3	UJ	0.3	UJ
Arsenic	57	507	700	8	U	8	U	7	U	7	U	20	U	6	U	6	U	6	U	6	U	6	U	7	U
Cadmium	5.1	11.3	14	0.6		0.5		0.4		0.3		0.7	U	0.7		0.3		0.3		0.2	U	0.3		0.5	
Chromium	---	267	---	23.2		24.2		20.8		17.1		19		15.9		19.2		15.2		14.7		16.3		20.6	
Copper	390	1,027	1,300	16.4		15.9		13.3		10.4		12.7		8.6		11.4		7.7		9.3		9.6		11.4	
Lead	450	975	1,200	4.6		4.8		3.0		2.4		2.3		1.9		2.1		1.8		1.9		1.9		2.2	
Mercury	0.41	1.5	2.3	0.07	U	0.07	U	0.06	U	0.07	U	0.06	U	0.05	U	0.05	U	0.05	U	0.05	U	0.06	U	0.05	U
Nickel	140	370	370	20		18		16		13		15		12		16		11		12		13		16	
Selenium	---	3.0	---	0.3	U	0.4		0.7	U	0.7	U	0.7	U	0.7	U	0.3	U	0.3	U	0.6	U	0.3	U	0.7	U
Silver	6.1	6.1	8.4	0.5	U	0.5	U	0.4	U	0.4	U	1	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U
Zinc	410	2,783	3,800	47		42		41		30		32		26		29		24		25		29		30	
ORGANOMETALLIC COMPOUNDS (ug/L interstitial water)																									
Tributyltin (ion)	0.15	0.15	---	0.019	UJ	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.034		0.019	U	0.019	U	0.019	U	0.019	U
LPAH (ug/kg dry)																									
2-Methylnaphthalene	670	---	1,900	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
Acenaphthene	500	---	2,000	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
Acenaphthylene	560	---	1,300	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
Anthracene	960	---	13,000	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
Fluorene	540	---	3,600	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
Naphthalene	2,100	---	2,400	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
Phenanthrene	1,500	---	21,000	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
Total LPAH	5,200	---	29,000	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
HPAH (ug/kg dry)																									
Benzo(a)anthracene	1,300	---	5,100	20	U	19	U	20	U	20	U	19	U	20	UJ	20	U	20	U	20	U	19	U	19	U
Benzo(a)pyrene	1,600	---	3,600	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	UJ	19	U
Benzo(g,h,i)perylene	670	---	3,200	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	UJ	19	U
Benzofluoranthenes	3,200	---	9,900	48		19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
Chrysene	1,400	---	21,000	20		19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
Dibenzo(a,h)anthracene	230	---	1,900	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	UJ	19	U
Fluoranthene	1,700	4,600	30,000	35		20		20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
Indeno(1,2,3-c,d)pyrene	600	---	4,400	20	U	19	U	20	U	20	U	19	U	20	UJ	20	U	20	U	20	U	19	U	19	U
Pyrene	2,600	11,980	16,000	42		24		20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
Total HPAH	12,000	---	69,000	145		44		20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
CHLORINATED HYDROCARBONS (ug/kg dry)																									
1,2,4-Trichlorobenzene	31	---	64	7.8	U	6.2	U	5.7	U	5.6	U	5.7	UJ	5.7	U	6.7	U	6.3	U	6.1	U	6.7	U	5.5	U
1,2-Dichlorobenzene	35	---	110	1.6	U	1.2	U	1.1	U	1.1	U	1.1	U	1.2	U	1.4	U	1.3	U	1.2	U	1.3	U	1.1	U
1,3-Dichlorobenzene	170	---	---	1.6	U	1.2	U	1.1	U	1.1	U	1.1	U	1.2	U	1.4	U	1.3	U	1.2	U	1.3	U	1.1	U
1,4-Dichlorobenzene	110	---	120	1.6	U	1.2	U	1.1	U	1.1	U	1.1	U	1.2	U	1.4	U	1.3	U	1.2	U	1.3	U	1.1	U
Hexachlorobenzene	22	168	230	0.97	U	0.98	U	0.99	U	0.98	U	0.97	U	0.96	U	0.96	U	0.96	U	0.96	U	0.96	U	0.96	U

Table 4. Chemical results compared to DMMP regulatory guidelines.

CHEMICAL	SL	BT	ML	SMA-1		SMA-2		SMA-3		SMA-4		SMA-5		SMA-6		SMB-1		SMB-2		SMB-3		SMB-4		SMB-5	
				conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL
PHTHALATES (ug/kg dry)																									
Bis(2-ethylhexyl)phthalate	1,300	---	8,300	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
Butyl benzyl phthalate	63	---	970	6.1	U	6.0	U	6.1	U	6.0	U	6.2	U	6.1	U	5.9	U	6.1	U	6.2	U	6.1	U	6.0	U
Di-n-butyl phthalate	1,400	---	5,100	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
Di-n-octyl phthalate	6,200	---	6,200	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
Diethyl phthalate	200	---	1,200	6.1	U	18		6.1	U	6.0	U	6.2	U	6.1	U	6.5		9.2		6.2	U	6.1	U	6.0	U
Dimethyl phthalate	71	---	1,400	6.10	U	6.00	U	6.10	U	6.00	U	6.20	U	6.10	U	5.90	U	6.10	U	6.20	U	6.10	U	6.00	U
PHENOLS (ug/kg dry)																									
2 Methylphenol	63	---	77	6.1	U	6.0	U	6.1	U	6.0	U	6.2	U	6.1	U	5.9	U	6.1	U	6.2	UJ	6.1	U	6.0	U
2,4-Dimethylphenol	29	---	210	6.1	UJ	6.0	UJ	6.1	U	6.0	U	6.2	UJ	6.1	UJ	5.9	UJ	6.1	UJ	6.2	UJ	6.1	UJ	6.0	UJ
4 Methylphenol	670	---	3,600	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
Pentachlorophenol	400	504	690	30	U	30	U	30	U	30	U	31	U	30	U	30	U	30	U	31	U	30	U	30	U
Phenol	420	---	1,200	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	40		19	U
MISCELLANEOUS EXTRACTABLES (ug/kg dry)																									
Benzoic acid	650	---	760	200	U	190	U	200	U	200	U	190	U	200	U	200	U	200	U	200	U	190	U	190	U
Benzyl alcohol	57	---	870	30	UJ	30	U	30	U	30	U	31	U	30	UJ	30	UJ	30	UJ	31	UJ	30	UJ	30	U
Dibenzofuran	540	---	1,700	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
Hexachlorobutadiene	29	---	270	0.97	U	0.98	U	0.99	U	0.98	U	0.97	U	0.96	U	0.96	U	0.96	U	0.96	U	0.96	U	0.96	U
Hexachloroethane	1,400	---	14,000	20	U	19	UJ	20	UJ	20	UJ	19	UJ	20	UJ	20	U	20	U	20	U	19	UJ	19	UJ
N-Nitrosodiphenylamine	28	---	130	6.1	U	6.0	U	6.1	U	6.0	U	6.2	U	6.1	U	5.9	U	6.1	U	6.2	U	6.1	U	6.0	U
VOLATILE ORGANICS (ug/kg dry)																									
Ethylbenzene	10	---	50	1.6	U	1.2	U	1.1	U	1.1	U	1.1	U	1.2	U	1.4	U	1.3	U	1.2	U	1.3	U	1.1	U
Tetrachloroethene	57	---	210	1.6	U	1.2	U	1.1	U	1.1	U	1.1	U	1.2	U	1.4	U	1.3	U	1.2	U	1.3	U	1.1	U
Total Xylene	40	---	160	1.6	U	1.2	U	1.1	U	1.1	U	1.1	U	1.2	U	1.4	U	1.3	U	1.2	U	1.3	U	1.1	U
Trichloroethene	160	---	1,600	1.6	U	1.2	U	1.1	U	1.1	U	1.1	U	1.2	U	1.4	U	1.3	U	1.2	U	1.3	U	1.1	U
PESTICIDES AND PCBs (ug/kg dry)																									
Aldrin	10	---	---	0.97	U	0.98	U	0.99	U	0.98	U	0.97	U	0.96	U	0.96	U	0.96	U	0.96	U	0.96	U	0.96	U
Chlordane	10	37	---	1.9	U	2.0	U	2.0	U	2.0	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U
Dieldrin	10	---	---	1.9	U	2.0	U	2.0	U	2.0	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U
Heptachlor	10	---	---	0.97	U	0.98	U	0.99	U	0.98	U	0.97	U	0.96	U	0.96	U	0.96	U	0.96	U	0.96	U	0.96	U
Lindane	10	---	---	0.97	U	0.98	U	0.99	U	0.98	U	0.97	U	0.96	U	0.96	U	0.96	U	0.96	U	0.96	U	0.96	U
Total DDT	6.9	50	69	1.9	U	2.0	U	2.0	U	2	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U
Total PCBs	130	---	3,100	3.9	U	9.8	U	9.8	U	9.8	U	9.7	U	9.8	U	3.9	U	3.8	U	3.9	U	3.8	U	9.5	U
Total PCBs (mg/kg OC)	---	38	---	0.6	U	0.98	U	1.6	U	1.5	U	1.9	U	2.0	U	1.2	U	1.0	U	0.7	U	0.3	U	1.6	U

J = the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
U = undetected above the sample reporting limit
QL = laboratory qualifier
OC = organic carbon
SL = screening level
BT = bioaccumulation trigger
ML = maximum level

Table 5. Chemical results compared to SMS regulatory guidelines.

CHEMICAL	SQS	CSL	SMA-1		SMA-2		SMA-3		SMA-4		SMA-5		SMA-6		SMB-1		SMB-2		SMB-3		SMB-4		SMB-5	
			conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL
METALS (mg/kg dry)																								
Arsenic	57	93	8	U	8	U	7	U	7	U	20	U	6	U	6	U	6	U	6	U	6	U	7	U
Cadmium	5.1	6.7	0.6		0.5		0.4		0.3		0.7	U	0.7		0.3		0.3		0.2	U	0.3		0.5	
Chromium	260	270	23.2		24.2		20.8		17.1		19		15.9		19.2		15.2		14.7		16.3		20.6	
Copper	390	390	16.4		15.9		13.3		10.4		12.7		8.6		11.4		7.7		9.3		9.6		11.4	
Lead	450	530	4.6		4.8		3.0		2.4		2.3		1.9		2.1		1.8		1.9		1.9		2.2	
Mercury	0.41	0.59	0.07	U	0.07	U	0.06	U	0.07	U	0.06	U	0.05	U	0.05	U	0.05	U	0.05	U	0.06	U	0.05	U
Silver	6.1	6.1	0.5	U	0.5	U	0.4	U	0.4	U	1	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U
Zinc	410	960	47		42		41		30		32		26		29		24		25		29		30	
LPAH (mg/kg OC)																								
2-Methylnaphthalene	38	64	2.9	U	1.9	U	2.0	U	3.1	U	3.8	U	4.0	U	6.3	U	5.0	U	3.3	U	1.6	U	3.1	U
Acenaphthene	16	57	2.9	U	1.9	U	2.0	U	3.1	U	3.8	U	4.0	U	6.3	U	5.0	U	3.3	U	1.6	U	3.1	U
Acenaphthylene	66	66	2.9	U	1.9	U	2.0	U	3.1	U	3.8	U	4.0	U	6.3	U	5.0	U	3.3	U	1.6	U	3.1	U
Anthracene	220	1200	2.9	U	1.9	U	2.0	U	3.1	U	3.8	U	4.0	U	6.3	U	5.0	U	3.3	U	1.6	U	3.1	U
Fluorene	23	79	2.9	U	1.9	U	2.0	U	3.1	U	3.8	U	4.0	U	6.3	U	5.0	U	3.3	U	1.6	U	3.1	U
Naphthalene	99	170	2.9	U	1.9	U	2.0	U	3.1	U	3.8	U	4.0	U	6.3	U	5.0	U	3.3	U	1.6	U	3.1	U
Phenanthrene	100	480	2.9	U	1.9	U	2.0	U	3.1	U	3.8	U	4.0	U	6.3	U	5.0	U	3.3	U	1.6	U	3.1	U
Total LPAH	370	780	2.9	U	1.9	U	2.0	U	3.1	U	3.8	U	4.0	U	6.3	U	5.0	U	3.3	U	1.6	U	3.1	U
HPAH (mg/kg OC)																								
Benzo(a)anthracene	110	270	2.9	U	1.9	U	2.0	U	3.1	U	3.8	U	4.0	UJ	6.3	U	5.0	U	3.3	U	1.6	U	3.1	U
Benzo(a)pyrene	99	210	2.9	U	1.9	U	2.0	U	3.1	U	3.8	U	4.0	U	6.3	U	5.0	U	3.3	U	1.6	UJ	3.1	U
Benzo(g,h,i)perylene	34	88	2.9	U	1.9	U	2.0	U	3.1	U	3.8	U	4.0	U	6.3	U	5.0	U	3.3	U	1.6	UJ	3.1	U
Benzofluoranthenes	230	450	7.0		1.9	U	2.0	U	3.1	U	3.8	U	4.0	U	6.3	U	5.0	U	3.3	U	1.6	U	3.1	U
Chrysene	110	460	2.9		1.9	U	2.0	U	3.1	U	3.8	U	4.0	U	6.3	U	5.0	U	3.3	U	1.6	U	3.1	U
Dibenzo(a,h)anthracene	12	33	2.9	U	1.9	U	2.0	U	3.1	U	3.8	U	4.0	U	6.3	U	5.0	U	3.3	U	1.6	UJ	3.1	U
Fluoranthene	160	1200	5.1		2.0		2.0	U	3.1	U	3.8	U	4.0	U	6.3	U	5.0	U	3.3	U	1.6	U	3.1	U
Indeno(1,2,3-c,d)pyrene	34	88	2.9	U	1.9	U	2.0	U	3.1	U	3.8	U	4.0	UJ	6.3	U	5.0	U	3.3	U	1.6	U	3.1	U
Pyrene	1000	1400	6.1		2.4		2.0	U	3.1	U	3.8	U	4.0	U	6.3	U	5.0	U	3.3	U	1.6	U	3.1	U
Total HPAH	960	5300	21.0		4.4		2.0	U	3.1	U	3.8	U	4.0	U	6.3	U	5.0	U	3.3	U	1.6	U	3.1	U
CHLORINATED HYDROCARBONS (mg/kg OC)																								
1,2,4-Trichlorobenzene	0.81	1.8	***1.1***	U	0.6	U	0.6	U	***0.9***	U	***1.1***	UJ	***1.1***	U	***2.1***	U	***1.6***	U	***1.0***	U	0.6	U	***0.9***	U
1,2-Dichlorobenzene	2.3	2.3	0.2	U	0.1	U	0.1	U	0.2	U	0.2	U	0.2	U	0.4	U	0.3	U	0.2	U	0.1	U	0.2	U
1,4-Dichlorobenzene	3.1	9	0.2	U	0.1	U	0.1	U	0.2	U	0.2	U	0.2	U	0.4	U	0.3	U	0.2	U	0.1	U	0.2	U
Hexachlorobenzene	0.38	2.3	0.1	U	0.1	U	0.1	U	0.2	U	0.2	U	0.2	U	0.3	U	0.2	U	0.2	U	0.1	U	0.2	U

Table 5. Chemical results compared to SMS regulatory guidelines.

CHEMICAL	SQS	CSL	SMA-1		SMA-2		SMA-3		SMA-4		SMA-5		SMA-6		SMB-1		SMB-2		SMB-3		SMB-4		SMB-5	
			conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL
PHTHALATES (mg/kg OC)																								
Bis(2-ethylhexyl)phthalate	47	78	2.9	U	1.9	U	2.0	U	3.1	U	3.8	U	4.0	U	6.3	U	5.0	U	3.3	U	1.6	U	3.1	U
Butyl benzyl phthalate	4.9	64	0.9	U	0.6	U	0.6	U	0.9	U	1.2	U	1.2	U	1.8	U	1.5	U	1.0	U	0.5	U	1.0	U
Di-n-butyl phthalate	220	1700	2.9	U	1.9	U	2.0	U	3.1	U	3.8	U	4.0	U	6.3	U	5.0	U	3.3	U	1.6	U	3.1	U
Di-n-octyl phthalate	58	4500	2.9	U	1.9	U	2.0	U	3.1	U	3.8	U	4.0	U	6.3	U	5.0	U	3.3	U	1.6	U	3.1	U
Diethyl phthalate	61	110	0.9	U	1.8		0.6	U	0.9	U	1.2	U	1.2	U	2.0		2.3		1.0	U	0.5	U	1.0	U
Dimethyl phthalate	53	53	0.9	U	0.6	U	0.6	U	0.9	U	1.2	U	1.2	U	1.8	U	1.5	U	1.0	U	0.5	U	1.0	U
PHENOLS (ug/kg dry)																								
2 Methylphenol	63	63	6.1	U	6.0	U	6.1	U	6.0	U	6.2	U	6.1	U	5.9	U	6.1	U	6.2	UJ	6.1	U	6.0	U
2,4-Dimethylphenol	29	29	6.1	UJ	6.0	UJ	6.1	U	6.0	U	6.2	UJ	6.1	UJ	5.9	UJ	6.1	UJ	6.2	UJ	6.1	UJ	6.0	UJ
4 Methylphenol	670	670	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
Pentachlorophenol	360	690	30	U	30	U	30	U	30	U	31	U	30	U	30	U	30	U	31	U	30	U	30	U
Phenol	420	1200	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	40		19	U
MISCELLANEOUS EXTRACTABLES (ug/kg dry)																								
Benzoic acid	650	650	200	U	190	U	200	U	200	U	190	U	200	U	200	U	200	U	200	U	190	U	190	U
Benzyl alcohol	57	73	30	UJ	30	U	30	U	30	U	31	U	30	UJ	30	UJ	30	UJ	31	UJ	30	UJ	30	U
MISCELLANEOUS EXTRACTABLES (mg/kg OC)																								
Dibenzofuran	15	58	2.9	U	1.9	U	2.0	U	3.1	U	3.8	U	4.0	U	6.3	U	5.0	U	3.3	U	1.6	U	3.1	U
Hexachlorobutadiene	3.9	6.2	0.1	U	0.1	U	0.1	U	0.2	U	0.2	U	0.2	U	0.3	U	0.2	U	0.2	U	0.1	U	0.2	U
N-Nitrosodiphenylamine	11	11	0.9	U	0.6	U	0.6	U	0.9	U	1.2	U	1.2	U	1.8	U	1.5	U	1.0	U	0.5	U	1.0	U
PCBs (mg/kg OC)																								
Total PCBs	12	65	0.6	U	0.98	U	1.6	U	1.5	U	1.9	U	2.0	U	1.2	U	1.0	U	0.7	U	0.3	U	1.6	U

J = the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
U = undetected above the sample reporting limit
QL = laboratory qualifier
OC = organic carbon
SL = screening level
BT = bioaccumulation trigger
ML = maximum level

Table 6. Chemical results compared to MTCA regulatory guidelines.

CHEMICAL	Method A[1]	Method B[2]	SMA-1		SMA-2		SMA-3		SMA-4		SMA-5		SMA-6		SMB-1		SMB-2		SMB-3		SMB-4		SMB-5	
			conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL
METALS (mg/kg dry)																								
Arsenic, inorganic	20	0.67	***8***	U	***8***	U	***7***	U	***7***	U	***20***	U	***6***	U	***6***	U	***6***	U	***6***	U	***6***	U	***7***	U
Cadmium	2	---	0.6		0.5		0.4		0.3		0.7	U	0.7		0.3		0.3		0.2	U	0.3		0.5	
Chromium (total)	---	---	***23.2***		***24.2***		***20.8***		17.1		19		15.9		***19.2***		15.2		14.7		16.3		***20.6***	
Chromium VI	19	---																						
Copper	---	---	16.4		15.9		13.3		10.4		12.7		8.6		11.4		7.7		9.3		9.6		11.4	
Lead	250	---	4.6		4.8		3.0		2.4		2.3		1.9		2.1		1.8		1.9		1.9		2.2	
Mercury	2	---	0.07	U	0.07	U	0.06	U	0.07	U	0.06	U	0.05	U	0.05	U	0.05	U	0.05	U	0.06	U	0.05	U
Silver	---	---	0.5	U	0.5	U	0.4	U	0.4	U	1	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U
Zinc	---	---	47		42		41		30		32		26		29		24		25		29		30	
LPAH (ug/kg dry)																								
Acenaphthene	---	---	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
Anthracene	---	---	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
Fluorene	---	---	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
Naphthalene	5,000	---	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
HPAH (ug/kg dry)																								
Benzo(a)anthracene	---	140	20	U	19	U	20	U	20	U	19	U	20	UJ	20	U	20	U	20	U	19	U	19	U
Benzo(a)pyrene	100	140	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	UJ	19	U
Benzo(b,k)fluoranthenes	---	---	48		19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
Benzo(b)fluoranthene	---	140	25		19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
Benzo(k)fluoranthene	---	140	23		19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
Chrysene	---	140	20		19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
Dibenzo(a,h)anthracene	---	140	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	UJ	19	U
Fluoranthene	---	---	35		20		20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
Indeno(1,2,3-c,d)pyrene	---	140	20	U	19	U	20	U	20	U	19	U	20	UJ	20	U	20	U	20	U	19	U	19	U
Pyrene	---	---	42		24		20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
CHLORINATED HYDROCARBONS (ug/kg dry)																								
1,2,4-Trichlorobenzene	---	---	7.8	U	6.2	U	5.7	U	5.6	U	5.7	UJ	5.7	U	6.7	U	6.3	U	6.1	U	6.7	U	5.5	U
1,2-Dichlorobenzene	---	---	1.6	U	1.2	U	1.1	U	1.1	U	1.1	U	1.2	U	1.4	U	1.3	U	1.2	U	1.3	U	1.1	U
1,4-Dichlorobenzene	---	42,000	1.6	U	1.2	U	1.1	U	1.1	U	1.1	U	1.2	U	1.4	U	1.3	U	1.2	U	1.3	U	1.1	U
Hexachlorobenzene	---	630	0.97	U	0.98	U	0.99	U	0.98	U	0.97	U	0.96	U	0.96	U	0.96	U	0.96	U	0.96	U	0.96	U

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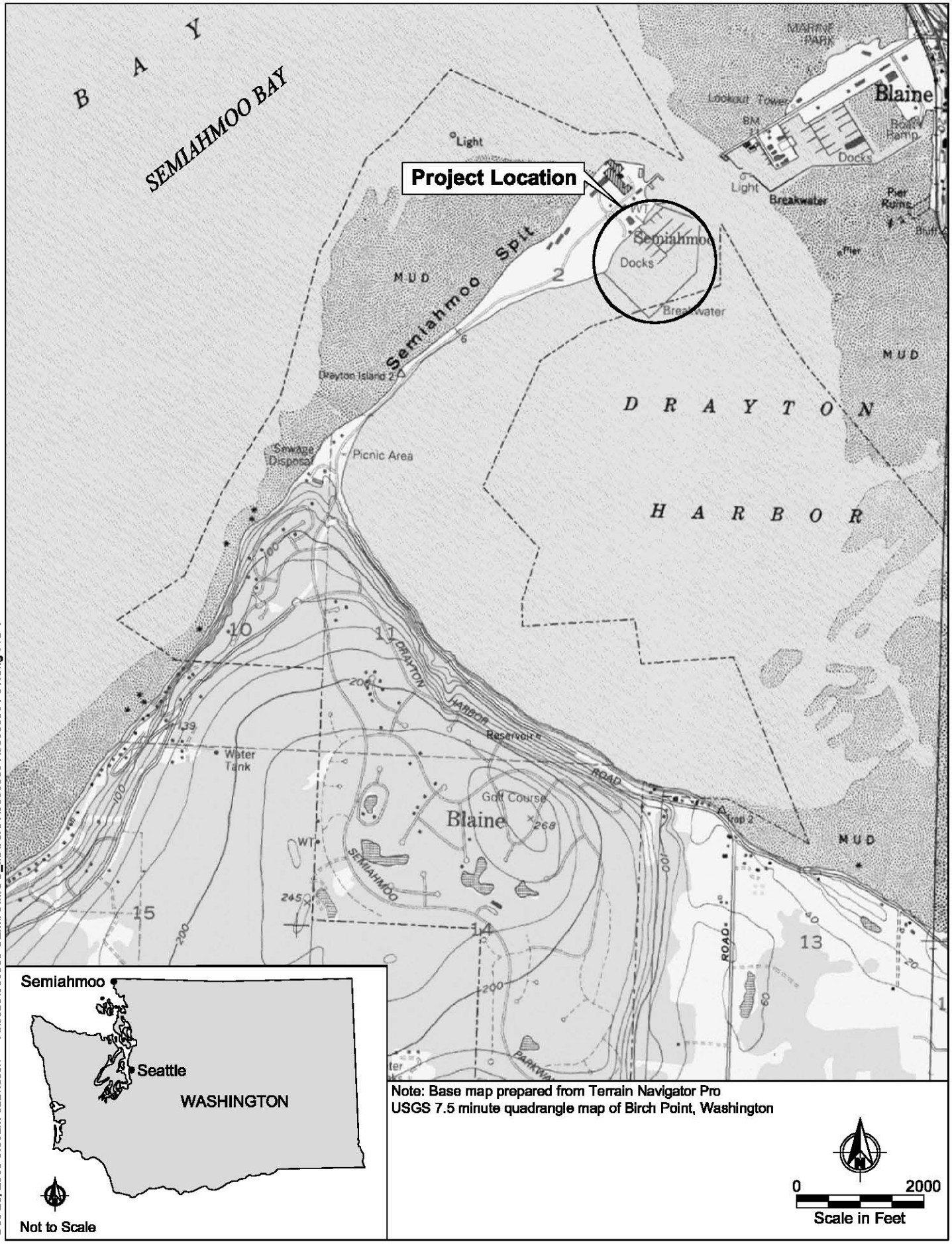
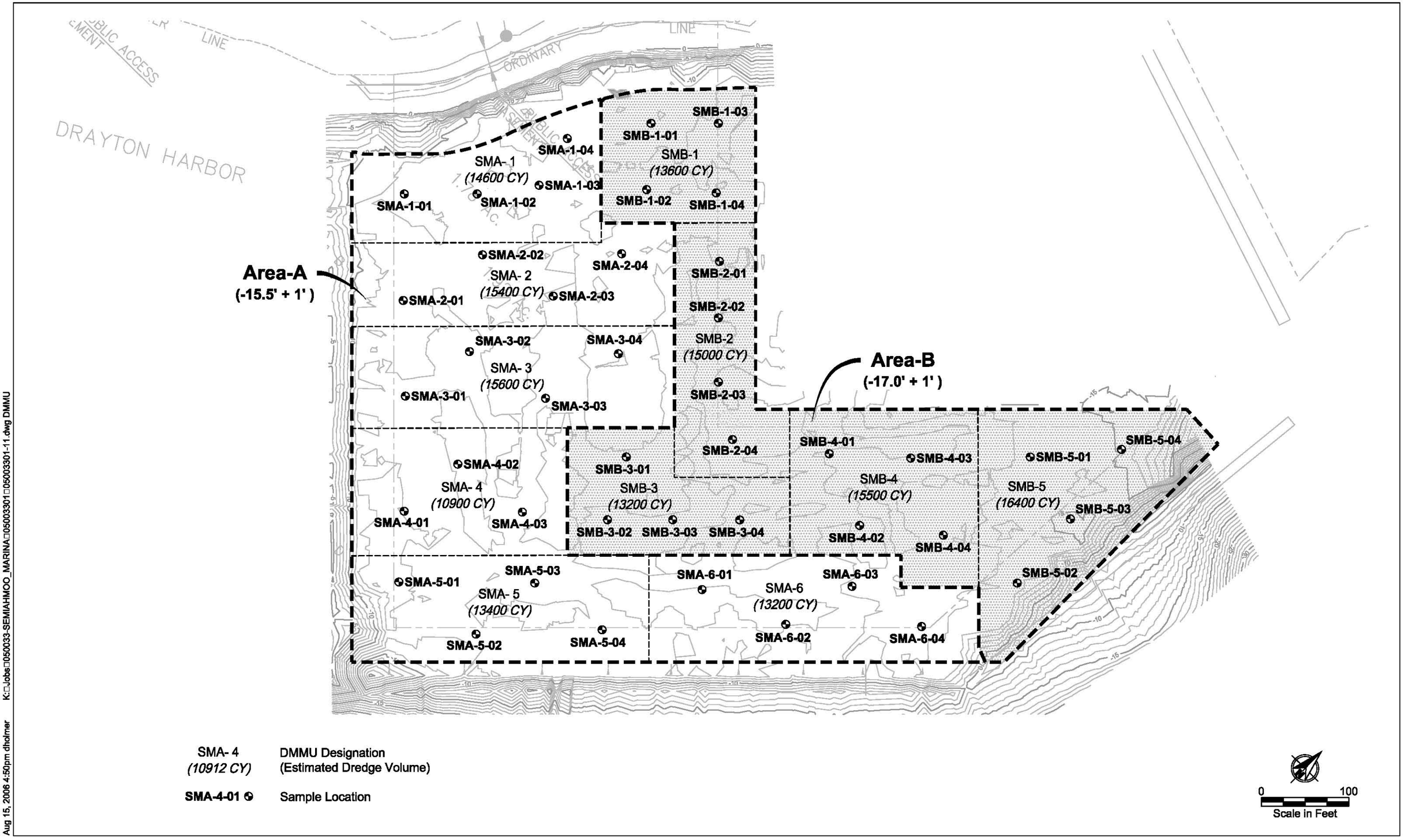
CHEMICAL	Method A[1]	Method B[2]	SMA-1		SMA-2		SMA-3		SMA-4		SMA-5		SMA-6		SMB-1		SMB-2		SMB-3		SMB-4		SMB-5	
			conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL	conc	QL
PHTHALATES (ug/kg dry)																								
Bis(2-ethylhexyl)phthalate	---	71,000	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
Butyl benzyl phthalate	---	---	6.1	U	6.0	U	6.1	U	6.0	U	6.2	U	6.1	U	5.9	U	6.1	U	6.2	U	6.1	U	6.0	U
Di-n-butyl phthalate	---	---	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
Di-n-octyl phthalate	---	---	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
Diethyl phthalate	---	---	6.1	U	18		6.1	U	6.0	U	6.2	U	6.1	U	6.5		9.2		6.2	U	6.1	U	6.0	U
Dimethyl phthalate	---	---	6.10	U	6.00	U	6.10	U	6.00	U	6.20	U	6.10	U	5.90	U	6.10	U	6.20	U	6.10	U	6.00	U
PHENOLS (ug/kg dry)																								
2,4-Dimethylphenol	---	---	6.1	UJ	6.0	UJ	6.1	U	6.0	U	6.2	UJ	6.1	UJ	5.9	UJ	6.1	UJ	6.2	UJ	6.1	UJ	6.0	UJ
Pentachlorophenol	---	8,300	30	U	30	U	30	U	30	U	31	U	30	U	30	U	30	U	31	U	30	U	30	U
Phenol	---	---	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	40		19	U
MISCELLANEOUS EXTRACTABLES (ug/kg dry)																								
Benzoic acid	---	---	200	U	190	U	200	U	200	U	190	U	200	U	200	U	200	U	200	U	190	U	190	U
Benzyl alcohol	---	---	30	UJ	30	U	30	U	30	U	31	U	30	UJ	30	UJ	30	UJ	31	UJ	30	UJ	30	U
Dibenzofuran	---	---	20	U	19	U	20	U	20	U	19	U	20	U	20	U	20	U	20	U	19	U	19	U
Hexachlorobutadiene	---	13,000	0.97	U	0.98	U	0.99	U	0.98	U	0.97	U	0.96	U	0.96	U	0.96	U	0.96	U	0.96	U	0.96	U
N-Nitrosodiphenylamine	---	200,000	6.1	U	6.0	U	6.1	U	6.0	U	6.2	U	6.1	U	5.9	U	6.1	U	6.2	U	6.1	U	6.0	U
VOLATILE ORGANICS (ug/kg dry)																								
Ethylbenzene	6,000	---	1.6	U	1.2	U	1.1	U	1.1	U	1.1	U	1.2	U	1.4	U	1.3	U	1.2	U	1.3	U	1.1	U
Tetrachloroethene	50	1,900	1.6	U	1.2	U	1.1	U	1.1	U	1.1	U	1.2	U	1.4	U	1.3	U	1.2	U	1.3	U	1.1	U
Total Xylene	9,000	---	1.6	U	1.2	U	1.1	U	1.1	U	1.1	U	1.2	U	1.4	U	1.3	U	1.2	U	1.3	U	1.1	U
Trichloroethene	30	2,500	1.6	U	1.2	U	1.1	U	1.1	U	1.1	U	1.2	U	1.4	U	1.3	U	1.2	U	1.3	U	1.1	U
PESTICIDES AND PCBs (ug/kg dry)																								
Aldrin	---	59	0.97	U	0.98	U	0.99	U	0.98	U	0.97	U	0.96	U	0.96	U	0.96	U	0.96	U	0.96	U	0.96	U
Chlordane	---	2,900	1.9	U	2.0	U	2.0	U	2.0	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U
Dieldrin	---	63	1.9	U	2.0	U	2.0	U	2.0	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U
Heptachlor	---	220	0.97	U	0.98	U	0.99	U	0.98	U	0.97	U	0.96	U	0.96	U	0.96	U	0.96	U	0.96	U	0.96	U
Heptachlor epoxide	---	110	0.97	U	0.98	U	0.99	U	0.98	U	0.97	U	0.96	U	0.96	U	0.96	U	0.96	U	0.96	U	0.96	U
Lindane	10	770	0.97	U	0.98	U	0.99	U	0.98	U	0.97	U	0.96	U	0.96	U	0.96	U	0.96	U	0.96	U	0.96	U
Total DDT	---	---	1.9	U	2.0	U	2.0	U	2	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U
DDT	3,000	2,900	1.9	U	2.0	U	2.0	U	2	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U
DDE	---	2,900	1.9	U	2.0	U	2.0	U	2	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U
Total PCBs	1,000	500	3.9	U	9.8	U	9.8	U	9.8	U	9.7	U	9.8	U	3.9	U	3.8	U	3.9	U	3.8	U	9.5	U



Dec 28, 2005 8:30am cdavidson K:\Jobs\050033-SEMIAHMOO_MARINA\05003301\05003301-01.dwg FIG 1

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 1
Vicinity Map
Semiahmoo Marina



Aug 15, 2006 4:50pm dholmer K:□Jobs□0500033-SEMIAHMOO_MARINA□05003301□05003301-11.dwg DMMU

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 2
Proposed Dredge Areas, DMMUs, and Sampling Locations
Semiahmoo Marina