Foth & Van Dyke

Memorandum

June 1, 2006

TO: Bill Hartman, GW Partners

CC: JP Causey, WTM1
Skip Missimer, Glatfelter
John Blind, Glatfelter
Amie Obermeier, GW Partners
Pat Zaepfel, Meyer, Unkovic & Scott
Mike Jury, CH2MHill
John Trast, STS
Jeanne Tarvin, STS
Nancy Peterson, Q&B
Tony Vogel, Q&B
Steve Laszewski, Foth & Van Dyke
Denis Roznowski, Foth & Van Dyke

FR: Jerry Eykholt, Ph.D., P.E.

RE: Discussion and details for core averaging procedures used to delineate TSCA-level sediment regions for the 2006 RA in OU1

This memo addresses the details for core averaging used to delineate TSCA-level sediment regions for the Proposed 2006 Remedial Action in OU1. As a result of recent discussions with the Agencies and Oversight Team (A/OT), the methods used to develop core-average PCB concentrations for the TSCA delineation method have been changed. Results from the former method are described in my previous memo dated April 28, 2006. Details of the former method are also attached for your reference (Attachment 1).

The revised TSCA characterization method results in a slight expansion of the TSCA delineation for the 2006 RA. The revised TSCA area has been expanded by 18.3% to 47,203 sq. ft. The revised TSCA volume (with 4-inch overcut) has expanded by 16.6% from 1415 cy to 1650 cy. Without overcut considered, the TSCA volume has increased from 922 cy to 1068 cy. The full TSCA area for the 2006 RA is still centered about the core POG3-32. No other cores associated with the 2006 RA were classified as TSCA by the revised method.

The revised TSCA delineation method uses a core-average PCB concentration, using all portions of actual sediment sample intervals within the top 30 inches of sediment (equal to the cutterhead diameter), the next 30 inches (if available), and to greater depths with the same averaging interval, so long as the averaging interval does not extend beneath the expected dredge cut at the core location. For the 2006 RA, the expected dredge cut is defined as the 1.0 ppm isopach thickness with an expected 4.0-inch overcut.

The revised TSCA delineation method would be applied as follows:

1. If the core sediment thickness is less than 30 inches and the expected dredge cut at the core is deeper than the core sediment thickness, then the length-weighted average PCB concentration (see attachment 1) would be computed for all sample intervals from the core.

2. If the expected dredge cut at the core is less than 30 inches, then the length-weighted average PCB concentration would be computed only for those portions of the core that are within the expected dredge cut.

3. If the core sediment thickness is greater than 30 inches and the expected dredge cut at the core is also greater than 30 inches, then a core-average PCB concentration from the top 30 inches is computed and reported. Core averages are also computed and reported for each remaining 30-inch segment (as limited by the expected dredge cut).

Other portions of the core are ignored when computing the core-average.

Some complexity may arise in the application of the method for cores with high PCB concentration, larger sediment thickness, and expected dredge cuts that are deep. At the moment, there is no clear guidance for horizontal delineation of the TSCA region when there is more than one 30-inch interval with TSCA-level average PCB concentrations. However, for the 2006 RA, there are no cores that meet these criteria.

For the OU1 2006 RA regions, the representative core-average PCB concentrations of the expected dredge cut (1 ppm isopach plus 4-inch overcut) were all less than 50 ppm, except for the core that had previously been designated as TSCA (POG3-32). Details of the evaluation are shown below, within the discussion of the revised TSCA averaging procedure.

Core-Average PCB Concentrations for 2006 RA

In applying the revised TSCA delineation method, we first surveyed the PCB sample dataset (OU1 BODR) for any individual PCB concentrations equal to or greater than 50 ppm, including the additional cores collected by Foth & Van Dyke in April 2006. For the 2006 RA, the regions to be remediated include the northern portions of Sub-area C/D2S, Sub-area POG2, Sub-area POG3 South, certain portions of Sub-area POG3 North, Sub-area POG4 South, and the southern portion of Sub-area E1. The locations and summaries of all cores with PCB concentrations equal to or greater than 50 ppm are shown in Figure 1.

All samples at the 9 core locations shown in Figure 1 were analyzed to determine the core-average PCB concentration. Details of the samples are presented in Table 1. As described above, core averages are limited by a maximum interval thickness of 30 inches

and are constrained by the expected thickness of dredge cut. Three cores had sediment thickness greater than 30 inches, but the average PCB concentrations for these cores in all averaging intervals were less than 50 ppm. Only one core, POG3-32, had a core-average PCB concentration that would be classified as TSCA using the revised method. This core is located in POG3 South.

Revision to Horizontal Delineation of TSCA Region

The application of the revised TSCA delineation method to determine the horizontal extent of the TSCA area around the core at POG3-32 is described in Attachment 1. The core-average PCB concentrations of cores within 250 ft. of the TSCA core were calculated, then a 2D interpolation routine (IDW, nearest 4 points) was used to provide the horizontal delineation of the area expected to have a representative average PCB concentration of 50 ppm or greater.

Because the expected dredge cut is to the 1.0 ppm isopach with a 4-inch overcut, core-averages for the nearby cores were computed for this expected overcut.

In April 2006, additional samples were collected in the Sub-area POG3 South for the purposes of refining proposed, no-dredge areas. Although none of the additional cores contained samples with PCBs of 50 ppm or greater, two of the new cores were located within 250 ft. of the core at POG3-32. However, at one of the two locations, POG3-R1, no sample could be collected due to the absence of soft sediment (the sampler could not be pushed through the firm granular river bottom on two attempts). The other core, POG3-R16, had only one sample (0-3.25 inches) with a total PCB concentration of 7.1 ppm. The locations of the cores and horizontal delineation of the TSCA area are shown in Figure 2. Core-average PCB concentrations for these cores are shown in Table 2. Further details for cores with more than one sample interval are presented in Table 3.

Summary

The expected dredge cut in 2006 is the depth to the 1.0 ppm isopach plus an expected 4-inch overcut. Using the revised TSCA delineation method, we calculated an adjusted core-average PCB concentration for all the relevant cores for the OU1 2006 project. The only core in the 2006 set that had a representative average PCB concentration of 50 ppm or greater was POG3-32. This core had previously been designated as TSCA. However, as a result of the revised TSCA delineation method, the computed core-average PCB concentration at POG3-32 increased from 89 ppm to 118 ppm. Minor changes in the core-average PCB concentrations of the neighboring cores also led to a modest expansion of the TSCA area. The revised TSCA area has been expanded by 18.3% to 47,203 sq. ft. The revised TSCA volume (with 4-inch overcut) has expanded by 16.6% from 1415 cy to 1650 cy.

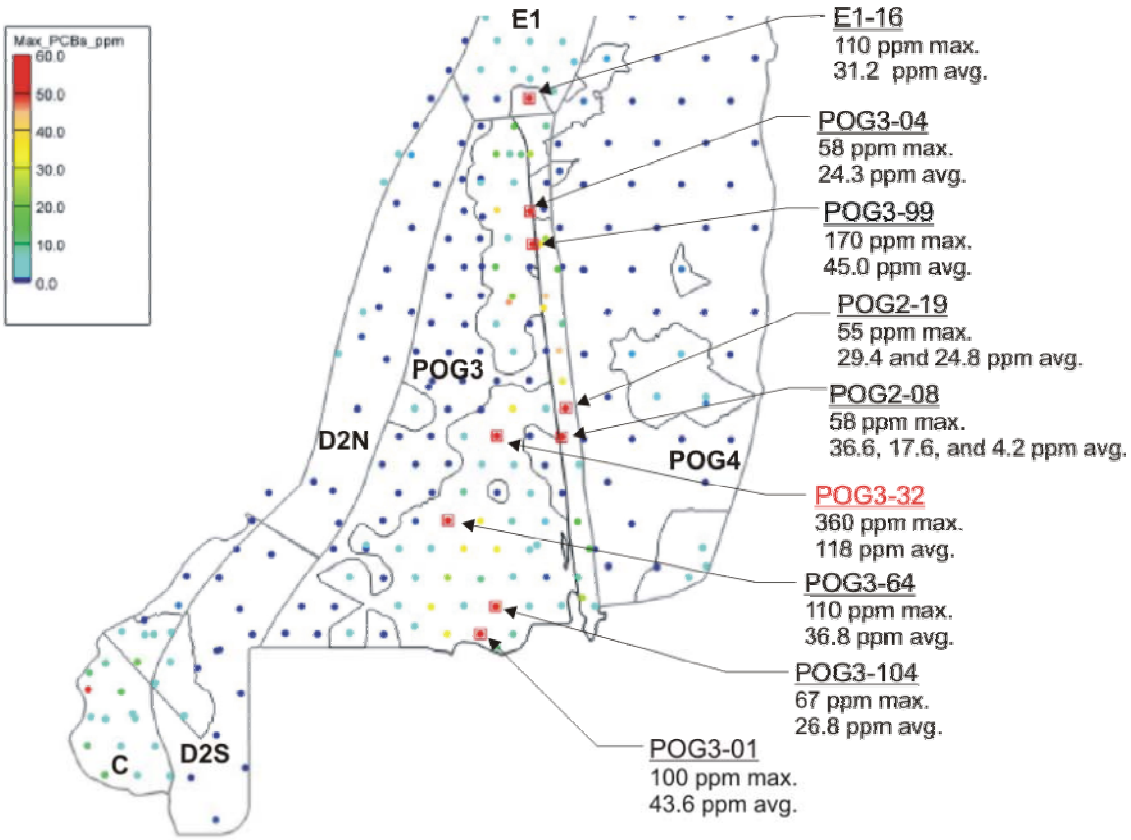

Figure 1. Selected OU1 Sub-areas and Cores with Maximum PCB Concentrations of 50 ppm or Greater. Southern Areas of C and D2S Addressed in 2005.

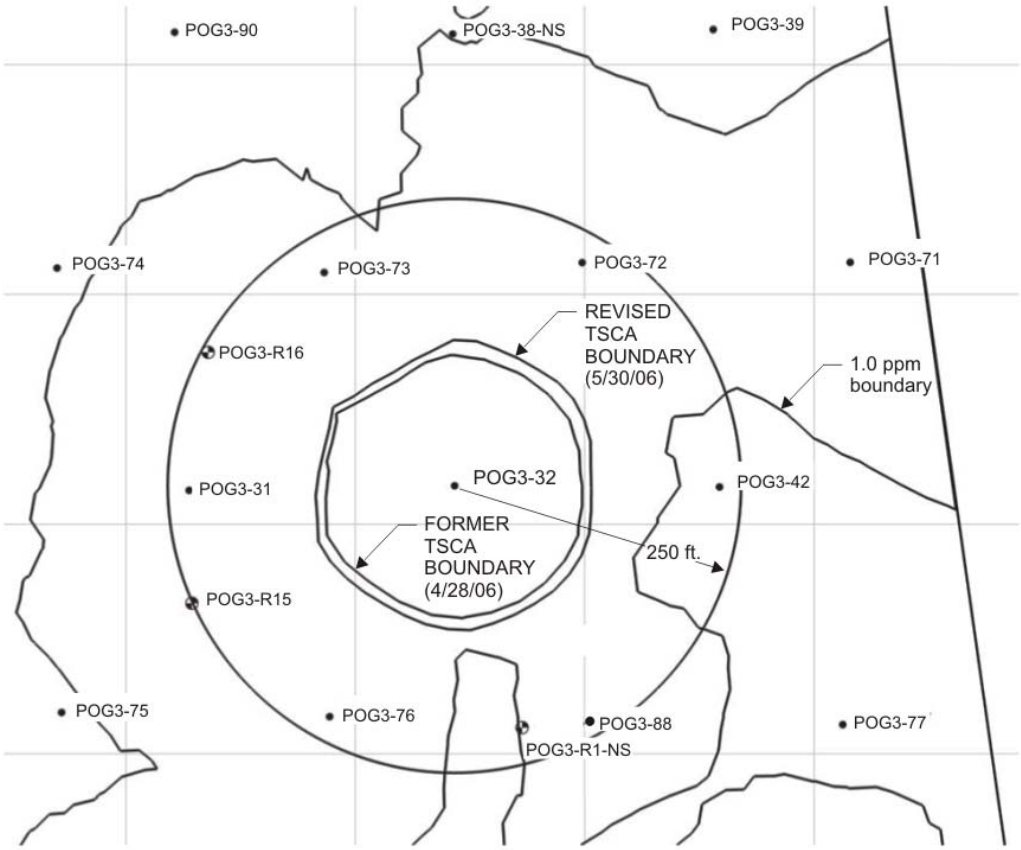

Figure 2. Horizontal Delineation of TSCA region in Southern POG3. Revisions to TSCA region were necessary because core averaging procedure was changed. Revised TSCA boundary has area of 47,203 sq. ft. (up 17.7% from 40,108 sq. ft.). Core average concentrations are presented in Table 2. 200 ft. grid.

Table 1. Details of Core Averaging for All PCB Samples with an Individual Sample 50 ppm or Greater in OU1 2006 Areas.

Action Area	SampleID	Easting (X, SPS ft.)	Northing (Y, SPS ft.)	PCB (ppm)	zMin (feet below surface)	zMax (feet below surface)	Interval (ft.)	distance above (ft.)	distance below TSCA (ft.)	distance below 1 ppm isopach (ft.)	applicable interval, L (ft.)	PCB*L	Core avg
Southern POG3	POG3-01-A	2371395	806639	100	0	-0.328	0.328	0.000	0.000		0.328	32.8	43.6
	POG3-01-A-C	2371395	806639	0.23	-0.328	-0.755	0.427		0.427	0.255	0.427	0.1	
	POG3-104-A	2371503	806834	67	0	-0.328	0.328	0.000	0.000		0.328	22.0	26.8
	POG3-104-A-C	2371503	806834	5.4	-0.328	-0.656	0.328		0.328		0.328	1.8	
	POG3-104-D	2371503	806834	0.0135	-0.656	-0.886	0.230		0.558	0.156	0.230	0.0	
	POG3-64-A	2371165	807440	110	0	-0.328	0.328	0.000	0.000		0.328	36.1	36.8
	POG3-64-A-C	2371165	807440	9.1	-0.328	-0.656	0.328		0.328		0.328	3.0	
	POG3-64-D	2371165	807440	0.11	-0.656	-0.984	0.328		0.656	0.254	0.328	0.0	
	POG3-64-E	2371165	807440	0.0135	-0.984	-1.312	0.328		0.984	0.582	0.079	0.0	
	POG3-64-F	2371165	807440	0.0135	-1.312	-1.640	0.328		1.312	0.910	0.000	0.0	
	POG3-32-A	2371512	808037	360	0	-0.328	0.328	0.000	0.000		0.328	118.1	118.0
	POG3-32-A-C	2371512	808037	1.5	-0.328	-0.656	0.328		0.328		0.328	0.5	
	POG3-32-D	2371512	808037	0.091	-0.656	-0.984	0.328		0.656	0.312	0.328	0.0	
	POG3-32-E	2371512	808037	0.0135	-0.984	-1.312	0.328		0.984	0.640	0.021	0.0	
	POG3-32-F	2371512	808037	0.0135	-1.312	-1.640	0.328		1.312	0.968	0.000	0.0	
Northern POG3	POG3-99-A	2371763	809389	3.1	0	-0.328	0.328	0.328			0.328	1.0	45.0
	POG3-99-A-C	2371763	809389	170	-0.328	-0.656	0.328	0.000			0.328	55.8	
	POG3-99-D	2371763	809389	79	-0.656	-0.984	0.328		0.000		0.328	25.9	
	POG3-99-E	2371763	809389	12	-0.984	-1.312	0.328		0.328		0.328	3.9	
	POG3-99-F	2371763	809389	5.6	-1.312	-1.640	0.328		0.656		0.328	1.8	
	POG3-99-G	2371763	809389	0.48	-1.640	-1.968	0.328		0.984	0.258	0.328	0.2	
	POG3-04-A	2371745	809620	2.9	0	-0.328	0.328	0.328			0.328	1.0	24.3
	POG3-04-A-C	2371745	809620	58	-0.328	-0.656	0.328	0.000	0.000		0.328	19.0	
	POG3-04-D	2371745	809620	46	-0.656	-0.984	0.328		0.328		0.328	15.1	
	POG3-04-E	2371745	809620	0.44	-0.984	-1.312	0.328		0.656	0.192	0.328	0.1	
	POG3-04-F	2371745	809620	0.7	-1.312	-1.640	0.328		0.984	0.520	0.141	0.1	
POG2	POG2-08-A	2371969	808029	1.5	0	-0.328	0.328	1.640			0	0.0	36.6
	POG2-08-A-C	2371969	808029	3.8	-0.328	-0.656	0.328	1.312			0.016	0.1	
	POG2-08-D	2371969	808029	2.3	-0.656	-0.984	0.328	0.984			0.328	0.8	
	POG2-08-E	2371969	808029	6.8	-0.984	-1.312	0.328	0.656			0.328	2.2	
	POG2-08-F	2371969	808029	24	-1.312	-1.640	0.328	0.328			0.328	7.9	
	POG2-08-G	2371969	808029	63	-1.640	-1.968	0.328	0.000			0.328	20.7	
	POG2-08-H	2371969	808029	55	-1.968	-2.297	0.328				0.328	18.0	
	POG2-08-J-top	2371969	808029	91	-2.297	-2.500	0.203				0.203	18.5	
	POG2-08-J-bottom	2371969	808029	91	-2.500	-2.625	0.125		0.000		0.125	11.3	17.6
	POG2-08-K	2371969	808029	5.6	-2.625	-2.953	0.328		0.328		0.328	1.8	
	POG2-08-L	2371969	808029	7.7	-2.953	-3.281	0.328		0.656		0.328	2.5	
	POG2-08-M	2371969	808029	40	-3.281	-3.609	0.328		0.984		0.328	13.1	
	POG2-08-N	2371969	808029	19	-3.609	-3.937	0.328		1.312		0.328	6.2	
	POG2-08-P	2371969	808029	9.9	-3.937	-4.265	0.328		1.640		0.328	3.2	
	POG2-08-Q	2371969	808029	14	-4.265	-4.593	0.328		1.968		0.328	4.6	
	POG2-08-R	2371969	808029	2.3	-4.593	-4.921	0.328		2.297		0.328	0.8	
	POG2-08-S-top	2371969	808029	3.2	-4.921	-5.000	0.079		2.375		0.079	0.3	
	POG2-08-S-bottom	2371969	808029	3.2	-5.000	-5.249	0.249		2.625		0.249	0.8	4.2
	POG2-08-T	2371969	808029	5.5	-5.249	-5.577	0.328		2.953		0.328	1.8	
	POG2-08-U	2371969	808029	3.2	-5.577	-5.774	0.197		3.150	-2.066	0.197	0.6	
	POG2-19-A	2371995	808234	6	0	-0.328	0.328	0.328			0.328	2.0	29.4
	POG2-19-A-C	2371995	808234	18	-0.328	-0.656	0.328	0.000			0.328	5.9	
	POG2-19-D	2371995	808234	55	-0.656	-0.984	0.328		0.000		0.328	18.0	
	POG2-19-E	2371995	808234	24	-0.984	-1.312	0.328		0.328		0.328	7.9	
	POG2-19-F	2371995	808234	28	-1.312	-1.640	0.328		0.656		0.328	9.2	
	POG2-19-G	2371995	808234	46	-1.640	-1.968	0.328		0.984		0.328	15.1	
	POG2-19-H	2371995	808234	21	-1.968	-2.297	0.328		1.312		0.328	6.9	
	POG2-19-J-top	2371995	808234	37	-2.297	-2.625	0.328		1.640		0.328	12.1	
	POG2-19-J-bottom	2371995	808234	37	-2.297	-2.625	0.328		1.640		0.328	12.1	24.8
	POG2-19-K	2371995	808234	16	-2.625	-3.084	0.459		2.100	-2.676	0.459	7.3	
E1	E1-16-A	2371740	810424	3.7	0	-0.328	0.328	0.656			0.328	1.2	31.2
	E1-16-A-C	2371740	810424	3.7	-0.328	-0.656	0.328	0.328			0.328	1.2	
	E1-16-D	2371740	810424	61	-0.656	-0.984	0.328	0.000			0.328	20.0	
	E1-16-E	2371740	810424	110	-0.984	-1.312	0.328		0.000		0.328	36.1	
	E1-16-F	2371740	810424	0.0135	-1.312	-1.640	0.328		0.328	0.098	0.328	0.0	
	E1-16-G	2371740	810424	0.0135	-1.640	-1.968	0.328		0.656	0.426	0.235	0.0	
	E1-16-H	2371740	810424	0.0135	-1.968	-2.297	0.328		0.984	0.755	0	0	
	E1-16-J-top	2371740	810424	0.0135	-2.297	-2.500	0.203		1.188	0.958	0	0	
	E1-16-J-bottom	2371740	810424	0.0135	-2.500	-2.625	0.125		1.312	1.083	0	0	NA
	E1-16-K	2371740	810424	0.0135	-2.625	-2.953	0.328		1.640	1.411	0	0	
	E1-16-L	2371740	810424	0.0135	-2.953	-3.281	0.328		1.968	1.739	0	0	
	E1-16-M	2371740	810424	0.25	-3.281	-3.609	0.328		2.297	2.067	0	0	
	E1-16-N	2371740	810424	0.25	-3.609	-3.839	0.230		2.526	2.297	0	0	

Table 2. Summary of Core Average PCB Concentrations for Cores Located Within 250 ft. of TSCA Core, POG3-32.

Core Station ID	Easting X (SPS, ft.)	Northing Y (SPS, ft.)	Maximum PCB Concentration (ppm)	Thickness of soft sediment (ft.)	Sediment depth to 1 ppm isopach (ft.)	Sediment depth to 1 ppm isopach minus 4" (ft.)	Core average PCB (ppm) from TSCA delineation
POG3-32	2371512	808037	360	-2.717	-0.672	-1.005	118.0
POG3-31	2371281	808033	1.9	-3.780	-0.322	-0.655	1.87
POG3-42	2371743	808036	0.29	-0.771	0.000	-0.333	0.29
POG3-72	2371623	808231	32	-1.444	-0.751	-1.085	19.6
POG3-73	2371398	808223	1	-3.211	-0.138	-0.471	0.71
POG3-76	2371403	807836	2.8	-2.710	-0.349	-0.683	1.42
POG3-88	2371631	807832	1.9	-4.379	-0.297	-0.630	1.02
POG3-R16	2371297	808153	7.1	-3.667	-0.528	-0.861	7.10

Table 3. Details of Core Average PCB Concentrations for Cores Located Within 250 ft. of TSCA Core, POG3-32.

SampleID	adjusted easting (X)	adjusted northing (Y)	PCB (ppm)	depth to bottom of sample interval (ft.)	depth below 1 ppm isopach	interval thickness or relevant length within interval (L)	PCB*L	Core average PCB concentration (ppm)
POG3-32-A	2371512	808037	360	0.328		0.328	118.110	118.0
POG3-32-A-C	2371512	808037	1.5	0.656		0.328	0.492	
POG3-32-D	2371512	808037	0.091	0.984	0.312	0.328	0.030	
POG3-32-E	2371512	808037	0.0135	1.312	0.640	0.021	0.000	
POG3-32-F	2371512	808037	0.0135	1.640	0.968	0	0	
POG3-31-A	2371280	808033	1.9	0.328	0.006	0.328	0.623	1.87
POG3-31-A-C	2371280	808033	0.0135	0.656	0.334	0.005	0.000	
POG3-31-D	2371280	808033	0.0135	0.984	0.662	0	0	
POG3-31-E	2371280	808033	0.0135	1.312	0.990	0	0	
POG3-31-F	2371280	808033	0.0135	1.640	1.318	0	0	
POG3-42-A	2371743	808036	0.29	0.328	0.328	0.328	0.095	0.29
POG3-42-A-C	2371743	808036	0.0135	0.656	0.656	0.005	0.000	
POG3-72-A	2371623	808231	9.3	0.328		0.328	3.051	19.6
POG3-72-A-C	2371623	808231	32	0.656		0.328	10.499	
POG3-72-D	2371623	808231	0.0135	0.984	0.233	0.328	0.004	
POG3-72-E	2371623	808231	0.0135	1.444	0.693	0.100	0.001	
POG3-73-A	2371398	808223	1.0	0.328	0.190	0.328	0.328	0.71
POG3-73-A-C	2371398	808223	0.06	0.656	0.518	0.143	0.009	
POG3-73-D	2371398	808223	0.0135	0.984	0.846	0	0	
POG3-73-E	2371398	808223	0.0135	1.312	1.174	0	0	
POG3-73-F	2371398	808223	0.0135	1.640	1.502	0	0	
POG3-76-A	2371403	807836	2.8	0.328		0.328	0.919	1.42
POG3-76-A-C	2371403	807836	0.16	0.656	0.307	0.328	0.052	
POG3-76-D	2371403	807836	0.0135	0.984	0.635	0.026	0.000	
POG3-76-E	2371403	807836	0.0135	1.312	0.963	0	0.000	
POG3-76-F	2371403	807836	0.0135	1.640	1.291	0	0.000	
POG3-88-A	2371631	807832	1.9	0.328	0.031	0.328	0.623	1.02
POG3-88-A-C	2371631	807832	0.058	0.656	0.359	0.302	0.018	
POG3-88-D	2371631	807832	0.0135	0.984	0.687	0	0	
POG3-88-E	2371631	807832	0.0135	1.312	1.015	0	0	
POG3-88-F	2371631	807832	0.0135	1.640	1.343	0	0	

ATTACHMENT 1

Former TSCA Delineation Method Used in Lower Fox River Project, OU1 Remedial Action:

1. Vertical Delineation.
   The first step is to scan all sample data in BODR sample dataset, with focus on those cores with at least one sample having PCB concentration greater than or equal to 50 ppm. Average PCB concentrations in the cores are computed, for the sample interval portions that are within 12" of any sample interval with a PCB concentration of 50 ppm or greater.

   Depth-weighted averaging would be used to estimate the "as removed" concentration. Depth-weighted averaging follows the simple formula:

$$PCB_{dwa} = \frac{\sum PCB_i \, \Delta z_i}{\sum \Delta z_i} \qquad (1)$$

   where PCB_{dwa} is the depth-weighted average concentration, PCB_i is the PCB concentration of the depth interval i, and Δz_i is the thickness of the depth interval.

2. Horizontal Delineation
   A. For those cores having an average PCB concentration at or above 50 ppm (from step 1), select the nearby cores that are located within 250 ft. horizontally of these cores. This radius is appropriate, since it will include a reasonable number of nearby cores for 2D interpolation of the 50 ppm region (step 2C).

   B. For the cores selected in step 2A, calculate the depth-weighted average PCB concentration over an appropriate segment of the core. The appropriate segment is defined as:

      1. Include 12" above the top of the shallowest sampling interval of core with PCB concentration of 50 ppm or higher.
      2. Include 12" below the bottom of the deepest sample interval with PCB concentration of 50 ppm or higher.
      3. For all cores with all samples having PCB concentrations less than 50 ppm, the appropriate segment for the weighted average calculation was from the top of the core to a depth 6" below the 1.0 ppm isopach depth at that core location, or the bottom of the lowest sample interval, whichever resulted in the shallowest depth.

   C. 2D interpolation is then used over the region of the selected cores to derive the contours of PCB concentration to a triangulated irregular network (TIN) with the same internal TIN nodes as the RAL isopach. Shepard's Method inverse distance weighting (idw) method with the nearest 4 points is used. This method is similar to the 3D interpolation method used to develop the 1.0 ppm RAL isopach. Then, the region with an average PCB concentration at or above 50 ppm is defined.

3. Assignment of Isopach Depths to 50 ppm Region The region with average PCB concentration of 50 ppm or greater is discretized into another TIN, with the same internal TIN nodes as the RAL isopach. The RAL isopach is linearly interpolated to this region TIN. This allows the sediment volumes to be estimated, and the dredge plan for the area can be developed.

Source: "Lower Fox River OU1 2005 Remedial Action, Delineation of TSCA-Characterized Sediment within Sub-area A", Memo from Jerry Eykholt to Steven Laszewski, Foth & Van Dyke and Associates, June 21, 2005.