FINAL MEMORANDUM CH2MHILL

Modification to the Work Plan for Conducting Bench-Scale Studies at Site 17, NSF-IH, Indian Head, Maryland

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FROM: Gunarti Coghlan/CH2M HILL

DATE: March 27, 2007

This memorandum documents the modification to the approach for the bench-scale studies at Site 17, Naval Support Facility, Indian Head (NSF-IH) in Indian Head Maryland. The approach was documented in the final work plan dated January 19, 2007. The modification was necessary based on the results of the contaminant mass distribution profiling and the lithology observation by XDD. Four soil borings were sent to XDD for the bench-scale studies: IS17DP64 (4 to 16 feet below ground surface [bgs]), IS17DP66 (4 to 12 feet bgs), IS17DP67 (4 to 20 feet bgs), and IS17DP68 (4 to 20 feet bgs). The results of the mass distribution profile and the lithology observation, as well as the proposed modification by XDD are included as Attachment A. The proposed modification was discussed via a conference call between XDD and CH2M HILL on February 16, 2007 and concurred by the Indian Head Installation Restoration Team in a conference call on March 22, 2007. The agreed upon point by point modification is presented below in italics:

1. In the final work plan, it was hypothesized that the subsurface of Site 17 consisted of two dominant lithologies: sand and clay. Based on this assumption, separate studies were to be conducted for each material. The lithology observation indicated that approximately 70 percent (%) of the soil mass is clay. *Therefore, bench-scale studies will be performed on the soil mass instead of separate clay and sand materials*.

2. The PID readings and the volatile organic compound (VOCs) analysis results indicated that contaminant mass generally resides in the depth interval of 8 feet bgs or deeper. Furthermore, peat-like organic matter layers were observed up to the depth of 8 feet bgs, with the exception of soil core IS17DP64 where it was observed up to the depth of 10 feet bgs. *Based on these results, saturated soil taken from the depth up to 8 feet bgs at IS17DP66,*

IS17DP67, and IS17DP68, and the depth up to 10 feet bgs at IS17DP64 will be excluded from the bench-scale studies.

3. Because the soil mass consists predominantly of clay, unactivated persulfate will also be considered as an oxidant in the studies. Unactivated persulfate may provide a longer residence/contact time that will be favorable in a clay soil application. *Therefore, three persulfate technologies, instead of the two technologies presented in the original work plan, will be evaluated in the persulfate activation preliminary testing. The three persulphate technologies are: 1) alkaline activated persulfate, 2) iron activated persulfate, and 3) unactivated persulfate.*

4. The original work plan specifies that soil concentrations will be spiked at approximately 20 to 50% over the maximum observed concentrations from the contaminant mass distribution profiling. Because TCE was observed at 12,000 mg/kg, the original spiking plan was deemed not practicable. *Therefore, for the preliminary testing, soil concentrations will be spiked to approximately 2,000 mg/kg TCE, which is equivalent to the soil concentration in equilibrium with TCE concentration in groundwater of 870,000 ug/L. The TCE spiked soil concentrations for the injection simulation studies will be determined based on the results of the soil oxidant demand (SOD) test.*

5. Because the soil mass consists mostly of clay, unactivated persulfate will be added to the SOD test, which will increase the number of technologies from two (as proposed in the work plan) to three. *SOD tests will be performed on the following three technologies: 1) activated persulfate, 2) unactivated persulfate, and 3) permanganate. Furthermore, the contact time in the SOD test will be extended up to 90 days, if necessary, to evaluate potential reactivity of oxidants over time. The simulation tests will use the SOD data collected during the first 30 days.*

6. As described in the original work plan, injection simulation test will be performed using two technologies (1) persulfate – activated or unactivated and 2) permanganate) on the composite soil type. *The change is that pre-tests will determine if unactivated persulfate is better suited than the two activated persulfate approaches (alkaline and iron).*

7. *XDD proposed that zero valent iron (ZVI) should be added in the bench-scale studies; however, it was determined that no benefit will be gained by performing a bench-scale study on ZVI.* There is enough information available regarding the performance of ZVI for TCE DNAPL treatment at the full-scale level.

Because the subsurface lithology consists predominantly of clay, it should be noted that delivery of oxidant or reductant via soil mixing should be considered for the pilot study and the full-scale remedy implementation for the shallow groundwater at Site 17.

Attachment A

MEMORANDUM

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To: Gunarti Coghlan, CH2M HILL **Date:** February 13, 2007

From: Annette Lee **cc:** file (06010)

Re: Mass Profiling Summary and Bench Test Recommendations
Site 17
Indian Head, Maryland

SOIL MASS PROFILING SUMMARY

Four soil cores (DP64, DP66, DP67 and DP68) were screened for VOCs at approximately 5-inch intervals using a PID. The attached sheets illustrate the soil lithology and the PID detections above 100 ppmv in the four soil cores. The laboratory results for the TCE concentrations are also presented. The general observations of the mass profiling are detailed below:

- The cores were received as follows:
  - DP64 = 4 to 16 feet below grade,
  - DP66 = 4 to 12 feet below grade,
  - DP67 = 4 to 20 feet below grade, and
  - DP68 = 4 to 20 feet below grade.
- All soil above 8 feet had no detections with the PID except DP64 (highest detection = 275 ppmv). Additionally, the 4- to 8-foot soil interval generally had a high level of organic matter and peat (which can potentially lead to misleading/high SOD). NOTE: because of the little to no PID detections and the high level of organic matter, the 4- to 8-foot soil interval was split out separately from the rest of the cores. Unless otherwise directed by CH2M HILL, XDD does not plan to conduct the bench testing on this soil interval from the cores received.
- Based on the soil screening and lithologic observations, the soils were divided into four categories:
  - sand,
  - sandy clay,
  - clay, and

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- soil shallower than 8 feet.

- The soil greater than 14 feet in the three deeper cores (DP64, DP68 and DP67) was clay. Unknown for DP66 because it ended at 12 feet.
- From the soil interval between 8 and 20 feet below grade, the distribution of soil type was approximately 71% clay (~16 Kg), 11% sandy clay (~2.5 Kg) and 18% sand (~4 Kg). Note that the amount of sand is much less than expected.
- DP67 had the highest PID detections - greater than 9,999 ppmv at depths of 8 to 10 feet, 12 to 14 feet and 16 to 18 feet.
- A total of 20 samples were collected from the soil cores for laboratory analysis. Sample locations were based on a combination of factors including the PID results; soil interface between clay; sand and sandy clay; and concentration gradient. The table presented below summarizes the soil type and rationale for each sample submitted for laboratory analysis. It also provides the results of the laboratory analysis.

Sample Name	TCE Concentration (mg/Kg)	Notes
IH17-64-10.75	6.5	SAND @ soil interface; elevated PID reading
IH17-64-11.00	170	CLAY just below soil interface
IH17-64-13.75	200	SANDY CLAY – mini concentration profile across three soil types
IH17-64-14.1	110	SAND – mini concentration profile across three soil types
IH17-64-15	220	CLAY – mini concentration profile across three soil types
IH17-64-16	18	CLAY – mini concentration profile across three soil types
IH17-66-8.8	4.6	SANDY CLAY – mid interval
IH17-66-10.5	6.2	CLAY – concentration in clay with sand strings
IH17-66-11.5	4	CLAY – concentration in clay lens within SAND layer
IH17-67-8.25	350	SAND – elevated PID reading
IH17-67-10.25	65	CLAY – interface with elevated PID reading in sand above
IH17-67-11.75	44	SAND – interface with clay
IH17-67-12.25	12,000	CLAY – elevated PID reading @ interface with sand
IH17-67-14.5	140	CLAY – elevated PID reading
IH17-67-17.5	160	CLAY – elevated PID reading

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Sample Name	TCE Concentration (mg/Kg)	Notes
IH17-68-11	5.7	SANDY CLAY – confirm PID reading (0 ppmv)
IH17-68-14.5	86	CLAY – mini concentration profile @ mid interval
IH17-68-15.5	110	CLAY – mini concentration profile
IH17-68-15.75	110	CLAY – mini concentration profile @ interface with sandy clay
IH17-68-19.5	20	CLAY – elevated PID readings @ the base of the core

RECOMMENDED MODIFICATIONS TO BENCH TEST APPROACH

Based on the results and observations from the mass profiling test, a few changes are recommended for the bench scale evaluation at the site. These changes in approach are discussed below.

Preliminary Tests

The preliminary tests will be performed on composite soils (a mixture of sand, sandy clay and clay) instead of the sand and clay soils separately. In addition, unactivated persulfate will be evaluated. Therefore, the preliminary tests will consist of three persulfate technologies:

- Alkaline activated persulfate;
- Iron activated persulfate; and
- Unactivated persulfate.

As part of the preliminary testing, the buffering capacity will be evaluated for the alkaline activated persulfate system to estimate the quantity of base required to raise the subsurface conditions to the target pH, typically greater than pH 10.5.

The work plan specified that the spiked concentration will be 20 to 50% over the maximum observed during mass profiling soil sampling. Since the maximum concentration from the mass profiling test was very high (12,000 mg/Kg), the proposed spiked concentration for the remainder of the preliminary testing is 2,000 mg/Kg (this is a rough equivalent soil concentration to the maximum observed in groundwater at the site: 870,000 µg/L). For the purposes of the injection simulation tests, the spike concentration will be finalized following the Soil Oxidant Demand (SOD) testing.

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Soil Oxidant Demand (SOD)

The SOD testing will be performed on both sand and clay soils to determine the range of oxidant demand for each of the following systems:

- Activated persulfate (activator determined from the preliminary tests);
- Unactivated persulfate; and
- Permanganate.

Owing to site conditions (i.e. tight clay soil), extended contact time may be necessary for determining the SOD. Therefore, these tests will be extended until the SOD is stabilized (up to 90 days maximum).

Injection Simulation Test

The results from the SOD and preliminary tests will be used to finalize the persulfate (activated or unactivated persulfate) approach for the injection simulation tests. The injection simulation will also be performed on composite soils. The original work plan specified that the injection simulation tests would be conducted on both sand and clay soils. Additionally, the metals mobilization potential for persulfate and permanganate will be performed on composite soils.

Based on the observations from mass profiling, including the predominant amount of clay mass relative to sand, the proposed approach has been modified to include an additional technology, Zero Valent Iron (ZVI). Therefore, three technologies will be evaluated for the treatment of TCE contamination:

- Persulfate (activator determined from the preliminary tests);
- Permanganate; and
- ZVI.

The ZVI testing will utilize two ZVI products: nano-scale (Toda ZVI; 10-100 nm) and granular iron material. The test will evaluate the overall ZVI effectiveness using two different mass loadings of each ZVI over single time interval (approximately four weeks), similar in setup to the initial tests performed for Site 47.

COMPUTATION SHEET

Client _____ Site _____ Description _____

Page _____ of _____

Job # _____

Computed By _____ Date _____

Checked By _____ Date _____

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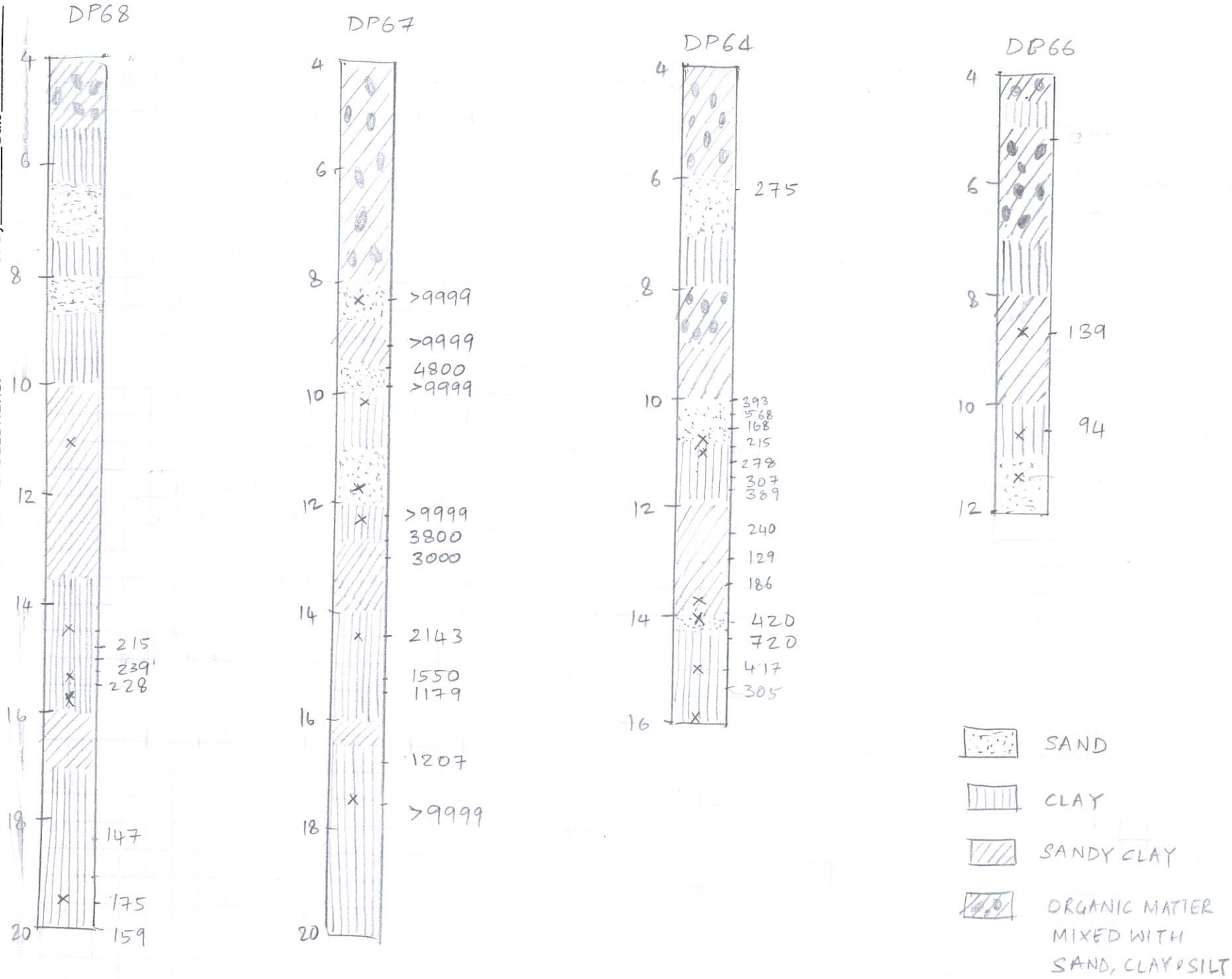

COMPUTATION SHEET

Client: CH2MHill

Site: Site-47- Indian Head

Description: Mass Profiling Results

Page 1 of 1

Job #: 06010

Computed By: DKN Date: 1/19/07

Checked By: AL Date: 2/8/07

XDD STRATEGIC. ENVIRONMENTAL. SOLUTIONS.

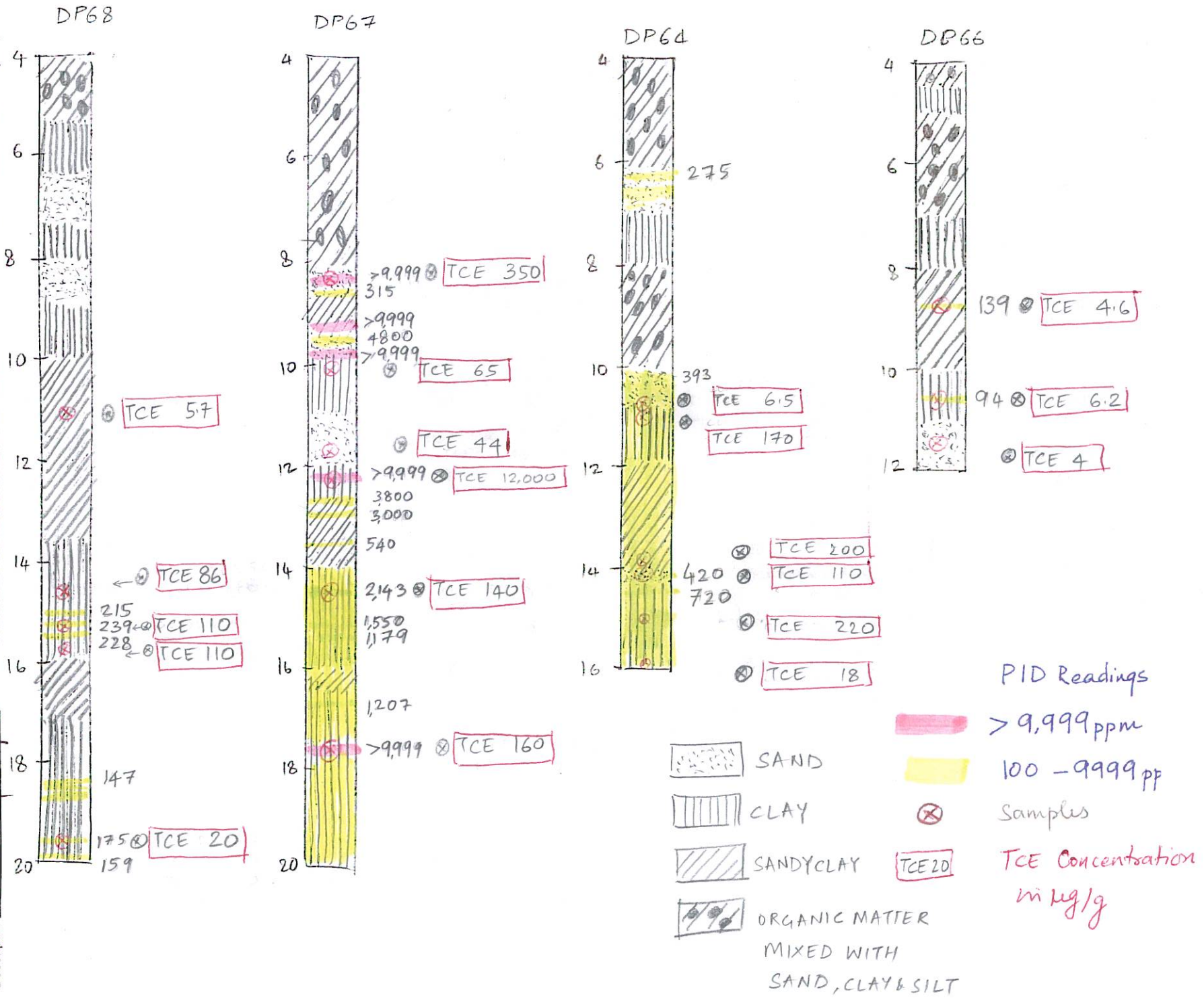

TABLE 1
Project Schedule - Revised February 13, 2007
(Based on Mass Profiling Results)
Site 17, Indian Head, Maryland
XDD Project 06010

Milestone	Week
Submit Baseline Analysis Samples; Perform Persulfate Buffer Capacity Tests	1
Receive Baseline Analysis Results	2-3
Perform Preliminary Persulfate Activation Test Samples	2
Submit Preliminary Persulfate Activation Test Samples	5
Receive Preliminary Persulfate Activation Test Results	7
Perform Extended Soil Oxidant Demand	8
Discuss Preliminary SOD Results with CH2M Hill to Confirm Approach for Remainder of Evaluation	12-13
Begin Persulfate, Permanganate and ZVI Injection Simulation Tests	13
Complete Persulfate, Permanganate and ZVI Injection Simulation Test	21
Begin and Complete Dissolved Metals Tests	19-21
Draft Report to CH2M HILL	25-27

TABLE 2
Baseline Assessment and Preliminary Tests - Revised February 13, 2007

Site 17, Indian Head, Maryland
XDD Project 06010

Mass Distribution Profiling		# Samples	Sample Type	Analysis	TAT (Turnaround Time)
Assume (4) 10- to 15-foot cores (boreholes); up to 5 samples per core => 20 samples					
	Sand	up to 10	soil	VOCs (CLP OLM04.3)	STD 14 days
	Clay	up to 10	soil	VOCs (CLP OLM04.3)	STD 14 days
# Laboratory Analyses =>		up to 20			

Baseline Analysis		# Samples	Sample Type	Analysis	TAT (Turnaround Time)
Grain Size	Sand	1	soil	Grain Size (ASTM D422)	STD 14 days
	Clay	1	soil	Grain Size (ASTM D422)	STD 14 days
# Laboratory Analyses =>		2			
VOCs (unspiked, composited)	Sand	2	soil	VOCs (CLP OLM04.3)	STD 14 days
	Clay	2	soil	VOCs (CLP OLM04.3)	STD 14 days
	Groundwater	2	water	VOCs (CLP OLM04.3)	STD 14 days
# Laboratory Analyses =>		6			
Metals (composited)	Sand	2	soil	Total Metals (CLP ILM05.3)	STD 14 days
	Clay	2	soil	Total Metals (CLP ILM05.3)	STD 14 days
	Groundwater	2	water	Total Metals (CLP ILM05.3)	STD 14 days
	Groundwater	2	water	Dissolved Metals (CLP ILM05.3)	STD 14 days
# Laboratory Analyses =>		8			

Preliminary Persulfate Activation Test

Soil - Composite		Reactors	Sample Type	Analysis	TAT (Turnaround Time)
Baseline		1	soil	VOCs (CLP OLM04.3)	STD 72 TAT
Alkaline Activation	Application 1	1	soil	VOCs (CLP OLM04.3)	STD 14 days
	Control	1	soil	VOCs (CLP OLM04.3)	STD 14 days
Iron Activation	Application 1	1	soil	VOCs (CLP OLM04.3)	STD 14 days
	Control	1	soil	VOCs (CLP OLM04.3)	STD 14 days
Unactivated Persulfate	Application 1	1	soil	VOCs (CLP OLM04.3)	STD 14 days
	Control	1	soil	VOCs (CLP OLM04.3)	STD 14 days
# Laboratory Analyses =>		7			

TABLE 3
Persulfate Evaluation Structure - Revised February 13, 2007

Site 17, Indian Head, Maryland
XDD Project 06010

Soil- Composite

Injection Simulation		Reactors	Sample Type	Analysis	TAT (Turnaround Time)
	Baseline of Spiked Soil	2	soil	VOCs (CLP OLM04.3)	72 hours
Control	Application 1	2	soil	VOCs (CLP OLM04.3)	STD 14 days
	Application 2	2	soil	VOCs (CLP OLM04.3)	STD 14 days
	or	1	water	VOCs (CLP OLM04.3)	STD 14 days
	Application 3[2]				
High Oxidant Concentration[1]	Application 1	2	soil	VOCs (CLP OLM04.3)	STD 14 days
	Application 2	2	soil	VOCs (CLP OLM04.3)	STD 14 days
	or	1	water	VOCs (CLP OLM04.3)	STD 14 days
	Application 3[2]				
Low Oxidant Concentration[1]	Application 1	2	soil	VOCs (CLP OLM04.3)	STD 14 days
	Application 2	2	soil	VOCs (CLP OLM04.3)	STD 14 days
	or	1	water	VOCs (CLP OLM04.3)	STD 14 days
	Application 3[2]				
# Laboratory Analyses =>		17			

Metals Test		Reactors	Sample Type	Analysis	TAT (Turnaround Time)
High Oxidant Concentration[2,3]	Control	2	water	Total/Dissolved Metals (CLP ILM05.3)	STD 14 days
	Application 1	2	water	Total/Dissolved Metals (CLP ILM05.3)	STD 14 days
# Laboratory Analyses =>		8	(equivalent to 8 analyses: 4 total, 4 dissolved)		

Notes:

1. High and Low oxidant loading concentrations will be determined following receipt of the baseline soils data.
2. *As necessary: Results from Application 1 will be evaluated to determine if the final samples are submitted for laboratory analysis following either the 2nd or 3rd application.*
3. High was selected to create most extreme case scenario.

TABLE 4
Permanganate Evaluation Structure - Revised February 13, 2007

Site 17, Indian Head, Maryland
XDD Project 06010

Soil- Composite

Injection Simulation		Reactors	Sample Type	Analysis	TAT (Turnaround Time)
	Baseline of Spiked Soil	shared[1]	soil	VOCs (CLP OLM04.3)	72 hours
Control	Application 1	2	soil	VOCs (CLP OLM04.3)	STD 14 days
	Application 2 or Application 3[3]	2 1	soil water	VOCs (CLP OLM04.3) VOCs (CLP OLM04.3)	STD 14 days STD 14 days
High Oxidant Concentration[2]	Application 1	2	soil	VOCs (CLP OLM04.3)	STD 14 days
	Application 2 or Application 3[3]	2 1	soil water	VOCs (CLP OLM04.3) VOCs (CLP OLM04.3)	STD 14 days STD 14 days
Low Oxidant Concentration[2]	Application 1	2	soil	VOCs (CLP OLM04.3)	STD 14 days
	Application 2 or Application 3[3]	2 1	soil water	VOCs (CLP OLM04.3) VOCs (CLP OLM04.3)	STD 14 days STD 14 days
# Laboratory Analyses =>		15			

Metals Test		Reactors	Sample Type	Analysis	TAT (Turnaround Time)
High Oxidant Concentration[2,4]	Control	2	water	Total/Dissolved Metals (CLP ILM05.3)	STD 14 days
	Application 1	2	water	Total/Dissolved Metals (CLP ILM05.3)	STD 14 days
# Laboratory Analyses =>		8	(equivalent to 8 analyses: 4 total, 4 dissolved)		

Notes:

1. Baseline results will be the shared between the persulfate and permanganate tests.
2. High and Low oxidant loading concentrations will be determined following receipt of the baseline soils data
3. *As necessary: Results from Application 1 will be evaluated to determine if the final samples are submitted for laboratory analysis following either the 2nd or 3rd application.*
4. High was selected to create most extreme case scenario.

TABLE 5
ZVI Evaluation Structure - Revised February 13, 2007

Site 17, Indian Head, Maryland
XDD Project 06010

Soil- Composite

Injection Simulation		Reactors	Sample Type	Analysis
	Baseline of Spiked Soil	shared[1]	soil	VOCs (CLP OLM04.3)
Control		2	soil	VOCs (CLP OLM04.3)
		1	water	VOCs (CLP OLM04.3)
		2	soil	VOCs (CLP OLM04.3)
High Iron Loading[2]	granular ZVI	1	water	VOCs (CLP OLM04.3)
		2	soil	VOCs (CLP OLM04.3)
	NZVI	1	water	VOCs (CLP OLM04.3)
		2	soil	VOCs (CLP OLM04.3)
Low Iron Loading[2]	granular ZVI	1	water	VOCs (CLP OLM04.3)
		2	soil	VOCs (CLP OLM04.3)
	NZVI	1	water	VOCs (CLP OLM04.3)
# Laboratory Analyses =>		15		

Notes:

1. Baseline results will be the shared between the persulfate and permanganate tests
2. High and Low Iron loading concentrations will be determined following receipt of the baseline soils data.

TAT (Turnaround Time)
72 hours
STD 14 days
STD 14 days
STD 14 days
STD 14 days
STD 14 days
STD 14 days
STD 14 days
STD 14 days
STD 14 days
STD 14 days