

14 May 2003  
Project #0003706

John E. Dustman  
Summit Envirosolutions, Inc.  
1217 Bandana Boulevard North  
St. Paul, Minnesota 55108

RE: Absorption/Desorption Tests for  
Black Lake Grocery, Olympia, Washington

Dear John,

This letter report presents the basic findings of the treatability study performed by ERM's Remediation Technology Group (RTG) on groundwater from the Black Lake Grocery site using an engineered sphagnum peat moss product (P.O.L. Sorb). The study consisted of four phases of work: (1) initial characterization, (2) hydration of the P.O.L. Sorb, (3) absorption/ adsorption test, and (4) absorption/ adsorption stability test (a follow-up desorption test).

## **SUPPLY OF SAMPLES**

On 14 March 2003, two cubitainers containing a total of 14.13 kg of groundwater from MW-1 arrived at ERM's Remediation Technology Center (RTC) in Lawrenceville, New Jersey. The samples arrived intact and were logged in as sample number 08169-01. The groundwater was refrigerated until used in the study.

On 18 March 2003, eight bags containing a total of 1.4 kg of P.O.L. Sorb arrived at the RTC, compliments of The ARK Enterprises, Inc., Belton, Missouri. The bags arrived intact and were logged in as sample number 08169-02. The peat was stored at room temperature until used in the study.

## **INITIAL CHARACTERIZATION**

On 19 March 2003, the groundwater from MW-1 was composited and transferred to amber glass jugs with zero headspace. These jugs were labeled "Black Lake Composite," and were refrigerated until needed. All eight bags of the P.O.L. Sorb product were also composited and

transferred to one large bag. The bag was labeled "Black Lake P.O.L. Sorb," and was stored at room temperature until needed.

On 19 March 2003, two 40-ml VOA vials containing groundwater from MW-1, along with 50 g of the P.O.L. Sorb were sent to North Creek Analytical (NCA) in Bothell, Washington for BTEX and TPH-G analysis using EPA Method 8021B.

The results of these analyses are shown in Table 1. Site groundwater contained a significant concentration of dissolved gasoline components, including BTEX. In addition, the dried peat appeared to contain a small but detectable level of toluene. This result was felt to be artifactual.

### **HYDRATION OF P.O.L. SORB**

On 3 April 2003, 100 grams of P.O.L. Sorb were added to a 2-liter glass beaker. The beaker was then filled with 1.7 liters of distilled water. A magnetic stir bar was added, and the beaker covered and placed on a magnetic stir plate to mix. The solution was mixed for four days (3 to 7 April) to hydrate the peat. At the end of the hydration period the excess water was drained off of the peat. The total weight of hydrated P.O.L. Sorb was 800 grams. This mass increase was consistent with the manufacturer's claims for absorption of neat fuel hydrocarbons. The hydrated P.O.L. Sorb was used in the remainder of the study.

On 7 April 2003, a sample of the hydrated P.O.L. Sorb was sent to NCA for BTEX and TPH-G analysis using EPA Method 8021B. None of the target analytes was detected above its reporting limit, as shown in Table 1. This sample analysis also served as the "Time = 0" concentration point for the subsequent Absorption/Desorption Study.

### **ABSORPTION/ADSORPTION TEST**

This experiment was begun on 7 April 2003. Hydrated P.O.L. Sorb (50 grams) was added to each of six 1-liter amber wide mouth jars. A magnetic stir bar was also placed inside each jar. The six jars were then filled to zero headspace, using groundwater from MW-1 and distilled water, as needed, to provide the following four treatment conditions:

- (1) MW-1, Undiluted: The first two jars received undiluted groundwater only;
- (2) MW-1, 2X Dilution: This jar received a 1:1 mix of groundwater and distilled water;
- (3) MW-1, 20X Dilution: This jar received a 1:19 mix of groundwater and distilled water; and
- (4) MW-1, 200X Dilution: Two jars received a 1:199 mix of groundwater and distilled water.

The dilutions were designed to provide a range of total BTEX concentrations from 68 to 13,439  $\mu\text{g}/\text{l}$ , and a range of TPH-G concentrations from 128 to 25,600  $\mu\text{g}/\text{l}$ .

The duplicate “MW-1, Undiluted” and “MW-1, 200X Dilution” bottles were used in the subsequent “Absorption/ Adsorption Stability Test.”

At the beginning of the experiment, aqueous samples from each of the four final solutions were sent to NCA for “Time = 0” analysis of BTEX and TPH-G using EPA Method 8021B.

The six jars were capped and placed on magnetic stir plates to mix at room temperature for a 72-hour period. On 10 April 2003, aqueous samples from each of the four groundwater concentrations tested were sent to NCA for BTEX and TPH-G analyses. These results are shown in Tables 2-A through 2-D.

The highest removal efficiency in the batch tests (essentially 100%) was attained with ethylbenzene. Depending upon its starting concentration, benzene removal ranged from 34 to 48%, toluene removal ranged from 51 to 89%, total xylenes removal ranged from 45 to 58%, and TPH-G removal ranged from 46 to 59%.

A sample of the P.O.L. Sorb from one “MW-1, Undiluted” jar and from one “MW-1, 200X Dilution” jar were also sent for BTEX and

TPH-G analyses; these results are shown in Tables 3-A and 3-B. Because of the higher reporting limits associated with solids analyses, only quantifiable concentrations of total xylenes and TPH-G were present in the peat from the undiluted groundwater test. With the 200X-diluted groundwater test, the concentrations of the target analytes were all below their reporting limits for the peat sample submitted.

### **ABSORPTION/ADSORPTION STABILITY TEST**

On 10 April 2003, the duplicate jars of “MW-1, Undiluted” and “MW-1, 200X Dilution” were used to begin this experiment. The peat from each jar was gently washed with distilled water to remove any groundwater clinging to the peat. The washed peat from each jar was then transferred to clean 1-liter jars, magnetic stir bars added, and each jar filled to zero headspace with distilled water. The jars were capped and placed on magnetic stir plates to mix at room temperature for a 7-day reaction time period. On 17 April 2003, aqueous samples from each of the two jars were sent to NCA for “Time = Final” analysis of BTEX and TPH-G using EPA Method 8021B. The peat was not analyzed for residual BTEX and TPH-G.

The results of this experiment are shown in Tables 3-A and 3-B. In the undiluted groundwater test, it is apparent that desorption of target compounds from the peat to the distilled water is occurring, based on the presence of detectable levels of benzene, toluene, total xylenes, and TPH-G. With the 200X-diluted groundwater, desorption is not as apparent since only toluene and xylenes are reported in the distilled water above their reporting limits.

### **RESULTS AND DISCUSSION**

While P.O.L. Sorb is marketed as an absorbent for free product hydrocarbons such as diesel and motor oils, it also has some ability to adsorb/absorb dissolved-phase gasoline constituents. In the batch tests conducted, the hydrated P.O.L. Sorb is most effective at removing dissolved ethylbenzene (essentially 100%) from groundwater, and removes benzene, toluene, xylenes, and non-specific TPH-G components to lesser extents: an average of 43% for benzene, an average of 51% for total xylenes, an average of 71% for toluene, and an average of 51% for TPH-G. The four specific

efficiencies attained with each contaminant were very similar regardless of the four starting contaminant concentrations tested.

Following the absorption/adsorption test, the stability of the BTEX and TPH-G associated with the P.O.L. Sorb from the lowest and highest groundwater concentrations used was evaluated. Assuming that the distilled water used in the desorption tests contained undetectable levels of BTEX and TPH-G, any of these compounds found in the water samples after the reaction period must have come from the contaminated P.O.L. Sorb present in each bottle. Based on a starting hydrated P.O.L. Sorb mass of 50 grams (equivalent to an average of 3.77 grams of peat on a dry-weight basis) and approximately 954 ml of distilled water per bottle, Tables 4-A and 4-B show the percent mass of each target compound attributed to desorption from the peat into the distilled water during the 7-day batch test.

Accurate desorption percentages can only be calculated when a known mass of contaminant was determined in both the peat and distilled water samples. For the "Undiluted" experiment, approximately 24% of the total xylenes and approximately 22% of the TPH-G were apparently desorbed over the 7-day period. No comments can be made on the percent desorption of benzene, toluene, and ethylbenzene in this experiment due to analytical data limitations. For the "200X-Dilution" experiment, no comments can be made on the percent desorption of any of the target analytes due to analytical data limitations.

## **CONCLUSIONS**

Based on this study, the following conclusions can be drawn:

- The engineered sphagnum peat product (P.O.L. Sorb) is partially effective in removing dissolved benzene, toluene, ethylbenzene, total xylenes, and TPH-G contaminants found in the Black Lake Grocery groundwater under the batch conditions of the tests employed;
- P.O.L. Sorb is most effective in removing dissolved ethylbenzene from the groundwater; and
- At least some desorption of total xylenes and TPH-G from the peat to the distilled water was observed in the "Undiluted" desorption test.

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Should you have any questions or need additional information,  
please feel free to contact me at 609-895-0050.

Sincerely,

George J. Skladany  
*Program Director,*  
*Remediation Technologies Group*

cc: Erik Ipsen, ERM

**Table 1. Initial Characterization / Pre-Treatment Results**

**Black Lake Grocery**

*Olympia, Washington*

14-May-03

Analyte	MW-1 ( $\mu\text{g/l}$ )	P.O.L. Sorb - Dry ( $\text{mg/kg-dry weight}$ )	P.O.L. Sorb - Hydrated ( $\text{mg/kg-dry weight}$ )
Benzene	5,930	< 0.3	< 0.46
Toluene	3,920	0.742	< 0.76
Ethylbenzene	399	< 0.5	< 0.76
Xylenes ( <i>o, m, p</i> )	3,190	< 1.0	< 1.53
TPH-G	25,600	< 50.0	< 76.4

**Table 2. Absorption/Adsorption Test Results**

Black Lake Grocery

Olympia, Washington

14-May-03

**Table 2-A. MW-1, Undiluted**

Analyte	Theoretical (µg/l)	Actual (µg/l)	Final (µg/l)	% Removal
Benzene	5,930	5,060	3,330	34
Toluene	3,920	3,480	1,690	51
Ethylbenzene	399	179	< 25.0	100
Xylenes (o, m, p)	3,190	2,910	1,510	48
TPH-G	25,600	29,500	15,900	46

**Table 2-B. MW-1, 2X Dilution**

Analyte	Theoretical (µg/l)	Actual (µg/l)	Final (µg/l)	% Removal
Benzene	2,965	2,170	1,120	48
Toluene	1,960	1,490	305	80
Ethylbenzene	200	72.2	< 25.0	100
Xylenes (o, m, p)	1,595	1,240	580	53
TPH-G	12,800	12,800	5,260	59

**Table 2-C. MW-1, 20X Dilution**

Analyte	Theoretical (µg/l)	Actual (µg/l)	Final (µg/l)	% Removal
Benzene	297	191	106	45
Toluene	196	125	14	89
Ethylbenzene	20	5.88	< 2.5	100
Xylenes (o, m, p)	160	105	58	45
TPH-G	1,280	1,070	518	52

**Table 2D. MW-1, 200X Dilution**

Analyte	Theoretical (µg/l)	Actual (µg/l)	Final (µg/l)	% Removal
Benzene	30	17.4	9.6	45
Toluene	20	11.4	4.3	63
Ethylbenzene	2	0.544	< 0.5	100
Xylenes (o, m, p)	16	9.52	4.0	58
TPH-G	128	102	52.6	48

**Table 3. Absorption/Adsorption Stability Test Results**

**Black Lake Grocery**

*Olympia, Washington*

*14-May-03*

**Table 3-A. MW-1, Undiluted**

Analyte	"Time = 0" Peat (mg/kg-dry weight)	"Time = Final" GW (µg/l)
Benzene	< 0.656	2.63
Toluene	< 1.09	1.26
Ethylbenzene	< 1.09	< 0.50
Xylenes ( <i>o, m, p</i> )	44.30	42.20
TPH-G	162.00	144.00

**Table 3-B. MW-1, 200X Dilution**

Analyte	"Time = 0" Peat (mg/kg-dry weight)	"Time = Final" GW (µg/l)
Benzene	< 0.67	< 0.50
Toluene	< 1.12	0.54
Ethylbenzene	< 1.12	< 0.50
Xylenes ( <i>o, m, p</i> )	< 2.23	1.30
TPH-G	< 112.0	< 50.0

## Table 4. Stability Test Analysis

Black Lake Grocery

Olympia, Washington

14-May-03

Table 4-A. MW-1, Undiluted

Analyte	Mass in Peat ( $\mu\text{g}$ )	Mass in Water ( $\mu\text{g}$ )	Mass % Desorbed
Benzene	< 2.47	2.51	*
Toluene	< 4.11	1.20	*
Ethylbenzene	< 4.11	< 0.48	*
Xylenes ( <i>o, m, p</i> )	167.01	40.26	24
TPH-G	610.74	137.38	22

\*Cannot be accurately calculated because of analytical data limitations.

Table 4-B. MW-1, 200X Dilution

Analyte	Mass in Peat ( $\mu\text{g}$ )	Mass in Water ( $\mu\text{g}$ )	Mass % Desorbed
Benzene	< 2.53	< 0.48	*
Toluene	< 4.22	0.52	*
Ethylbenzene	< 4.22	< 0.48	*
Xylenes ( <i>o, m, p</i> )	< 8.41	1.24	*
TPH-G	< 422.24	< 47.70	*