NC STATE UNIVERSITY

Dept. of Civil, Construction, and Environmental Engineering
Box 7908, Raleigh, NC 27695-7908

February 12, 2011

Timothy Parker
EOS Remediation, Inc.
1101 Nowell Rd.
Raleigh, NC 27607

Dear Mr. Parker,

Per your request, we have completed the oil retention testing of the samples of aquifer material provided by Shaw Environmental & Infrastructure Group from a perchlorate impacted site in Henderson, NV. As you are aware, the original plan was to conduct column tests to evaluate the retention of EOS598b42 and a lecithin emulsion in by the aquifer material. However, the very high silt-clay content of the material (28% passing a #200 sieve) resulted in a very low hydraulic conductivity and rapid clogging of the columns.

After consultation with Shaw and their client, we developed an alternative approach to evaluate oil retention. The aquifer material was first passed through a #4 sieve to remove large particles. Then, a batch sorption test was conducted by adding 40g moist soil to 50 mL falcon centrifuge tubes and sufficient tap water to cover the soil surface. The tubes were then amended with 0, 0.1, 0.4 or 1.0 mL of EOS598B42 or lecithin emulsion. The tubes were filled to the 50 mL mark with water, sealed, mixed to distribute the emulsion, and then allowed to settle overnight, and then the aqueous phase was decanted off to determine the amount of oil not attached to the soil. The soil settled very well and centrifugation was not required to separate the soil from the liquid phase. The tubes were then refilled with water, washed, settled overnight, and decanted two additional times to determine the amount of oil that would be released during additional washing. Liquid and soil volatile solids concentrations were determined by drying at 105 °C followed by ashing at 550 °C. All sorption tests were run in duplicate. Oil retention was calculated as VSS of the final soil sample minus the average VSS of untreated control sample. The average VSS of the untreated control was 14.74 mg/g (Sample A = 14.67 mg/g, Sample B = 14.82 mg/g).

Overall, the very large majority of the oil was retained by the soil and very little was released in the aqueous phase. On average, 99.5% (range = 99.1 to 99.7%) of the volatile solids were present in the soil and 0.10%, 0.14%, and 0.25% of the volatile material was present in the first, second and third wash, respectively.

Figure 1 shows the measured oil retention vs the VSS concentration in the first water decant. Oil retention increases somewhat with aqueous phase concentration. However, most of this increase is due to the larger amount of oil added. This effect is illustrated in Figure 2. The fraction of VSS present in the aqueous phase increases with aqueous phase concentration. However, the total amount of VSS in the aqueous phase never exceeded

1%, regardless of the aqueous phase concentration. This indicates that we never approached the maximum oil retention of this soil.

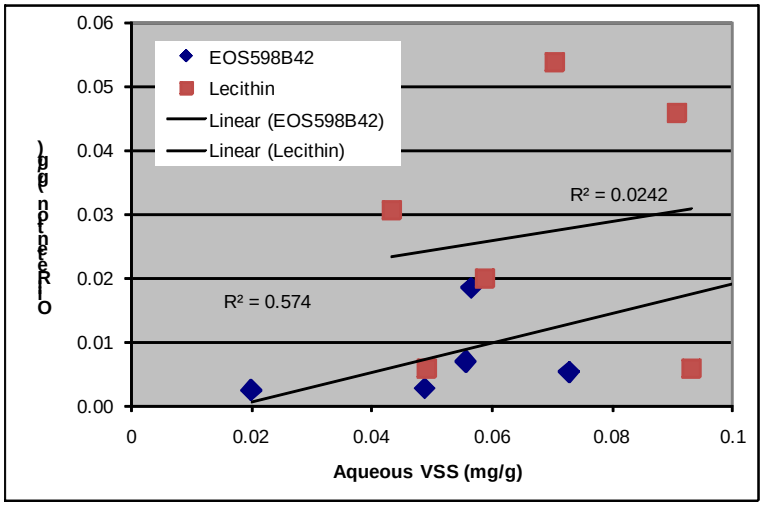


Figure 1 Oil retention vs VSS concentration of first water wash.

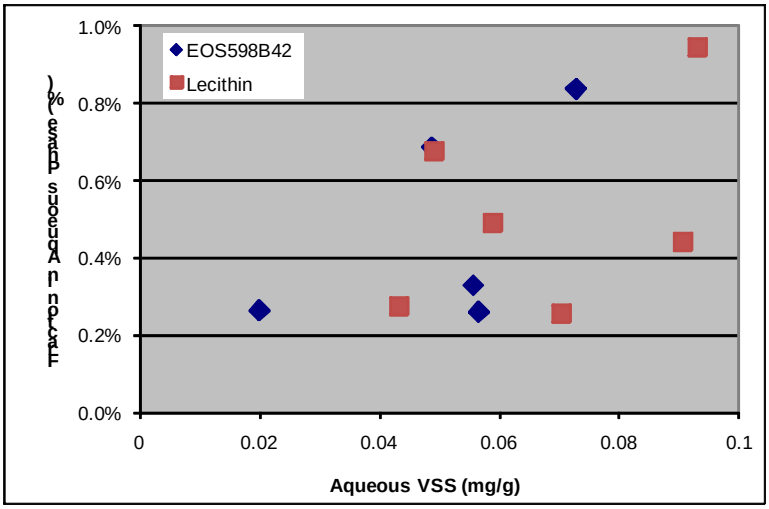


Figure 2 Fraction oil in the aqueous phase (sum of wash 1, 2 and 3) vs VSS of first water wash.

Overall, the sorption tests indicate the maximum oil retention of the sample provided to us is over 0.02 g/g for EOS598B42 and over 0.06 g/g for the lecithin emulsion. My understanding is the groundwater flow velocity at the site is very high. This is not consistent with the high silt-clay content of the sample provided to us, indicating this sample may not be representative of condition at the site. If the sample provided to us is not representative of field conditions, the sorption test results would not provide a useful indication of the likely extent of oil retention at the site.

If you have any additional questions, please do not hesitate to contact me.

Sincerely yours,

Robert C. Borden, Professor
Dept. of Civil, Construction, and Environmental Engineering
919-515-1625 (ph)
rcborden@eos.ncsu.edu

CQM, INC.

SIEVE ANALYSIS OF COARSE TO FINE AGGREGATES (ASTM D422)

GENERAL DATA:

Client:	**Pace Analytical Services, Inc.**
Project:	**No. 4042116**
Location Sampled:	**SS-1**
Sample No:	**4042116-001**
Depth of Sample:	
Date Received:	**2/1/11**
Sample Designated For:	**Soil Classification**
Source of Sample:	**Project 140871**
Munsell Color Code:	**7.5YR 3/4**
Date Sampled:	**12/6/10**

LABORATORY DATA:

Date Tested:	February 2-3, 2011
Test Performed By:	JLN

24 Hrs. Turn Around:	NO
Washed Gradation:	YES

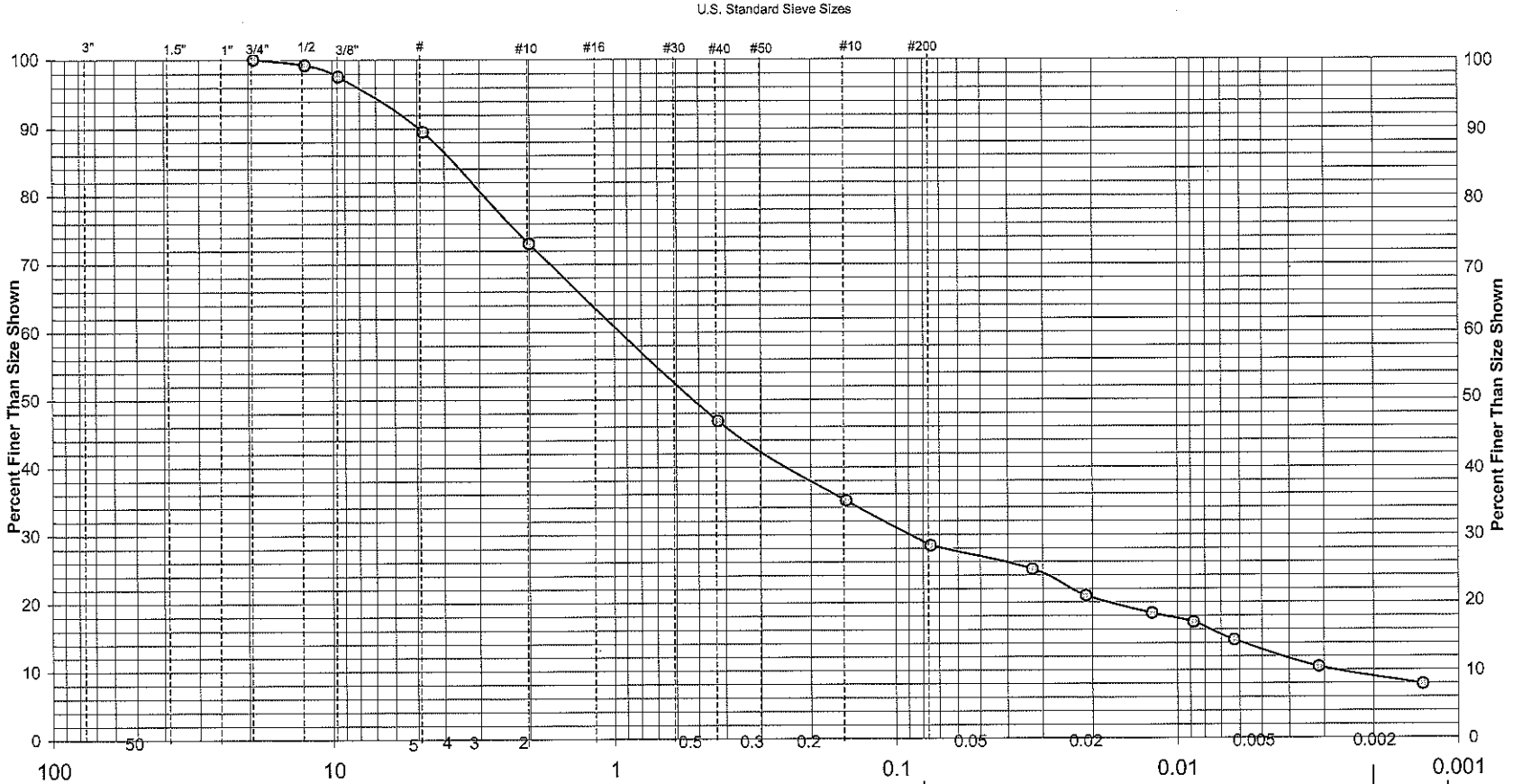
Dry Weight of Soil (gms): 520.5

Sieve Size	Weight Retained	% Retained	% Passing	Project Specification % Passing by Weight	Source of Specification
3"					
1 1/2"					
1"					
3/4"	0.0	0.0	100.0		
1/2"	4.2	0.8	99.2		
3/8"	8.4	1.6	97.6		
#4	42.3	8.1	89.5		
#10	86.1	16.5	73.0		
#40	136.2	26.2	46.8		
#100	61.5	11.8	35.0		
#200	34.5	6.6	28.4		

REVIEWED BY:	Robert R Rose
DATE REVIEWED:	2/7/11

Remarks:

GRAIN SIZE DISTRIBUTION CURVE



Gravel		Sand				
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
	10.5%	16.5%	26.2%	18.4%	19.4%	9.0%

Soil Classification: CLAYEY SAND, medium to fine to coarse grained, a little gravel, dark brown (SC)

Location Sampled: SS-1			Elevation or Depth: .	Date Sampled:	12/6/10
Sample Number: 4042116-001			Sampled Moisture Content (%): 11.7	Report No.:	116-1
Sample Source: Project 140871			*CQM, INC.*		
Atterberg Limits:	LL=	PL=	PI=	Client:	**Pace Analytical Services, Inc.**
Munsell Color Code: 7.5YR 3/4				Project:	**No. 4042116**
Date Received: 2/1/11				Prepared by:	Michael R. Andraschko
Coefficients: Cc=		Cu=		Checked by:	Robert A Bowe

Page:	2
Date:	2/4/11
Date:	2/7/11

UPPER MIDWEST REGION
MN: 612-607-1700 WI: 920-469-2436

Pace Analytical®
www.pacelabs.com

CHAIN OF CUSTODY

4042116

(Please Print Clearly)	
Company Name:	Shaw Environmental
Branch/Location:	Milwaukee, WI
Project Contact:	Jay Diebold
Phone:	414-291-2357
Project Number:	140871
Project Name:	
Project State:	Nevada
Sampled By (Print):	Chris Pesheck
Sampled By (Sign):	
PO #:	Regulatory Program:

*Preservation Codes
A=None B=HCL C=H2SO4 D=HNO3 E=DI Water F=Methanol G=NaOH
H=Sodium Bisulfate Solution I=Sodium Thiosulfate J=Other

Quote #:	See Kang $100.00
Mail To Contact:	Jay Diebold
Mail To Company:	Shaw Environmental
Mail To Address:	111 W. Pleasant St. Suite 10 Milwaukee, WI 53212
Invoice To Contact:	Denne Dichristopher
Invoice To Company:	
Invoice To Address:	as above
Invoice To Phone:	414-291-2350

Data Package Options (billable)
☐ EPA Level III
☐ EPA Level IV

MS/MSD
☐ On your sample (billable)
☐ NOT needed on your sample

Matrix Codes
A = Air, W = Water, B = Biota, DW = Drinking Water, C = Charcoal, GW = Ground Water, O = Oil, SW = Surface Water, S = Soil, WW = Waste Water, SI = Sludge, WP = Wipe

PACE LAB #	CLIENT FIELD ID	COLLECTION DATE	COLLECTION TIME	MATRIX	FILTERED? (YES/NO)	PRESERVATION (CODE)*	Analyses Requested	CLIENT COMMENTS	LAB COMMENTS (Lab Use Only)	Profile #
					Y/N	Pick Letter				
001	SS-1	12/6/10	1200	S	N	A	Hydrometer Fraction passing 200 screen or whatever cutoff is appropriate under ASTM		1-5 gallon pail	
					N	A	X			

Rush Turnaround Time Requested - Prelims
(Rush TAT subject to approval/surcharge)
Date Needed:

Transmit Prelim Rush Results by (complete what you want):

Email #1:	
Email #2:	
Telephone:	
Fax:	

Samples on HOLD are subject to special pricing and release of liability

Relinquished By:	Date/Time:	Received By:	Date/Time:
	1/31/11 0950		1/31/11 1050
	1/31/11 1700		
US Logistics	2/1/11 1000		2/1/11 1000

PACE Project No.
4042116

Receipt Temp = N/A °C

Sample Receipt pH OK / Adjusted N/A

Cooler Custody Seal
Present / Not Present
Intact / Not Intact

Version 5.0 06/14/06

C019a(27Jun2006)

ORIGINAL

Pace Analytical Services, Inc.
1241 Bellevue Street, Suite 9
Green Bay, WI 54302

Pace Analytical

Sample Condition Upon Receipt

Client Name: Shaw Project # 4042116

Courier: ☐ Fed Ex ☐ UPS ☐ USPS ☐ Client ☒ Commercial ☐ Pace Other _____

Tracking #: _____

Custody Seal on Cooler/Box Present: ☒ yes ☐ no Seals intact: ☒ yes ☐ no

Custody Seal on Samples Present: ☐ yes ☒ no Seals intact: ☐ yes ☐ no

Packing Material: ☐ Bubble Wrap ☐ Bubble Bags ☒ None Other

Thermometer Used N/A **Type of Ice:** Wet Blue Dry (None) ☐ Samples on ice, cooling process has begun

Cooler Temperature N/A **Biological Tissue is Frozen:** ☐ yes ☐ no

Temp Blank Present: ☐ yes ☒ no

Optional
Proj. Due Date:
Proj. Name:

Temp should be above freezing to 6°C for all sample except Biota.
Biota Samples should be received ≤ 0°C.

Person examining contents:
Date: 2/1/11
Initials: AE

		Comments:
Chain of Custody Present:	☒Yes ☐No ☐N/A	1.
Chain of Custody Filled Out:	☒Yes ☐No ☐N/A	2.
Chain of Custody Relinquished:	☒Yes ☐No ☐N/A	3.
Sampler Name & Signature on COC:	☒Yes ☐No ☐N/A	4.
Samples Arrived within Hold Time:	☒Yes ☐No ☐N/A	5.
Short Hold Time Analysis (<72hr):	☐Yes ☒No ☐N/A	6.
Rush Turn Around Time Requested:	☐Yes ☒No ☐N/A	7.
Sufficient Volume:	☒Yes ☐No ☐N/A	8.
Correct Containers Used:	☒Yes ☐No ☐N/A	9.
-Pace Containers Used:	☐Yes ☒No ☐N/A	
Containers Intact:	☒Yes ☐No ☐N/A	10.
Filtered volume received for Dissolved tests	☐Yes ☐No ☒N/A	11.
Sample Labels match COC:	☒Yes ☐No ☐N/A	12.
-Includes date/time/ID/Analysis Matrix: S		
All containers needing preservation have been checked.	☐Yes ☐No ☒N/A	13.
All containers needing preservation are found to be in compliance with EPA recommendation.	☐Yes ☐No ☒N/A	
exceptions: VOA, coliform, TOC, O&G, WI-DRO (water)	☐Yes ☐No	Initial when completed / Lot # of added preservative
Samples checked for dechlorination:	☐Yes ☐No ☒N/A	14.
Headspace in VOA Vials (>6mm):	☐Yes ☐No ☒N/A	15.
Trip Blank Present:	☐Yes ☐No ☒N/A	16.
Trip Blank Custody Seals Present	☐Yes ☐No ☒N/A	
Pace Trip Blank Lot # (if purchased): _____		

Client Notification/ Resolution: Field Data Required? Y / N

Person Contacted: _____ Date/Time: _____

Comments/ Resolution: _____

Project Manager Review: _____ **Date:** 2/1/11

Note: Whenever there is a discrepancy affecting North Carolina compliance samples, a copy of this form will be sent to the North Carolina DEHNR Certification Office (i.e out of hold, incorrect preservative, out of temp, incorrect containers)