MW-33S (b) 0 to 5 feet

MW-33S (b) 5 to 10 feet

SI Soil Boring Core Field Photographs MW-33S (b)

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

0186-846-01 Date Exported: 01/18/19

MW-33S (b) 5 to 10 feet

MW-33S (b) 5 to 10 feet

SI Soil Boring Core Field Photographs MW-33S (b)

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

MW-33S (b) 10 to 15 feet

MW-33S (b) 10 to 15 feet

SI Soil Boring Core Field Photographs MW-33S (b)

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

0186-846-01 Date Exported: 01/18/19

MW-33S (b) 10 to 15 feet

MW-33S (b) 15 to 20 feet

SI Soil Boring Core Field Photographs MW-33S (b)

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

MW-33S (b) 15 to 20 feet

MW-33S (b) 15 to 20 feet

SI Soil Boring Core Field Photographs MW-33S (b)

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

0186-846-01 Date Exported: 01/18/19

MW-33S (b) 20 to 25 feet

MW-33S (b) 20 to 25 feet

SI Soil Boring Core Field Photographs MW-33S (b)

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

MW-33S (b) 20 to 25 feet

MW-33S (b) 25 to 30 feet

SI Soil Boring Core Field Photographs MW-33S (b)

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

MW-33S (b) 25 to 30 feet

MW-33S (b) 25 to 30 feet

SI Soil Boring Core Field Photographs MW-33S (b)

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

MW-34S 0 to 5 feet

MW-34S 0 to 5 feet

SI Soil Boring Core Field Photographs MW-34S

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

MW-34S 0 to 5 feet

MW-34S 5 to 10 feet

SI Soil Boring Core Field Photographs MW-34S

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

MW-34S 5 to 10 feet

MW-34S 5 to 10 feet

SI Soil Boring Core Field Photographs MW-34S

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

MW-35S 0 to 5 feet

MW-35S 0 to 5 feet

SI Soil Boring Core Field Photographs MW-35S

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

0186-846-01 Date Exported: 01/18/19

MW-35S 0 to 5 feet

MW-35S 0 to 5 feet

SI Soil Boring Core Field Photographs MW-35S

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

0186-846-01 Date Exported: 01/18/19

MW-35S 5 to 10 feet

MW-35S 5 to 10 feet

SI Soil Boring Core Field Photographs MW-35S

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

MW-35S 5 to 10 feet

MW-35S 5 to 10 feet

SI Soil Boring Core Field Photographs MW-35S

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

MW-35S 10 to 15 feet

MW-35S 10 to 15 feet

SI Soil Boring Core Field Photographs MW-35S

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

MW-36D 0 to 5 feet

MW-36D 0 to 5 feet

SI Soil Boring Core Field Photographs MW-36D

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

MW-36D 0 to 5 feet

MW-36D 5 to 10 feet

SI Soil Boring Core Field Photographs MW-36D

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

MW-36D 5 to 10 feet

MW-36D 5 to 10 feet

SI Soil Boring Core Field Photographs MW-36D

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

MW-36D 10 to 15 feet

MW-36D 10 to 15 feet

SI Soil Boring Core Field Photographs MW-36D

Gas Works Park Site
Seattle, Washington

GeoEngineers

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0186-846-01 Date Exported: 01/18/19

MW-36D 10 to 15 feet

MW-36D 15 to 20 feet

SI Soil Boring Core Field Photographs MW-36D

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

MW-36D 15 to 20 feet

MW-36D 20 to 25 feet

SI Soil Boring Core Field Photographs MW-36D	
Gas Works Park Site Seattle, Washington	
GeoEngineers	Appendix 2A-4

0186-846-01 Date Exported: 01/18/19

MW-36D 20 to 25 feet

MW-36D 20 to 25 feet

SI Soil Boring Core Field Photographs MW-36D

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

0186-846-01 Date Exported: 01/18/19

MW-36D 25 to 28 feet

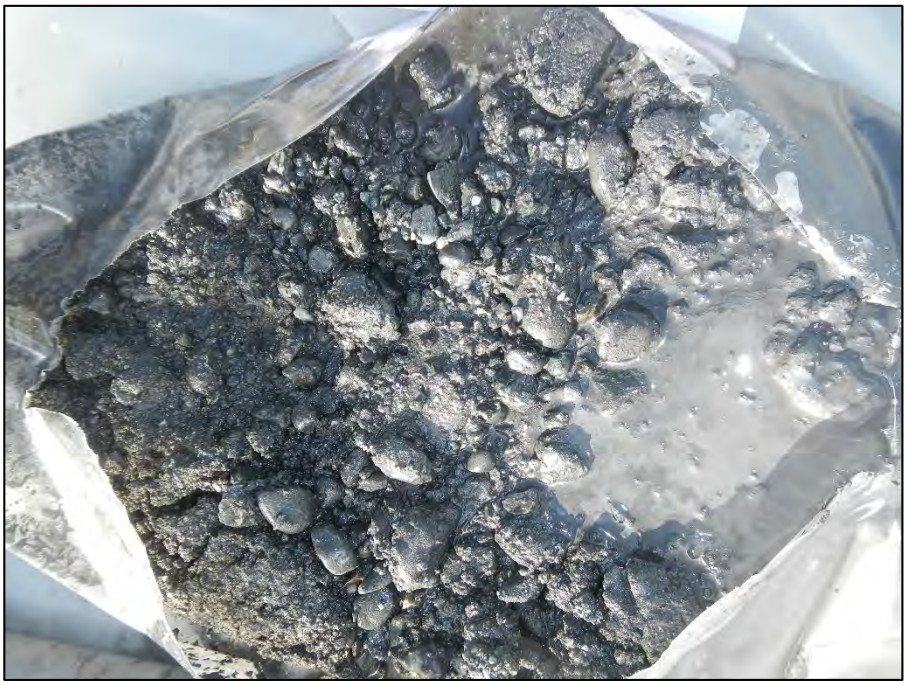
MW-36D 25 to 28 feet

SI Soil Boring Core Field Photographs MW-36D

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4



MW-36D 25 to 28 feet

MW-36D 25 to 28 feet

SI Soil Boring Core Field Photographs MW-36D

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

0186-846-01 Date Exported: 01/18/19

MW-36D 30 to 35 feet

MW-36D 30 to 35 feet

SI Soil Boring Core Field Photographs MW-36D

Gas Works Park Site
Seattle, Washington

GeoEngineers

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0186-846-01 Date Exported: 01/18/19

MW-36D 30 to 35 feet

MW-36D 80 to 85 feet

SI Soil Boring Core Field Photographs MW-36D

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

MW-36D 80 to 85 feet

SI Soil Boring Core Field Photographs MW-36D

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

MW-36S 0 to 5 feet

MW-36S 0 to 5 feet

SI Soil Boring Core Field Photographs MW-36S

Gas Works Park Site
Seattle, Washington

GeoEngineers

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0186-846-01 Date Exported: 01/18/19

MW-36S 0 to 5 feet

MW-36S 5 to 10 feet

SI Soil Boring Core Field Photographs MW-36S	
Gas Works Park Site Seattle, Washington	
GeoEngineers	Appendix 2A-4

0186-846-01 Date Exported: 01/18/19

MW-36S 5 to 10 feet

MW-36S 5 to 10 feet

SI Soil Boring Core Field Photographs MW-36S	
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GeoEngineers	Appendix 2A-4

0186-846-01 Date Exported: 01/18/19

MW-36S 10 to 15 feet

MW-36S 10 to 15 feet

SI Soil Boring Core Field Photographs MW-36S

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

MW-36S 10 to 15 feet

MW-36S 15 to 20 feet

SI Soil Boring Core Field Photographs MW-36S

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

0186-846-01 Date Exported: 01/18/19

MW-36S 20 to 24 feet

MW-36S 20 to 24 feet

SI Soil Boring Core Field Photographs MW-36S

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

MW-36S 20 to 24 feet

SI Soil Boring Core Field Photographs MW-36S

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

0186-846-01 Date Exported: 01/18/19

MW-37S 0 to 5 feet

MW-37S 5 to 10 feet

SI Soil Boring Core Field Photographs MW-37S	
Gas Works Park Site Seattle, Washington	
GeoEngineers	Appendix 2A-4

0186-846-01 Date Exported: 01/18/19

MW-37S 5 to 10 feet

MW-37S 5 to 10 feet

SI Soil Boring Core Field Photographs MW-37S

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

0186-846-01 Date Exported: 01/18/19

MW-37S 9 feet

MW-37S 10 to 15 feet

SI Soil Boring Core Field Photographs MW-37S

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

MW-37S 15 to 20 feet

MW-37S 15 to 20 feet

SI Soil Boring Core Field Photographs MW-37S

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

MW-37S 15 to 20 feet

MW-37S

SI Soil Boring Core Field Photographs MW-37S

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

MW-38S 0 to 5 feet

MW-38S 5 to 10 feet

SI Soil Boring Core Field Photographs MW-38S	
Gas Works Park Site Seattle, Washington	
GeoEngineers	Appendix 2A-4

0186-846-01 Date Exported: 01/18/19

MW-38S 10 to 15 feet

MW-38S 15 to 18 feet

SI Soil Boring Core Field Photographs MW-38S	
Gas Works Park Site Seattle, Washington	
GeoEngineers	Appendix 2A-4

0186-846-01 Date Exported: 01/18/19

MW-38S 15 to 18 feet

SI Soil Boring Core Field Photographs MW-38S	
Gas Works Park Site Seattle, Washington	
GeoEngineers	Appendix 2A-4

0186-846-01 Date Exported: 01/18/19

MW-39 D 0 to 5 feet

MW-39 D 5 to 10 feet

SI Soil Boring Core Field Photographs MW-39D

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

0186-846-01 Date Exported: 01/18/19

MW-39 D 10 to 14 feet

MW-39 D 14 to 15 feet

SI Soil Boring Core Field Photographs MW-39D	
Gas Works Park Site Seattle, Washington	
GeoEngineers	Appendix 2A-4

0186-846-01 Date Exported: 01/18/19

MW-39 D 14 to 15 feet

MW-39 D 15 to 20 feet

SI Soil Boring Core Field Photographs MW-39D	
Gas Works Park Site Seattle, Washington	
GeoEngineers	Appendix 2A-4

0186-846-01 Date Exported: 01/18/19

MW-39 D 15 to 20 feet

MW-39 D 15 to 20 feet

SI Soil Boring Core Field Photographs MW-39D

Gas Works Park Site
Seattle, Washington

GeoEngineers

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0186-846-01 Date Exported: 01/18/19

MW-39S 0 to 5 feet

MW-39S 5 to 10 feet

SI Soil Boring Core Field Photographs MW-39S

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

0186-846-01 Date Exported: 01/18/19

MW-39S 5 to 10 feet

MW-39S 10 to 14 feet

SI Soil Boring Core Field Photographs MW-39S

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

0186-846-01 Date Exported: 01/18/19

MW-40S 0 to 5 feet

MW-40S 0 to 5 feet

SI Soil Boring Core Field Photographs MW-40S

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

0186-846-01 Date Exported: 01/18/19

MW-40S 5 to 10 feet

MW-40S 5 to 10 feet

SI Soil Boring Core Field Photographs MW-40S

Gas Works Park Site
Seattle, Washington

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0186-846-01 Date Exported: 01/18/19

MW-40S 5 to 10 feet

MW-40S 5 to 10 feet

SI Soil Boring Core Field Photographs MW-40S

Gas Works Park Site
Seattle, Washington

GeoEngineers

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0186-846-01 Date Exported: 01/18/19

MW-40S 10 to 15 feet

MW-40S 10 to 15 feet

SI Soil Boring Core Field Photographs MW-40S	
Gas Works Park Site Seattle, Washington	
GeoEngineers	Appendix 2A-4

MW-40S 15 to 20 feet

MW-40S 15 to 20 feet

SI Soil Boring Core Field Photographs MW-40S

Gas Works Park Site
Seattle, Washington

GeoEngineers

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0186-846-01 Date Exported: 01/18/19

MW-40S 15 to 20 feet

MW-40S 15 to 20 feet

SI Soil Boring Core Field Photographs MW-40S

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

0186-846-01 Date Exported: 01/18/19

MW-40S 15 to 20 feet

SI Soil Boring Core Field Photographs MW-40S

Gas Works Park Site
Seattle, Washington

GeoEngineers

Appendix 2A-4

0186-846-01 Date Exported: 01/18/19

ATTACHMENT 2A-5
SI Geotechnical Lab Results

Table of Contents: ARI Job WN09

Client: Geoengineers

Project: 0186-846-01,Task 1400 Gas Works Park

_____ May-02-2013

Signature Date

Analytical Resources, Incorporated
Analytical Chemists and Consultants

May 2, 2013

Zanna Satterwhite
GeoEngineers, Inc.
Plaza 600 Building
600 Stewart Street, Suite 1700
Seattle, WA 98101

RE: Client Project: Gas Works Park, 0186-846-01
ARI Job No.: WN09

Dear Zanna:

Please find enclosed the Chain of Custody records (COCs), sample receipt documentation, and the final data package for samples from the project referenced above.

Sample receipt and details of these analyses are discussed in the Case Narrative.

An electronic copy of this package will remain on file with ARI. Should you have any questions or problems, please feel free to contact me at your convenience.

Sincerely,

ANALYTICAL RESOURCES, INC.

Cheronne Oreiro
Project Manager
(206) 695-6214
cheronneo@arilabs.com
www.arilabs.com

cc: eFile: WN09

Enclosures

4611 South 134th Place, Suite 100 • Tukwila WA 98168 • **206-695-6200** • **206-695-6201** fax

Chain of Custody Documentation

ARI Job ID: WN09

Chain of Custody Record & Laboratory Analysis Request

ARI Assigned Number:	Turn-around Requested: Standard	Date: 4/17/13	
ARI Client Company: GeoEngineers	Phone: 206-239-3258	Page: 1 of 2	
Client Contact: Tim Bailey		No. of Coolers:	Cooler Temps:
Client Project Name: Gas Works Park			
Client Project #: 0186-846-01, Task 1400	Samplers: Bag Samples		

Analytical Resources, Incorporated
Analytical Chemists and Consultants
4611 South 134th Place, Suite 100
Tukwila, WA 98168
206-695-6200 206-695-6201 (fax)

Sample ID	Date	Time	Matrix	No Containers	Analysis Requested: SIEVE ANALYSIS	Analysis Requested: PERCENT PASSING #200	Notes/Comments
MW 32D 8.5-10.5'	4/10/13		SOIL	BAG		X	
10.5-12.5					X		
10.5-18					X		
18.5-20.5					X		
20.5-22.5					X		
22.5-24						X	
26.5 28						X	
28.5-30.5					X		
35.5-37					X		
42-43						X	

Comments/Special Instructions	Relinquished by (Signature)	Received by (Signature)	Relinquished by (Signature)	Received by (Signature)
	Printed Name: Tim Bailey	Printed Name: Chris Brown	Printed Name: Chris Brown	Printed Name: A. Volgardsen
	Company: GeoEngineers	Company: GeoEngineers	Company: GeoEngineers	Company: ARI
	Date & Time: 1445 4/17/13	Date & Time: 1445 4/17/13	Date & Time: 1705 4/18/13	Date & Time: 4/18/13 1705

Sample Retention Policy: Unless specified by workorder or contract, all water/soil samples submitted to ARI will be discarded or returned, no sooner than 90 days after receipt or 60 days after submission of hardcopy data, whichever is longer. Sediment samples submitted under PSDDA/PSEP/SMS protocol will be stored frozen for up to one year and then discarded.

Chain of Custody Record & Laboratory Analysis Request

ARI Assigned Number:	Turn-around Requested: Standard	Date: 4/17/13	
ARI Client Company: GeoEngineers	Phone: 206-239-3258	Page: 2 of 2	
Client Contact: Tim Bailey		No. of Coolers:	Cooler Temps:
Client Project Name: Gas Works Park			
Client Project #: 0186-846-01, Task 1400	Samplers: Bag Samples		

Analytical Resources, Incorporated
Analytical Chemists and Consultants
4611 South 134th Place, Suite 100
Tukwila, WA 98168
206-695-6200 206-695-6201 (fax)

Sample ID	Date	Time	Matrix	No Containers	Analysis Requested: SIEVE ANALYSIS	Analysis Requested: PERCENT PASSING #200	Notes/Comments
GEO-3 15-17'	4/12/13		SOIL	1 BAG	X		
GEO-3 20-21.5'	4/12/13		SOIL	1 BAG	X		
GEO-2 9-10.5'	4/11/13		"	"	X		
GEO-2 14-16'	4/11/13		"	"	X		
GEO-2 19-20.5'	4/11/13		"	"		X	
GEO-2 24-26'	4/11/13		"	"	X		
GEO-2 34-36'	4/11/13		"	"	X		
GEO-2 39-40.5'	4/11/13		"	"	X		
GEO-2 44-44.5'	4/11/13		"	"	X		

Comments/Special Instructions	Relinquished by (Signature)	Received by (Signature)	Relinquished by (Signature)	Received by (Signature)
	Printed Name: TIM BAILEY	Printed Name: Chris Breese	Printed Name: Chris Brown	Printed Name: A Volgardsen
	Company: GEO ENGINEERS	Company: GEO	Company: GEO	Company: ARI
	Date & Time: 1745 4/17/13	Date & Time: 1445 4/17/13	Date & Time: 1705 4/18/13	Date & Time: 4/18/13 1705

Limits of Liability: *ARI will perform all requested services in accordance with appropriate methodology following ARI Standard Operating Procedures and the ARI Quality Assurance Program. This program meets standards for the industry. The total liability of ARI, its officers, agents, employees, or successors, arising out of or in connection with the requested services, shall not exceed the Invoiced amount for said services. The acceptance by the client of a proposal for services by ARI release ARI from any liability in excess thereof, not withstanding any provision to the contrary in any contract, purchase order or co-signed agreement between ARI and the Client.*

Sample Retention Policy: Unless specified by workorder or contract, all water/soil samples submitted to ARI will be discarded or returned, no sooner than 90 days after receipt or 60 days after submission of hardcopy data, whichever is longer. Sediment samples submitted under PSDDA/PSEP/SMS protocol will be stored frozen for up to one year and then discarded.

Analytical Resources, Incorporated
Analytical Chemists and Consultants

Cooler Receipt Form

ARI Client GeoEngineers Project Name Gas Works Park

COC No(s) _____ (NA) Delivered by Fed-Ex UPS Courier Hand Delivered Other _____

Assigned ARI Job No WN39 Tracking No: _____ NA

Preliminary Examination Phase:

Were intact, properly signed and dated custody seals attached to the outside of to cooler?	YES	(NO)
Were custody papers included with the cooler?	(YES)	NO
Were custody papers properly filled out (ink, signed, etc)	(YES)	NO

Temperature of Cooler(s) (°C) (recommended 2 0-6 0 °C for chemistry) 12.3

If cooler temperature is out of compliance fill out form 00070F Temp Gun ID# 90897952

Cooler Accepted by AV Date 4/18/13 Time 1705

Complete custody forms and attach all shipping documents

Log-In Phase:

Was a temperature blank included in the cooler?		YES	(NO)
What kind of packing material was used?	Bubble Wrap Wet Ice Gel Packs (Baggies) Foam Block Paper Other _____		
Was sufficient ice used (if appropriate)?	~~NA~~	YES	~~NO~~
Were all bottles sealed in individual plastic bags?		(YES)	NO
Did all bottles arrive in good condition (unbroken)?		(YES)	NO
Were all bottle labels complete and legible?		(YES)	NO
Did the number of containers listed on COC match with the number of containers received?		(YES)	NO
Did all bottle labels and tags agree with custody papers?		(YES)	NO
Were all bottles used correct for the requested analyses?		(YES)	NO
Do any of the analyses (bottles) require preservation? (attach preservation sheet, excluding VOCs)	(NA)	YES	NO
Were all VOC vials free of air bubbles?	(NA)	YES	NO
Was sufficient amount of sample sent in each bottle?		(YES)	NO
Date VOC Trip Blank was made at ARI	(NA)		

Was Sample Split by ARI: (NA) YES Date/Time _____ Equipment: _____ Split by: _____

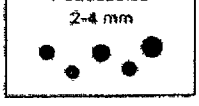
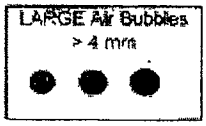
Samples Logged by: TS Date 4-23-13 Time 930

***** Notify Project Manager of discrepancies or concerns *****

Sample ID on Bottle	Sample ID on COC	Sample ID on Bottle	Sample ID on COC

Additional Notes, Discrepancies, & Resolutions:

By: _____ Date: _____

Small Air Bubbles ~2mm	Peabubbles 2-4 mm	LARGE Air Bubbles > 4 mm
		

Small → "sm"
Peabubbles → "pb"
Large → "lg"
Headspace → "hs"

UNOS 00005

Case Narrative, Data Qualifiers, Control Limits

ARI Job ID: WN09

Analytical Resources, Incorporated
Analytical Chemists and Consultants

Client: GeoEngineers	**ARI Job No.:** WN09
Client Project: Gas Works Park	**Client Project No.:** 0186-846-01,Task 1400

Case Narrative

1. Nineteen samples were submitted for analysis on April 18, 2013.
2. Fourteen samples were submitted for grain size distribution according to ASTM D422. The samples were prepared according to ASTM D421.
3. An assumed specific gravity of 2.65 was used in the hydrometer calculations.
4. A standard milkshake mixer type device was used to disperse the fine fraction sample for one minute.
5. One sample from this job, MW32D 35.5-37', was chosen for triplicate analysis. The triplicate data can be found on the QA summary table.
6. Due to the sandy nature of the samples, there was not enough fine material to acquire accurate hydrometer readings. Samples MW32D 18.5-20.5', MW32D 20.5-22.5' and GEO-2 14-16' required curve fitting between the sand and silt fractions.
7. Five samples were submitted for percent finer than the No. 200 sieve. The samples were run according to ASTM D1140.
8. The data is provided in summary tables and plots.
9. There were no further anomalies in the samples or test method.

Released by: _____ Date: May 1, 2013
Technician

Reviewed by: Katherine J Buchanan Date: May 1, 2013
Technician

Sample ID Cross Reference Report

ANALYTICAL RESOURCES INCORPORATED

ARI Job No: WN09
Client: Geoengineers
Project Event: 0186-846-01,Task 1400
Project Name: Gas Works Park

	Sample ID	ARI Lab ID	ARI LIMS ID	Matrix	Sample Date/Time	VTSR
1.	MW32D 8.5-10.5'	WN09A	13-8517	Soil	04/10/13	04/18/13 17:05
2.	MW32D 22.5-24'	WN09B	13-8518	Soil	04/10/13	04/18/13 17:05
3.	MW32D 26.5-28'	WN09C	13-8519	Soil	04/10/13	04/18/13 17:05
4.	MW32D 42-43'	WN09D	13-8520	Soil	04/10/13	04/18/13 17:05
5.	GEO-2 19-20.5'	WN09E	13-8521	Soil	04/11/13	04/18/13 17:05
6.	MW32D 10.5-12.5'	WN09F	13-8522	Soil	04/10/13	04/18/13 17:05
7.	MW32D 16.5-18'	WN09G	13-8523	Soil	04/10/13	04/18/13 17:05
8.	MW32D 18.5-20.5'	WN09H	13-8524	Soil	04/10/13	04/18/13 17:05
9.	MW32D 20.5-22.5'	WN09I	13-8525	Soil	04/10/13	04/18/13 17:05
10.	MW32D 28.5-30.5'	WN09J	13-8526	Soil	04/10/13	04/18/13 17:05
11.	MW32D 35.5-37'	WN09K	13-8527	Soil	04/10/13	04/18/13 17:05
12.	GEO-3 15-17'	WN09L	13-8528	Soil	04/12/13	04/18/13 17:05
13.	GEO-3 20-21.5'	WN09M	13-8529	Soil	04/12/13	04/18/13 17:05
14.	GEO-2 9-10.5'	WN09N	13-8530	Soil	04/11/13	04/18/13 17:05
15.	GEO-2 14-16'	WN09O	13-8531	Soil	04/11/13	04/18/13 17:05
16.	GEO-2 24-26'	WN09P	13-8532	Soil	04/11/13	04/18/13 17:05
17.	GEO-2 34-36'	WN09Q	13-8533	Soil	04/11/13	04/18/13 17:05
18.	GEO-2 39-40.5'	WN09R	13-8534	Soil	04/11/13	04/18/13 17:05
19.	GEO-2 44-44.5'	WN09S	13-8535	Soil	04/11/13	04/18/13 17:05

Geotechnical Analysis
Report and Summary QC Forms

ARI Job ID: WN09

ANALYTICAL RESOURCES INCORPORATED

GEOTECHNICAL ANALYSIS DATA SHEET
Percent Fines by Method ASTM D1140

Data Release Authorized: [signature]
Reported: 05/01/13
Date Received: 04/18/13
Page 1 of 1

QC Report No: WN09-Geoengineers
Project: Gas Works Park
0186-846-01,Task 1400

Client/ ARI ID	Date Sampled	Matrix	Analysis Date	Result
MW32D 8.5-10.5' WN09A 13-8517	04/10/13	Soil	04/24/13 14:45	3.7
MW32D 22.5-24' WN09B 13-8518	04/10/13	Soil	04/24/13 14:45	8.3
MW32D 26.5-28' WN09C 13-8519	04/10/13	Soil	04/24/13 14:45	20.5
MW32D 42-43' WN09D 13-8520	04/10/13	Soil	04/24/13 14:45	6.7
GEO-2 19-20.5' WN09E 13-8521	04/11/13	Soil	04/24/13 14:45	10.8

Reported in Percent

GeoEngineers
Gas Works Park
0186-846-01,Task 1400

ASTM D1140
Percentage of Material Finer than #200 Sieve

Sample Identification	Initial Dry Mass of Sample (g)	Percent Fines (<#200 Sieve)
MW32D 8.5-10.5'	279.44	3.7
MW32D 22.5-24'	195.73	8.3
MW32D 26.5-28'	566.47	20.5
MW32D 42-43'	21.33	6.7
GEO-2 19-20.5'	278.47	10.8

WN09

GeoEngineers
0186-846-01,Task 1400
Gas Works Park

Percent Finer (Passing) Than the Indicated Size

Sieve Size (microns)	3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4 (4750)	#10 (2000)	#20 (850)	#40 (425)	#60 (250)	#100 (150)	#200 (75)	32	22	13	9	7	3.2	1.3
MW32D 35 5-37'	100 0	100.0	100.0	100 0	100.0	92.8	92 0	74 4	64 1	55.8	40 5	18 4	7.0	2 9	1 5	1 5	1 2	0.9	0.6	0 6	0.6
	100.0	100 0	100 0	100.0	100 0	95.5	92.6	75 4	67.9	59 8	44.4	19 8	7.2	2 7	1 5	1 5	1.2	0.9	0.6	0.6	0 6
	100 0	100 0	100.0	100 0	100 0	92 3	88 8	78 9	69 1	61 2	46 3	21.3	7 8	3 0	1 6	1 3	1.3	0 9	0.6	0.6	0 6
MW32D 10 5-12.5'	100 0	100 0	100 0	100.0	97 3	94 5	87.5	59 3	37 8	26 8	16.4	10.4	8 0	5 7	5 1	4 2	2.9	2.4	1.8	0.9	0 4
MW32D 16 5-18'	100 0	100.0	100 0	100.0	91.5	87 3	80.3	66.3	53.4	41 9	34 8	29.3	24.6	18 9	16 9	15 3	13 0	10 7	9 2	6 1	3 4
MW32D 18.5-20 5'	100.0	100 0	100 0	100 0	100.0	95.6	92.0	78.3	54 5	32.5	21 5	15 2	11 4	8 1	7 9	6 7	6 2	5 1	4 2	3 4	2 5
MW32D 20 5-22 5'	100.0	100.0	100 0	97.0	94 0	89 3	87 3	76 3	63.9	47 8	35.0	25 0	17 7	11 1	11 1	9 1	6.8	6 2	4 6	2 9	1 3
MW32D 28 5-30 5'	100 0	100 0	100 0	82.2	67 9	46 6	39.7	30 6	25 5	20 6	14 7	8.5	5 0	3.1	2 6	2 2	1 7	1 3	0 9	0.4	0.3
GEO-3 15-17'	100 0	100.0	100 0	96.1	81.2	64 1	54 2	35.9	22 9	14 1	8 2	4.4	2.5	1.4	1 3	1.2	1 0	0.8	0.5	0 3	0.2
GEO-3 20-21 5'	100.0	100.0	100.0	100.0	100 0	100.0	100 0	97 9	85 1	67.2	43.1	21 0	9.4	4 7	3.4	3.0	2 6	2.2	1.7	0.9	0.9
GEO-2 9-10 5'	100.0	100 0	100.0	100 0	95.7	95 0	79.0	54 4	46 0	40.0	33.4	27 2	22 3	17.3	12.8	11 4	8 8	6.8	5.1	2.6	0.9
GEO-2 14-16'	100 0	100 0	100 0	95 2	95.2	90.8	86 3	71.9	55.6	37.9	26.0	17 7	12.1	7 0	6 6	6.0	4.7	3 6	2.7	1.1	0.5
GEO-2 24-26'	100 0	100 0	100 0	100 0	100.0	99 5	95 3	90.4	83.4	77.9	71.3	60 6	44 4	23.2	15 1	11 9	9.2	7.6	5.4	3.2	1 1
GEO-2 34-36'	100 0	100 0	79 6	58 6	55.3	48 8	44 9	41 3	37.1	30.7	22.3	13 6	6 1	2.0	0 8	0 6	0.4	0 4	0.0	0.0	0.0
GEO-2 39-40.5'	100.0	100.0	59 2	53 2	46 0	44 6	42.9	38 4	34 1	30 6	23.0	10.4	4 0	1 8	1 0	0 7	0.7	0.3	0 3	0.0	0 0
GEO-2 44-44 5'	100.0	100.0	100.0	90.7	83 6	73 9	68 1	60 4	53 7	49 1	38 9	18 4	6.5	1.9	0 5	0 3	0.3	0 0	0 0	0.0	0.0

Testing performed according to ASTM D421/D422

WN09

GeoEngineers
0186-846-01,Task 1400
Gas Works Park

Percent Retained in Each Size Fraction

Description	% Coarse Gravel				% Gravel			% Coarse Sand	% Medium Sand		% Fine Sand			% Very Coarse Silt	% Coarse Silt	% Medium Silt	% Fine Silt	% Fine Silt	% Very Fine Silt	% Clay	
Particle Size (microns)	3-2"	2-1 1/2"	1 1/2"-1"	1-3/4"	3/4-1/2"	1/2-3/8"	3/8"-4750	4750-2000	2000-850	850-425	425-250	250-150	150-75	75-32	32-22	22-13	13-9	9-7	7-3 2	3 2-1 3	<1 3
MW32D 35 5-37'	0 0	0 0	0 0	0.0	7 2	0 8	17 6	10.3	8.3	15 3	22 1	11 4	4 1	1.5	0.0	0 3	0.3	0 3	0 0	0.0	0 6
	0 0	0 0	0 0	0 0	4 5	2 9	17 2	7.5	8 1	15 4	24 6	12 6	4 5	1 1	0.0	0 3	0.3	0 3	0 0	0 0	0 6
	0 0	0 0	0 0	0 0	7.7	3.5	10.0	9 8	7 9	14 9	25 0	13.4	4.9	1 4	0.3	0 0	0.3	0.3	0 0	0 0	0.6
MW32D 10.5-12 5'	0 0	0 0	0 0	2.7	2 8	7.0	28 3	21.4	11.0	10 4	6.0	2 4	2 3	0 6	0.9	1 3	0 6	0 6	0 9	0 6	0 4
MW32D 16.5-18'	0 0	0 0	0 0	8 5	4 3	6.9	14 0	13.0	11 4	7.2	5 5	4 8	5 6	2 1	1.5	2 3	2.3	1 5	3.1	2 7	3 4
MW32D 18.5-20 5'	0.0	0.0	0.0	0 0	4 4	3 6	13.7	23 7	22 1	11.0	6 3	3.8	3 3	0 2	1 1	0 6	1 1	0.8	0.8	0.8	2 5
MW32D 20 5-22 5'	0 0	0 0	3.0	3 0	4 7	2 0	10.9	12.4	16.1	12 8	10 0	7.3	6.5	0 1	2 0	2.3	0.7	1.6	1.6	1.6	1 3
MW32D 28 5-30 5'	0 0	0 0	17.8	14 4	21 3	6.9	9 2	5 0	5 0	5.9	6.2	3 5	1.9	0 5	0 4	0.5	0 4	0.4	0 5	0.1	0.3
GEO-3 15-17'	0 0	0.0	3.9	14.9	17 1	10 0	18.2	13 1	8 7	5.9	3 9	1 9	1 1	0 1	0.1	0 1	0 2	0 3	0 1	0.1	0.2
GEO-3 20-21 5'	0.0	0.0	0 0	0 0	0.0	0.0	2 1	12.8	17 9	24 1	22.1	11 6	4.7	1 2	0.4	0 4	0 4	0 4	0.9	0.0	0 9
GEO-2 9-10 5'	0 0	0 0	0.0	4 3	0 7	16 0	24.5	8 4	6 0	6.6	6 1	4 9	5 0	4 5	1.4	2.6	2.0	1 7	2.6	1 7	0 9
GEO-2 14-16'	0 0	0 0	4.8	0 0	4 5	4.4	14 5	16 3	17 7	11 9	8 3	5.6	5 1	0 4	0 5	1 4	1 1	0 8	1.6	0 5	0.5
GEO-2 24-26'	0 0	0 0	0.0	0 0	0 5	4.1	4.9	7.0	5.6	6.6	10 6	16.3	21 1	8 1	3 2	2.7	1 6	2.2	2.2	2 2	1.1
GEO-2 34-36'	0.0	20 4	21 0	3.3	6 5	3.9	3.7	4 2	6.4	8.4	8.7	7 4	4 2	1 2	0 2	0.2	0 0	0 4	0 0	0.0	0 0
GEO-2 39-40.5'	0.0	40 8	6 1	7.2	1.4	1 7	4.6	4.2	3 6	7 6	12 5	6.4	2.2	0 8	0 3	0.0	0 3	0 0	0 3	0 0	0.0
GEO-2 44-44 5'	0 0	0 0	9 3	7 1	9 6	5 8	7.7	6 7	4.6	10 2	20.5	12 0	4.5	1 4	0 3	0.0	0 3	0 0	0 0	0 0	0 0

WN09

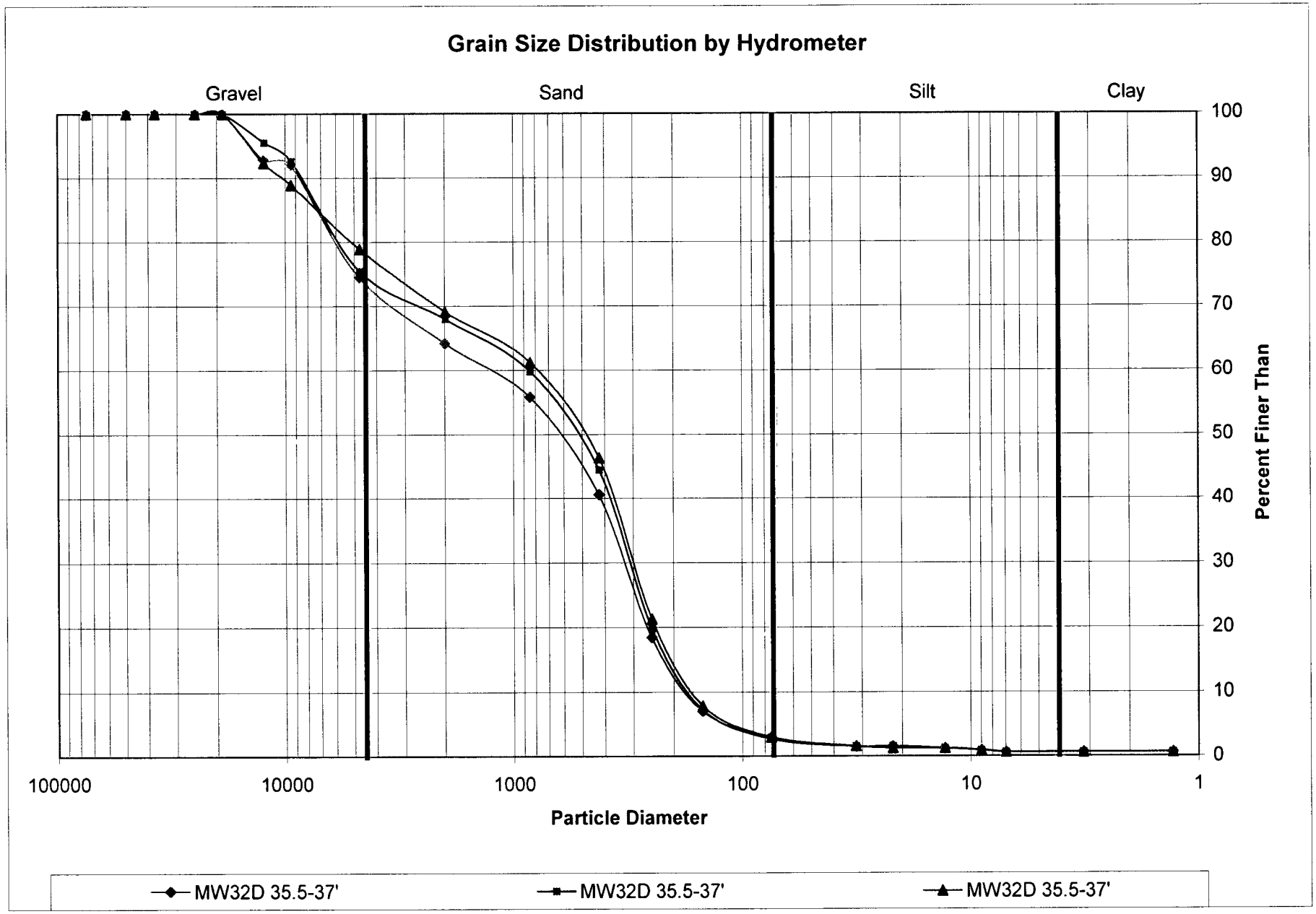
Client	GeoEngineers	Project No	0186-846-01,Task 14C
		Project	Gas Works Park
ARI Triplicate Sample ID	WN09K	Batch No	WN09-01
Client Triplicate Sample ID	MW32D 35 5-37'	Page	1 of 1

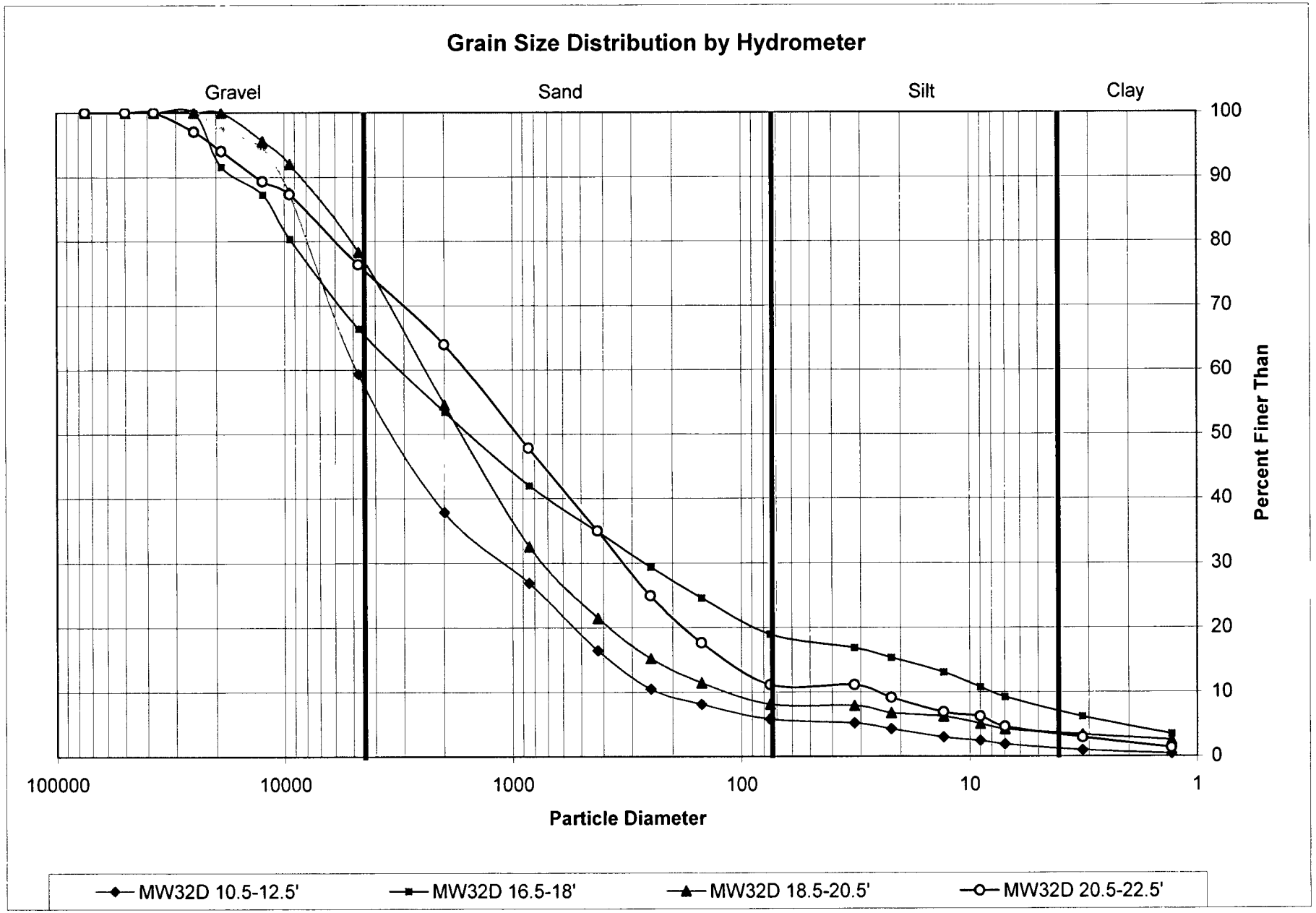
Relative Standard Deviation, By Size

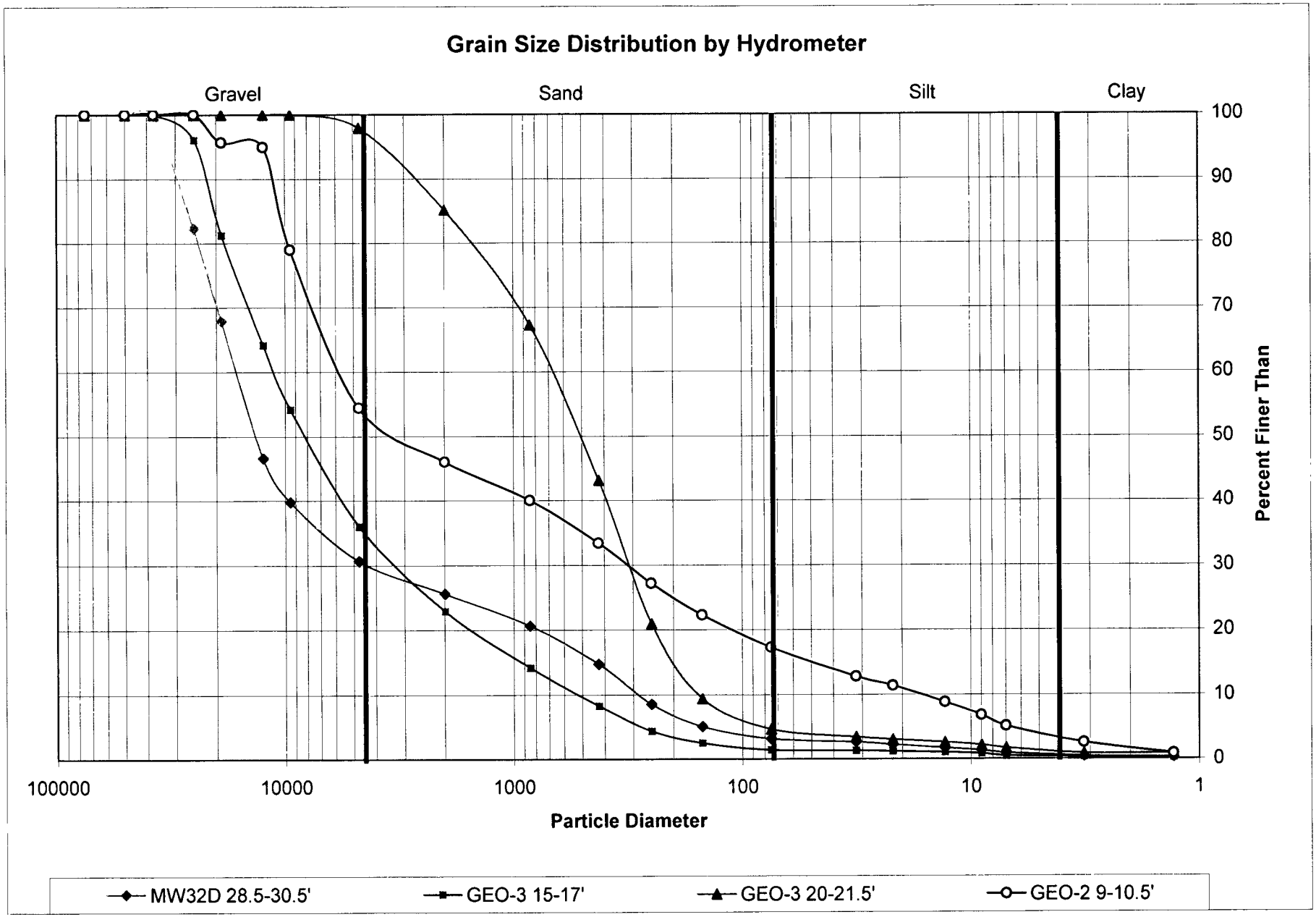
Sample ID	75000	50000	37500	25000	19000	12500	9500	4750	2000	850	425	250	150	75	32	22	13	9	7	3 2	1 3
MW32D 35 5-37'	100 0	100 0	100 0	100 0	100 0	92 8	92.0	74 4	64 1	55 8	40.5	18 4	7 0	2 9	1 5	1 5	1 2	0 9	0 6	0 6	0 6
MW32D 35 5-37'	100 0	100 0	100 0	100 0	100 0	95 5	92 6	75 4	67 9	59 8	44 4	19 8	7 2	2 7	1 5	1 5	1 2	0 9	0 6	0 6	0 6
MW32D 35 5-37'	100 0	100 0	100 0	100 0	100 0	92 3	88 8	78 9	69 1	61 2	46 3	21 3	7 8	3 0	1 6	1 3	1 3	0 9	0 6	0 6	0 6
AVE	100 00	100 00	100 00	100 00	100 00	93 53	91 13	76 21	67 02	58 90	43 72	19 82	7 33	2 85	1 52	1 42	1 22	0 91	0 61	0 61	0 61
STDEV	0 00	0 00	0 00	0 00	0 00	1 72	2 02	2 35	2 60	2 80	2 94	1 45	0 44	0 17	0 06	0 14	0 05	0 04	0 03	0 03	0 03
%RSD	0 00	0 00	0 00	0 00	0 00	1 84	2 21	3 08	3 88	4 76	6 72	7 31	6 04	5 92	4 26	10 10	4 26	4 26	4 26	4 26	4 26

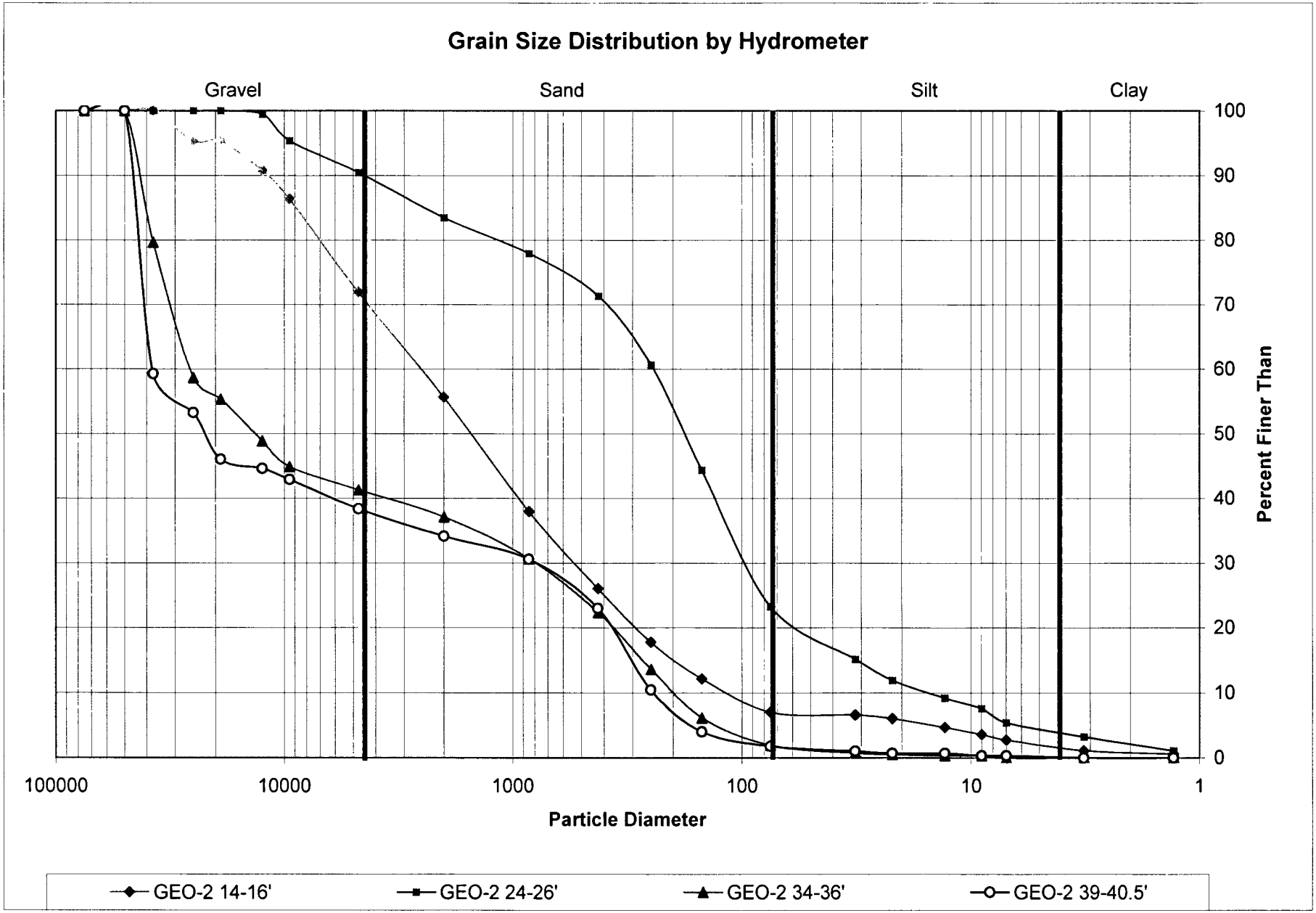
This Triplicate applies to the Batch Containing the Following Samples

Sample ID	Date Sampled	Date Set up	Date Started	Date Complete	Data Qualifiers
MW32D 35 5-37'	4/10/2013	4/24/2013	4/29/2013	5/1/2013	
	4/10/2013	4/24/2013	4/29/2013	5/1/2013	
	4/10/2013	4/24/2013	4/29/2013	5/1/2013	
MW32D 10 5-12 5'	4/10/2013	4/24/2013	4/29/2013	5/1/2013	
MW32D 16 5-18'	4/10/2013	4/24/2013	4/29/2013	5/1/2013	
MW32D 18 5-20 5'	4/10/2013	4/24/2013	4/29/2013	5/1/2013	
MW32D 20 5-22 5'	4/10/2013	4/24/2013	4/29/2013	5/1/2013	
MW32D 28 5-30 5'	4/10/2013	4/24/2013	4/29/2013	5/1/2013	
GEO-3 15-17'	4/12/2013	4/24/2013	4/29/2013	5/1/2013	
GEO-3 20-21 5'	4/12/2013	4/24/2013	4/29/2013	5/1/2013	
GEO-2 9-10 5'	4/11/2013	4/24/2013	4/29/2013	5/1/2013	
GEO-2 14-16'	4/11/2013	4/24/2013	4/29/2013	5/1/2013	
GEO-2 24-26'	4/11/2013	4/24/2013	4/29/2013	5/1/2013	
GEO-2 34-36'	4/11/2013	4/24/2013	4/29/2013	5/1/2013	
GEO-2 39-40 5'	4/11/2013	4/24/2013	4/29/2013	5/1/2013	
GEO-2 44-44 5'	4/11/2013	4/24/2013	4/29/2013	5/1/2013	


Grain Size Distribution by Hydrometer
Gravel
Sand
Silt
Clay
100
90
80
70
60
50
40
30
20
10
0
Percent Finer Than
100000
10000
1000
100
10
1
Particle Diameter
MW32D 35.5-37'
MW32D 35.5-37'
MW32D 35.5-37'


Grain Size Distribution by Hydrometer
Gravel
Sand
Silt
Clay
100
90
80
70
60
50
40
30
20
10
0
Percent Finer Than
100000
10000
1000
100
10
1
Particle Diameter
MW32D 10.5-12.5'
MW32D 16.5-18'
MW32D 18.5-20.5'
MW32D 20.5-22.5'


Grain Size Distribution by Hydrometer
Gravel
Sand
Silt
Clay
100
90
80
70
60
50
40
30
20
10
0
Percent Finer Than
100000
10000
1000
100
10
1
Particle Diameter
MW32D 28.5-30.5'
GEO-3 15-17'
GEO-3 20-21.5'
GEO-2 9-10.5'


Grain Size Distribution by Hydrometer
Gravel
Sand
Silt
Clay
100
90
80
70
60
50
40
30
20
10
0
Percent Finer Than
100000
10000
1000
100
10
1
Particle Diameter
GEO-2 14-16'
GEO-2 24-26'
GEO-2 34-36'
GEO-2 39-40.5'

ANALYTICAL RESOURCES INCORPORATED

Percent Finer Than the No. 200 Sieve
ASTM D-1140

ARI Job No.: WN09 Date Set up: 04·24·2013 Tested by: kb

Notes: SAMPLES A, B, C, AND E CONSUMED. VOLUME ON THESE SAMPLES WAS LOW.

ARI Sample ID	A	B	C	D	E					
Tare Number	A	B	C @	D	E					
Tare, g	10.33	10.04	749.7219	10.21	10.30					
Wet Soil + Tare, g	333.23	283.26	1731.23	35.92	457.03					
Dry Soil + Tare, g	289.77	205.77	1315.66	831.54	288.77					
Dry Soil + Tare after Wash	279.33	189.62	1199.51	30.11	258.63					

ARI Sample ID										
Tare Number										
Tare, g										
Wet Soil + Tare, g										
Dry Soil + Tare, g										
Dry Soil + Tare after Wash										

1102F
Rev. 0

Geotechnical Raw Data
Analyst Notes and Raw Data

ARI Job ID: WN09

Sample Number	MW32D 35 5-37'	100 00	100 00	100 00	100 00	100 00	100 00	92 80	91 96	74 38	64 09	55 77	40 51	18 38	6 99	2 93	1 45	1 45	1 16	0 87	0 58	0 58	0 58
		125000	75000	50000	37500	25000	19000	12500	9500	4750	2000	850	425	250	150	75	36 7	23 2	13 4	9 5	6 8	3 3	1 4
Test Temperature	21 5"	3"	2"		1 5"	1"	3/4"	1/2"	3/8"	4	10	20	40	60	100	200							
Specific Gravity	2 65																						

Wet Wt & Tare	25 29
Dry Wt & Tare	25 23
Wt Moisture	0 06
Wt Tare	1 57
Dry Soil	23 66
Moisture Content	0 002535926
Air Dry Total Sample	210 72
Oven Dry Total Samp	210 3780607
Air Dry Hydro Sample	110 86
Oven Dry Wt Hydro	110 5795784
Amount Plus #10	75 54
W (14 2) =	172 5293077

Sieve Analysis Portion					
Sieve Size	Weight of Soil + Tare	Total Weight of Soil		Percent Retained	Percent Passing
5"	10 13	0 00		0 00	100 00
3"	10 13	0 00		0 00	100 00
2"	10 13	0 00		0 00	100 00
1 5"	10 13	0 00		0 00	100 00
1	10 13	0 00		0 00	100 00
3/4	10 13	0 00		0 00	100 00
1/2	25 28	15 15		7 20	92 80
3/8	27 05	16 92		8 04	91 96
4	64 02	53 89		25 62	74 38
10	85 67	75 54		35 91	64 09
20	100 03	14 36	8 32	44 23	55 77
40	126 36	40 69	23 58	59 49	40 51
60	164 54	78 87	45 71	81 62	18 38
100	184 19	98 52	57 10	93 01	6 99
200	191 2	105 53	61 17	97 07	2 93

Hydrometer Analysis Portion								
Time	Hydro Reading	Comp Correct	Percent Finer	"L"	D	K	a
1	9	6 0	1 74	14 8	51 78251	0 01345	1 001385
2	8 5	6 0	1 45	14 9	36 71684	0 01345	1 001385
5	8 5	6 0	1 45	14 9	23 22177	0 01345	1 001385
15	8	6 0	1 16	15 0	13 4439	0 01345	1 001385
30	7 5	6 0	0 87	15 1	9 532229	0 01345	1 001385
60	7	6 0	0 58	15 2	6 758607	0 01345	1 001385
250	7	6 0	0 58	15 2	3 311028	0 01345	1 001385
1440	7	6 0	0 58	15 2	1 379595	0 01345	1 001385

Sample Number	MW32D 35 5-37'	100 00	100 00	100 00	100 00	100 00	100 00	95 50	92 60	75 39	67 88	59 75	44 38	19 80	7 17	2 66	1 54	1 54	1 23	0 93	0 62	0 62	0 62
		125000	75000	50000	37500	25000	19000	12500	9500	4750	2000	850	425	250	150	75	36 7	23 2	13 4	9 5	6 8	3 3	1 4
Test Temperature	21	5"	3"	2"	1 5"	1"	3/4"	1/2"	3/8"	4	10	20	40	60	100	200							
Specific Gravity	2 65																						

Wet Wt & Tare	30 7
Dry Wt & Tare	30 6
Wt Moisture	0 1
Wt Tare	1 56
Dry Soil	29 04
Moisture Content	0 003443526
Air Dry Total Sample	206 56
Oven Dry Total Samp	206 078291
Air Dry Hydro Sample	110 59
Oven Dry Wt Hydro	110 2104873
Amount Plus #10	66 19
W (14 2) =	162 3580409

Sieve Analysis Portion

Sieve Size	Weight of Soil + Tare	Total Weight of Soil		Percent Retained	Percent Passing
5"	10 06	0 00		0 00	100 00
3"	10 06	0 00		0 00	100 00
2"	10 06	0 00		0 00	100 00
1 5"	10 06	0 00		0 00	100 00
1	10 06	0 00		0 00	100 00
3/4	10 06	0 00		0 00	100 00
1/2	19 34	9 28		4 50	95 50
3/8	25 31	15 25		7 40	92 60
4	60 77	50 71		24 61	75 39
10	76 25	66 19		32 12	67 88
20	89 45	13 20	8 13	40 25	59 75
40	114 41	38 16	23 50	55 62	44 38
60	154 31	78 06	48 08	80 20	19 80
100	174 82	98 57	60 71	92 83	7 17
200	182 14	105 89	65 22	97 34	2 66

Time	Hydro Reading	Comp Correct	Percent Finer	"L"	D	K	a
1	9	6	1 85	14 8	51 78251	0 01345	1 001385
2	8 5	6	1 54	14 9	36 71684	0 01345	1 001385
5	8 5	6	1 54	14 9	23 22177	0 01345	1 001385
15	8	6	1 23	15 0	13 4439	0 01345	1 001385
30	7 5	6	0 93	15 1	9 532229	0 01345	1 001385
60	7	6	0 62	15 2	6 758607	0 01345	1 001385
250	7	6	0 62	15 2	3 311028	0 01345	1 001385
1440	7	6	0 62	15 2	1 379595	0 01345	1 001385

Sample Number	MW32D 35 5-37'	100 00	100 00	100 00	100 00	100 00	100 00	92 29	88 83	78 86	69 07	61 18	46 28	21 28	7 83	2 97	1 58	1 26	1 26	0 95	0 63	0 63	0 63
		125000	75000	50000	37500	25000	19000	12500	9500	4750	2000	850	425	250	150	75	36 7	23 3	13 4	9 5	6 8	3 3	1 4
Test Temperature	21	5"	3"	2"	1 5"	1"	3/4"	1/2"	3/8"	4	10	20	40	60	100	200							
Specific Gravity	2 65																						

Wet Wt & Tare	32 23
Dry Wt & Tare	32 111
Wt Moisture	0 119
Wt Tare	1 51
Dry Soil	30 601
Moisture Content	0 003888762
Air Dry Total Sample	204 88
Oven Dry Total Samp	204 3311357
Air Dry Hydro Sample	110 11
Oven Dry Wt Hydro	109 6834671
Amount Plus #10	63 19
W (14 2) =	158 7896207

Sieve Analysis Portion

Sieve Size	Weight of Soil + Tare	Total Weight of Soil		Percent Retained	Percent Passing
5"	10 4	0 00		0 00	100 00
3"	10 4	0 00		0 00	100 00
2"	10 4	0 00		0 00	100 00
1 1/2"	10 4	0 00		0 00	100 00
1	10 4	0 00		0 00	100 00
3/4	10 4	0 00		0 00	100 00
1/2	26 16	15 76		7 71	92 29
3/8	33 22	22 82		11 17	88 83
4	53 6	43 20		21 14	78 86
10	73 59	63 19		30 93	69 07
20	86 13	12 54	7 90	38 82	61 18
40	109 79	36 20	22 80	53 72	46 28
60	149 49	75 90	47 80	78 72	21 28
100	170 84	97 25	61 24	92 17	7 83
200	178 55	104 96	66 10	97 03	2 97

Hydrometer Analysis Portion

Time	Hydro Reading	Comp Correct	Percent Finer	"L"	D	K	a
1	9	6	1 89	14 8	51 78251	0 01345	1 001385
2	8 5	6	1 58	14 9	36 71684	0 01345	1 001385
5	8	6	1 26	15 0	23 28552	0 01345	1 001385
15	8	6	1 26	15 0	13 4439	0 01345	1 001385
30	7 5	6	0 95	15 1	9 532229	0 01345	1 001385
60	7	6	0 63	15 2	6 758607	0 01345	1 001385
250	7	6	0 63	15 2	3 311028	0 01345	1 001385
1440	7	6	0 63	15 2	1 379595	0 01345	1 001385

Sample Number	MW32D 10 5-12 5'	100 00	100 00	100 00	100 00	100 00	97 28	94 50	87 54	59 26	37 82	26 84	16 43	10 43	8 04	5 74	5 14	4 22	2 94	2 38	1 83	0 92	0 37
		125000	75000	50000	37500	25000	19000	12500	9500	4750	2000	850	425	250	150	75	34 3	22 0	13 0	9 3	6 6	3 3	1 4
Test Temperature	21	5"	3"	2"	1 5"	1"	3/4"	1/2"	3/8"	4	10	20	40	60	100	200							
Specific Gravity	2 65																						

Wet Wt & Tare	50 65
Dry Wt & Tare	49 68
Wt Moisture	0 97
Wt Tare	1 52
Dry Soil	48 16
Moisture Content	0 020141196
Air Dry Total Sample	428 85
Oven Dry Total Samp	425 6079137
Air Dry Hydro Sample	105 31
Oven Dry Wt Hydro	103 2308081
Amount Plus #10	264 64
W (14 2) =	272 9478679

Sieve Analysis Portion

Sieve Size	Weight of Soil + Tare	Total Weight of Soil		Percent Retained	Percent Passing
5"	10 25	0 00		0 00	100 00
3"	10 25	0 00		0 00	100 00
2"	10 25	0 00		0 00	100 00
1 5"	10 25	0 00		0 00	100 00
1	10 25	0 00		0 00	100 00
3/4	21 81	11 56		2 72	97 28
1/2	33 67	23 42		5 50	94 50
3/8	63 28	53 03		12 46	87 54
4	183 66	173 41		40 74	59 26
10	274 89	264 64		62 18	37 82
20	304 85	29 96	10 98	73 16	26 84
40	333 28	58 39	21 39	83 57	16 43
60	349 65	74 76	27 39	89 57	10 43
100	356 17	81 28	29 78	91 96	8 04
200	362 44	87 55	32 08	94 26	5 74

Hydrometer Analysis Portion

Time	Hydro Reading	Comp Correct	Percent Finer	"L"	D	K	a
1	23	6	6 24	12 5	47 60609	0 01345	1 001385
2	20	6	5 14	13 0	34 31681	0 01345	1 001385
5	17 5	6	4 22	13 4	22 04273	0 01345	1 001385
15	14	6	2 94	14 0	12 99534	0 01345	1 001385
30	12 5	6	2 38	14 2	9 269405	0 01345	1 001385
60	11	6	1 83	14 5	6 610761	0 01345	1 001385
250	8 5	6	0 92	14 9	3 284054	0 01345	1 001385
1440	7	6	0 37	15 2	1 379595	0 01345	1 001385

Sample Number	MW32D 16 5-18'	100 00	100 00	100 00	100 00	100 00	91 54	87 26	80 34	66 35	53 38	41 95	34 78	29 33	24 57	18 94	16 86	15 32	13 03	10 73	9 19	6 13	3 45
		125000	75000	50000	37500	25000	19000	12500	9500	4750	2000	850	425	250	150	75	32 5	20 9	12 3	8 9	6 3	3 2	1 4
Test Temperature		21 5"	3"	2"	1 5"	1"	3/4"	1/2"	3/8"	4	10	20	40	60	100	200							
Specific Gravity		2 65																					

Wet Wt & Tare	11 57
Dry Wt & Tare	11 37
Wt Moisture	0 2
Wt Tare	1 55
Dry Soil	9 82
Moisture Content	0 020366599
Air Dry Total Sample	180 61
Oven Dry Total Samp	178 6676846
Air Dry Hydro Sample	71 18
Oven Dry Wt Hydro	69 75924152
Amount Plus #10	83 30
W (14 2) =	130 6912526

Sieve Analysis Portion

Sieve Size	Weight of Soil + Tare	Total Weight of Soil		Percent Retained	Percent Passing
5"	10 32	0 00		0 00	100 00
3"	10 32	0 00		0 00	100 00
2"	10 32	0 00		0 00	100 00
1 5"	10 32	0 00		0 00	100 00
1	10 32	0 00		0 00	100 00
3/4	25 44	15 12		8 46	91 54
1/2	33 09	22 77		12 74	87 26
3/8	45 45	35 13		19 66	80 34
4	70 45	60 13		33 65	66 35
10	93 62	83 30		46 62	53 38
20	108 56	14 94	11 43	58 05	41 95
40	117 92	24 30	18 59	65 22	34 78
60	125 05	31 43	24 05	70 67	29 33
100	131 27	37 65	28 81	75 43	24 57
200	138 62	45 00	34 43	81 06	18 94

Hydrometer Analysis Portion

Time	Hydro Reading	Comp Correct	Percent Finer	"L"	D	K	a
1	33	6	20 69	10 9	44 38298	0 01345	1 001385
2	28	6	16 86	11 7	32 54301	0 01345	1 001385
5	26	6	15 32	12 0	20 86812	0 01345	1 001385
15	23	6	13 03	12 5	12 29184	0 01345	1 001385
30	20	6	10 73	13 0	8 860563	0 01345	1 001385
60	18	6	9 19	13 3	6 343745	0 01345	1 001385
250	14	6	6 13	14 0	3 183195	0 01345	1 001385
1440	10 5	6	3 45	14 6	1 353225	0 01345	1 001385

Sample Number	MW32D 18 5-20 5'	100 00	100 00	100 00	100 00	100 00	100 00	95 56	92 00	78 29	54 55	32 49	21 47	15 19	11 42	8 09	7 86	6 74	6 18	5 05	4 21	3 37	2 53
		125000	75000	50000	37500	25000	19000	12500	9500	4750	2000	850	425	250	150	75	34 3	22 0	12 8	9 1	6 5	3 2	1 4
Test Temperature	21 5"	3"	2"	1 5"	1"	3/4"	1/2"	3/8"	4	10	20	40	60	100	200								
Specific Gravity	2 65																						

Wet Wt & Tare	38 28
Dry Wt & Tare	36 58
Wt Moisture	1 7
Wt Tare	1 5
Dry Soil	35 08
Moisture Content	0 048460661
Air Dry Total Sample	459 33
Oven Dry Total Samp	447 5007178
Air Dry Hydro Sample	102
Oven Dry Wt Hydro	97 28548124
Amount Plus #10	203 40
W (14 2) =	178 3498348

Sieve Analysis Portion

Sieve Size	Weight of Soil + Tare	Total Weight of Soil		Percent Retained	Percent Passing
5"	10 04	0 00		0 00	100 00
3"	10 04	0 00		0 00	100 00
2"	10 04	0 00		0 00	100 00
1 5"	10 04	0 00		0 00	100 00
1	10 04	0 00		0 00	100 00
3/4	10 04	0 00		0 00	100 00
1/2	29 9	19 86		4 44	95 56
3/8	45 82	35 78		8 00	92 00
4	107 2	97 16		21 71	78 29
10	213 44	203 40		45 45	54 55
20	252 78	39 34	22 06	67 51	32 49
40	272 44	59 00	33 08	78 53	21 47
60	283 63	70 19	39 36	84 81	15 19
100	290 35	76 91	43 12	88 58	11 42
200	296 3	82 86	46 46	91 91	8 09

Hydrometer Analysis Portion

Time	Hydro Reading	Comp Correct	Percent Finer	"L"	D	K	a
1	27 5	6	12 07	11 8	46 18354	0 01345	1 001385
2	20	6	7 86	13 0	34 31681	0 01345	1 001385
5	18	6	6 74	13 3	21 97538	0 01345	1 001385
15	17	6	6 18	13 5	12 76515	0 01345	1 001385
30	15	6	5 05	13 8	9 135158	0 01345	1 001385
60	13 5	6	4 21	14 1	6 516654	0 01345	1 001385
250	12	6	3 37	14 3	3 220236	0 01345	1 001385
1440	10 5	6	2 53	14 6	1 353225	0 01345	1 001385

Sample Number	MW32D 20 5-22 5'	100 00	100 00	100 00	100 00	97 00	94 01	89 30	87 26	76 32	63 92	47 81	34 96	24 95	17 68	11 13	11 06	9 11	6 83	6 18	4 56	2 93	1 30
		125000	75000	50000	37500	25000	19000	12500	9500	4750	2000	850	425	250	150	75	33 7	21 7	12 8	9 1	6 5	3 2	1 4
Test Temperature	21	5"	3"	2"	1 5"	1"	3/4"	1/2"	3/8"	4	10	20	40	60	100	200							
Specific Gravity	2 65																						

Wet Wt & Tare	36 62
Dry Wt & Tare	36 04
Wt Moisture	0 58
Wt Tare	1 52
Dry Soil	34 52
Moisture Content	0 016801854
Air Dry Total Sample	284 87
Oven Dry Total Samp	281 8429288
Air Dry Hydro Sample	100
Oven Dry Wt Hydro	98 34757835
Amount Plus #10	101 68
W (14 2) =	153 8527915

Sieve Analysis Portion

Sieve Size	Weight of Soil + Tare	Total Weight of Soil		Percent Retained	Percent Passing
5	10 13	0 00		0 00	100 00
3	10 13	0 00		0 00	100 00
2	10 13	0 00		0 00	100 00
1 5	10 13	0 00		0 00	100 00
1	18 59	8 46		3 00	97 00
3/4	27 01	16 88		5 99	94 01
1/2	40 29	30 16		10 70	89 30
3/8	46 04	35 91		12 74	87 26
4	76 87	66 74		23 68	76 32
10	111 81	101 68		36 08	63 92
20	136 6	24 79	16 11	52 19	47 81
40	156 37	44 56	28 96	65 04	34 96
60	171 77	59 96	38 97	75 05	24 95
100	182 96	71 15	46 25	82 32	17 68
200	193 03	81 22	52 79	88 87	11 13

Hydrometer Analysis Portion

Time	Hydro Reading	Comp Correct	Percent Finer	"L"	D	K	a
1	26	6	13 02	12 0	46 66254	0 01345	1 001385
2	23	6	11 06	12 5	33 66259	0 01345	1 001385
5	20	6	9 11	13 0	21 70386	0 01345	1 001385
15	16 5	6	6 83	13 6	12 8038	0 01345	1 001385
30	15 5	6	6 18	13 8	9 108071	0 01345	1 001385
60	13	6	4 56	14 2	6 535584	0 01345	1 001385
250	10 5	6	2 93	14 6	3 24774	0 01345	1 001385
1440	8	6	1 30	15 0	1 372112	0 01345	1 001385

Sample Number	MW32D 28 5-30 5'	100 00	100 00	100 00	100 00	82 24	67 86	46 58	39 73	30 57	25 54	20 57	14 69	8 50	5 00	3 10	2 58	2 19	1 68	1 29	0 90	0 39	0 26
		125000	75000	50000	37500	25000	19000	12500	9500	4750	2000	850	425	250	150	75	35 2	22 4	13 1	9 3	6 7	3 3	1 4
Test Temperature	21 5"	3"	2"		1 5"	1"	3/4"	1/2"	3/8"	4	10	20	40	60	100	200							
Specific Gravity	2 65																						

Wet Wt & Tare	40 46
Dry Wt & Tare	40 14
Wt Moisture	0 32
Wt Tare	1 51
Dry Soil	38 63
Moisture Content	0 008283717
Air Dry Total Sample	998 82
Oven Dry Total Samp	996 7110398
Air Dry Hydro Sample	99 96
Oven Dry Wt Hydro	99 13876252
Amount Plus #10	742 12
W (14 2) =	388 1232393

Sieve Analysis Portion

Sieve Size	Weight of Soil + Tare	Total Weight of Soil		Percent Retained	Percent Passing
5	10 37	0 00		0 00	100 00
3	10 37	0 00		0 00	100 00
2	10 37	0 00		0 00	100 00
1 5	10 37	0 00		0 00	100 00
1	187 34	176 97		17 76	82 24
3/4	330 72	320 35		32 14	67 86
1/2	542 81	532 44		53 42	46 58
3/8	611 13	600 76		60 27	39 73
4	702 37	692 00		69 43	30 57
10	752 49	742 12		74 46	25 54
20	771 8	19 31	4 98	79 43	20 57
40	794 6	42 11	10 85	85 31	14 69
60	818 64	66 15	17 04	91 50	8 50
100	832 24	79 75	20 55	95 00	5 00
200	839 61	87 12	22 45	96 90	3 10

Hydrometer Analysis Portion

Time	Hydro Reading	Comp Correct	Percent Finer	"L"	D	K	a
1	17	6	2 84	13 5	49 4392	0 01345	1 001385
2	16	6	2 58	13 7	35 17019	0 01345	1 001385
5	14 5	6	2 19	13 9	22 44263	0 01345	1 001385
15	12 5	6	1 68	14 2	13 10892	0 01345	1 001385
30	11	6	1 29	14 5	9 349028	0 01345	1 001385
60	9 5	6	0 90	14 7	6 666587	0 01345	1 001385
250	7 5	6	0 39	15 1	3 302061	0 01345	1 001385
1440	7	6	0 26	15 2	1 379595	0 01345	1 001385

Sample Number	GEO-3 15-17'	100 00	100 00	100 00	100 00	96 08	81 22	64 12	54 16	35 95	22 88	14 14	8 23	4 35	2 49	1 38	1 27	1 16	1 04	0 81	0 46	0 35	0 23
		125000	75000	50000	37500	25000	19000	12500	9500	4750	2000	850	425	250	150	75	36 1	22 9	13 3	9 4	6 7	3 3	1 4
Test Temperature	21	5"	3"	2"	1 5"	1"	3/4"	1/2"	3/8"	4	10	20	40	60	100	200							
Specific Gravity	2 65																						

Wet Wt & Tare	57 25
Dry Wt & Tare	56 84
Wt Moisture	0 41
Wt Tare	1 49
Dry Soil	55 35
Moisture Content	0 007407407
Air Dry Total Sample	1132 23
Oven Dry Total Samp	1130 314191
Air Dry Hydro Sample	99 76
Oven Dry Wt Hydro	99 02647059
Amount Plus #10	871 68
W (14 2) =	432 7773698

Sieve Analysis Portion

Sieve Size	Weight of Soil + Tare	Total Weight of Soil		Percent Retained	Percent Passing
5	10 22	0 00		0 00	100 00
3	10 22	0 00		0 00	100 00
2	10 22	0 00		0 00	100 00
1 5	10 22	0 00		0 00	100 00
1	54 57	44 35		3 92	96 08
3/4	222 47	212 25		18 78	81 22
1/2	415 74	405 52		35 88	64 12
3/8	528 31	518 09		45 84	54 16
4	734 23	724 01		64 05	35 95
10	881 9	871 68		77 12	22 88
20	919 73	37 83	8 74	85 86	14 14
40	945 32	63 42	14 65	91 77	8 23
60	962 1	80 20	18 53	95 65	4 35
100	970 13	88 23	20 39	97 51	2 49
200	974 94	93 04	21 50	98 62	1 38

Hydrometer Analysis Portion

Time	Hydro Reading	Comp Correct	Percent Finer	"L"	D	K	a
1	12	6	1 39	14 3	50 91641	0 01345	1 001385
2	11 5	6	1 27	14 4	36 10613	0 01345	1 001385
5	11	6	1 16	14 5	22 90035	0 01345	1 001385
15	10 5	6	1 04	14 6	13 25884	0 01345	1 001385
30	9 5	6	0 81	14 7	9 427978	0 01345	1 001385
60	8	6	0 46	15 0	6 72195	0 01345	1 001385
250	7 5	6	0 35	15 1	3 302061	0 01345	1 001385
1440	7	6	0 23	15 2	1 379595	0 01345	1 001385

Sample Number	GEO-3 20-21 5'	100 00	100 00	100 00	100 00	100 00	100 00	100 00	100 00	97 92	85 11	67 22	43 11	20 97	9 37	4 65	3 45	3 02	2 59	2 15	1 72	0 86	0 86
		125000	75000	50000	37500	25000	19000	12500	9500	4750	2000	850	425	250	150	75	36 4	23 1	13 4	9 5	6 7	3 3	1 4
Test Temperature	21 5"	3"		2"	1 5"	1"	3/4"	1/2"	3/8"	4	10	20	40	60	100	200							
Specific Gravity	2 65																						

Wet Wt & Tare	57 98
Dry Wt & Tare	57 7
Wt Moisture	0 28
Wt Tare	1 47
Dry Soil	56 23
Moisture Content	0 004979548
Air Dry Total Sample	312 88
Oven Dry Total Samp	311 5595753
Air Dry Hydro Sample	99 37
Oven Dry Wt Hydro	98 87763405
Amount Plus #10	46 39
W (14 2) =	116 1757477

Sieve Analysis Portion

Sieve Size	Weight of Soil + Tare	Total Weight of Soil		Percent Retained	Percent Passing
5	10 45	0 00		0 00	100 00
3	10 45	0 00		0 00	100 00
2	10 45	0 00		0 00	100 00
1 5	10 45	0 00		0 00	100 00
1	10 45	0 00		0 00	100 00
3/4	10 45	0 00		0 00	100 00
1/2	10 45	0 00		0 00	100 00
3/8	10 45	0 00		0 00	100 00
4	16 92	6 47		2 08	97 92
10	56 84	46 39		14 89	85 11
20	77 62	20 78	17 89	32 78	67 22
40	105 63	48 79	42 00	56 89	43 11
60	131 36	74 52	64 14	79 03	20 97
100	144 83	87 99	75 74	90 63	9 37
200	150 31	93 47	80 46	95 35	4 65

Hydrometer Analysis Portion

Time	Hydro Reading	Comp Correct	Percent Finer	"L"	D	K	a
1	10	6	3 45	14 7	51 49542	0 01345	1 001385
2	10	6	3 45	14 7	36 41276	0 01345	1 001385
5	9 5	6	3 02	14 7	23 09374	0 01345	1 001385
15	9	6	2 59	14 8	13 37019	0 01345	1 001385
30	8 5	6	2 15	14 9	9 480247	0 01345	1 001385
60	8	6	1 72	15 0	6 72195	0 01345	1 001385
250	7	6	0 86	15 2	3 311028	0 01345	1 001385
1440	7	6	0 86	15 2	1 379595	0 01345	1 001385

Sample Number	GEO-2 9-10 5'	100 00	100 00	100 00	100 00	100 00	95 69	94 96	78 99	54 45	46 04	40 01	33 37	27 22	22 31	17 29	12 78	11 36	8 80	6 82	5 11	2 56	0 85
		125000	75000	50000	37500	25000	19000	12500	9500	4750	2000	850	425	250	150	75	32 4	20 9	12 4	9 0	6 5	3 1	1 4
Test Temperature	21	5"	3"	2"	1 5"	1"	3/4"	1/2"	3/8"	4	10	20	40	60	100	200							
Specific Gravity	2 65																						

Wet Wt & Tare	9 89
Dry Wt & Tare	9 68
Wt Moisture	0 21
Wt Tare	1 46
Dry Soil	8 22
Moisture Content	0 025547445
Air Dry Total Sample	257 43
Oven Dry Total Samp	254 4371886
Air Dry Hydro Sample	83 24
Oven Dry Wt Hydro	81 16640569
Amount Plus #10	137 29
W (14 2) =	176 2889261

Sieve Analysis Portion

Sieve Size	Weight of Soil + Tare	Total Weight of Soil		Percent Retained	Percent Passing
5"	10 09	0 00		0 00	100 00
3"	10 09	0 00		0 00	100 00
2"	10 09	0 00		0 00	100 00
1 5"	10 09	0 00		0 00	100 00
1"	10 09	0 00		0 00	100 00
3/4"	21 06	10 97		4 31	95 69
1/2"	22 92	12 83		5 04	94 96
3/8"	63 54	53 45		21 01	78 99
4	125 99	115 90		45 55	54 45
10	147 38	137 29		53 96	46 04
20	158 02	10 64	6 04	59 99	40 01
40	169 72	22 34	12 67	66 63	33 37
60	180 56	33 18	18 82	72 78	27 22
100	189 22	41 84	23 73	77 69	22 31
200	198 06	50 68	28 75	82 71	17 29

Hydrometer Analysis Portion

Time	Hydro Reading	Comp Correct	Percent Finer	"L"	D	K	a
1	34	6	15 91	10 7	44 0477	0 01345	1 001385
2	28 5	6	12 78	11 6	32 42892	0 01345	1 001385
5	26	6	11 36	12 0	20 86812	0 01345	1 001385
15	21 5	6	8 80	12 8	12 41186	0 01345	1 001385
30	18	6	6 82	13 3	8 97141	0 01345	1 001385
60	15	6	5 11	13 8	6 459532	0 01345	1 001385
267	10 5	6	2 56	14 6	3 142647	0 01345	1 001385
1440	7 5	6	0 85	15 1	1 375859	0 01345	1 001385

Sample Number	GEO-2 14-16'	100 00	100 00	100 00	100 00	95 24	95 24	90 76	86 34	71 88	55 61	37 91	26 00	17 72	12 11	6 98	6 58	6 04	4 66	3 57	2 74	1 10	0 55
		125000	75000	50000	37500	25000	19000	12500	9500	4750	2000	850	425	250	150	75	34 7	22 1	13 0	8 2	6 1	3 2	1 4
Test Temperature	21 5"	3"	2"		1 5"	1"	3/4"	1/2"	3/8"	4	10	20	40	60	100	200							
Specific Gravity	2 65																						

Wet Wt & Tare	41 81
Dry Wt & Tare	41 22
Wt Moisture	0 59
Wt Tare	1 46
Dry Soil	39 76
Moisture Content	0 014839034
Air Dry Total Sample	431 06
Oven Dry Total Samp	427 5321363
Air Dry Hydro Sample	103
Oven Dry Wt Hydro	101 4939281
Amount Plus #10	189 79
W (14 2) =	182 5167242

Sieve Analysis Portion

Sieve Size	Weight of Soil + Tare	Total Weight of Soil		Percent Retained	Percent Passing
5"	10 02	0 00		0 00	100 00
3"	10 02	0 00		0 00	100 00
2"	10 02	0 00		0 00	100 00
1 5"	10 02	0 00		0 00	100 00
1"	30 37	20 35		4 76	95 24
3/4"	30 37	20 35		4 76	95 24
1/2"	49 54	39 52		9 24	90 76
3/8"	68 4	58 38		13 66	86 34
4	130 26	120 24		28 12	71 88
10	199 81	189 79		44 39	55 61
20	232 12	32 31	17 70	62 09	37 91
40	253 85	54 04	29 61	74 00	26 00
60	268 97	69 16	37 89	82 28	17 72
100	279 2	79 39	43 50	87 89	12 11
200	288 57	88 76	48 63	93 02	6 98

Time	Hydro Reading	Comp Correct	Percent Finer	"L"	D	K	a
1	22	6	8 78	12 7	47 91648	0 01345	1 001385
2	18	6	6 58	13 3	34 74612	0 01345	1 001385
5	17	6	6 04	13 5	22 10988	0 01345	1 001385
15	14 5	6	4 66	13 9	12 95726	0 01345	1 001385
38	12 5	6	3 57	14 2	8 236082	0 01345	1 001385
70	11	6	2 74	14 5	6 120375	0 01345	1 001385
259	8	6	1 10	15 0	3 235348	0 01345	1 001385
1440	7	6	0 55	15 2	1 379595	0 01345	1 001385

Sample Number	GEO-2 24-26'	100 00	100 00	100 00	100 00	100 00	100 00	99 46	95 31	90 42	83 44	77 87	71 27	60 62	44 36	23 21	15 13	11 89	9 19	7 57	5 40	3 24	1 08
		125000	75000	50000	37500	25000	19000	12500	9500	4750	2000	850	425	250	150	75	34 3	22 1	13 0	9 2	6 6	3 3	1 4
Test Temperature	21	5"	3"	2"	1 5"	1"	3/4"	1/2"	3/8"	4	10	20	40	60	100	200							
Specific Gravity	2 65																						

Wet Wt & Tare	7 05
Dry Wt & Tare	6 96
Wt Moisture	0 09
Wt Tare	1 54
Dry Soil	5 42
Moisture Content	0 016605166
Air Dry Total Sample	118 05
Oven Dry Total Samp	116 4366969
Air Dry Hydro Sample	78 59
Oven Dry Wt Hydro	77 30631579
Amount Plus #10	19 28
W (14 2) =	92 64716018

Sieve Analysis Portion

Sieve Size	Weight of Soil + Tare	Total Weight of Soil		Percent Retained	Percent Passing
5	9 98	0 00		0 00	100 00
3	9 98	0 00		0 00	100 00
2	9 98	0 00		0 00	100 00
1 5	9 98	0 00		0 00	100 00
1	9 98	0 00		0 00	100 00
3/4	9 98	0 00		0 00	100 00
1/2	10 61	0 63		0 54	99 46
3/8	15 44	5 46		4 69	95 31
4	21 13	11 15		9 58	90 42
10	29 26	19 28		16 56	83 44
20	34 42	5 16	5 57	22 13	77 87
40	40 54	11 28	12 18	28 73	71 27
60	50 4	21 14	22 82	39 38	60 62
100	65 47	36 21	39 08	55 64	44 36
200	85 06	55 80	60 23	76 79	23 21

Hydrometer Analysis Portion

Time	Hydro Reading	Comp Correct	Percent Finer	"L"	D	K	a
1	31	6	27 02	11 2	45 04606	0 01345	1 001385
2	20	6	15 13	13 0	34 31681	0 01345	1 001385
5	17	6	11 89	13 5	22 10988	0 01345	1 001385
15	14 5	6	9 19	13 9	12 95726	0 01345	1 001385
30	13	6	7 57	14 2	9 242711	0 01345	1 001385
60	11	6	5 40	14 5	6 610761	0 01345	1 001385
250	9	6	3 24	14 8	3 275013	0 01345	1 001385
1440	7	6	1 08	15 2	1 379595	0 01345	1 001385

Sample Number	GEO-2 34-36'	100 00	100 00	100 00	79 64	58 63	55 32	48 84	44 91	41 26	37 10	30 65	22 30	13 59	6 14	1 95	0 75	0 56	0 38	0 38	0 00	0 00	0 00
		125000	75000	50000	37500	25000	19000	12500	9500	4750	2000	850	425	250	150	75	36 8	23 3	13 5	9 6	6 8	3 3	1 4
Test Temperature	21 5"	3"	2"		1 5"	1"	3/4"	1/2"	3/8"	4	10	20	40	60	100	200							
Specific Gravity	2 65																						

Wet Wt & Tare	66 35
Dry Wt & Tare	66 21
Wt Moisture	0 14
Wt Tare	1 46
Dry Soil	64 75
Moisture Content	0 002162162
Air Dry Total Sample	635 26
Oven Dry Total Samp	634 7508306
Air Dry Hydro Sample	99 22
Oven Dry Wt Hydro	99 00593312
Amount Plus #10	399 26
W (14 2) =	266 8643111

Sieve Analysis Portion

Sieve	Weight of	Total		Percent	Percent
5"	9 72	0 00		0 00	100 00
3"	9 72	0 00		0 00	100 00
2"	9 72	0 00		0 00	100 00
1 5"	138 98	129 26		20 36	79 64
1	272 3	262 58		41 37	58 63
3/4	293 3	283 58		44 68	55 32
1/2	334 43	324 71		51 16	48 84
3/8	359 38	349 66		55 09	44 91
4	382 56	372 84		58 74	41 26
10	408 98	399 26		62 90	37 10
20	426 19	17 21	6 45	69 35	30 65
40	448 48	39 50	14 80	77 70	22 30
60	471 72	62 74	23 51	86 41	13 59
100	491 6	82 62	30 96	93 86	6 14
200	502 77	93 79	35 15	98 05	1 95

Hydrometer Analysis Portion

Time	Hydro	Comp	Percent	"L"	D	K	a
1	8 5	6	0 94	14 9	51 92545	0 01345	1 001385
2	8	6	0 75	15 0	36 81764	0 01345	1 001385
5	7 5	6	0 56	15 1	23 3491	0 01345	1 001385
15	7	6	0 38	15 2	13 51721	0 01345	1 001385
30	7	6	0 38	15 2	9 558114	0 01345	1 001385
60	6	6	0 00	15 3	6 795066	0 01345	1 001385
250	6	6	0 00	15 3	3 328889	0 01345	1 001385
1440	6	6	0 00	15 3	1 387037	0 01345	1 001385

Sample Number	GEO-2 39-40 5'		100 00	100 00	100 00	59 25	53 19	46 02	44 60	42 90	38 35	34 13	30 57	22 97	10 43	4 04	1 79	1 03	0 69	0 69	0 34	0 34	0 00	0 00
			125000	75000	50000	37500	25000	19000	12500	9500	4750	2000	850	425	250	150	75	36 6	23 3	13 4	9 6	6 8	3 3	1 4
Test Temperature		21 5"	3"	2"		1 5"	1"	3/4"	1/2"	3/8"	4	10	20	40	60	100	200							
Specific Gravity		2 65																						

Wet Wt & Tare	61 42
Dry Wt & Tare	61 27
Wt Moisture	0 15
Wt Tare	1 51
Dry Soil	59 76
Moisture Content	0 00251004
Air Dry Total Sample	995 59
Oven Dry Total Samp	994 7379469
Air Dry Hydro Sample	99 52
Oven Dry Wt Hydro	99 27082624
Amount Plus #10	655 28
W (14 2) =	290 9004157

Sieve Analysis Portion

Sieve Size	Weight of Soil + Tare	Total Weight of Soil		Percent Retained	Percent Passing
5	10 31	0 00		0 00	100 00
3	10 31	0 00		0 00	100 00
2	10 31	0 00		0 00	100 00
1 5	415 71	405 40		40 75	59 25
1	475 97	465 66		46 81	53 19
3/4	547 3	536 99		53 98	46 02
1/2	561 37	551 06		55 40	44 60
3/8	578 26	567 95		57 10	42 90
4	623 54	613 23		61 65	38 35
10	665 59	655 28		65 87	34 13
20	675 93	10 34	3 55	69 43	30 57
40	698 05	32 46	11 16	77 03	22 97
60	734 51	68 92	23 69	89 57	10 43
100	753 11	87 52	30 09	95 96	4 04
200	759 64	94 05	32 33	98 21	1 79

Time	Hydro Reading	Comp Correct	Percent Finer	"L"	D	K	a
1	9 5	6	1 20	14 7	51 63916	0 01345	1 001385
2	9	6	1 03	14 8	36 61576	0.01345	1 001385
5	8	6	0 69	15 0	23 28552	0 01345	1 001385
15	8	6	0 69	15 0	13 4439	0 01345	1 001385
30	7	6	0 34	15 2	9 558114	0 01345	1 001385
60	7	6	0 34	15 2	6 758607	0 01345	1 001385
250	6	6	0 00	15 3	3 328889	0 01345	1 001385
1440	6	6	0 00	15 3	1 387037	0 01345	1 001385

Sample Number	GEO-2 44-44 5'	100 00	100 00	100 00	100 00	90 68	83 56	73 94	68 13	60 45	53 74	49 11	38 91	18 45	6 48	1 93	0 54	0 27	0 27	0 00	0 00	0 00	0 00
		125000	75000	50000	37500	25000	19000	12500	9500	4750	2000	850	425	250	150	75	37 0	23 5	13 6	9 6	6 8	3 3	1 4
Test Temperature	21 5"	3"	2"	1 5"	1"	3/4"	1/2"	3/8"	4	10	20	40	60	100	200								
Specific Gravity	2 65																						

Wet Wt & Tare	63 59
Dry Wt & Tare	63 44
Wt Moisture	0 15
Wt Tare	1 51
Dry Soil	61 93
Moisture Content	0
Air Dry Total Sample	709 25
Oven Dry Total Samp	709 25
Air Dry Hydro Sample	99 18
Oven Dry Wt Hydro	99 18
Amount Plus #10	328 13
W (14 2) =	184 5702535

Sieve Analysis Portion

Sieve Size	Weight of Soil + Tare	Total Weight of Soil		Percent Retained	Percent Passing
5	10 51	0 00		0 00	100 00
3	10 51	0 00		0 00	100 00
2	10 51	0 00		0 00	100 00
1 5	10 51	0 00		0 00	100 00
1	76 59	66 08		9 32	90 68
3/4	127 14	116 63		16 44	83 56
1/2	195 37	184 86		26 06	73 94
3/8	236 58	226 07		31 87	68 13
4	291 02	280 51		39 55	60 45
10	338 64	328 13		46 26	53 74
20	347 18	8 54	4 63	50 89	49 11
40	366 01	27 37	14 83	61 09	38 91
60	403 77	65 13	35 29	81 55	18 45
100	425 86	87 22	47 26	93 52	6 48
200	434 25	95.61	51 80	98 07	1 93

Hydrometer Analysis Portion

Time	Hydro Reading	Comp Correct	Percent Finer	"L"	D	K	a
1	7 5	6	0 81	15 1	52 21017	0 01345	1 001385
2	7	6	0 54	15 2	37 01842	0 01345	1 001385
5	6 5	6	0 27	15 2	23 47574	0 01345	1 001385
15	6 5	6	0 27	15 2	13 55372	0 01345	1 001385
30	6	6	0 00	15 3	9 609674	0 01345	1 001385
60	6	6	0 00	15 3	6 795066	0 01345	1 001385
250	6	6	0 00	15 3	3 328889	0 01345	1 001385
1440	6	6	0 00	15 3	1 387037	0 01345	1 001385

ANALYTICAL RESOURCES, INC.

Sieve/Hydrometer Particle Size Analysis - ASTM D421/422

ARI Job No.: WN09 ARI Sample ID.: K-1 Setup Date: 04.24.2013 Initials: kb
Sample Description: sand, rocks, organic debris
Method of size reduction: Sample Splitter [ ] Quartering [ ] Stockpile [✓] Whole Sample [ ]

Tare Number	K-1
Tare Weight (g)	10.12
Tare + Air-Dried Sample Weight (g) (before #10 preparation)	220.84
Hydro Test Sample Weight (g) (not including beaker weight)	110.86
Tare + Oven-Dried #10 Washed (g)	85.60
Tare + Oven-Dried #200 Washed (g) (including plus #10 material)	191.55

Hygroscopic Moisture Content	
Tare Number	K1
Tare Weight (g)	1.57
Wet Soil + Tare (g)	25.29
Dry Soil + Tare (g)	25.23

Hydro Beaker: BA Calgon Batch #: 284 Calgon Date: 04/28/13 Technician: kb
Method of size reduction: Sample Splitter [ ] Quartering [ ] Stockpile [✓] Whole Sample [ ]

Hydrometer Analysis

4/29/2013 193285 Technician: kb

Time	Δ Time	Test Cylinder	Calgon Blank	Temp (°C)
12:55:00	START			
12:56:00	1	9.0	6	21
12:57:00	2	8.5	6	21
13:00:00	5	8.5	6	21
13:10:00	15	8.0	6	21
13:25:00	30	7.5	6	21
13:55:00	60	7.0	6	21.5
17:05:00	250	7	6	22.0
12:55:00	1440	7	6	21.5

Sieve Analysis

Sieve Date: 5/1/13 Sieve Set #: 3 Technician: JG

Sieve Size	Cumulative Weight (g)
Empty Tare	10.113 JG
2"	↕
1½"	
1"	
3/4"	10.113 eg for TA
1/2"	25.28
3/8"	27.05
#4	64.02
#10	85.67
#20	100.03
#40	126.36
#60	164.584 JG
#100	184.19
#200	191.55 20 JG
Pan	191.48

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ANALYTICAL RESOURCES, INC.

Sieve/Hydrometer Particle Size Analysis - ASTM D421/422

ARI Job No.: WN09 ARI Sample ID.: K-2 Setup Date: 04.24.2013 Initials: kb
Sample Description: sand, rocks, organic debris
Method of size reduction: Sample Splitter [ ] Quartering [ ] Stockpile [✓] Whole Sample [ ]

Tare Number	K-2
Tare Weight (g)	10.05
Tare + Air-Dried Sample Weight (g) (before #10 preparation)	216.61
Hydro Test Sample Weight (g) (not including beaker weight)	110.59
Tare + Oven-Dried #10 Washed (g)	76.20
Tare + Oven-Dried #200 Washed (g) (including plus #10 material)	182.33 JG

Hygroscopic Moisture Content	
Tare Number	K-2
Tare Weight (g)	1.56
Wet Soil + Tare (g)	30.70
Dry Soil + Tare (g)	30.60

Hydro Beaker: AB Calgon Batch #: 284 Calgon Date: 04/28/13 Technician: kb
Method of size reduction: Sample Splitter [ ] Quartering [ ] Stockpile [✓] Whole Sample [ ]

Hydrometer Analysis

4/29/2013 193285 Technician: kb

Time	Δ Time	Test Cylinder	Calgon Blank	Temp (°C)
13:02:00	START			
13:03:00	1	9.0	6	21
13:04:00	2	8.5	6	21
13:07:00	5	8.5	6	21
13:17:00	15	8.0	6	21
13:32:00	30	7.5	6	21
14:02:00	60	7.0	6	21.5
17:12:00	250	7	6	22.0
13:02:00	1440	7	6	21.5

Sieve Analysis

Sieve Date: 5/1/13 Sieve Set #: 4 Technician: JG

Sieve Size	Cumulative Weight (g)
Empty Tare	10.06
2"	↑
1½"	
1"	↓
3/4"	10.06
1/2"	19.34
3/8"	25.31
#4	50.77
#10	76.25
#20	89.45
#40	114.341 JG
#60	154.31
#100	174.82
#200	182.14
Pan	182.32

ANALYTICAL RESOURCES, INC.

Sieve/Hydrometer Particle Size Analysis - ASTM D421/422

ARI Job No.: WN09 ARI Sample ID.: K-3 Setup Date: 04.24.2013 Initials: kb
Sample Description: sand, rocks, organic debris
Method of size reduction: Sample Splitter [ ] Quartering [ ] Stockpile [Y] Whole Sample [ ]

Tare Number	K-3
Tare Weight (g)	10.38
Tare + Air-Dried Sample Weight (g) (before #10 preparation)	215.26
Hydro Test Sample Weight (g) (not including beaker weight)	110.11
Tare + Oven-Dried #10 Washed (g)	73.63
Tare + Oven-Dried #200 Washed (g) (including plus #10 material)	178.86

Hygroscopic Moisture Content	
Tare Number	K-3
Tare Weight (g)	1.51
Wet Soil + Tare (g)	32.23
Dry Soil + Tare (g)	32.11

Hydro Beaker: BF Calgon Batch #: 284 Calgon Date: 04/28/13 Technician: kb
Method of size reduction: Sample Splitter [ ] Quartering [ ] Stockpile [Y] Whole Sample [ ]

Hydrometer Analysis

4/29/2013 193285 Technician: kb

Time	Δ Time	Test Cylinder	Calgon Blank	Temp (°C)
13:09:00	START			
13:10:00	1	9.0	6	21
13:11:00	2	8.5	6	21
13:14:00	5	8.0	6	21
13:24:00	15	8.0	6	21
13:39:00	30	7.5	6	21
14:09:00	60	7.0	6	21.5
17:19:00	250	7	6	22.0
13:09:00	1440	7	6	21.5

Sieve Analysis

Sieve Date: 5/1/13 Sieve Set #: 3 Technician: JG

Sieve Size	Cumulative Weight (g)
Empty Tare	10.40
2"	
1½"	
1"	
3/4"	10.40
1/2"	26.16
3/8"	33.22
#4	53.60
#10	73.59
#20	86.813 JG
#40	109.79
#60	149.49
#100	170.84
#200	178.55
Pan	178.814 JG

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Sieve/Hydrometer Particle Size Analysis - ASTM D421/422

ARI Job No.: WN09 ARI Sample ID.: F Setup Date: 04.24.2013 Initials: kb
Sample Description: rocks, sand, silt
Method of size reduction: Sample Splitter [ ] Quartering [ ] Stockpile [ ] Whole Sample [✓]

Tare Number	F
Tare Weight (g)	10.24
Tare + Air-Dried Sample Weight (g) (before #10 preparation)	439.09
Hydro Test Sample Weight (g) (not including beaker weight)	105.31
Tare + Oven-Dried #10 Washed (g)	279.54
Tare + Oven-Dried #200 Washed (g) (including plus #10 material)	363.31

★ SAMPLE CONSUMED

Hygroscopic Moisture Content	
Tare Number	~~1.52~~ F
Tare Weight (g)	~~50~~ 1.52
Wet Soil + Tare (g)	50.65
Dry Soil + Tare (g)	49.68

Hydro Beaker: DR Calgon Batch #: 284 Calgon Date: 04/28/13 Technician: kb
Method of size reduction: Sample Splitter [ ] Quartering [ ] Stockpile [✓] Whole Sample [ ]

Hydrometer Analysis

4/29/2013 193285 Technician: kb

Time	Δ Time	Test Cylinder	Calgon Blank	Temp (°C)
13:16:00	START			
13:17:00	1	23.0	6	21
13:18:00	2	20.0	6	21
13:21:00	5	17.5	6	21
13:31:00	15	14.0	6	21
13:46:00	30	12.5	6	21.5
14:16:00	60	11.0	6	21.5
17:26:00	250	8.5	6	22.0
13:16:00	1440	7	6	21.5

Sieve Analysis

Sieve Date: 5/1/13 Sieve Set #: 4 Technician: [illegible]

Sieve Size	Cumulative Weight (g)
Empty Tare	10.25
2"	↕
1½"	
1"	10.25
3/4"	21.81
1/2"	33.67
3/8"	63.28
#4	123.66
#10	274.89
#20	304.85
#40	333.28
#60	349.65
#100	356.17
#200	362.44
Pan	363.80

ANALYTICAL RESOURCES, INC.

Sieve/Hydrometer Particle Size Analysis - ASTM D421/422

ARI Job No.: WN09 ARI Sample ID.: G Setup Date: 04·24·2013 Initials: kb
Sample Description: sand, rocks, silt, organic debris
Method of size reduction: Sample Splitter [ ] Quartering [ ] Stockpile [ ] Whole Sample [H]

★ SAMPLE CONSUMED

Tare Number	G
Tare Weight (g)	10.29
Tare + Air-Dried Sample Weight (g) (before #10 preparation)	190.90
Hydro Test Sample Weight (g) (not including beaker weight)	71.18
Tare + Oven-Dried #10 Washed (g)	98.45
Tare + Oven-Dried #200 Washed (g) (including plus #10 material)	140.60

Hygroscopic Moisture Content	
Tare Number	G
Tare Weight (g)	1.55
Wet Soil + Tare (g)	11.57
Dry Soil + Tare (g)	11.37

Hydro Beaker: G Calgon Batch #: 284 Calgon Date: 04/28/13 Technician: kb
Method of size reduction: Sample Splitter [ ] Quartering [H] Stockpile [ ] Whole Sample [ ]

Hydrometer Analysis

4/29/2013 193285 Technician: kb

Time	Δ Time	Test Cylinder	Calgon Blank	Temp (°C)
13:23:00	START			
13:24:00	1	33.0	6	21
13:25:00	2	28.0	6	21
13:28:00	5	26.0	6	21
13:38:00	15	23.0	6	21
13:53:00	30	20.0	6	21.5
14:23:00	60	18.0	6	21.5
17:33:00	250	14	6	22.0
13:23:00	1440	10.5	6	21.5

Sieve Analysis

Sieve Date: 5/1/13 Sieve Set #: 3 Technician: JC

Sieve Size	Cumulative Weight (g)
Empty Tare	10.32
2"	↕
1½"	
1"	10.32
3/4"	25.44
1/2"	33.09
3/8"	45.45
#4	70.95
#10	93.62
#20	106.56
#40	117.92
#60	125.05
#100	131.27
#200	138.62
Pan	140.81

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WN09 : 00041

ANALYTICAL RESOURCES, INC.

Sieve/Hydrometer Particle Size Analysis - ASTM D421/422

ARI Job No.: WN09 ARI Sample ID.: H Setup Date: 04·24·2013 Initials: kb
Sample Description: clayey, coarse sand, rocks
Method of size reduction: Sample Splitter [ ] Quartering [ ] Stockpile [ ] Whole Sample [Y]

★SAMPLE CONSUMED

Tare Number	H
Tare Weight (g)	9.95
Tare + Air-Dried Sample Weight (g) (before #10 preparation)	469.28
Hydro Test Sample Weight (g) (not including beaker weight)	★~~99.59~~ 102.00
Tare + Oven-Dried #10 Washed (g)	229.18
Tare + Oven-Dried #200 Washed (g) (including plus #10 material)	298.25

Hygroscopic Moisture Content	
Tare Number	H
Tare Weight (g)	1.50
Wet Soil + Tare (g)	38.28
Dry Soil + Tare (g)	36.58

Hydro Beaker: BH Calgon Batch #: 284 Calgon Date: 4/28/13 Technician: kb
Method of size reduction: Sample Splitter [ ] Quartering [ ] Stockpile [ ] Whole Sample [Y]

Hydrometer Analysis

4/29/2013 193285 Technician: kb

Time	Δ Time	Test Cylinder	Calgon Blank	Temp (°C)
13:30:00	START			
13:31:00	1	27.5	6	21
13:32:00	2	20.0	6	21
13:35:00	5	18.0	6	21
13:45:00	15	17.0	6	21.5
14:00:00	30	15.0	6	21.5
14:30:00	60	13.5	6	21.5
17:40:00	250	12	6	22.0
13:30:00	1440	10.5	6	21.5

Sieve Analysis

Sieve Date: 5/1/13 Sieve Set #: 4 Technician: JC

Sieve Size	Cumulative Weight (g)
Empty Tare	10.64
2"	↑
1½"	
1"	↓
3/4"	10.64
1/2"	29.90
3/8"	45.82
#4	~~106.64~~ 107.20 JC
#10	213.44
#20	252.78
#40	272.44
#60	283.63
#100	290.35
#200	296.30
Pan	298.49

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★ Curve fitting was applied

UNDS 0002

ANALYTICAL RESOURCES, INC.

Sieve/Hydrometer Particle Size Analysis - ASTM D421/422

ARI Job No.: WN09 ARI Sample ID.: I Setup Date: 04.24.2013 Initials: kb
Sample Description: silty, coarse sand, rocks, rubbery particles, debris
Method of size reduction: Sample Splitter [ ] Quartering [ ] Stockpile [✓] Whole Sample [ ]

Tare Number	I
Tare Weight (g)	10.09
Tare + Air-Dried Sample Weight (g) (before #10 preparation)	294.96
Hydro Test Sample Weight (g) (not including beaker weight)	★ ~~99.35~~ 100.00 g
Tare + Oven-Dried #10 Washed (g)	122.02
Tare + Oven-Dried #200 Washed (g) (including plus #10 material)	195.76

Hygroscopic Moisture Content	
Tare Number	I
Tare Weight (g)	1.52
Wet Soil + Tare (g)	36.62
Dry Soil + Tare (g)	36.04

Hydro Beaker: I Calgon Batch #: 284 Calgon Date: 04/28/13 Technician: kb
Method of size reduction: Sample Splitter [ ] Quartering [✓] Stockpile [ ] Whole Sample [ ]

Hydrometer Analysis

4/29/2013 193285 Technician: kb

Time	Δ Time	Test Cylinder	Calgon Blank	Temp (°C)
13:37:00	START			
13:38:00	1	26.0	6	21
13:39:00	2	23.0	6	21
13:42:00	5	20.0	6	21
13:52:00	15	16.5	6	21.5
14:07:00	30	15.5	6	21.5
14:37:00	60	13.0	6	21.5
17:47:00	250	10.5	6	22.0
13:37:00	1440	8	6	21.5

Sieve Analysis

Sieve Date: 5/1/13 Sieve Set #: 3 Technician: JC

Sieve Size	Cumulative Weight (g)
Empty Tare	10.13
2"	10.13
1½"	10.13
1"	18.59
3/4"	27.01
1/2"	40.29
3/8"	46.04
#4	76.897 JC
#10	111.81
#20	136.60
#40	156.37
#60	171.77
#100	182.96
#200	193.03
Pan	196.04

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★ curve fitting was applied.

UNOS : 00013

ANALYTICAL RESOURCES, INC.

Sieve/Hydrometer Particle Size Analysis - ASTM D421/422

ARI Job No.: WN09 ARI Sample ID.: J Setup Date: 04.24.2013 Initials: kb
Sample Description: rocks, sand
Method of size reduction: Sample Splitter [ ] Quartering [ ] Stockpile [✓] Whole Sample [ ]

Tare Number	J
Tare Weight (g)	10.36
Tare + Air-Dried Sample Weight (g) (before #10 preparation)	1009.18
Hydro Test Sample Weight (g) (not including beaker weight)	99.96
Tare + Oven-Dried #10 Washed (g)	754.84
Tare + Oven-Dried #200 Washed (g) (including plus #10 material)	840.66

Hygroscopic Moisture Content	
Tare Number	J
Tare Weight (g)	1.51
Wet Soil + Tare (g)	40.46
Dry Soil + Tare (g)	40.14

Hydro Beaker: J Calgon Batch #: 284 Calgon Date: 04/28/13 Technician: kb
Method of size reduction: Sample Splitter [ ] Quartering [✓] Stockpile [ ] Whole Sample [ ]

Hydrometer Analysis

4/29/2013 193285 Technician: kb

Time	Δ Time	Test Cylinder	Calgon Blank	Temp (°C)
13:44:00	START			
13:45:00	1	17.0	6	21.5
13:46:00	2	16.0	6	21.5
13:49:00	5	14.5	6	21.5
13:59:00	15	12.5	6	21.5
14:14:00	30	11.0	6	21.5
14:44:00	60	9.5	6	21.5
17:54:00	250	7.5	6	22.0
13:44:00	1440	7	6	21.5

Sieve Analysis

Sieve Date: 5/1/13 Sieve Set #: 4 Technician: JC

Sieve Size	Cumulative Weight (g)
Empty Tare	10.37
2"	10.37
1½"	~~187.34~~
1"	~~330.72~~
3/4"	330.73
1/2"	542.81
3/8"	611.13
#4	702.37
#10	752.49
#20	771.80
#40	794.60
#60	818.64
#100	832.24
#200	839.61
Pan	840.63

10.37
187.34 JC

WN09 : 00011

ANALYTICAL RESOURCES, INC.

Sieve/Hydrometer Particle Size Analysis - ASTM D421/422

ARI Job No.: WN09 ARI Sample ID.: L Setup Date: 04.24.2013 Initials: bb
Sample Description: rocks, sand
Method of size reduction: Sample Splitter [ ] Quartering [ ] Stockpile [X] Whole Sample [ ]

Tare Number	L
Tare Weight (g)	10.20
Tare + Air-Dried Sample Weight (g) (before #10 preparation)	1142.43
Hydro Test Sample Weight (g) (not including beaker weight)	99.76
Tare + Oven-Dried #10 Washed (g)	889.49
Tare + Oven-Dried #200 Washed (g) (including plus #10 material)	975.78

Hygroscopic Moisture Content	
Tare Number	L
Tare Weight (g)	1.49
Wet Soil + Tare (g)	57.25
Dry Soil + Tare (g)	56.84

Hydro Beaker: L Calgon Batch #: 284 Calgon Date: 04/28/13 Technician: bb
Method of size reduction: Sample Splitter [ ] Quartering [X] Stockpile [ ] Whole Sample [ ]

Hydrometer Analysis

4/29/2013 193285 Technician: bb

Time	Δ Time	Test Cylinder	Calgon Blank	Temp (°C)
13:51:00	START			
13:52:00	1	12.0	6	21.5
13:53:00	2	11.5	6	21.5
13:56:00	5	11.0	6	21.5
14:06:00	15	10.5	6	21.5
14:21:00	30	9.5	6	21.5
14:51:00	60	8.0	6	21.5
18:01:00	250	7.5	6	22.0
13:51:00	1440	7	6	21.5

Sieve Analysis

Sieve Date: 5/1/13 Sieve Set #: 3 Technician: JC

Sieve Size	Cumulative Weight (g)
Empty Tare	10.22
2"	10.22
1½"	10.22
1"	54.57
3/4"	222.47
1/2"	415.74
3/8"	528.31
#4	734.23
#10	881.90
#20	919.73
#40	945.32
#60	962.10
#100	970.13
#200	974.94
Pan	975.82

ANALYTICAL RESOURCES, INC.

Sieve/Hydrometer Particle Size Analysis - ASTM D421/422

ARI Job No.: WN09 ARI Sample ID.: M Setup Date: 04.24.2013 Initials: kb
Sample Description: sand
Method of size reduction: Sample Splitter [ ] Quartering [ ] Stockpile [M] Whole Sample [ ]

Tare Number	M
Tare Weight (g)	10.44
Tare + Air-Dried Sample Weight (g) (before #10 preparation)	323.32
Hydro Test Sample Weight (g) (not including beaker weight)	99.37
Tare + Oven-Dried #10 Washed (g)	57.38
Tare + Oven-Dried #200 Washed (g) (including plus #10 material)	150.67

Hygroscopic Moisture Content	
Tare Number	M
Tare Weight (g)	1.47
Wet Soil + Tare (g)	57.98
Dry Soil + Tare (g)	57.70

Hydro Beaker: M Calgon Batch #: 284 Calgon Date: 04/28/13 Technician: kb
Method of size reduction: Sample Splitter [ ] Quartering [M] Stockpile [ ] Whole Sample [ ]

Hydrometer Analysis

4/29/2013 193285 Technician: kb

Time	Δ Time	Test Cylinder	Calgon Blank	Temp (°C)
13:58:00	START			
13:59:00	1	10.0	6	21.5
14:00:00	2	10.0	6	21.5
14:03:00	5	9.5	6	21.5
14:13:00	15	9.0	6	21.5
14:28:00	30	8.5	6	21.5
14:58:00	60	8.0	6	21.5
18:08:00	250	7	6	22.0
13:58:00	1440	7	6	21.5

Sieve Analysis

Sieve Date: 5/1/13 Sieve Set #: 4 Technician: JC

Sieve Size	Cumulative Weight (g)
Empty Tare	10.45
2"	
1½"	
1"	
3/4"	
1/2"	
3/8"	10.45
#4	16.92
#10	56.84
#20	77.62
#40	105.63
#60	131.36
#100	144.83
#200	150.31
Pan	150.51

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ANALYTICAL RESOURCES, INC.

Sieve/Hydrometer Particle Size Analysis - ASTM D421/422

ARI Job No.: WN09 ARI Sample ID.: N Setup Date: 04.24.2013 Initials: kb
Sample Description: rocks, rusty-colored clayey sand, debris, organic debris
Method of size reduction: Sample Splitter [ ] Quartering [ ] Stockpile [✓] Whole Sample [ ]

Tare Number	N
Tare Weight (g)	10.10
Tare + Air-Dried Sample Weight (g) (before #10 preparation)	267.53
Hydro Test Sample Weight (g) (not including beaker weight)	83.24
Tare + Oven-Dried #10 Washed (g)	150.39
Tare + Oven-Dried #200 Washed (g) (including plus #10 material)	200.37

Hygroscopic Moisture Content	
Tare Number	N
Tare Weight (g)	1.46
Wet Soil + Tare (g)	9.89
Dry Soil + Tare (g)	9.68

Hydro Beaker: DN Calgon Batch #: 284 Calgon Date: 04/28/13 Technician: kb
Method of size reduction: Sample Splitter [ ] Quartering [ ] Stockpile [ ] Whole Sample [✓]

Hydrometer Analysis

4/29/2013 193285 Technician: kb

Time	Δ Time	Test Cylinder	Calgon Blank	Temp (°C)
14:05:00	START			
14:06:00	1	34.0	6	21.5
14:07:00	2	28.5	6	21.5
14:10:00	5	26.0	6	21.5
14:20:00	15	21.5	6	21.5
14:35:00	30	18.0	6	21.5
15:05:00	60	15.0	6	22.0
18:15:00	250	10.5	6	22.0
14:05:00	1440	7.5	6	21.5

Sieve Analysis

Sieve Date: 5/1/13 Sieve Set #: 3 Technician: JC

Sieve Size	Cumulative Weight (g)
Empty Tare	10.09
2"	~~21.06~~ 10.09
1½"	~~22.92~~ 10.09
1"	10.09
3/4"	21.06
1/2"	22.92
3/8"	63.54
#4	125.99
#10	147.38
#20	158.02
#40	169.72
#60	180.56
#100	189.22
#200	198.06
Pan	200.38

JC

ANALYTICAL RESOURCES, INC.

Sieve/Hydrometer Particle Size Analysis - ASTM D421/422

ARI Job No.: WN09 ARI Sample ID: 0 Setup Date: 04·24·2013 Initials: kb
Sample Description: silty sand, rocks
Method of size reduction: Sample Splitter [ ] Quartering [ ] Stockpile [✓] Whole Sample [ ]

Tare Number	0
Tare Weight (g)	9.96
Tare + Air-Dried Sample Weight (g) (before #10 preparation)	441.02
Hydro Test Sample Weight (g) (not including beaker weight)	~~99.65~~ 103.00 ✓
Tare + Oven-Dried #10 Washed (g)	229.27
Tare + Oven-Dried #200 Washed (g) (including plus #10 material)	292.60

Hygroscopic Moisture Content	
Tare Number	0
Tare Weight (g)	1.46
Wet Soil + Tare (g)	41.81
Dry Soil + Tare (g)	41.22

Hydro Beaker: 0 Calgon Batch #: 284 Calgon Date: 04/28/13 Technician: kb
Method of size reduction: Sample Splitter [ ] Quartering [ ] Stockpile [✓] Whole Sample [ ]

Hydrometer Analysis

4/29/2013 193285 Technician: kb

Time	Δ Time	Test Cylinder	Calgon Blank	Temp (°C)
14:13:00	START			
14:14:00	1	22.0	6	21.5
14:15:00	2	18.0	6	21.5
14:18:00	5	17.0	6	21.5
14:28:00	15	14.5	6	21.5
14:43:00	30	12.5	6	21.5
15:13:00	60	11.0	6	22.0
18:23:00	250	8	6	22.0
14:13:00	1440	7	6	21.5

Sieve Analysis

Sieve Date: 5/1/13 Sieve Set #: 4 Technician: JC

Sieve Size	Cumulative Weight (g)
Empty Tare	10.02
2"	10.02
1½"	10.02
1"	30.37
3/4"	30.37
1/2"	49.54
3/8"	68.40
#4	130.26
#10	199.81
#20	232.12
#40	253.85
#60	268.97
#100	279.20
#200	288.57
Pan	292.55

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A CURVE FITTING WAS APPLIED LINDO · 2004.6

ANALYTICAL RESOURCES, INC.

Sieve/Hydrometer Particle Size Analysis - ASTM D421/422

ARI Job No.: WN09 ARI Sample ID.: P Setup Date: 04·24·2013 Initials: MB
Sample Description: medium, dark-colored sand, fuel-like odor, soft rubber-like particles
Method of size reduction: Sample Splitter [ ] Quartering [ ] Stockpile [ ] Whole Sample [✓]

Tare Number	P
Tare Weight (g)	9.97
Tare + Air-Dried Sample Weight (g) (before #10 preparation)	128.02
Hydro Test Sample Weight (g) (not including beaker weight)	78.59
Tare + Oven-Dried #10 Washed (g)	30.77
Tare + Oven-Dried #200 Washed (g) (including plus #10 material)	88.53

★ SAMPLE CONSUMED

Hygroscopic Moisture Content	
Tare Number	P
Tare Weight (g)	1.54
Wet Soil + Tare (g)	7.05
Dry Soil + Tare (g)	6.96

Hydro Beaker: P Calgon Batch #: 284 Calgon Date: 04/28/13 Technician: MB
Method of size reduction: Sample Splitter [ ] Quartering [ ] Stockpile [ ] Whole Sample [✓]

Hydrometer Analysis

4/29/2013 193285 Technician: MB

Time	Δ Time	Test Cylinder	Calgon Blank	Temp (°C)
14:20:00	START			
14:21:00	1	31.0	6	21.5
14:22:00	2	20.0	6	21.5
14:25:00	5	17.0	6	21.5
14:35:00	15	14.5	6	21.5
14:50:00	30	13.0	6	21.5
15:20:00	60	11.0	6	22.0
18:30:00	250	9	6	22.0
14:20:00	1440	7	6	21.5

Sieve Analysis

Sieve Date: 5/1/13 Sieve Set #: 3 Technician: JC

Sieve Size	Cumulative Weight (g)
Empty Tare	9.98
2"	
1½"	
1"	
3/4"	
1/2"	10.61
3/8"	15.44
#4	21.13
#10	29.26
#20	34.42
#40	40.54
#60	50.40
#100	65.47
#200	85.06
Pan	88.86

ANALYTICAL RESOURCES, INC.

Sieve/Hydrometer Particle Size Analysis - ASTM D421/422

ARI Job No.: WN09 ARI Sample ID.: Q Setup Date: 04.24.2013 Initials: kb
Sample Description: Sand, rocks
Method of size reduction: Sample Splitter [ ] Quartering [ ] Stockpile [~~✓~~] Whole Sample [ ]

Tare Number	Q
Tare Weight (g)	9.72
Tare + Air-Dried Sample Weight (g) (before #10 preparation)	644.98
Hydro Test Sample Weight (g) (not including beaker weight)	99.22
Tare + Oven-Dried #10 Washed (g)	409.35
Tare + Oven-Dried #200 Washed (g) (including plus #10 material)	502.96

Hygroscopic Moisture Content	
Tare Number	Q
Tare Weight (g)	1.46
Wet Soil + Tare (g)	66.35
Dry Soil + Tare (g)	66.21

Hydro Beaker: Q Calgon Batch #: 284 Calgon Date: 04/28/13 Technician: kb
Method of size reduction: Sample Splitter [ ] Quartering [~~✓~~] Stockpile [ ] Whole Sample [ ]

Hydrometer Analysis

4/29/2013 @ 193~~+24~~285 Technician: kb

Time	Δ Time	Test Cylinder	Calgon Blank	Temp (°C)
14:27:00	START			
14:28:00	1	8.5	6	21.5
14:29:00	2	8.0	6	21.5
14:32:00	5	7.5	6	21.5
14:42:00	15	7.0	6	21.5
14:57:00	30	7.0	6	21.5
15:27:00	60	6.0	6	22.0
18:37:00	250	6	~~6~~ 6 ey	~~21.5~~ 22.0 ey
14:27:00	1440	6	6	21.5

Sieve Analysis

Sieve Date: 5.1.13 Sieve Set #: 4 Technician: ey

Sieve Size	Cumulative Weight (g)
Empty Tare	9.72
2"	
1½"	138.98
1"	272.30
3/4"	293.30
1/2"	334.43
3/8"	359.38
#4	382.56
#10	408.98
#20	426.19
#40	448.48
#60	471.72
#100	491.60
#200	502.77
Pan	503.11

ANALYTICAL RESOURCES, INC.

Sieve/Hydrometer Particle Size Analysis - ASTM D421/422

ARI Job No.: WN09 ARI Sample ID.: R Setup Date: 04·24·2013 Initials: kb
Sample Description: sand, large rocks
Method of size reduction: Sample Splitter [ ] Quartering [ ] Stockpile [ ] Whole Sample [✓]

Tare Number	R
Tare Weight (g)	10.30
Tare + Air-Dried Sample Weight (g) (before #10 preparation)	1005.89
Hydro Test Sample Weight (g) (not including beaker weight)	99.52
Tare + Oven-Dried #10 Washed (g)	666.80
Tare + Oven-Dried #200 Washed (g) (including plus #10 material)	759.82

★SAMPLE CONSUMED

Hygroscopic Moisture Content	
Tare Number	R
Tare Weight (g)	151
Wet Soil + Tare (g)	61.42
Dry Soil + Tare (g)	61.27

Hydro Beaker: CR Calgon Batch #: 284 Calgon Date: 04/28/13 Technician: kb
Method of size reduction: Sample Splitter [ ] Quartering [✓] Stockpile [ ] Whole Sample [ ]

Hydrometer Analysis

4/29/2013 1931285 (kb) Technician: kb

Time	Δ Time	Test Cylinder	Calgon Blank	Temp (°C)
14:34:00	START			
14:35:00	1	9.5	6	21.5
14:36:00	2	9.0	6	21.5
14:39:00	5	8.0	6	21.5
14:49:00	15	8.0	6	21.5
15:04:00	30	7.0	6	22.0
15:34:00	60	7.0	6	22.0
18:44:00	250	6	6	22.0
14:34:00	1440	6	6	21.5

Sieve Analysis

Sieve Date: 5·1·13 Sieve Set #: 3 Technician: eg

Sieve Size	Cumulative Weight (g)
Empty Tare	10.31
2"	
1½"	415.71
1"	476.97
3/4"	547.30
1/2"	561.37
3/8"	578.26
#4	623.54
#10	665.59
#20	675.93
#40	698.05
#60	734.51
#100	753.11
#200	759.64
Pan	759.88

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ANALYTICAL RESOURCES, INC.

Sieve/Hydrometer Particle Size Analysis - ASTM D421/422

ARI Job No.: WN09 ARI Sample ID.: S Setup Date: 04.24.2013 Initials: kb
Sample Description: Sand, rocks
Method of size reduction: Sample Splitter [ ] Quartering [ ] Stockpile [ ] Whole Sample [✓]

Tare Number	S
Tare Weight (g)	10.46
Tare + Air-Dried Sample Weight (g) (before #10 preparation)	719.71
Hydro Test Sample Weight (g) (not including beaker weight)	99.18
Tare + Oven-Dried #10 Washed (g)	339.21
Tare + Oven-Dried #200 Washed (g) (including plus #10 material)	434.59

★ SAMPLE CONSUMED

Hygroscopic Moisture Content	
Tare Number	S
Tare Weight (g)	1.51
Wet Soil + Tare (g)	63.59
Dry Soil + Tare (g)	63.44

Hydro Beaker: BS Calgon Batch #: 284 Calgon Date: 04/28/13 Technician: kb
Method of size reduction: Sample Splitter [ ] Quartering [✓] Stockpile [ ] Whole Sample [ ]

Hydrometer Analysis

4/29/2013 193285 Technician: kb

Time	Δ Time	Test Cylinder	Calgon Blank	Temp (°C)
14:41:00	START			
14:42:00	1	7.5	6	21.5
14:43:00	2	7.0	6	21.5
14:46:00	5	6.5	6	21.5
14:56:00	15	6.5	6	21.5
15:11:00	30	6.0	6	22.0
15:41:00	60	6	6	22.0
18:51:00	250	6	6	22
14:41:00	1440	6	6	21.5

Sieve Analysis

Sieve Date: 5.1.13 Sieve Set #: 4 Technician: ey

Sieve Size	Cumulative Weight (g)
Empty Tare	10.51
2"	
1½"	
1"	76.59
3/4"	127.14
1/2"	195.37
3/8"	236.58
#4	291.02
#10	338.64
#20	347.18
#40	366.01
#60	403.77
#100	425.86
#200	434.25
Pan	434.59

ATTACHMENT 2A-6
SI UV Photographs and Petrophysical Results

SUB-ATTACHMENT 2A-6.1
UV Photographs

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PTS File No.: 43238

20.0

Each Interval Equals One Tenth of a Foot

21.0

Project: North Lake Union-Gas Works Park

Project No.: 0186-846-01 Boring ID: PT01

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21.0

22.0

Each Interval Equals One Tenth of a Foot

Project: North Lake Union-Gas Works Park

Project No.: 0186-846-01 Boring ID: PT01

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22.0

Each Interval Equals One Tenth of a Foot

23.0

Project: North Lake Union-Gas Works Park

Project No.: 0186-846-01 Boring ID: PT01

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23.0

Each Interval Equals One Tenth of a Foot

24.0

Project: North Lake Union-Gas Works Park

Project No.: 0186-846-01 Boring ID: PT01

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24.0

Each Interval Equals One Tenth of a Foot

25.0

Project: North Lake Union-Gas Works Park

Project No.: 0186-846-01 Boring ID: PT01

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11.2

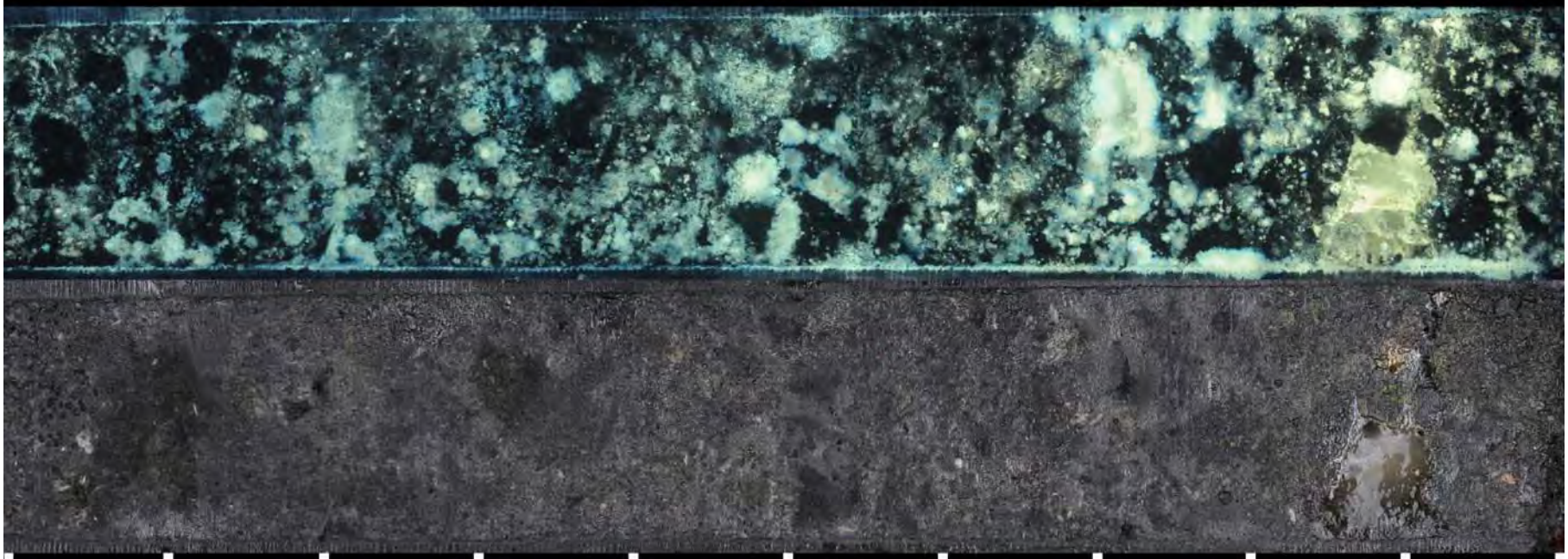
Each Interval Equals One Tenth of a Foot

12.2

Project: North Lake Union-Gas Works Park

Project No.: 0186-846-01 Boring ID: PT01B

PTS Laboratories
PTS File No.: 43238



12.2

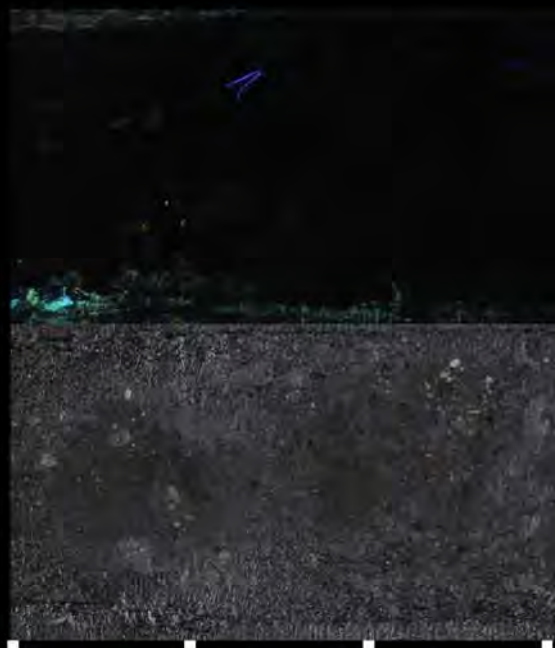
Each Interval Equals One Tenth of a Foot

13.2

Project: North Lake Union-Gas Works Park

Project No.: 0186-846-01 Boring ID: PT01B

PTS Laboratories
PTS File No.: 43238



8.0

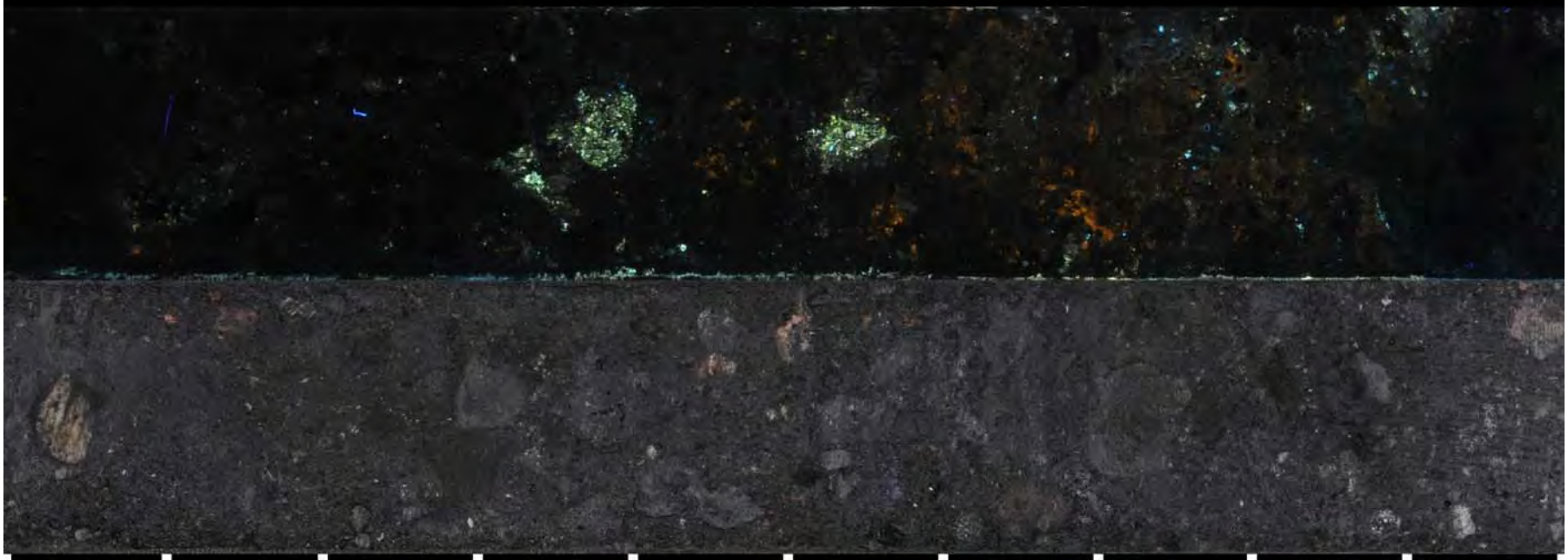
Each Interval Equals One Tenth of a Foot

9.0

Project: North Lake Union-Gas Works Park

Project No.: 0186-846-01 Boring ID: PT02

PTS Laboratories
PTS File No.: 43238



9.0

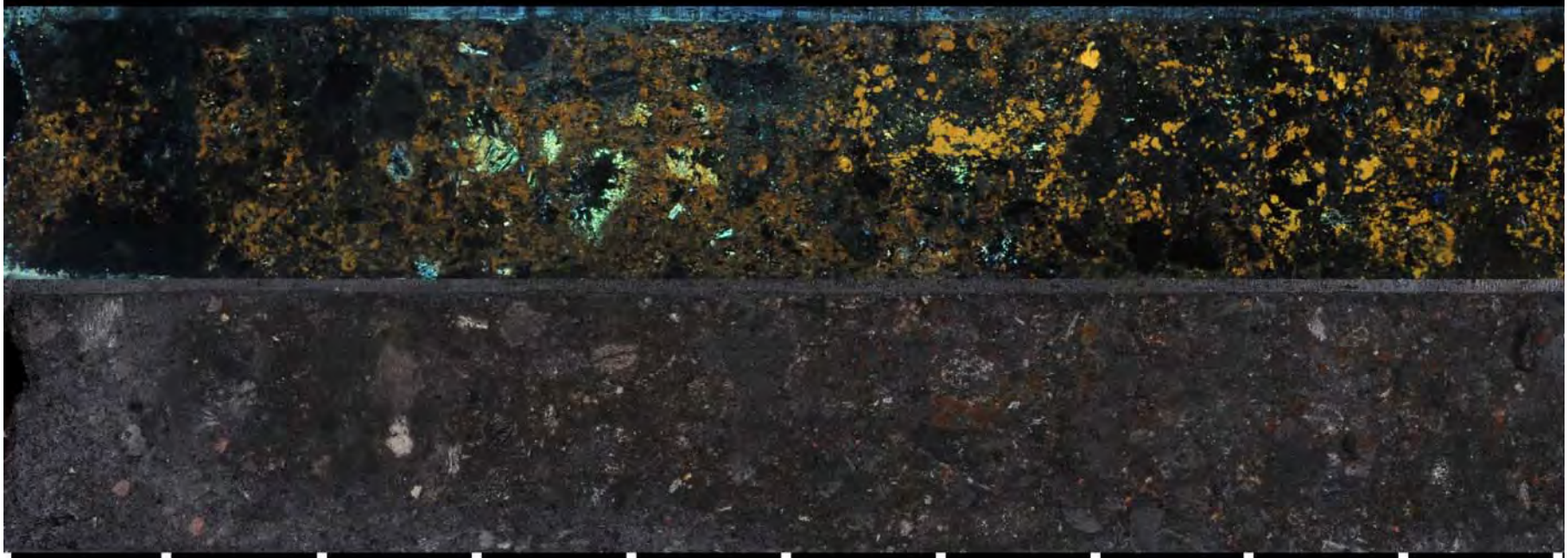
Each Interval Equals One Tenth of a Foot

10.0

Project: North Lake Union-Gas Works Park

Project No.: 0186-846-01 Boring ID: PT02

PTS Laboratories
PTS File No.: 43238



10.0

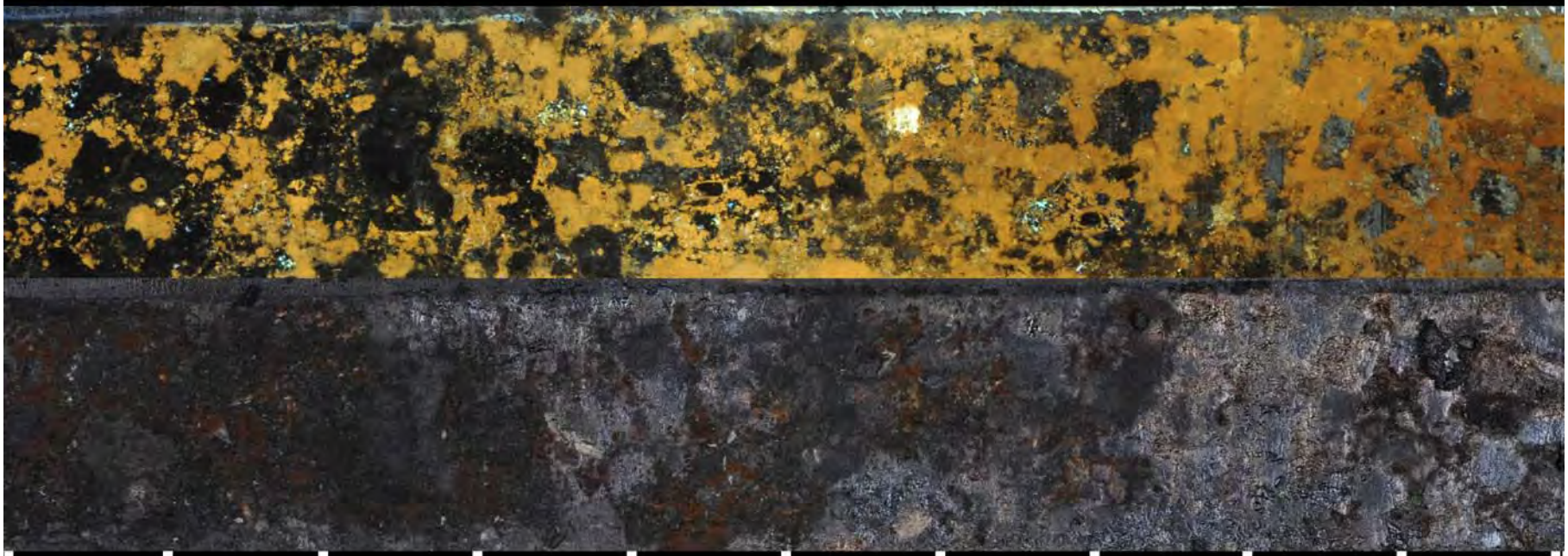
Each Interval Equals One Tenth of a Foot

11.0

Project: North Lake Union-Gas Works Park

Project No.: 0186-846-01 Boring ID: PT02

PTS Laboratories
PTS File No.: 43238



11.0

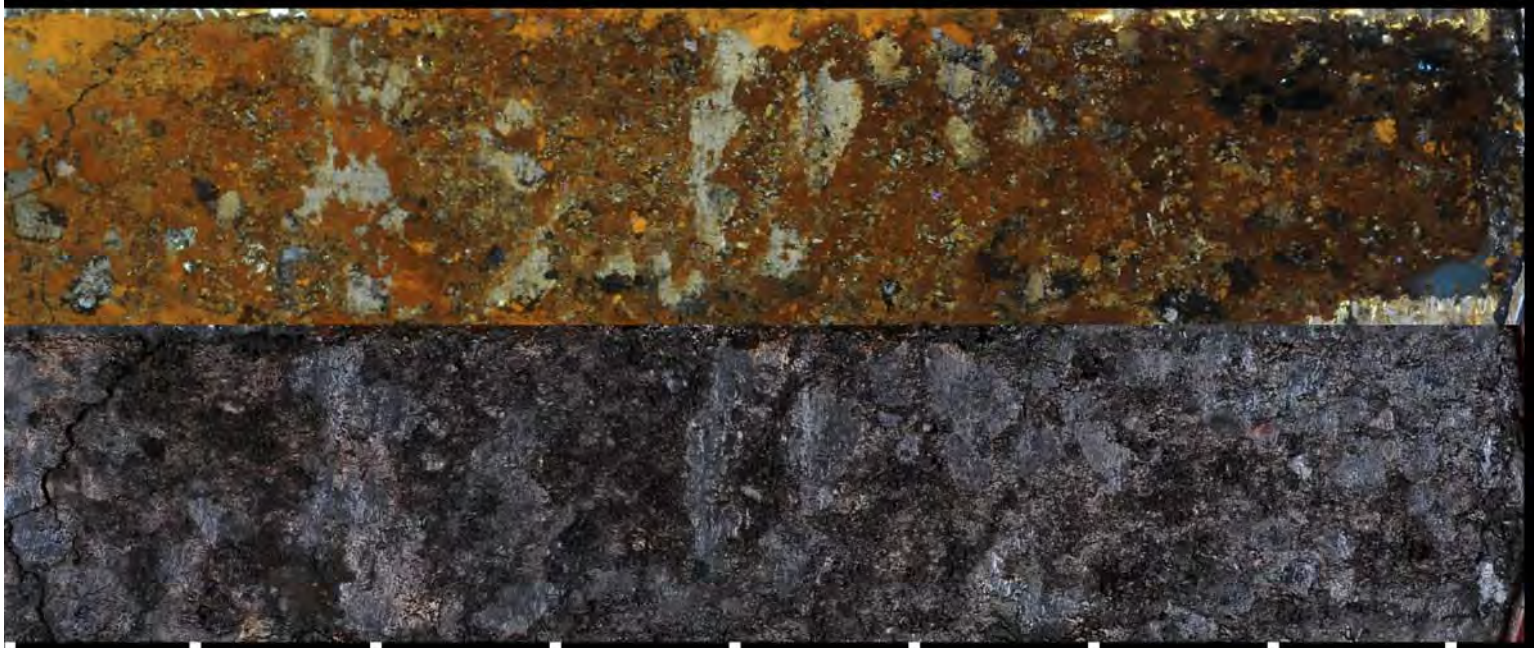
Each Interval Equals One Tenth of a Foot

12.0

Project: North Lake Union-Gas Works Park

Project No.: 0186-846-01 Boring ID: PT02

PTS Laboratories
PTS File No.: 43238



12.0

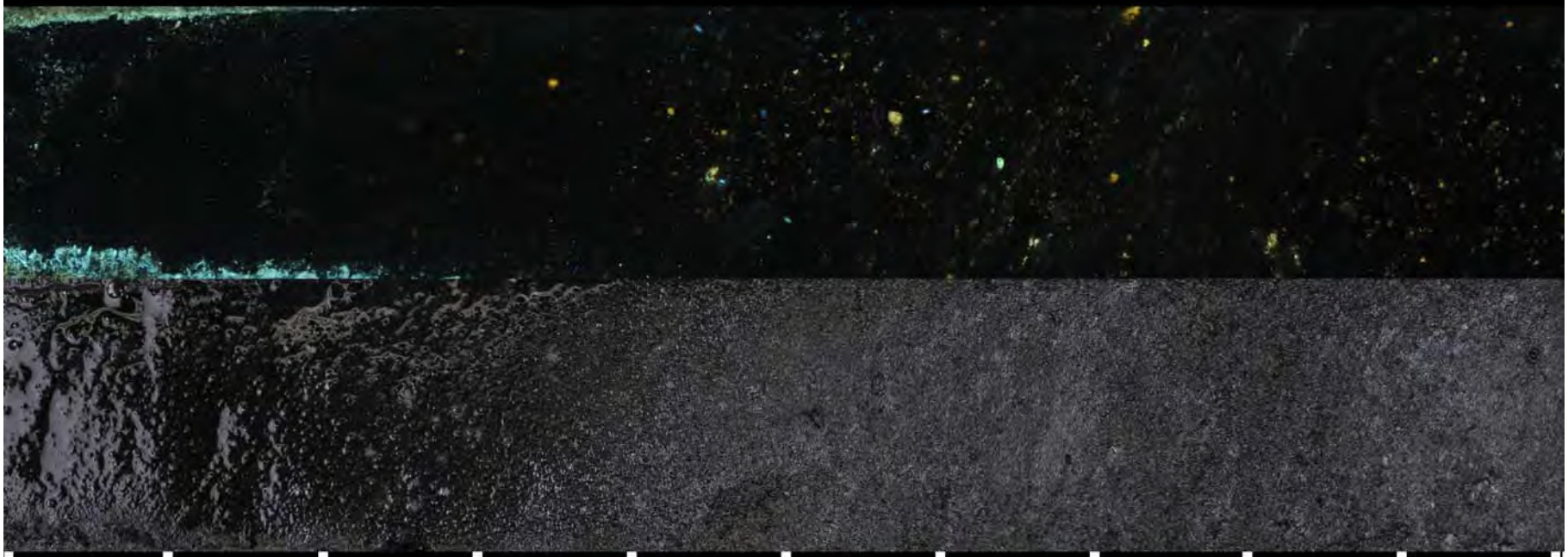
Each Interval Equals One Tenth of a Foot

13.0

Project: North Lake Union-Gas Works Park

Project No.: 0186-846-01 Boring ID: PT02

PTS Laboratories
PTS File No.: 43238



20.0

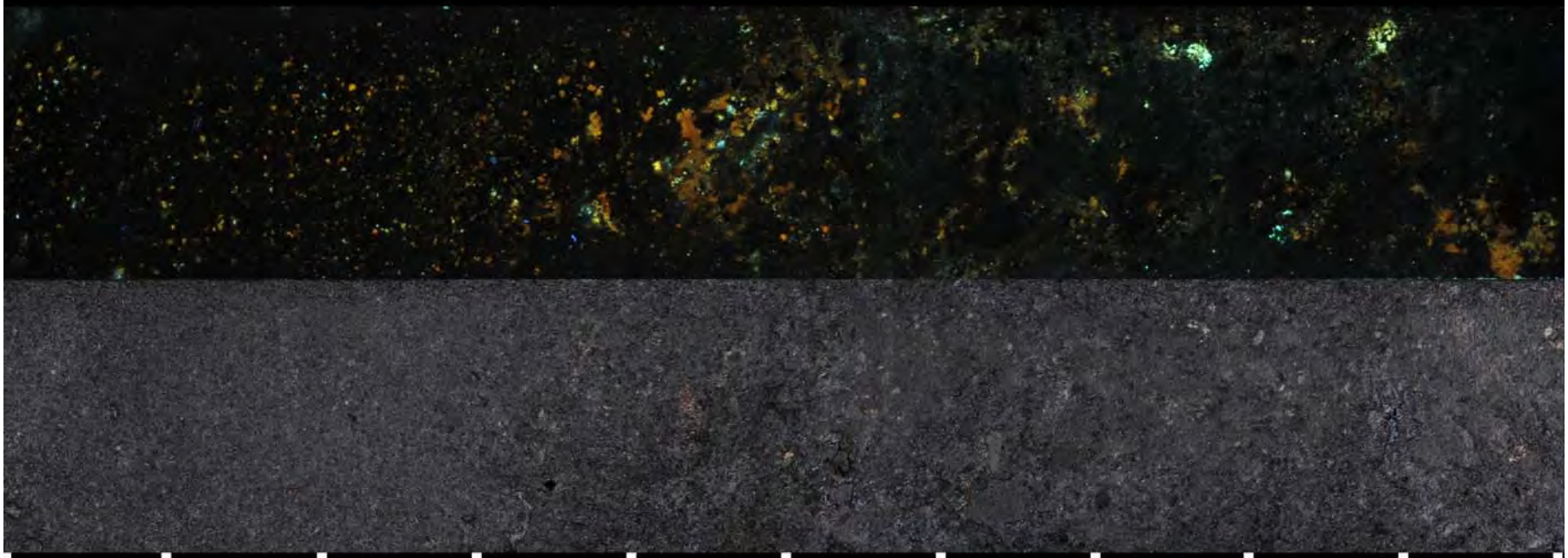
Each Interval Equals One Tenth of a Foot

21.0

Project: North Lake Union-Gas Works Park

Project No.: 0186-846-01 Boring ID: PT02

PTS Laboratories
PTS File No.: 43238



21.0

Each Interval Equals One Tenth of a Foot

22.0

Project: North Lake Union-Gas Works Park

Project No.: 0186-846-01 Boring ID: PT02

PTS Laboratories
PTS File No.: 43238

22.0

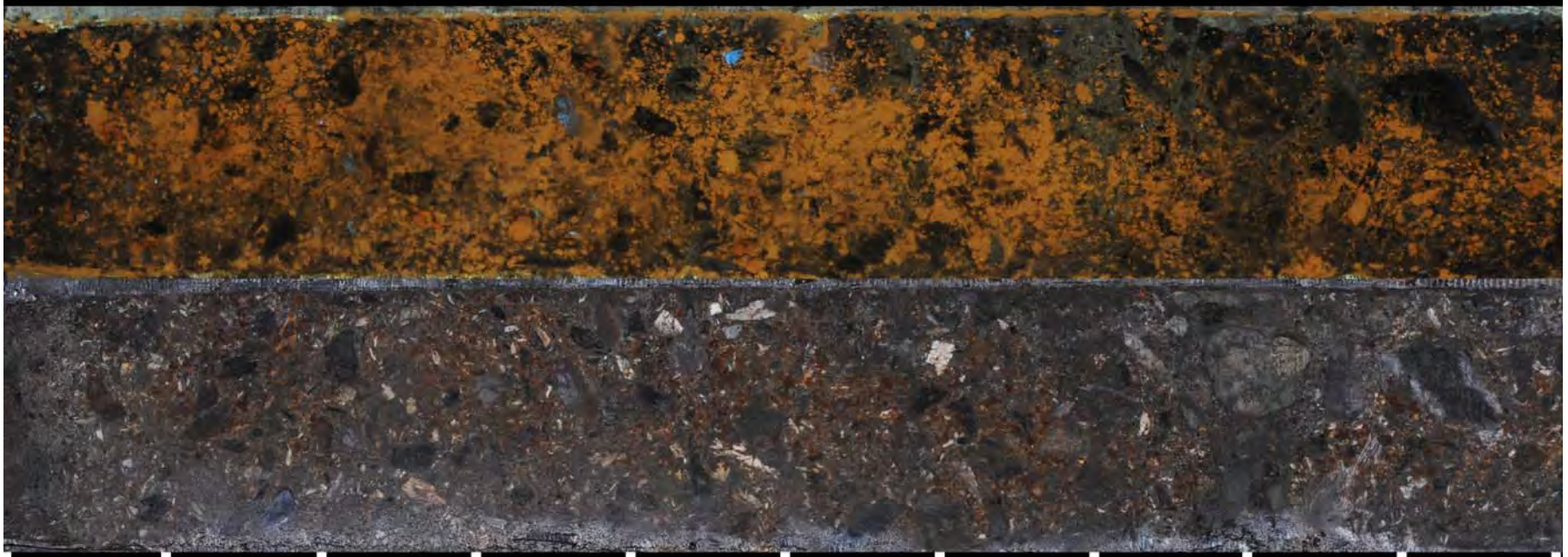
Each Interval Equals One Tenth of a Foot

23.0

Project: North Lake Union-Gas Works Park

Project No.: 0186-846-01 Boring ID: PT02

PTS Laboratories
PTS File No.: 43238



8.0

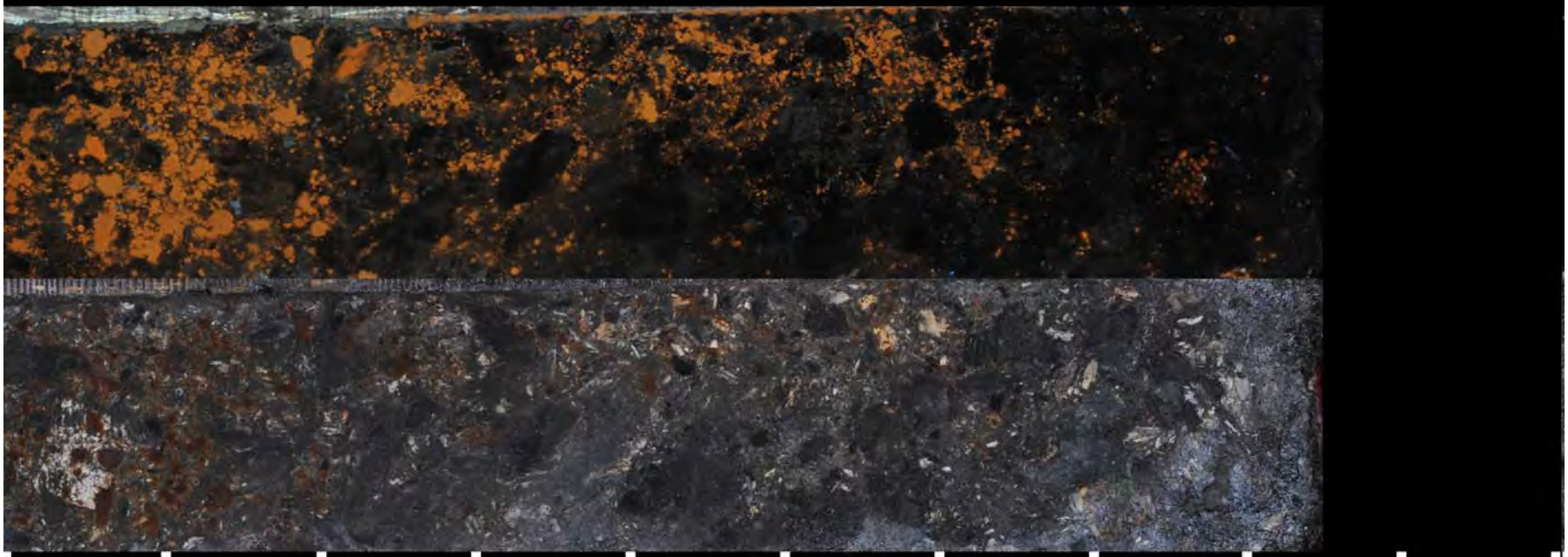
Each Interval Equals One Tenth of a Foot

9.0

Project: North Lake Union-Gas Works Park

Project No.: 0186-846-01 Boring ID: PT03

PTS Laboratories
PTS File No.: 43238



9.0

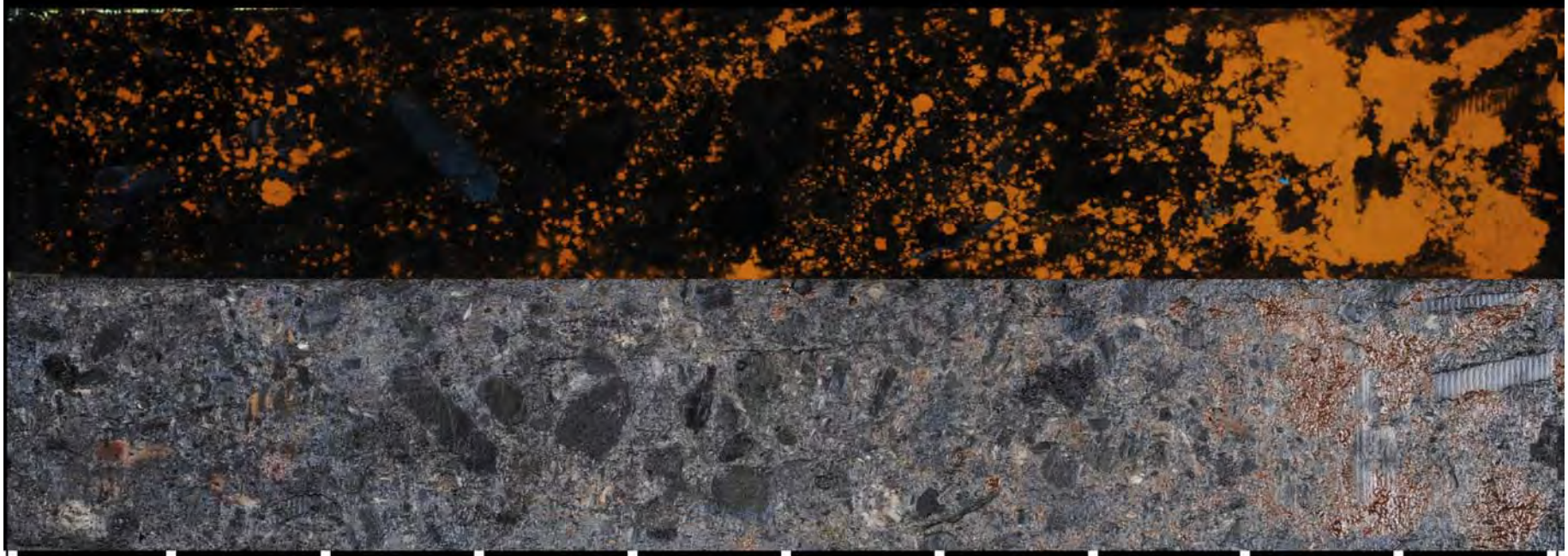
Each Interval Equals One Tenth of a Foot

10.0

Project: North Lake Union-Gas Works Park

Project No.: 0186-846-01 Boring ID: PT03

PTS Laboratories
PTS File No.: 43238



10.0

Each Interval Equals One Tenth of a Foot

11.0

Project: North Lake Union-Gas Works Park

Project No.: 0186-846-01 Boring ID: PT03

PTS Laboratories
PTS File No.: 43238

11.0

Each Interval Equals One Tenth of a Foot

12.0

Project: North Lake Union-Gas Works Park

Project No.: 0186-846-01 Boring ID: PT03

PTS Laboratories
PTS File No.: 43238

12.0

Each Interval Equals One Tenth of a Foot

13.0

Project: North Lake Union-Gas Works Park

Project No.: 0186-846-01 Boring ID: PT03

PTS Laboratories
PTS File No.: 43238

25.0

Each Interval Equals One Tenth of a Foot

26.0

Project: North Lake Union-Gas Works Park

Project No.: 0186-846-01 Boring ID: PT03

PTS Laboratories
PTS File No.: 43238

26.0

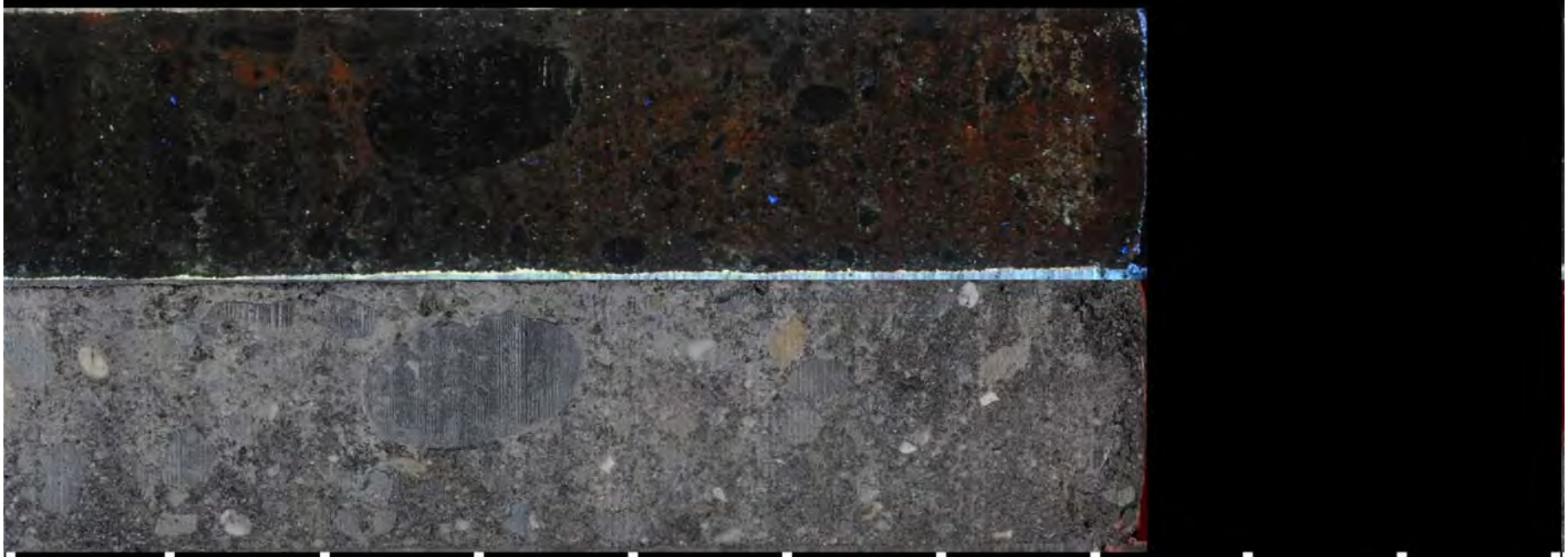
Each Interval Equals One Tenth of a Foot

27.0

Project: North Lake Union-Gas Works Park

Project No.: 0186-846-01 Boring ID: PT03

PTS Laboratories
PTS File No.: 43238



27.0

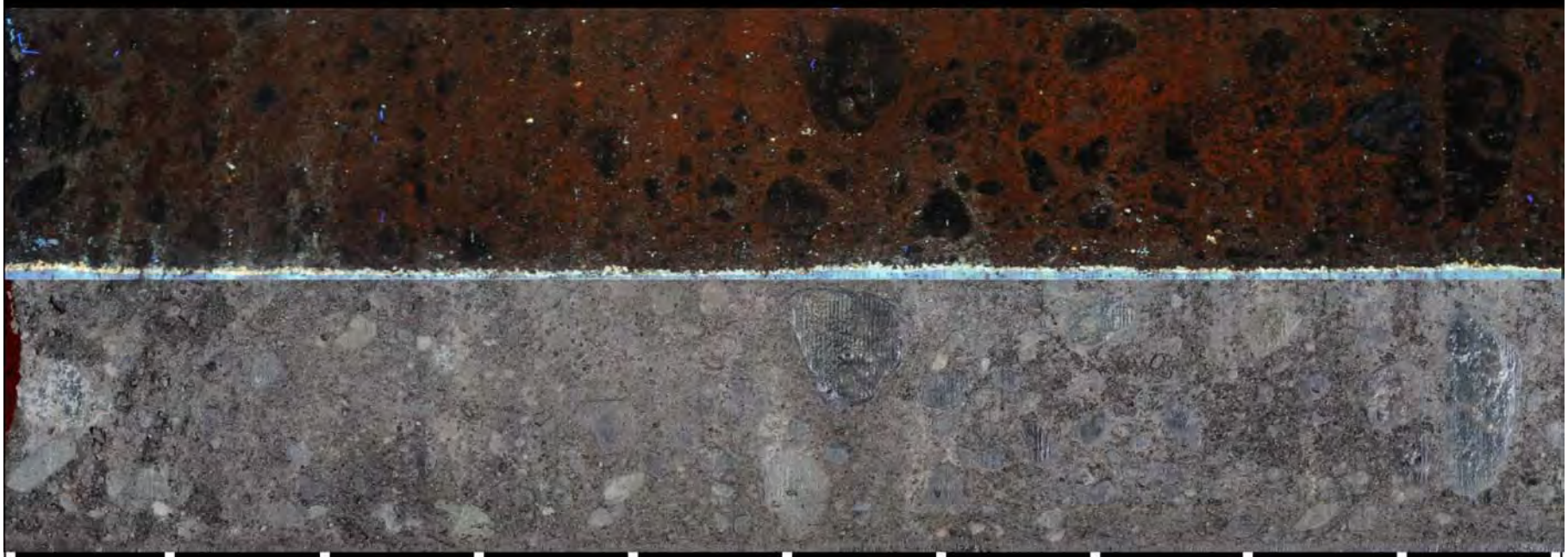
Each Interval Equals One Tenth of a Foot

28.0

Project: North Lake Union-Gas Works Park

Project No.: 0186-846-01 Boring ID: PT03

PTS Laboratories
PTS File No.: 43238



28.0

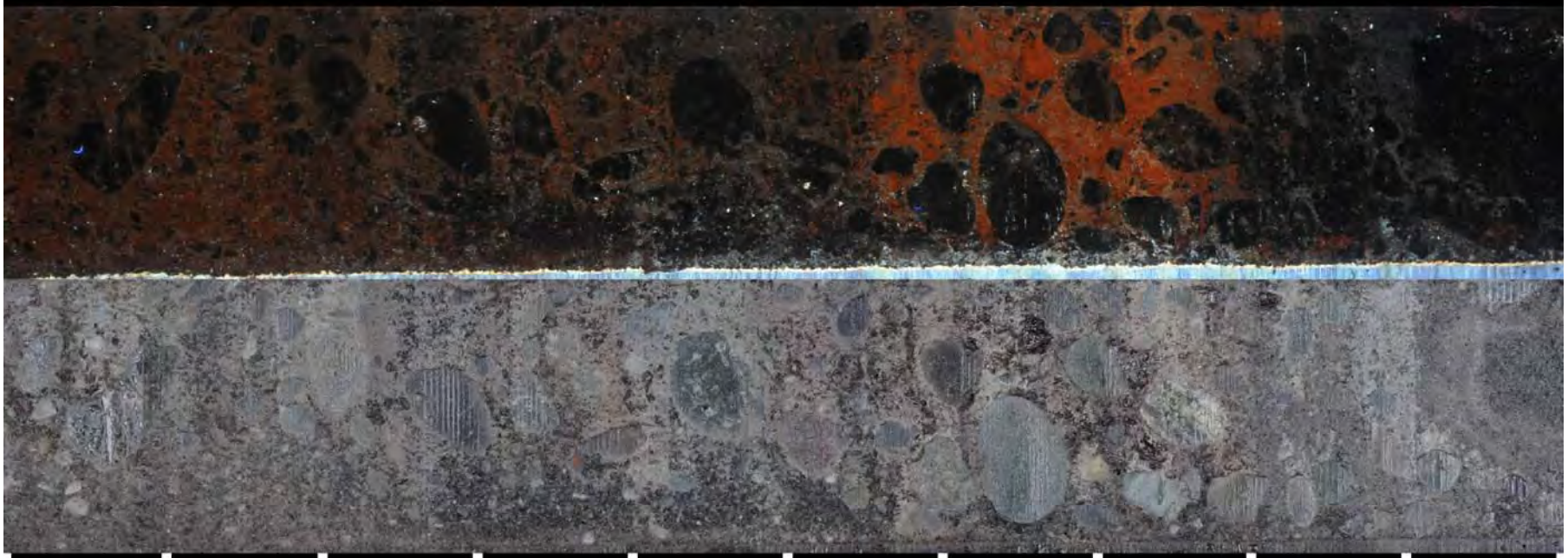
Each Interval Equals One Tenth of a Foot

29.0

Project: North Lake Union-Gas Works Park

Project No.: 0186-846-01 Boring ID: PT03

PTS Laboratories
PTS File No.: 43238



29.0

Each Interval Equals One Tenth of a Foot

30.0

Project: North Lake Union-Gas Works Park

Project No.: 0186-846-01 Boring ID: PT03

SUB-ATTACHMENT 2A-6.2
Petrophysical Data

PTS Laboratories, Inc.

8100 Secura Way • Santa Fe Springs, CA 90670
Telephone (562) 347-2500 • Fax (562) 907-3610

June 28, 2013

Zanna A. Satterwhite
GeoEngineers, Inc.
600 Stewart Street, Suite 1700
Seattle, WA 98101

Re: PTS File No: 43238
Physical Properties Data
North Lake Union-Gas Works Park; 0186-846-01

Dear Ms. Satterwhite:

Please find enclosed report for Physical Properties analyses conducted upon samples received from your North Lake Union-Gas Works Park; 0186-846-01 project. All analyses were performed by applicable ASTM, EPA, or API methodologies. Electronic versions of the core images and physical properties report have been uploaded to PTS Laboratories website, www.ptslabs.com. The cores remain in frozen storage and will be held indefinitely. Please note that core storage will be billed quarterly beginning September 1, 2013.

PTS Laboratories appreciates the opportunity to be of service. If you have any questions or require additional information, please contact Rachel Spitz at (562) 347-2504.

Sincerely,
PTS Laboratories

for Rachel Spitz

Michael Mark Brady, P.G.
District Manager

Encl.

PTS Laboratories

Project Name: North Lake Union-Gas Works Park
Project Number: 0186-846-01

PTS File No: 43238
Client: GeoEngineers, Inc.

TEST PROGRAM - 20130530

CORE ID	Depth ft.	Core Recovery ft.	Slab and Core Photo	*Free Product Mobility	*Free Product Mobility Under Water	Modified Free Product Mobility	Viscosity/ Density at 70ºF	Viscosity/ Density at 70ºF	Notes
Method:		**Plugs:**	1/4:3/4	Hor. 1.5"	Hor. 1.5"	Hor. 1.5"	ASTM D1481, D445	ASTM D1481, D445	Keep core frozen
Date Received: 20130424									
MW09-130415-LNAPL	**N/A**	**N/A**					**X**		200 mL LNAPL
MW09-130415-DNAPL	**N/A**	**N/A**						**X**	200 mL DNAPL
DW07-130415-DNAPL	**N/A**	**N/A**						**X**	200 mL DNAPL
DW04-130415-DNAPL	**N/A**	**N/A**							200 mL DNAPL HOLD
DW05-130415-DNAPL	**N/A**	**N/A**							200 mL DNAPL HOLD
PZ03-130417-DNAPL	**N/A**	**N/A**						**X**	200 mL DNAPL
MW18-130422-DNAPL	**N/A**	**N/A**						**X**	200 mL DNAPL
MW03-130419	**N/A**	**N/A**							2400 mL Water for FPM
PT01B-11-13.2A	**11-13.2**	**2.25**	**2**	**12.9**				Photograph 2 feet that appear most impacted	
PT02-8-10A	**8.7-10**	**1.30**	**2**						
PT02-10-13B	**10-13**	**2.85**	**3**		**11.8**				
PT02-20-23	**20-23**	**2.85**	**3**		**21.45**				
PT01-20-21.1A	**20-21.1**	**0.85**	**1**						Photograph lower foot
PT01-21.1-22B	**21.1-22**	**0.75**	**1**		**21.2**				
PT03-8-10A	**8-10**	**1.85**	**2**	**8.55**					Only photograph 8-10'
PT03-10-13B	**10-13**	**2.80**	**3**		**10.85**				No top or bottom labeled
PT03-25-28A	**25-28**	**2.70**	**3**						
PT03-28-30B	**28-30**	**2.00**	**2**		**29.7**				Photograph upper 2 feet
PT01-22-25C	**22-25**	**2.70**	**3**						
TOTALS:	**13 jars 11 cores**	**22.90**	**25**	**2**	**5**	**0**	**1**	**5**	**25**

Laboratory Test Program Notes

Contaminant identification: **Possible BTEX, PAH, & Arsenic**

Sample locations to be selected by GeoEngineers, Inc. personnel from core photography.

Standard TAT for basic analysis is 10 business days. Advanced tests require additional time.

*Free Product Mobility (Stepped): 250RPM, 500RPM, and 1000RPM.

Modified Free Product Mobility: Apply centrifugal force at 1000xG for one hour. Submit centrifuged sample to analytical laboratory selected by GeoEngineers, Inc.

Shipping not included.

Please contact laboratory if you would like the "HOLD" samples retained longer than 30 days.

PTS File No: 43238
Client: GeoEngineers, Inc.

PTS Laboratories

STEPPED FREE PRODUCT MOBILITY: INITIAL AND RESIDUAL SATURATIONS

(Centrifugal method: samples spun under air, stepped pressures.)

PROJECT NAME: North Lake Union-Gas Works Park
PROJECT NO: 0186-846-01

		METHODS:	API RP 40		API RP 40		ASTM D425M, DEAN-STARK			
							PORE FLUID SATURATIONS, % Pv			
			DENSITY				Initial Fluid Saturations		After Centrifuging	
SAMPLE ID.	DEPTH, ft.	SAMPLE ORIENTATION (1)	DRY BULK, g/cc	GRAIN, g/cc	TOTAL POROSITY, %Vb	APPLIED FORCE, RPM or xG	WATER (Swi) SATURATION	NAPL (Soi) SATURATION	WATER (Srw) SATURATION	NAPL (Sor) SATURATION
PT01B-11-13.2A	12.9	H	0.65	1.87	65.1	250 RPM	80.6	6.8	75.5	6.8
NOTE: No visible NAPL produced. Produced water cloudy with strong hydrocarbon odor.										
						500 RPM	75.5	6.8	30.9	6.8
NOTE: No visible NAPL produced. Produced water slightly cloudy with strong hydrocarbon odor.										
						1000 RPM	30.9	6.8	23.2	6.7
NOTE: Trace NAPL produced. Produced water slightly cloudy.										
PT03-8-10A	8.55	H	0.85	2.46	65.4	250 RPM	78.2	8.4	76.8	8.4
NOTE: No visible NAPL produced. Produced water clear with moderate hydrocarbon odor.										
						500 RPM	76.8	8.4	57.1	8.4
NOTE: No visible NAPL produced. Produced water slightly cloudy, yellow tint, and moderate hydrocarbon odor.										
						1000 RPM	57.1	8.4	43.3	8.4
NOTE: No visible NAPL produced. Produced water slightly cloudy, yellow tint, and moderate hydrocarbon odor.										

N/A = Not Analyzed. Vb = Bulk Volume, Pv = Pore Volume. (1) H = horizontal, V = vertical, R = remold
Soi = Initial NAPL Saturation as received prior to centrifuging at 1000xG, Swi = Initial Water Saturation as received prior to centrifuging at 1000xG
Sor = Residual NAPL Saturation after centrifuging at 1000xG, Srw = Residual Water Saturation after centrifuging at 1000xG
Water =0.9996 g/cc, NAPL = 0.9193 g/cc.

PTS File No: 43238
Client: GeoEngineers, Inc.

PTS Laboratories

FREE PRODUCT MOBILITY: INITIAL AND RESIDUAL SATURATIONS

(Samples spun under water, stepped pressures.)

PROJECT NAME: North Lake Union-Gas Works Park
PROJECT NO: 0186-846-01

		METHODS:	API RP 40		API RP 40		ASTM D425M, DEAN-STARK			
							PORE FLUID SATURATIONS, % Pv			
		SAMPLE	DENSITY		TOTAL	APPLIED	Initial Fluid Saturations		After Centrifuging	
SAMPLE ID.	DEPTH, ft.	ORIENTATION (1)	DRY BULK, g/cc	GRAIN, g/cc	POROSITY, %Vb	FORCE, RPM or xG	WATER (Swi) SATURATION	NAPL (Soi) SATURATION	WATER (Srw) SATURATION	NAPL (Sor) SATURATION
PT02-10-13B	11.8	H	0.44	2.00	77.8	250 RPM	47.6	46.6	49.5	46.6
NOTE: No visible NAPL produced. Produced water clear with strong hydrocarbon odor.										
						500 RPM	49.5	46.6	50.0	46.6
NOTE: No visible NAPL produced. Produced water clear with strong hydrocarbon odor.										
						1000 RPM	50.0	46.6	50.6	46.6
NOTE: No visible NAPL produced. Produced water clear with strong hydrocarbon odor.										
PT02-20-23	21.45	H	0.75	2.10	64.4	250 RPM	69.6	19.6	73.8	19.6
NOTE: No visible NAPL produced. Produced water clear with moderate hydrocarbon odor. Fines produced.										
						500 RPM	73.8	19.6	74.0	19.6
NOTE: No visible NAPL produced. Produced water clear with moderate hydrocarbon odor. Fines produced.										
						1000 RPM	74.0	19.6	74.4	19.6
NOTE: No visible NAPL produced. Produced water clear with moderate hydrocarbon odor. Fines produced.										
PT01-21.1-22B	21.2	H	1.69	2.70	37.2	250 RPM	70.9	10.3	75.3	10.3
NOTE: No visible NAPL produced. Produced water cloudy with moderate hydrocarbon odor. Fines produced.										
						500 RPM	75.3	10.3	75.3	10.3
NOTE: No visible NAPL produced. Produced water cloudy with moderate hydrocarbon odor. Fines produced.										
						1000 RPM	75.3	10.3	75.3	10.3
NOTE: No visible NAPL produced. Produced water cloudy with moderate hydrocarbon odor. Fines produced.										

N/A = Not Analyzed. Vb = Bulk Volume, Pv = Pore Volume. (1) H = horizontal, V = vertical, R = remold
Soi = Initial NAPL Saturation as received prior to centrifuging, Swi = Initial Water Saturation as received prior to centrifuging
Sor = Residual NAPL Saturation after centrifuging, Srw = Residual Water Saturation after centrifuging
Water =0.9996 g/cc, NAPL = 0.9193 g/cc.

PTS File No: 43238
Client: GeoEngineers, Inc.

PTS Laboratories

FREE PRODUCT MOBILITY: INITIAL AND RESIDUAL SATURATIONS

(Samples spun under water, stepped pressures.)

PROJECT NAME: North Lake Union-Gas Works Park
PROJECT NO: 0186-846-01

		METHODS:	API RP 40		API RP 40		ASTM D425M, DEAN-STARK			
							PORE FLUID SATURATIONS, % Pv			
		SAMPLE	DENSITY		TOTAL	APPLIED	Initial Fluid Saturations		After Centrifuging	
SAMPLE ID.	DEPTH, ft.	ORIENTATION (1)	DRY BULK, g/cc	GRAIN, g/cc	POROSITY, %Vb	FORCE, RPM or xG	WATER (Swi) SATURATION	NAPL (Soi) SATURATION	WATER (Srw) SATURATION	NAPL (Sor) SATURATION
PT03-10-13B	10.85	H	0.65	2.43	73.2	250 RPM	66.3	14.5	66.3	14.5
NOTE: No visible NAPL produced. Produced water clear with strong hydrocarbon odor. Fines produced.										
						500 RPM	66.3	14.5	66.3	14.5
NOTE: No visible NAPL produced. Produced water clear with moderate hydrocarbon odor. Fines produced.										
						1000 RPM	66.3	14.5	66.3	14.5
NOTE: No visible NAPL produced. Produced water clear with faint-moderate hydrocarbon odor. Fines produced. Sample compressed slightly from confining pressure.										
PT03-28-30B	29.7	H	1.90	2.73	30.1	250 RPM	57.3	13.8	65.0	13.8
NOTE: No visible NAPL produced. Produced water clear with strong hydrocarbon odor. Fines produced.										
						500 RPM	65.0	13.8	65.0	13.8
NOTE: No visible NAPL produced. Produced water clear with moderate hydrocarbon odor. Fines produced.										
						1000 RPM	65.0	13.8	65.0	13.8
NOTE: No visible NAPL produced. Produced water clear with moderate hydrocarbon odor. Fines produced.										

N/A = Not Analyzed. Vb = Bulk Volume, Pv = Pore Volume. (1) H = horizontal, V = vertical, R = remold
Soi = Initial NAPL Saturation as received prior to centrifuging, Swi = Initial Water Saturation as received prior to centrifuging
Sor = Residual NAPL Saturation after centrifuging, Srw = Residual Water Saturation after centrifuging
Water =0.9996 g/cc, NAPL = 0.9193 g/cc.

PTS File No: 43238
Client: GeoEngineers, Inc.

PTS Laboratories

VISCOSITY, DENSITY, and SPECIFIC GRAVITY DATA

(METHODOLOGY: ASTM D445, ASTM D1481, API RP40)

PROJECT NAME: North Lake Union-Gas Works Park
PROJECT NO: 0186-846-01

SAMPLE ID	MATRIX	TEMPERATURE, °F	SPECIFIC GRAVITY	DENSITY, g/cc	VISCOSITY	
					centistokes	centipoise
MW09-130415-LNAPL	NAPL	70	0.9212	0.9193	14.6	13.4

PTS File No: 43238
Client: GeoEngineers, Inc.

PTS Laboratories

VISCOSITY, DENSITY, and SPECIFIC GRAVITY DATA

(METHODOLOGY: ASTM D445, ASTM D1481, API RP40)

PROJECT NAME: North Lake Union-Gas Works Park
PROJECT NO: 0186-846-01

SAMPLE ID	MATRIX	TEMPERATURE, °F	SPECIFIC GRAVITY	DENSITY, g/cc	VISCOSITY	
					centistokes	centipoise
MW09-130415-DNAPL	NAPL	70	1.019	1.017	22.2	22.6
DW07-130415-DNAPL	NAPL	70	1.081	1.079	46.0	49.6
PZ03-130417-DNAPL	NAPL	70	1.082	1.080	685	740
MW18-130422-DNAPL	NAPL	70	1.109	1.107	1129	1250

PTS Laboratories, Inc.

CHAIN OF CUSTODY RECORD

PAGE 1 OF 1

COMPANY	GeoEngineers
ADDRESS	600 Stewart St Suite 1700
CITY	Seattle
ZIP CODE	98101
PROJECT MANAGER	Zanna Satterwhite
PROJECT NAME	GWP
PHONE NUMBER	2067282674
PROJECT NUMBER	0186-846-01
FAX NUMBER	2067282752
SITE LOCATION	GWP-Seattle
SAMPLER SIGNATURE	

ANALYSIS REQUEST

PO#

TURNAROUND TIME
24 HOURS ☐ 5 DAYS ☐
48 HOURS ☐ NORMAL ☒
72 HOURS ☐
OTHER: _____

SAMPLE INTEGRITY (CHECK):
INTACT ____ ON ICE ____

PTS QUOTE NO.: Q13-063

PTS FILE: 43238

SAMPLE ID NUMBER	DATE	TIME	DEPTH, FT	NUMBER OF SAMPLES	SOIL PROPERTIES PACKAGE	HYDRAULIC CONDUCTIVITY PACKAGE	PORE FLUID SATURATIONS PACKAGE	TCEQ/TNRCC PROPERTIES PACKAGE	CAPILLARITY PACKAGE	FLUID PROPERTIES PACKAGE	PHOTOLOG: CORE PHOTOGRAPHY	MOISTURE CONTENT, ASTM D2216	POROSITY: TOTAL, API RP40	POROSITY: EFFECTIVE, ASTM D425M	SPECIFIC GRAVITY, ASTM D854	BULK DENSITY (DRY), API RP40 or ASTM D2937	AIR PERMEABILITY, API RP40	HYDRAULIC CONDUCTIVITY, EPA9100, API RP40, D5084	GRAIN SIZE DISTRIBUTION, ASTM D422/4464M	TOC: WALKLEY-BLACK	ATTERBERG LIMITS, ASTM D4318	Moisture/Density ASTM D4945				COMMENTS
MW09-130415-LDAPL	4/15	845		1																	X				
MW09-130415-DDAPL	4/15	910		1																	X				
DW07-130415-DDAPL	4/15	1240		1																	X				
DW04-130415-DDAPL	4/15	1325		1																					* HOLD
DW05-130415-DDAPL	4/15	1340		1																					* HOLD
PZ03-130417-DDAPL	4/17	1537		1																	X				
MW18-130422-DDAPL	4/22	930		1																	X				
MW03-130419e	4/19	940		6			/																		for Free Product mobility
			6.5 ft																						

1. RELINQUISHED BY	2. RECEIVED BY	3. RELINQUISHED BY	4. RECEIVED BY
COMPANY: GeoEngineers	COMPANY: PTS LABS	COMPANY:	COMPANY:
DATE: 4/22 TIME: 1255	DATE: 4/24/13 TIME: 10:35	DATE: TIME:	DATE: TIME:

PTS Laboratories, Inc.

CHAIN OF CUSTODY RECORD

PAGE 1 OF 1

COMPANY	GeoEngineers
ADDRESS	600 Stewart Suite 1700
CITY	Seattle
ZIP CODE	98101
PROJECT MANAGER	Zanna Satterwhite
PROJECT NAME	GWP
PHONE NUMBER	(206) 7282674
PROJECT NUMBER	0186-846-01
FAX NUMBER	(206) 7282732
SITE LOCATION	GWP-Seattle
SAMPLER SIGNATURE	

PO#

TURNAROUND TIME
24 HOURS ☐ 5 DAYS ☐
48 HOURS ☐ NORMAL ☒
72 HOURS ☐
OTHER: _____

SAMPLE INTEGRITY (CHECK):
INTACT ____ ON ICE ____

PTS QUOTE NO.: Q13-063

PTS FILE: 43238

ANALYSIS REQUEST

SAMPLE ID NUMBER	DATE	TIME	DEPTH, FT	NUMBER OF SAMPLES	SOIL PROPERTIES PACKAGE	HYDRAULIC CONDUCTIVITY PACKAGE	PORE FLUID SATURATIONS PACKAGE	TCEQ/TNRCC PROPERTIES PACKAGE	CAPILLARITY PACKAGE	FLUID PROPERTIES PACKAGE	PHOTOLOG: CORE PHOTOGRAPHY	MOISTURE CONTENT, ASTM D2216	POROSITY: TOTAL, API RP40	POROSITY: EFFECTIVE, ASTM D425M	SPECIFIC GRAVITY, ASTM D854	BULK DENSITY (DRY), API RP40 or ASTM D2937	AIR PERMEABILITY, API RP40	HYDRAULIC CONDUCTIVITY, EPA9100, API RP40, D5084	GRAIN SIZE DISTRIBUTION, ASTM D422/4464M	TOC: WALKLEY-BLACK	ATTERBERG LIMITS, ASTM D4318	UV Photography	COMMENTS
PTØ1B-11-13.2A	4/17	1122	11 - 13.2	1																		
PTØ2-8-10A	4/17	1348	8-10	1																		
PTØ2-10-13B	4/17	1348	10-13	1																		
~~PTØ2-18-20A~~	~~4/17~~	~~1420~~	~~18-20~~	~~1~~																		
PTØ2-20-23	4/17	1420	20-23	1																		
PTØ1-20-21.1A	4/17	1028	20-21.1	1																		
PTØ1-21.1-22B	4/17	1028	21.1-22	1																		
PTØ3-8-10A	4/18	1015	8-10	1																		
PTØ3-10-13B	4/18	1015	10-13	1																		
PTØ3-25-28A	4/18	1100	25-28	1																		
PTØ3-28-30B	4/18	1100	28-30	1																		

1. RELINQUISHED BY	2. RECEIVED BY	3. RELINQUISHED BY	4. RECEIVED BY
COMPANY: GeoEngineers	COMPANY: PTS CARS	COMPANY	COMPANY
DATE: 4/22 TIME: 1250	DATE: 4/24/13 TIME: 10:35	DATE TIME	DATE TIME

-14.3 °F

PTS Laboratories, Inc.

CHAIN OF CUSTODY RECORD

PAGE 2 OF 2

COMPANY: GEOENGINEERS

ADDRESS | CITY | ZIP CODE

PROJECT MANAGER

PROJECT NAME | PHONE NUMBER

PROJECT NUMBER | FAX NUMBER

SITE LOCATION

SAMPLER SIGNATURE

PO#

TURNAROUND TIME
24 HOURS ☐ 5 DAYS ☐
48 HOURS ☐ NORMAL ☐
72 HOURS ☐
OTHER: _____

SAMPLE INTEGRITY (CHECK):
INTACT ____ ON ICE ____

PTS QUOTE NO.

PTS FILE: 43238

ANALYSIS REQUEST

SAMPLE ID NUMBER	DATE	TIME	DEPTH, FT	NUMBER OF SAMPLES	SOIL PROPERTIES PACKAGE	HYDRAULIC CONDUCTIVITY PACKAGE	PORE FLUID SATURATIONS PACKAGE	TCEQ/TNRCC PROPERTIES PACKAGE	CAPILLARITY PACKAGE	FLUID PROPERTIES PACKAGE	PHOTOLOG: CORE PHOTOGRAPHY	MOISTURE CONTENT, ASTM D2216	POROSITY: TOTAL, API RP40	POROSITY: EFFECTIVE, ASTM D425M	SPECIFIC GRAVITY, ASTM D854	BULK DENSITY (DRY), API RP40 or ASTM D2937	AIR PERMEABILITY, API RP40	HYDRAULIC CONDUCTIVITY, EPA9100, API RP40, D5084	GRAIN SIZE DISTRIBUTION, ASTM D422/4464M	TOC: WALKLEY-BLACK	ATTERBERG LIMITS, ASTM D4318	UV Photography	COMMENTS
PT01-22-25C	4/17	1028	22-25																			

1. RELINQUISHED BY	2. RECEIVED BY	3. RELINQUISHED BY	4. RECEIVED BY
COMPANY: GeoEngineers	COMPANY: PTS LABS	COMPANY	COMPANY
DATE: 4/22 TIME: 1250	DATE: 4/24/13 TIME: 10:35	DATE TIME	DATE TIME

-14.3°F

ATTACHMENT 2A-7
SI Slug Testing

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ATTACHMENT 2A-7
SLUG TESTING

1.0 INTRODUCTION

Slug testing was performed on seven wells at the Site between April 24 and 25, 2013. The purpose of the slug testing was to evaluate the hydraulic conductivity (*K*) within a subset of wells installed along the shoreline during the 2013 Supplemental Investigation (SI). The wells tested were MW-32S, MW-32D, MW-33S, MW-36S, MW-36D, MW-39S and MW-39D, and consisted of both shallow- ("S") and deep- ("D") screened wells. Groundwater levels were measured as hydrostatic pressures during testing by using a submerged 15-pounds per square inch (psi) INW PT2X vented pressure transducer and combined datalogger. Hydraulic conductivity was calculated using the Bouwer and Rice (1976) method or the Butler and Garnett (2000) method. Plots of the slug test response and type curves analyzed are presented in Figures 2A-7-1 through 2A-7-7. Table 2A-7-1 shows interpreted hydraulic conductivity values.

2.0 FIELD PROCEDURES

Prior to slug testing, the pre-test static water level was measured in each well using a decontaminated interface probe/water-level tape to measure depth to water from a surveyed reference mark at the top of the well casing. The pressure transducer/datalogger was programmed to record hydrostatic submergence pressure eight times per second, supplemented with manual electronic water-level meter readings before, during and after each slug test.

Each slug test was performed in two stages, resulting in a falling-head stage, followed by a rising-head stage:

1. A slug (weighted 5-foot length of sealed polyvinyl chloride [PVC] casing) of known volume was rapidly lowered into the well, causing displacement of the water level above its initial level. The water level in the well was monitored until it returned (fell) to the approximate pre-test water level. This part of the test is known as the falling-head stage.
2. The slug was then rapidly removed from the well, causing the water level to fall below its initial level. The water level in the well was then monitored until it returned (rose) to the approximate pre-test water level. This part of the test is known as the rising-head stage.

3.0 DATA ANALYSIS

After the sensor data were downloaded and processed using spreadsheet software, the hydraulic response was evaluated to determine the appropriate analytical method. In soils of moderate to low permeability, the recovery of the water level (rising or falling) back to its initial level is usually in the form of a monotonic trend, as seen in the slug test response from well MW-32S (Figure 2A-7-1). This type of hydraulic response has been classified as "overdamped" in the technical literature (Butler and Garnett 2000). In higher-permeability soils, where much rapid rates of recovery are possible, the response is classified as "underdamped."

Hydraulic response to slug testing in wells MW-36S and MW-39S exhibited an underdamped response, which is typically observed as decaying oscillations in water level following insertion or removal of the slug (Neville 2011), rather than the monotonic response. This type of response is typically due to high hydraulic conductivity of the aquifer in the vicinity of the well. Data from wells exhibiting this type of response were analyzed using a high-conductivity analytical method for slug tests developed by Butler and Garnett (2000). The authors developed their analytical method based on the work of Van Der Kamp (1976) and Kipp (1985), refining the method to be applicable to wells that do not penetrate the entire thickness of the aquifer. The Butler and Garnett (2000) method is widely used in slug test data analysis and can be applied to data from both confined and unconfined aquifers. Slug test data from all wells were analyzed assuming unconfined aquifer conditions.

The falling-head test data were not analyzed in wells where the water table occurred within the screened interval (i.e., in wells MW-33S and MW-39S). This is the case because the falling-head response may have been affected by partial well water drainage into the vadose zone. In each of these instances, the falling-head response occurs faster than the rising-head response. Therefore, only the rising head test data were used to calculate the hydraulic conductivity at these locations.

4.0 REFERENCES

Bouwer, H., and R.C. Rice. 1976. "A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells." *Water Resources Research* 12 (3):5.

Butler, J.J., and E.J. Garnett. 2000. Simple Procedures for Analysis of Slug Tests in Formations of High Hydraulic Conductivity Using Spreadsheet and Scientific Graphics Software. Kansas Geological Survey Open-File Rept. 2000-40.

Kipp. 1985. "Type Curve Analysis of Inertial Effects in the Response of a Well to a Slug Test." *Water Resources Research* 21 (9):12.

Neville, C.J. 2011. "Critical Thinking in Aquifer Test Interpretation." Presented in Conjunction with the 8th Washington Hydrogeology Symposium, Tacoma, Washington, April 28, 2011.

VanDerKamp, G. 1976. "Determining Aquifer Transmissivity by Means of Well Response Tests: The Underdamped Case." *Water Resources Research* 12 (1):6.

Table 2A-7-1

Hydraulic Conductivity Values

Gas Works Park Site

Seattle, Washington

Well	Hydraulic Conductivity (K, cm/sec)	Well Screened Interval (ft bgs)	Hydrogeologic Unit
MW-32S	7.15E-03	16.5 - 31	Fill
MW-32D/GEO-1	7.00E-04	42 - 46.8	Qva/Qpgt
MW-33S(b)	1.40E-02	13.1 - 22	Fill/Qvr
MW-36S	1.82E-02	8 - 22.8	Fill
MW-36D	9.35E-05	29.3 - 33.8	Qvr/Qpgt
MW-39S	4.05E-02	3.9 - 14	Fill/Qva
MW-39D	7.00E-04	17.1 - 21.8	Qva/Qpgt
Mean	**1.16E-02**	--	--
Standard Deviation	**1.46E-02**	--	--

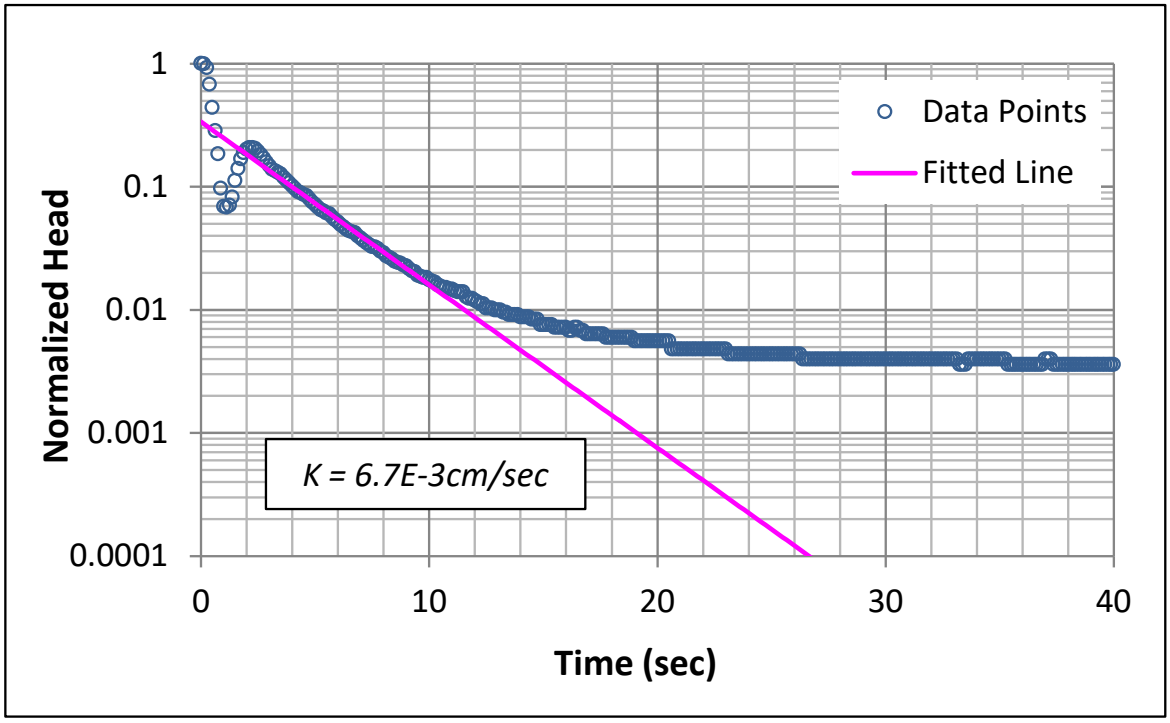
Notes:

cm/sec = centimeters per second

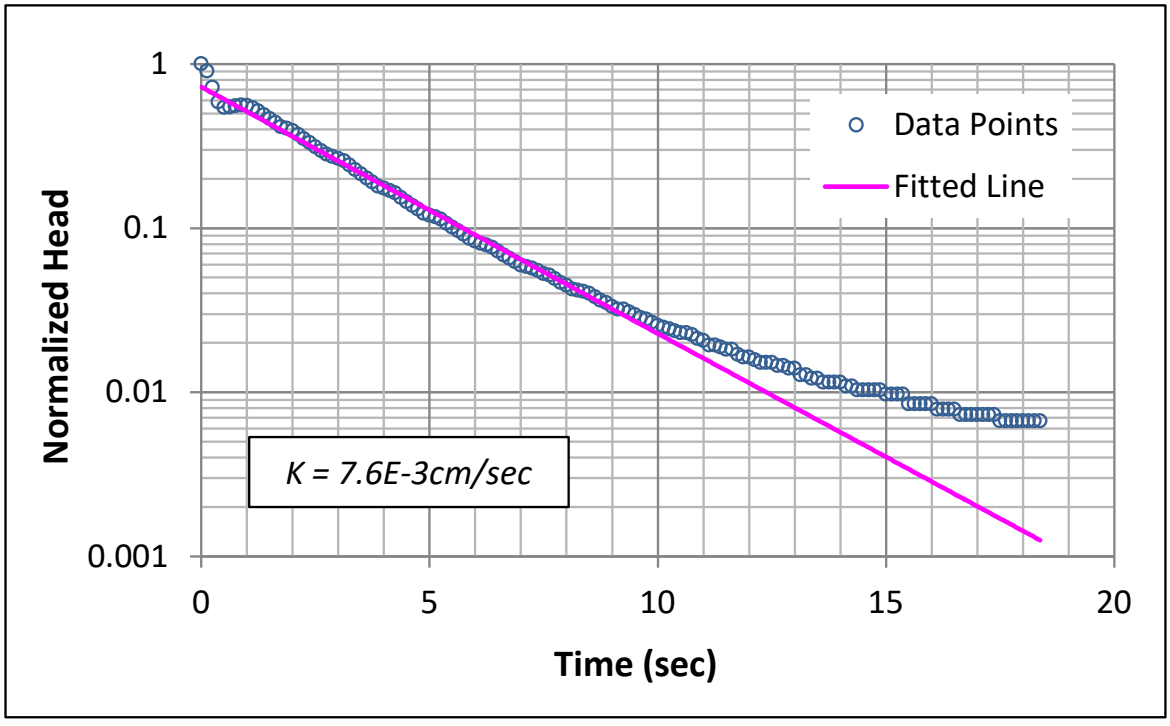
Hydraulic conductivity was estimated using the Bouwer and Rice (1976) method or the Butler and Garnett (2000) method.

Falling head data were not analyzed in wells MW-33S and MW-39S because the water table occurred within the screened interval.

Falling Head



Rising Head



Notes:

1. Slug Test conducted in Monitoring Well MW-32S on April 25, 2013.
2. Overdamped slug test response analyzed using Bouwer & Rice (1976) method.

Aquifer Slug Test, MW-32S

Gas Works Park Site
Seattle, Washington

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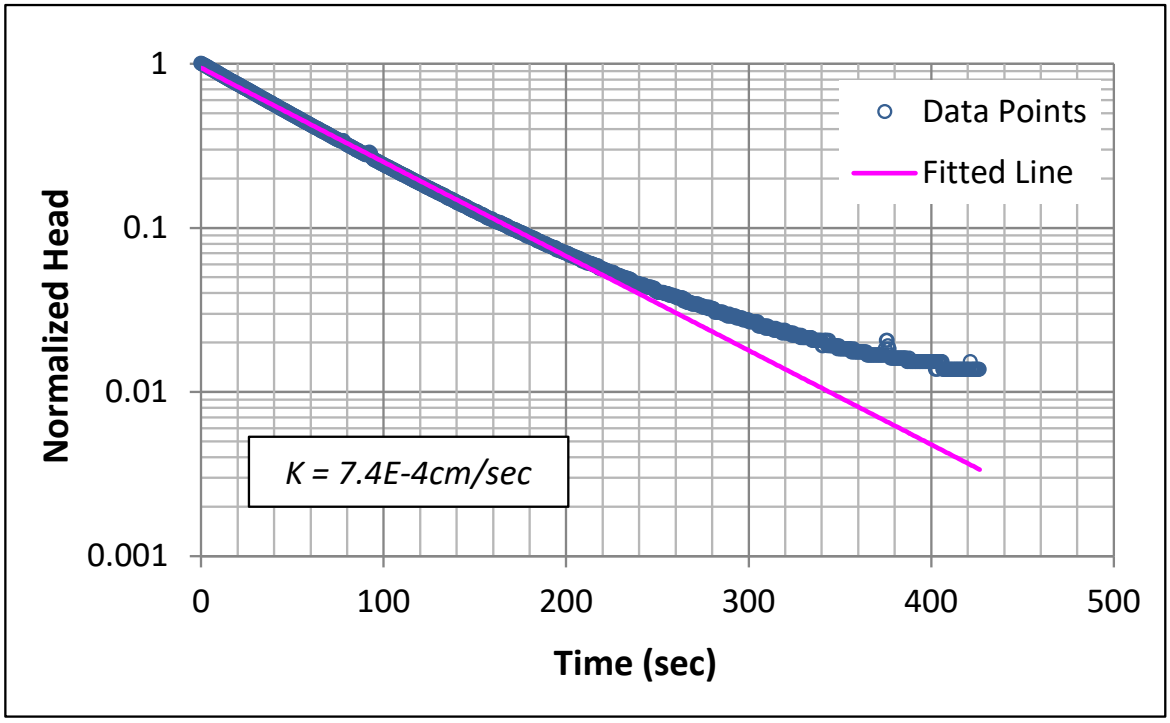
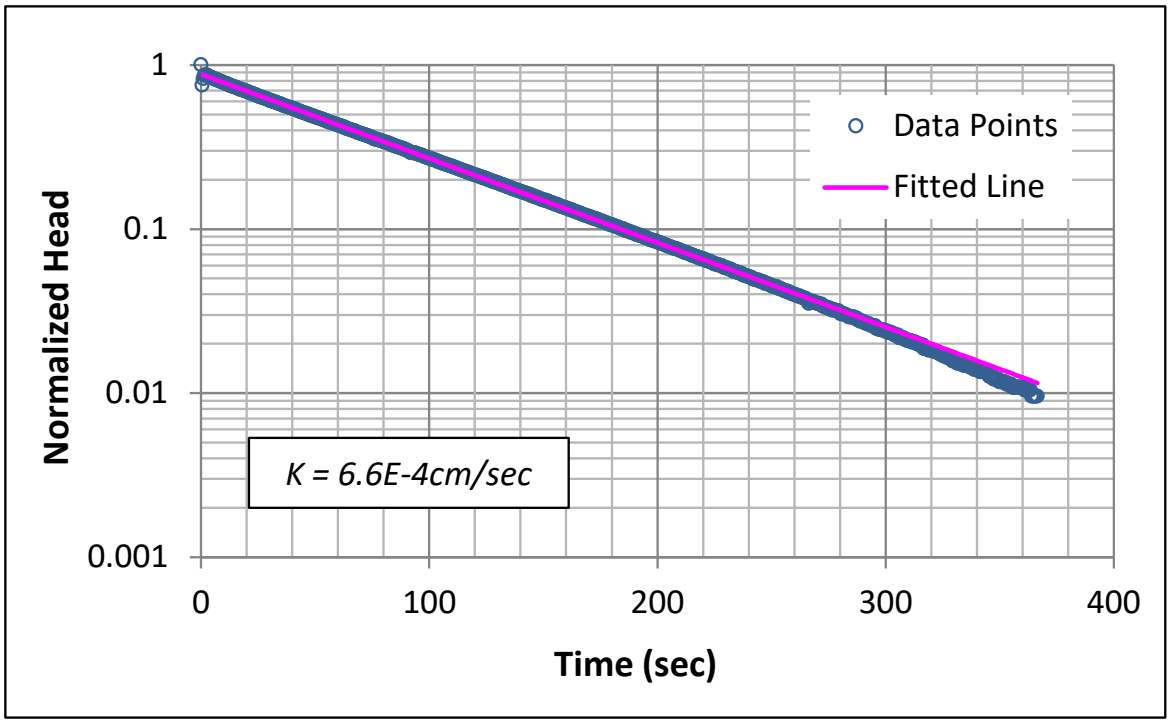
Figure 2A-7-1

Falling Head



Rising Head



Notes:

1. Slug Test conducted in Monitoring Well MW-32D on April 25, 2013.
2. Overdamped slug test response analyzed using Bouwer & Rice (1976) method.

Aquifer Slug Test, MW-32D

Gas Works Park Site
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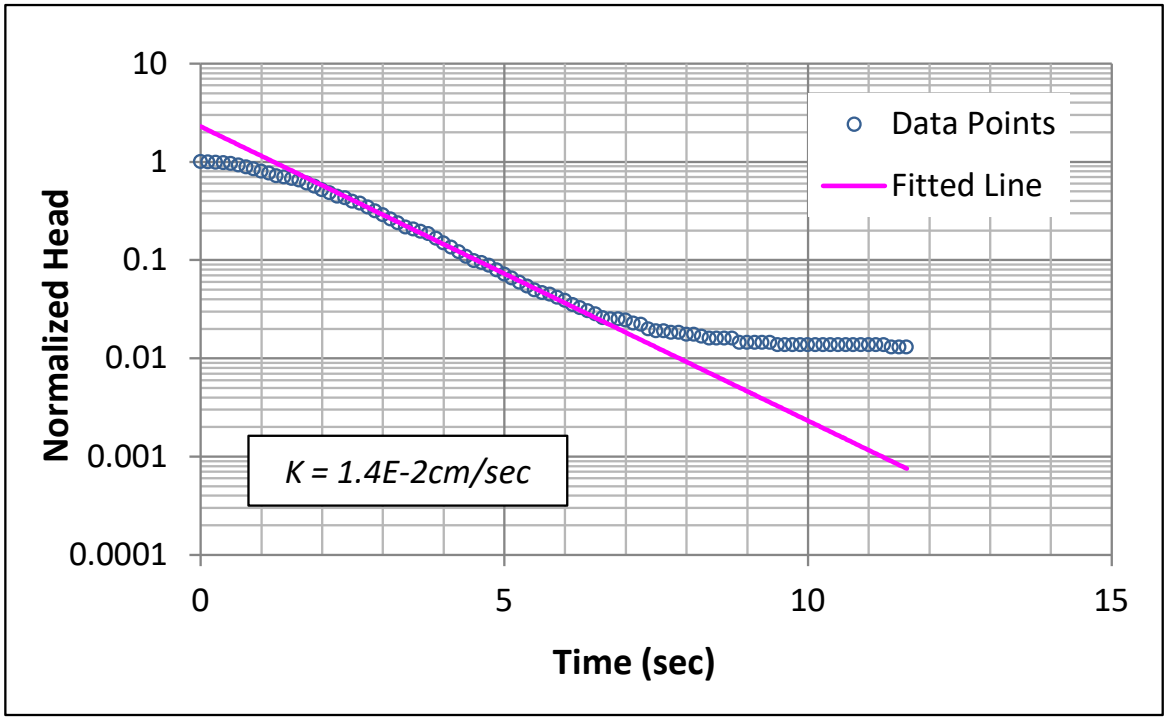
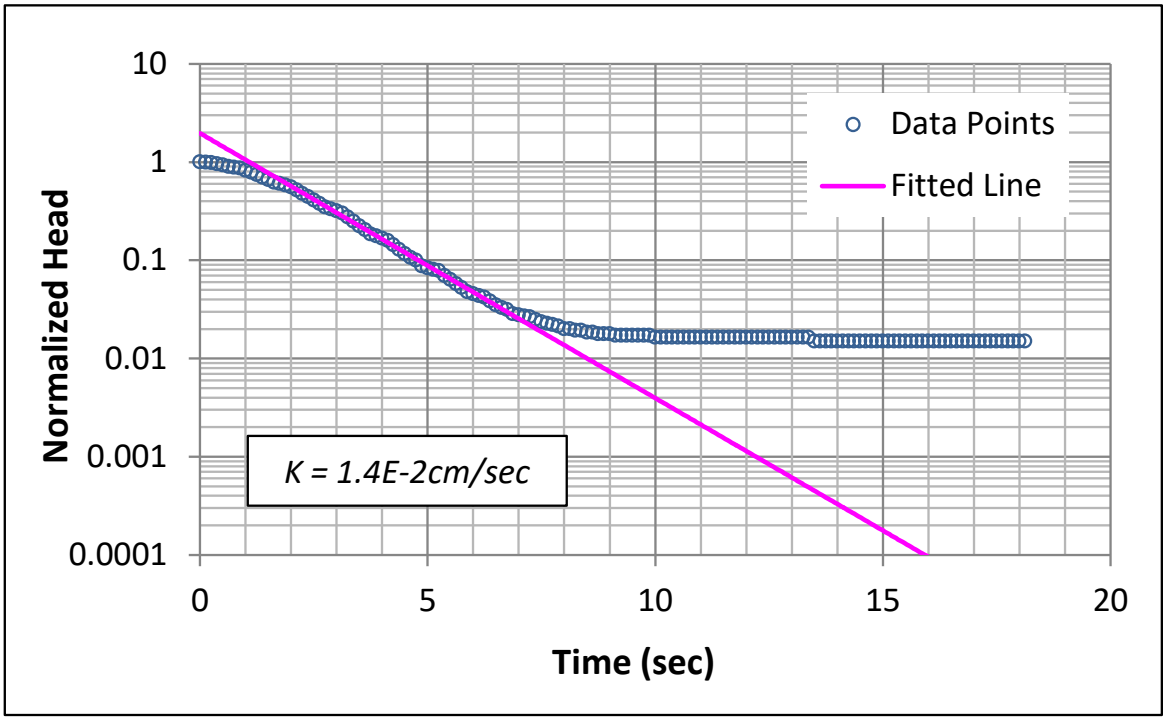
Figure 2A-7-2

Rising Head #1



Rising Head #2



Notes:

1. Slug Test conducted in Monitoring Well MW-33S on April 25, 2013.
2. Overdamped slug test response analyzed using Bouwer & Rice (1976) method.
3. Falling head test data not analyzed because well screen spans the water table.

Aquifer Slug Test, MW-33S

Gas Works Park Site
Seattle, Washington

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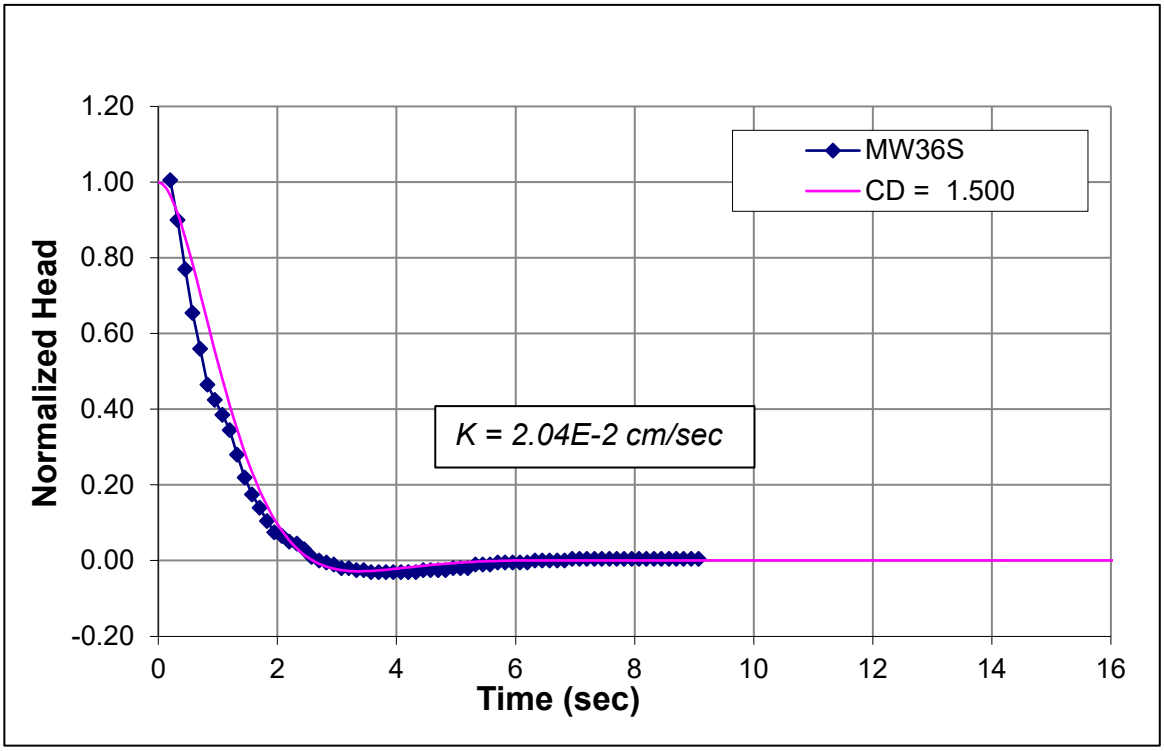
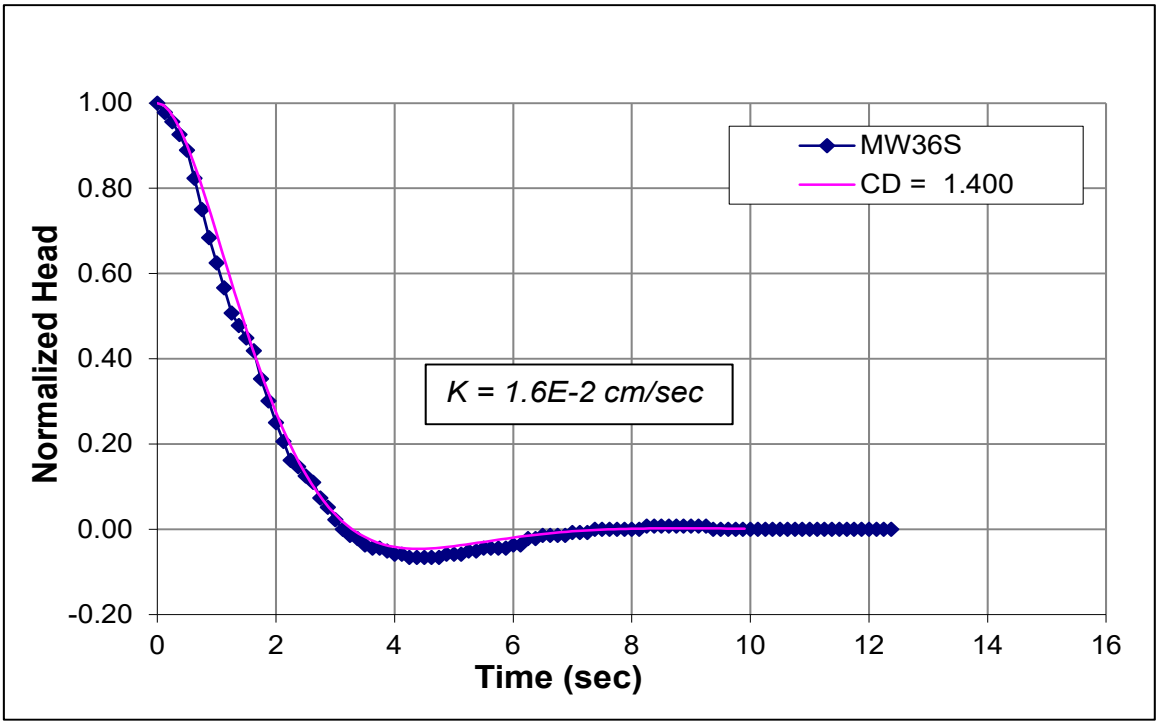
Figure 2A-7-3

Falling Head



Rising Head



Notes:

1. Slug Test conducted in Monitoring Well MW-36S on April 24, 2013.
2. Underdamped slug test response analyzed using Butler and Garnett (2000) method for slug test analysis in high hydraulic conductivity aquifers.

Aquifer Slug Test, MW-36S

Gas Works Park Site
Seattle, Washington

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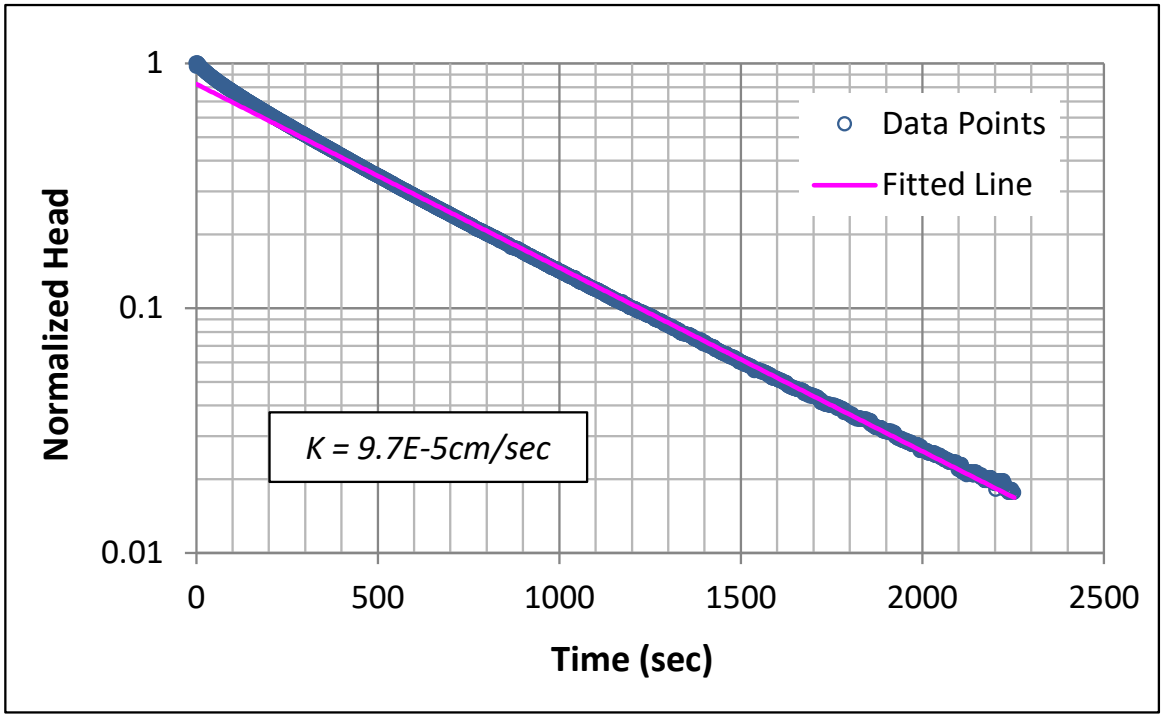
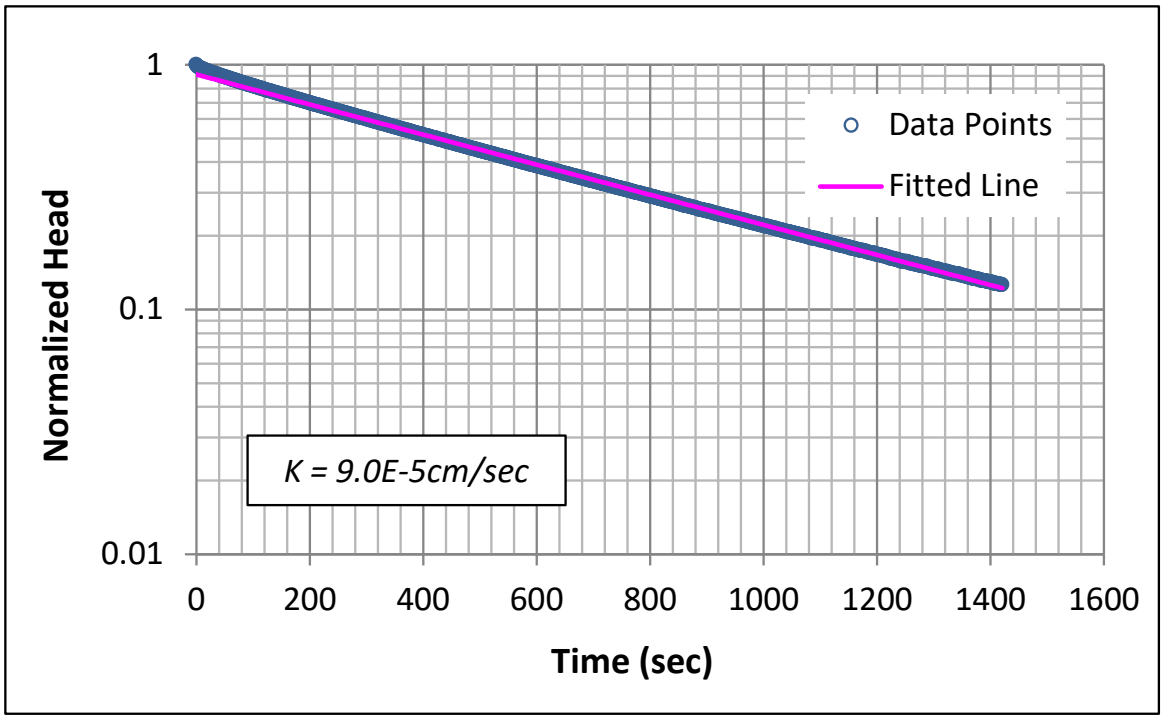
Figure 2A-7-4

Falling Head



Rising Head



Notes:

1. Slug Test conducted in Monitoring Well MW-36D on April 24, 2013.
2. Overdamped slug test response analyzed using Bouwer & Rice (1976) method.

Aquifer Slug Test, MW-36D

Gas Works Park Site
Seattle, Washington

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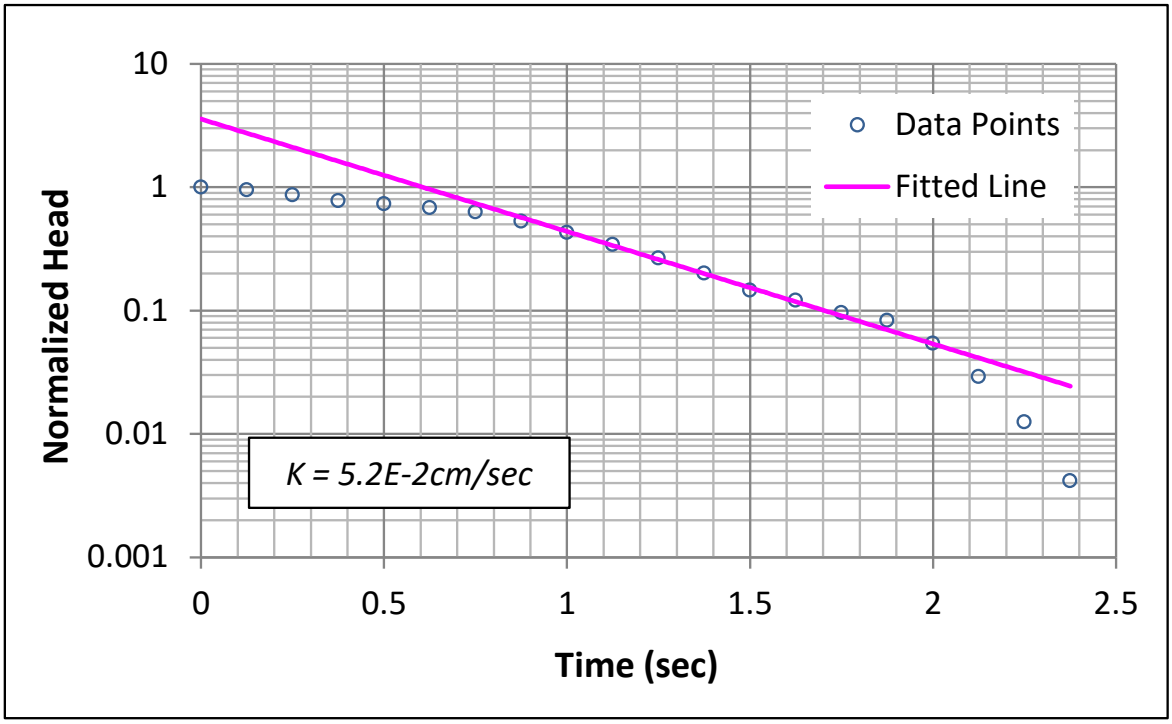
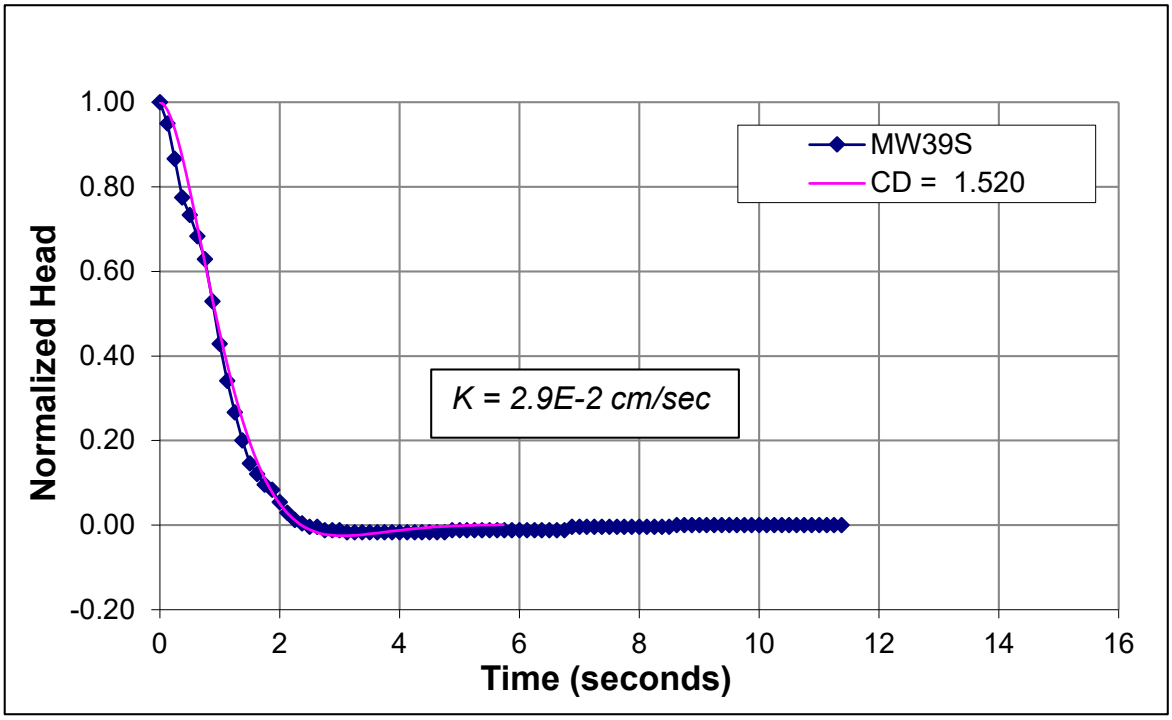
Figure 2A-7-5

Rising Head #1



Rising Head #2



Notes:

1. Slug Test conducted in Monitoring Well MW-39S on April 24, 2013.
2. Rising head test #1 analyzed using Bouwer & Rice (1976) method.
3. Rising test #2 analyzed using Butler and Garnett (2000) method for high hydraulic conductivity aquifers.

Aquifer Slug Test, MW-39S

Gas Works Park Site
Seattle, Washington

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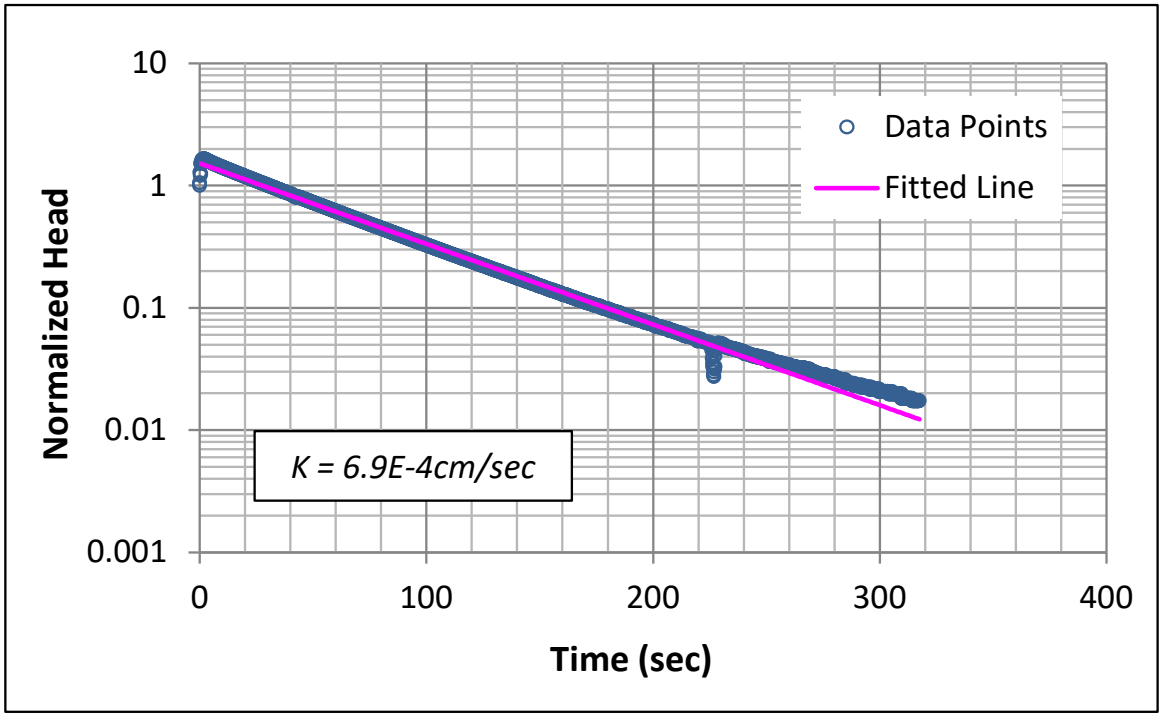
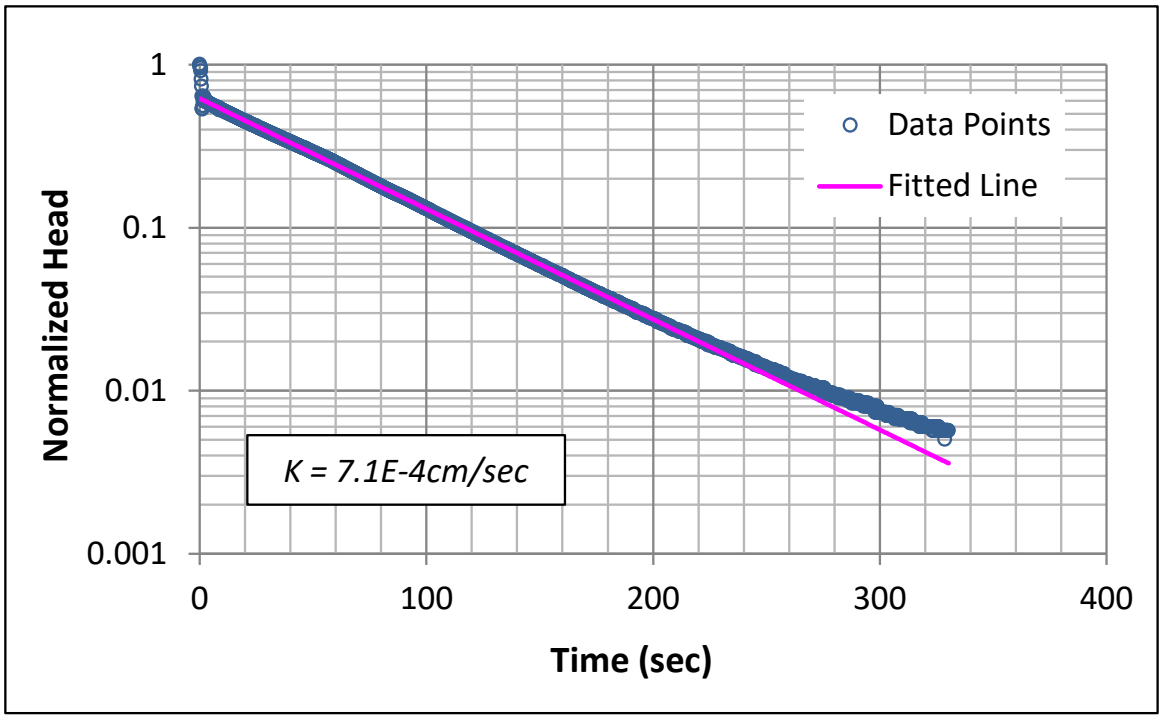
Figure 2A-7-6

Falling Head



Rising Head



Notes:

1. Slug Test conducted in Monitoring Well MW-39D on April 24, 2013.
2. Overdamped slug test response analyzed using Bouwer & Rice (1976) method.

Aquifer Slug Test, MW-39D

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 2A-7-7

ATTACHMENT 2A-8
SI NAPL Baildown Testing

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ATTACHMENT 2A-8
MW-09 LNAPL BAILDOWN FIELD PROCEDURES, METHODOLOGY, RESULTS

1.0 LNAPL BAILDOWN TESTING

Baildown tests in unconfined aquifers are commonly evaluated using the Bouwer and Rice method for groundwater slug tests (Bouwer and Rice 1976, Bouwer 1989). The Bouwer and Rice slug test analytical solution has been modified to estimate light nonaqueous phase liquid (LNAPL) transmissivity following one or more slug withdrawals (Huntley 2000, Kirkman 2012). LNAPL transmissivity is a measure of the potential flux of LNAPL per unit drawdown, or the volume of LNAPL travelling through a unit width of an aquifer per unit time per unit drawdown (units of length squared per time).

Based on the modified method, the purpose of the testing was twofold:

- Empirically and quantitatively evaluate the transmissivity of LNAPL in the geologic formation, and
- Assess the potential recoverability of LNAPL.

2.0 BAILDOWN TEST METHODOLOGY

A baildown test was conducted in well MW-09 on April 29, 2013, by removing LNAPL from the well, and measuring and recording the LNAPL recovery and associated groundwater response following removal of the LNAPL. Both LNAPL-air and LNAPL-water interfaces were measured following LNAPL removal. A hydraulic pressure transducer with datalogging capabilities was installed in the well to monitor groundwater pressure (elevation) changes during the early portion of the recovery period. Measurements continued frequently (once per minute gradually reducing in frequency to once per hour) on April 29 following removal of LNAPL, but NAPL recovery was slow. To observe long-term response and changes to LNAPL thickness in the well, it was necessary to conduct periodic measurements until October 14. The baildown field procedures, which are based on the methodology of Lundy (2002), are described in the work plan for the 2013 Supplemental Investigation (SI) (GeoEngineers 2013); results of the SI are presented as Appendix 2A to the remedial investigation (RI) report.

3.0 BAILDOWN TEST RESULTS

One baildown test was performed in well MW-09 to estimate the LNAPL transmissivity (T_n). The LNAPL thickness (volume) in MW-09 prior to the baildown test was 1.55 feet (0.25 gallons), which is considered a marginal LNAPL thickness for conducting a baildown test; a 1-foot thickness is generally considered the minimum for observing response and analyzing baildown test data. NAPL thicknesses in other wells at the Site, as measured during the April 2013 SI, were less than 1 foot, too thin for baildown testing. Following the removal of LNAPL from MW-09, the LNAPL thickness was 0.31 feet, with a volume of 0.050 gallons remaining in the well at the start of recovery monitoring. LNAPL-air and LNAPL-groundwater interface measurements from the April 2013 baildown test are shown in Figure 2A-8-1; transducer pressure measurements and groundwater potentiometric surface elevations are also shown.

Data from the MW-09 baildown test were not considered usable for transmissivity estimates. The small changes in LNAPL drawdown and LNAPL thickness precluded use of the method of analysis for the purpose intended. In addition, LNAPL recovery into the well was not consistent. For example, after LNAPL was removed from the well, the LNAPL thickness was 0.31 feet but fluctuated up to a maximum of 0.78 feet before dropping to less than 0.05 feet at the end of monitoring on April 29. The maximum thickness of LNAPL observed in MW-09 during recovery monitoring was 1.37 feet on August 23, 2013, which is equal to a volume of 0.22 gallons of LNAPL recovery since the baildown test was conducted on April 29, 2013.

The theoretical response of LNAPL in a small-diameter monitoring well after baildown was not observed. Possible explanations include fluctuating thickness of free LNAPL (i.e., thickness in formation capable of movement), insufficient LNAPL, questionable well construction or age of well (the well was constructed in 1986 and may not be up to par with today's construction standards), and LNAPL transmissivities that were too low to measure by the selected methods of analysis (Huntley 2000, Kirkman 2012).

4.0 REFERENCES

Bouwer, H. 1989. "The Bouwer and Rice Slug Test – An Update." *Ground Water* 27 (3):5.

Bouwer, H., and R.C. Rice. 1976. "A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells." *Water Resources Research* 12 (3):5.

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Huntley. 2000. "Analytic Determination of Hydrocarbon Transmissivity from Baildown Tests, Ground Water." 38 (1).

Kirkman. 2012. Refinement of Bouwer-Rice Baildown Test Analysis, Ground Water Monitoring & Remediation.

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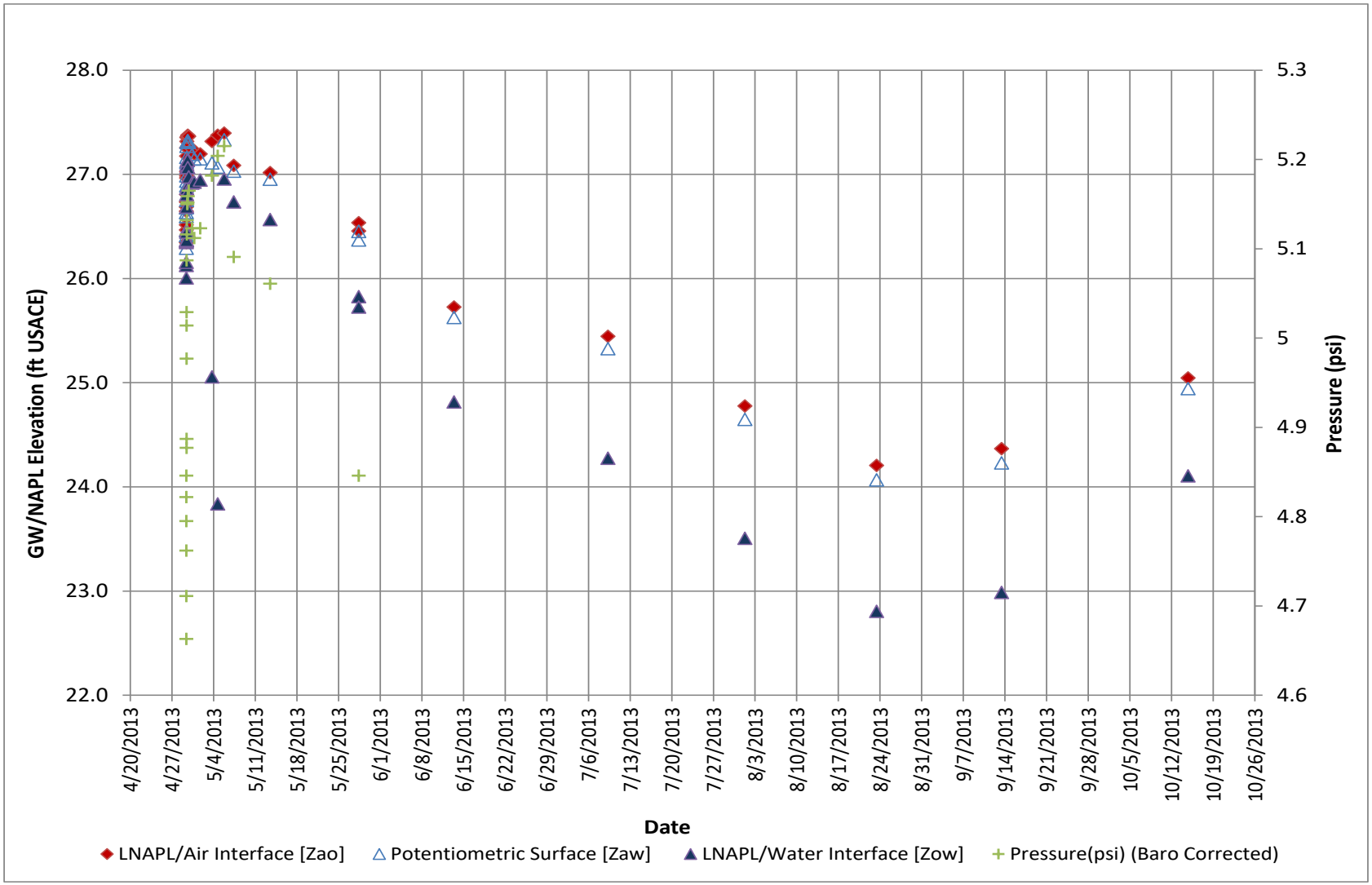

MW-09 Baildown Test -
LNAPL and Groundwater Elevations

Gas Works Park Site
Seattle, Washington

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Figure 2A-8-1

Notes:

1. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

ATTACHMENT 2A-9
SI Data Validation Memos and Lab Data Packages

SUB-ATTACHMENT 2A-9.1
Data Validation Memos

GeoEngineers

Plaza 600 Building, 600 Stewart Street, Suite 1700, Seattle, WA 98101, Telephone: 206.728.2674, Fax: 206.728.2732 www.geoengineers.com

Data Validation Report

Project:	PSE North Lake Union – 2013 Supplemental Upland Investigation (Soil)
File:	00186-846-01
Date:	August 19, 2013
Lab Report:	WJ09, WJ66, WJ79, WJ80, WK21, WK22, WL88, WY52, and WZ75

This report presents the results of a United States Environmental Protection Agency (USEPA)-defined Stage 2A validation (USEPA Document 540-R-08-005; USEPA, 2009) of analytical data from the analyses of soil boring samples obtained from the Supplemental Upland Investigation at the PSE North Lake Union site. Samples obtained were submitted to Analytical Resources, Incorporated (ARI) of Tukwila, Washington for chemical analysis of benzene, toluene, ethylbenzene, and xylene (BTEX) compounds by method SW8260C, polycyclic aromatic hydrocarbons (PAHs) and Alkylated PAHs by method SW8270-SIM, poly-chlorinated biphenyls (PCBs) by method SW8082, and arsenic by EPA Method 200.8.

The objective of this data quality assessment was to review laboratory analytical procedures and QC results to evaluate whether the samples were analyzed using well-defined and acceptable methods that provide quantitation limits below applicable regulatory criteria, the precision and accuracy of the data are well defined and sufficient to provide defensible data, and the quality assurance/quality control (QA/QC) procedures utilized by the laboratory meet acceptable industry practices and standards.

ARI Sample Delivery Groups (SDGs; noted above) were reviewed for the following quality control (QC) elements:

- Chain of Custody
- Holding Times
- Additional/Follow-up Analyses
- Surrogates/Labeled Compounds
- Method Blanks, Equipment Rinsate Blanks, and Trip Blanks
- Laboratory Control Samples
- Matrix Spikes/Matrix Spike Duplicates
- Laboratory and Field Duplicates

DATA QUALITY ASSESSMENT SUMMARY

The results for each of the QC elements are summarized below. The data assessment was performed using guidance in two USEPA documents: USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (USEPA, 2010) and USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (USEPA, 2008).

Chain-of-Custody Documentation

Chain-of-custody forms were provided with the laboratory analytical reports. No transcription errors were found, and the appropriate signatures were applied. There were no anomalies mentioned in the sample receipt forms, as the samples were transported to the laboratory at the appropriate temperatures of between 2 and 6 degrees Celsius, except in cases where the samples were transported directly to the laboratory from the field. In these cases, the laboratory recorded temperatures greater than 6 degrees Celsius. No action was taken because the samples were received by the laboratory within 12 hours of sampling.

Holding Times

The holding time is defined as the time that elapses between sample collection and sample analysis. Maximum holding time criteria exist for each analysis to help ensure that the analyte concentrations found at the time of analysis reflect the concentration present at the time of sample collection. Established holding times were met for all analyses, with the following exceptions:

- **SDG WK21** (BTEX): Samples GEI-13-13-16, GEI-13-23.5-24.5, GEI-13-25.0-25.5, and GEI-1-16.5-17.0 were analyzed 1 day outside of the holding time of 14 days. The positive results and reporting limits for non-detected compounds were qualified as estimated (J/UJ).

Additional/Follow-up Analyses

SDGs WY52 and WZ75: Additional arsenic analyses (by EPA 200.8) were requested for samples that had been archived and refrigerated by the laboratory upon delivery in late March 2013. The metals holding time of 6 months had not expired for the following samples, and the laboratory proceeded to report these results as two SDGs.

MW36S-22.5-23	MW37S-13.5-14.5	GEI-3-16-17
GEI-4-15.0-16.0	GEI-5-10-10.5	GEI-3-22-23
GEI-4-20.0-21.0	GEI-5-22-23	

Surrogate Recoveries

A surrogate compound is a compound that is chemically similar to the analytes of interest, but unlikely to be found in any environmental sample. Surrogates are used for organic analyses and are added to all samples, standards, and blanks to serve as an accuracy and specificity check of each analysis. The surrogates are added at a known concentration and percent recoveries are calculated following analysis. All surrogate recoveries for field samples were within the laboratory control limits, with the exceptions below:

- **SDGs WJ09, WJ66, WJ79, WJ80** (Alkylated PAHs/Regular PAHs): Due to the inherently high concentrations of target analytes in this sampling event, several soil samples had to be diluted by the laboratory. For the purposes of validation, any sample diluted at least 10 fold is considered to have the spiked surrogates diluted to levels which are lower than the calibration range of the instrument used for analysis and should not be relied upon as a measurement of accuracy.

  For this reason, there were no surrogate recoveries reported in the re-analyzed/dilutions of several samples in this sampling event. In each case, the absence of surrogate recoveries was found to be

within the realm of normal laboratory procedure for diluted samples in order to accommodate high concentrations of target analytes, and no qualifiers were necessary.

In almost all cases, the laboratory reported the samples that required dilution multiple times in order to achieve the lowest possible reporting limits for any target analytes that did not require dilution. For this reason, only the target analytes that exceeded the calibration range from each initial analysis were qualified as Do-Not-Report (DNR). Correspondingly, all other analytes were qualified as Do-Not-Report (DNR) in the more diluted analysis in order to avoid the redundant reporting of data.

- SDG WK21 (BTEX): The %R values for d4-1,2-dichloroethane and d4-1,2-dichlorobenzene exceeded the control limits in Sample DUP3-040113. The sample was re-analyzed at a medium level with no detections at higher reporting limits. The positive results for all target analytes were qualified as estimated (J) in the initial analysis while the reporting limits were labeled as Do-Not-Report in the medium level analysis.

  The %R value for d4-1,2-dichlorobenzene exceeded the control limit in Sample GEI-13-8-9.5. The sample was re-analyzed at a medium level with no detections at higher reporting limits. Since there were 3 other surrogate %R values within the control limits for this sample no action was taken for this outlier. The reporting limits were labeled as Do-Not-Report in the medium level analysis.

Method Blanks, Trip Blanks, and Equipment Rinsate Blanks

Method blanks are analyzed to ensure that laboratory procedures and reagents do not introduce measurable concentrations of the analytes of interest. Method blanks were analyzed with each batch of samples, at a frequency of one per twenty samples. For all sample batches, method blanks for all applicable methods were analyzed at the required frequency. None of the analytes of interest were detected in any of the method blanks, with the exceptions below:

- SDG WJ09 (PAHs): There was a positive result for naphthalene in the water method blank extracted on 3/30/13 that was less than the contract required quantitation limit. The positive result for naphthalene was qualified as not detected (U) in the associated Sample RINSE-032513.
- SDG WJ79 (PAHs): There was a positive result for naphthalene in the soil method blank extracted on 4/11/13 that was greater than the contract required quantitation limit. The positive result for naphthalene was qualified as not detected (U) in the associated Sample GEI-10-2-3. All other associated samples exhibited positive concentrations which were greater than 5 times the amount found in the method blank. No further action was required.
- SDG WL88 (PAHs): There was a positive result for naphthalene in the soil method blank extracted on 4/19/13 that was greater than the contract required quantitation limit. The positive result for naphthalene was qualified as not detected (U) in the associated Sample MW32D-43.5-44.5. All other associated samples exhibited positive concentrations which were greater than 10 times the amount found in the method blank after sample dilutions were taken into account. No further action was required.

Trip blanks are analyzed to provide an indication as to whether there has been any cross-contamination in the transportation process. Seven trip blanks were collected for this sampling event: TRIP BLANK-032613,

TRIP BLANK-03-27-13, TRIP BLANK_130328, TRIP BLANK-032913, TRIP BLANK-040113, and TRIP BLANK_130412. There were no positive results for any target analytes in these blanks.

Equipment rinsate blanks are analyzed to provide an indication as to whether field decontamination and sampling procedures effectively prevent cross-contamination in field activities. Four equipment rinsate blanks were collected for this sampling event: RINSE-032513, RINSE-032713, RINSE-032913, and RINSATE-040213. There were no positive results for any target analytes in these blanks, with the exceptions below:

- SDG WJ79 (PAHs): There were positive results for naphthalene, phenanthrene, fluoranthene, and pyrene in the equipment blank RINSE-032913 greater than the contract required quantitation limit. However, all the field sample concentrations were greater than 10 times the concentrations in the field blank. No further action was required.
- SDG WK22 (PAHs): There were positive results for all target analytes in the equipment blank RINSE-040213 greater than the contract required quantitation limit. However, all the field sample concentrations were greater than 10 times the concentrations in the field blank. No further action was required.

Matrix Spikes/Matrix Spike Duplicates

Because the actual analyte concentration in an environmental sample is not known, the accuracy of a particular analysis is usually inferred by performing a matrix spike (MS) analysis. One aliquot of sample is analyzed in the normal manner, and then a second aliquot of the sample is spiked with a known amount of analyte concentration and analyzed. From these analyses, a %R is calculated. Matrix spike duplicates (MSD) analyses are generally performed for organic analyses as a precision check. For some organic analytical methods, a laboratory control sample/ laboratory control sample duplicate (LCS/LCSD) sample set is performed in lieu of a MS/MSD analysis.

For inorganics methods, the matrix spike (referred to as a "spiked sample") is typically followed by a post spike sample if any element recoveries were outside the control limits in the "spiked sample".

Matrix spike analyses should be performed once per analytical batch or every twenty field samples, whichever is more frequent. The recovery criteria for matrix spikes and laboratory control samples are specified in the laboratory documents as are the relative percent difference (RPD) values. The frequency requirements were met for all analyses and the %R/RPD values were within the proper control limits, with the exceptions below:

- SDG WJ66 (Alkylated PAHs): The laboratory performed an MS/MSD set on Sample GEI-3-16-17. The %R values for several target analytes could not be reported because the parent sample concentrations were greater than four times the amount spiked into the sample. No action was taken.

  (Regular PAHs): The laboratory performed an MS/MSD set on Sample GEI-3-27-28. The %R values for naphthalene could not be reported because the parent sample concentration for this compound was greater than four times the amount spiked into the sample. No action was taken.

  (Arsenic): The laboratory performed an MS/MSD set on Sample MW35S-4.5-5. The %R value for arsenic was less than the control limit. The positive results for arsenic were qualified as estimated (J)

for Samples GEI-3-2.0-3.0, GEI-3-8-9, GEI-3-11.5-12.0, GEI-4-0.5-1.5, GEI-4-5.5-7.0, GEI-4-10.0-11.0, MW34S-7-8, and MW35S-4.5-5.

- SDG WJ79 (Regular PAHs): The laboratory performed an MS/MSD set on Sample GEI-5-15-16. The %R values and the RPD value for naphthalene could not be reported because the parent sample concentrations were greater than four times the amount spiked into the sample. No action was taken.

  The laboratory performed an MS/MSD set on Sample GEI-10-6.5-7.5. The %R values for fluoranthene and pyrene could not be reported because the parent sample concentrations were greater than four times the amount spiked into the sample. No action was taken.

- SDG WK21 (Regular PAHs): The laboratory performed an MS/MSD set on Sample GEI-2-16.0-17.0. The %R values for phenanthrene, fluoranthene, and pyrene could not be reported because the parent sample concentrations were greater than four times the amount spiked into the sample. No action was taken.

- SDG WK22 (Regular PAHs): The laboratory performed an MS/MSD set on Sample GEI-14-14.5-15.5. The %R values for all target analytes were not assessed because the parent sample concentrations for several compounds exceeded the linear calibration of the instrument. No action was taken.

  The laboratory performed an MS/MSD set on Sample GEI-14-37-38. The %R values for naphthalene and phenanthrene were not reported because the parent sample concentrations were greater than four times the amount spiked into the sample. No action was taken.

Laboratory Control Samples

A laboratory control sample is essentially a blank sample that is spiked with a known amount of analyte concentration and analyzed. It is to be treated much like a matrix spike, without the possibility for matrix interference. As there is no actual sample matrix in the analysis, the analytical expectations for accuracy and precision are usually more rigorous and qualification would apply to all samples in the batch, instead of the parent sample only.

Laboratory control sample analyses should be performed once per analytical batch or every twenty field samples, whichever is more frequent. The recovery criteria for laboratory control samples are specified in the laboratory documents as are the RPD values. The frequency requirements were met for all analyses, and the %R/RPD values were within the proper control limits.

Laboratory Duplicates (Arsenic only)

Internal laboratory duplicate analyses are performed to monitor the precision of the analyses. Two separate aliquots of a sample are analyzed as distinct samples in the laboratory, and the RPD between the two results is calculated. Duplicate analyses should be performed once per analytical batch. If one or more of the samples used has a concentration greater than five times the reporting limit for that sample, the absolute difference is used instead of the RPD as a measurement of precision.

Laboratory duplicates were analyzed at the proper frequency and the specified acceptance criteria were met, with the following exception:

- **SDG WJ09** (Arsenic): The laboratory performed an internal duplicate on Sample MW39D-0.5-1.5. The RPD value for arsenic was greater than the control limit of 20%. The positive results for arsenic were qualified as estimated (J) in all associated batched Samples: MW37S-0.5-1, MW37S-7.5-8, MW38S-0.5-1, MW38S-10-11, MW39D-0.5-1.5, MW39D-08-10, and MW39D-17-18.
- **SDG WJ66** (Arsenic): The laboratory performed an internal duplicate on Sample MW35S-4.5-5. The RPD value for arsenic was greater than the control limit of 20%. The positive results for arsenic were qualified as estimated (J) in all associated batched Samples: GEI-3-2.0-3.0, GEI-3-8-9, GEI-3-11.5-12.0, GEI-4-0.5-1.5, GEI-4-5.5-7.0, GEI-4-10.0-11.0, MW34S-7-8, and MW35S-4.5-5.

Field Duplicates

Field duplicate samples were collected and analyzed along with the reviewed sample batches. The duplicate samples were analyzed for the same parameters as the associated parent samples. As mentioned above for the laboratory duplicates the RPD is used as the criteria for assessing precision, if one or more of the samples used has a concentration greater than five times the reporting limit for that sample, the absolute difference is used instead of the RPD as a measurement of precision.

The following field duplicate sample sets were submitted for this sampling event:

- MW33S-13-14/DUP1-032813

  The RPD/absolute difference values for acenaphthene, acenaphthylene, benzo(a)anthracene, fluorene, naphthalene, and phenanthrene, and Total PAHs exceeded the control limits in this sample set, the results were qualified as estimated (J) in both samples.

- MW36D-23-24/DUP-2-032813

  The RPD/absolute difference values for all target analytes exceeded the control limits in this sample set, the results were qualified as estimated (J) in both samples.

- GEI-13-8-9.5/ DUP3-040113

  The RPD/absolute difference values for fluoranthene and naphthalene exceeded the control limits in this sample set, the results were qualified as estimated (J) in both samples.

Reporting Limits

The arsenic target practical quantitation limits listed in the Quality Assurance Project Plan (QAPP) were not met by the laboratory. The QAPP presents a value of 0.1 mg/kg whereas the laboratory used a value of 0.2 mg/kg as the reporting limit. The associated samples in this sampling event exhibited positive results which were greater than 0.1 mg/kg, therefore no further action was taken for this discrepancy.

OVERALL ASSESSMENT

As was determined by this data validation, the laboratory followed the specified analytical methods. Accuracy was acceptable, as demonstrated by the surrogates, LCS/LCSD, and MS/MSD %R values, with the exceptions noted above. Precision was acceptable, as demonstrated by the laboratory duplicate, field duplicates, LCS/LCSD and MS/MSD RPD and absolute difference values, with the exceptions noted above.

Data should be qualified as estimated because of holding time outliers, surrogate %R outliers, laboratory and field duplicate precision, MS/MSD %R outliers, and method blank contamination. See Table 1 for a summary of qualifiers.

No data points were rejected.

Based on the data quality review, it is our opinion that the analytical data, including data qualified as noted above, are of acceptable quality for their intended use.

REFERENCES

U.S. Environmental Protection Agency (USEPA). "Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review," OSWER 9240.1-51, EPA 540-R-10-011. January 2010.

U.S. Environmental Protection Agency (USEPA). "Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review," EPA-540-R-08-01. June 2008.

U.S. Environmental Protection Agency (USEPA). "Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use," EPA-540-R-08-005. January 2009.

GeoEngineers

Data Validation Report

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Project:	PSE North Lake Union – 2013 Supplemental Upland Investigation (Groundwater and NAPL; IDW)
File:	00186-846-01
Date:	July 11, 2013; December 5, 2013
Lab Report(s):	WM33, WM34, WM86, WN07, WN33, WN34, WN81, WN82, XK23, XK28, XK60, XK78, XK94

This report presents the results of a United States Environmental Protection Agency (USEPA)-defined Stage 2A validation (USEPA Document 540-R-08-005; USEPA, 2009) of analytical data from the analyses of groundwater and NAPL samples obtained from the Supplemental Upland Investigation at the Gas Works Park Site, and associated investigation-derived waste characterization composite samples (soil and groundwater). Samples obtained were submitted to Analytical Resources, Incorporated (ARI) of Tukwila, Washington for chemical analysis of Volatile Organic Compounds (VOCs), benzene, toluene, ethylbenzene, and xylene (BTEX) compounds by method SW8260C, polycyclic aromatic hydrocarbons (PAHs) and Alkylated PAHs by method SW8270-SIM, and arsenic by method EPA 200.8. IDW samples were analyzed for RCRA 8 total metals (water), and TCLP benzene and TCLP RCRA 8 metals (soil).

The objective of this data quality assessment was to review laboratory analytical procedures and QC results to evaluate whether the samples were analyzed using well-defined and acceptable methods that provide quantitation limits below applicable regulatory criteria, the precision and accuracy of the data are well defined and sufficient to provide defensible data, and the quality assurance/quality control (QA/QC) procedures utilized by the laboratory meet acceptable industry practices and standards.

The ARI Sample Delivery Groups (SDGs) noted above were reviewed for the following quality control (QC) elements:

- Chain of Custody
- Holding Times
- Surrogates/Labeled Compounds
- Method and Trip Blanks
- Laboratory Control Samples
- Matrix Spikes/Matrix Spike Duplicates
- Reporting Limits

LABORATORY AND FIELD DUPLICATES DATA QUALITY ASSESSMENT SUMMARY

The results for each of the QC elements are summarized below. The data assessment was performed using guidance in two USEPA documents: USEPA Contract Laboratory Program National Functional Guidelines for

Inorganic Data Review (USEPA, 2010) and USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (USEPA, 2008).

It should be noted that there were two sample names that were changed internally to Geoengineers after the samples were received by the laboratory:

IDW-3-130424 (Chain-of-Custody) was changed to TDW-3-130424,
and
TPW01-130417 (Chain-of-Custody) was changed to TDW01-130417

These changes were made in the Geoengineers database, while maintaining the original sample names along with a description of the changes. No other action was taken other than to note these discrepancies here.

Chain-of-Custody Documentation

Chain-of-custody forms were provided with the laboratory analytical reports. No transcription errors were found, and the appropriate signatures were applied. There were no anomalies mentioned in the sample receipt forms, as the samples were transported to the laboratory at the appropriate temperatures of between 2 and 6 degrees Celsius, except in cases where the samples were transported directly to the laboratory from the field. In these cases, the laboratory recorded temperatures greater than 6 degrees Celsius. No action was taken because the samples were received by the laboratory within 12 hours of sampling.

Holding Times

The holding time is defined as the time that elapses between sample collection and sample analysis. Maximum holding time criteria exist for each analysis to help ensure that the analyte concentrations found at the time of analysis reflect the concentration present at the time of sample collection. Established holding times were met for all analyses.

Surrogate Recoveries

A surrogate compound is a compound that is chemically similar to the analytes of interest, but unlikely to be found in any environmental sample. Surrogates are used for organic analyses and are added to all samples, standards, and blanks to serve as an accuracy and specificity check of each analysis. The surrogates are added at a known concentration and percent recoveries are calculated following analysis. All surrogate recoveries for field samples were within the laboratory control limits, with the exceptions below:

- All SDGs (Alkylated PAHs/Regular PAHs): Due to the inherently high concentrations of target analytes in this sampling event, several water samples had to be diluted by the laboratory. For the purposes of validation, any sample diluted at least 10 fold is considered to have the spiked surrogates diluted to levels which are lower than the calibration range of the instrument used for analysis and should not be relied upon as a measurement of accuracy.

  For this reason, there were no surrogate recoveries reported in the re-analyzed/dilutions of several samples in this sampling event. In each case, the absence of surrogate recoveries was found to be within the realm of normal laboratory procedure for diluted samples in order to accommodate high concentrations of target analytes, and no qualifiers were necessary.

In almost all cases, the laboratory reported the samples that required dilution multiple times in order to achieve the lowest possible reporting limits for any target analytes that did not require dilution. For this reason, only the target analytes that exceeded the calibration range from each initial analysis were qualified as Do-Not-Report (DNR). Correspondingly, all other analytes were qualified as Do-Not-Report (DNR) in the more diluted analysis in order to avoid the redundant reporting of data.

Method Blanks and Trip Blanks

Method blanks are analyzed to ensure that laboratory procedures and reagents do not introduce measurable concentrations of the analytes of interest. Method blanks were analyzed with each batch of samples, at a frequency of one per twenty samples. For all sample batches, method blanks for all applicable methods were analyzed at the required frequency. Analytes of interest were not detected above the contract required quantitation limits in any of the method blanks, with the exceptions below. If a qualifier was applied due to blank contamination, the effective reporting limit for that compound was elevated to the amount of the positive result.

- SDG WM33 (Regular PAHs): There was a positive result for naphthalene in the water method blank extracted on 4/19/13. The associated sample results for naphthalene were greater than 5 times the concentration found in the method blank. No further action was taken.
- SDG WM34 /WM86 (Regular PAHs): There were positive results for naphthalene in the water method blanks extracted on 4/19/13 and 4/22/13 (filtered) that were greater than the contract required quantitation limits. The associated sample results for naphthalene were greater than 5 times the concentration found in the method blank. No further action was taken. .
- SDG WN07 (VOCs): There was a positive result for acetone in the NAPL method blank analyzed on 4/29/13 that was greater than the contract required quantitation limit. There was no positive result for this compound in the associated NAPL sample. No further action was required.

  (Regular PAHs): There was a positive result for naphthalene in the water method blank analyzed on 4/23/13 that was greater than the contract required quantitation limit. However, all the associated field sample concentrations were greater than 5 times the concentrations in the field blank, no further action was required.

  There was a positive result for naphthalene in the water method blank analyzed on 4/24/13 that was greater than the contract required quantitation limit. The positive result for naphthalene was qualified as not detected (U) in the associated Sample MLS01-3-130418.

  (Metals): There was a positive result for barium in the TCLP method blank analyzed on 4/29/13 that was greater than the contract required quantitation limit. However, the associated field sample concentration was greater than 5 times the concentration in the prep blank. No further action was required.
- SDG WN33 (Regular PAHs): There was a positive result for naphthalene in the water method blank extracted on 4/25/13 that was greater than the contract required quantitation limit. The positive result for naphthalene was qualified as not detected (U) in the associated Sample RW01-130419.
- SDG WN81 (Regular PAHs): There was a positive result for naphthalene in the water method blank extracted on 4/30/13 that was greater than the contract required quantitation limit. The positive

results for naphthalene were qualified as not detected (U) in the associated Samples MW13-130424, MW37S-130424 and MW38S-130424.

- SDG XK23 (Regular PAHs): There was a positive result for naphthalene in the water method blank extracted on 10/21/13 that was greater than the contract required quantitation limit. However, the associated field sample concentrations were greater than 5 times the concentration in the prep blank. No further action was required.
- SDG XK60 (Regular PAHs): There was a positive result for naphthalene in the water method blank extracted on 10/22/13 that was greater than the contract required quantitation limit. However, the associated field sample concentrations were greater than 5 times the concentration in the prep blank. No further action was required.
- SDG XK78 (Regular PAHs): There was a positive result for naphthalene in the water method blank extracted on 10/23/13 that was greater than the contract required quantitation limit. The positive results for naphthalene were qualified as not detected (U) in the associated samples MW-23-131017, TSW-3-131018, FILTER BLANK, MW-23-131017-F, TSW-3-131018-F, MW-32D-131018-F.

Trip blanks are analyzed to provide an indication as to whether there has been any cross-contamination in the transportation process. Six trip blanks were collected for this sampling event: TRIP BLANKS_130419, TRIP BLANKS_130424, Trip Blank #1, Trip Blank #2, Trip Blank #3, and TRIP BLANKS_131016. There were no positive results for any target analytes in these blanks.

In the fall sampling event, one FILTER BLANK (sampled on 10/17/13) was analyzed to provide an indication as to whether there was any contamination through the PAH sample filters. After method blank contamination qualification was applied to all associated samples, there was a positive result found for acenaphthene in this filter blank. For this reason, the positive result for acenaphthene was qualified as not detected (U) in the associated Sample MW-32D-131018-F.

Matrix Spikes/Matrix Spike Duplicates

Because the actual analyte concentration in an environmental sample is not known, the accuracy of a particular analysis is usually inferred by performing a matrix spike (MS) analysis. One aliquot of sample is analyzed in the normal manner, and then a second aliquot of the sample is spiked with a known amount of analyte concentration and analyzed. From these analyses, a %R is calculated. Matrix spike duplicates (MSD) analyses are generally performed for organic analyses as a precision check. For some organic analytical methods, a laboratory control sample/ laboratory control sample duplicate (LCS/LCSD) sample set is performed in lieu of a MS/MSD analysis.

For inorganics methods, the matrix spike (referred to as a “spiked sample”) is typically followed by a post spike sample if any element recoveries were outside the control limits in the “spiked sample”.

Matrix spike analyses should be performed once per analytical batch or every twenty field samples, whichever is more frequent. The recovery criteria for matrix spikes and laboratory control samples are specified in the laboratory documents as are the relative percent difference (RPD) values. The frequency requirements were met for all analyses and the %R/RPD values were within the proper control limits, with the exceptions below:

- **SDG WM33** (VOCs): The laboratory performed an MS/MSD on Sample MW18-130415-DNAPL. The %R values for acetone were greater than the control limits in both the MS and MSD. The outliers were indicative of a high bias. As there was no positive result for acetone in the parent sample, no action was taken.

Laboratory Control Samples

A laboratory control sample is essentially a blank sample that is spiked with a known amount of analyte concentration and analyzed. It is to be treated much like a matrix spike, without the possibility for matrix interference. As there is no actual sample matrix in the analysis, the analytical expectations for accuracy and precision are usually more rigorous and qualification would apply to all samples in the batch, instead of the parent sample only.

Laboratory control sample analyses should be performed once per analytical batch or every twenty field samples, whichever is more frequent. The recovery criteria for laboratory control samples are specified in the laboratory documents as are the RPD values. The frequency requirements were met for all analyses, and the %R/RPD values were within the proper control limits, with the exceptions below.

- **SDG WM33** (VOCs): The %R values for acrolein and bromoform were less than the control limits in both the LCS/LCSD extracted on 4/19/13. The only field sample associated with this QC batch was a Trip Blank. No further action was taken.

  (Regular PAHs): The %R values for naphthalene were greater than the control limits in both the LCS/LCSD extracted on 4/19/13. The associated positive results for this compound were qualified as estimated (J) in Samples MLS04-3-130415 and MLS04-5-130415.

- **SDG WM34** (Regular PAHs): The %R values for naphthalene were greater than the control limits in both the LCS/LCSD extracted on 4/19/13. The associated positive results for this compound were qualified as estimated (J) in Samples MLS04-2-130416, MLS05-1-130416, MLS05-2-130416, MLS05-3-130416, MLS05-4-130416, MLS05-5-130416, MLS06-130416, MLS06-2-130416, MLS07-1-130416, MLS07-2-130416, MLS07-4-130416, CMP01-130416, DUP-130416, DW06-130416.

- **SDG XK78** (Regular PAHs): Seven RPD values were greater than the control limits in the LCS/LCSD extracted on 10/28/13. Upon further inspection it was found that all %R values for each of these outliers were found to be within the control limits. No further action was taken for these outliers.

Laboratory Duplicates (Arsenic and PAH-NAPL sample only)

Internal laboratory duplicate analyses are performed to monitor the precision of the analyses. Two separate aliquots of a sample are analyzed as distinct samples in the laboratory, and the RPD between the two results is calculated. Duplicate analyses should be performed once per analytical batch. If one or more of the samples used has a concentration greater than five times the reporting limit for that sample, the absolute difference is used instead of the RPD as a measurement of precision.

Laboratory duplicates were analyzed at the proper frequency and the specified acceptance criteria were met.

Field Duplicates

Field duplicate samples were collected and analyzed along with the reviewed sample batches. The duplicate samples were analyzed for the same parameters as the associated parent samples. As mentioned above for the laboratory duplicates the RPD is used as the criteria for assessing precision, if one or more of the samples used has a concentration greater than five times the reporting limit for that sample, the absolute difference is used instead of the RPD as a measurement of precision.

The following field duplicate sample sets were submitted for this sampling event:

- MLS05-4-130416/DUP-130416

  The RPD/absolute difference values for all target analytes were within the control limits in this sample set, no precision qualifiers were applied to either sample.

- MLS02-1-130418/DUP-130418

  The RPD/absolute difference values for all target analytes were within the control limits in this sample set, no precision qualifiers were applied to either sample.

- MW30-130419/DUP-130419

  The RPD/absolute difference values for all target analytes were within the control limits in this sample set, no precision qualifiers were applied to either sample.

- MLS02-1-130418/DUP-130418

  The RPD/absolute difference values for benzo(a)anthracene, benzo(a)pyrene, Total benzofluoranthenes, benzo(k)fluoranthene, benzo(g,h,i)perylene, indeno(1,2,3-cd)pyrene, chrysene, and carcinogenic PAH TEQ values were outside of the control limits in this sample set, the positive results for these compounds were qualified as estimated (J) in both samples.

- MW-40S-131016/DUP-131016 and MW-40S-131016-F/DUP-131016-F

  The RPD/absolute difference values for all target analytes were within the control limits in both sample sets, no precision qualifiers were applied to any sample.

- TSW-2-131018/DUP-131018 and TSW-2-131018-F/DUP-131018-F

  The RPD/absolute difference values for acenaphthene, fluorene, and naphthalene were outside of the control limits in the first sample set, the positive results for these compounds were qualified as estimated (J) in both samples.

  The RPD value for acenaphthene was outside of the control limit in the second sample set, the positive results for this compound was qualified as estimated (J) in both samples.

Reporting Limits

A great amount of the individual samples from this sampling event exhibited a high concentration of target analytes which required the laboratory to dilute these samples at factors of 100 times or more. Oftentimes, the target practical quantitation limits listed in the Quality Assurance Project Plan (QAPP) were not met by the laboratory because of the inherent necessity of internal laboratory dilutions.

Typically, the significance of elevated reporting limits was outweighed by the usable concentrations of other compounds which would exceed the linear calibration range of the analytical instrumentation if left undiluted.

OVERALL ASSESSMENT

As was determined by this data validation, the laboratory followed the specified analytical methods. Accuracy was acceptable, as demonstrated by the surrogates, LCS/LCSD, and MS/MSD %R values, with the exceptions noted above. Precision was acceptable, as demonstrated by the laboratory duplicate, field duplicates, LCS/LCSD and MS/MSD RPD and absolute difference values, with the exceptions noted above.

Data should be qualified as estimated because of LCS/LCSD %R outliers, field duplicate precision outliers, and qualified as not detected because of method blank contamination. See Tables 1 and 2 for a summary of qualifiers on Spring 2013 and Fall 2013 results.

No data points were rejected.

Based on the data quality review, it is our opinion that the analytical data, including data qualified as noted above, are of acceptable quality for their intended use.

ATTACHMENTS

Table 1 – Summary of Data Qualifiers for Spring 2013 Groundwater Sampling
Table 2 - Summary of Data Qualifiers for October 2013 Groundwater Sampling

REFERENCES

U.S. Environmental Protection Agency (USEPA). "Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review," OSWER 9240.1-51, EPA 540-R-10-011. January 2010.

U.S. Environmental Protection Agency (USEPA). "Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review," EPA-540-R-08-01. June 2008.

U.S. Environmental Protection Agency (USEPA). "Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use," EPA-540-R-08-005. January 2009.

SUB-ATTACHMENT 2A-9.2
Laboratory Data Packages

Provided on DVD