



Appendix B

Bench-Scale Test Results

Bench-scale Test Mayflower Pipeline Incident Response, Mayflower, Arkansas

Bench-scale tests were conducted to provide data for design of the reactive cap and in-situ amendments to be placed in the Cove Open Water Area and Heavily Vegetated Area, respectively. These activities were completed between April 21 and May 2, 2014. Attachments documenting procedures, test data sheets, results, and photologs for the (1) Reactive Media Bench-Scale Settling Test, (2) Organoclay Sorption Capacity Bench-Scale Test, and (3) PTS Laboratories Tests are enclosed. The bench-scale tests are briefly summarized below.

Reactive Media Bench-Scale Settling Test

The main objective of the Reactive Media Bench-Scale Settling Test is to evaluate the settling rate and characteristics of organoclay products (PM-199, PMFI, and AquaGate) and organoclay-sand mixtures (90% Sand – 10% PM-199 and 90% Sand – 10% PMFI). Data collected during each settling test are presented in Test Data Sheets and photolog.

Organoclay Sorption Capacity Bench-Scale Test

The main objective of the Organoclay Sorption Capacity Bench-Scale Test is to provide an estimate of the mass of site-specific oil (non-aqueous phase liquid [NAPL]) that can be sorbed by a specific mass of organoclay such that a sheen is not produced from the resulting material upon contact with water. Data collected during these tests are presented in Test Data Sheets and photolog.

PTS Laboratories Tests

Sediment cores were collected from Pre-Design Study locations within the Open Water Area for evaluation of residual oil content. Six cores were submitted to PTS Laboratories (PTS) of Santa Fe, California for evaluation. PTS conducted core photography (white light and UV light) on the six cores. The core photography was used to select nine samples with the most potential residual oil for analysis by Method API RP 40 (Dean-Stark Method). These tests were conducted to evaluate crude oil mass in the reactive capping and in-situ amendment area.

PTS indicated based on their evaluation of the cores that there was little or no physical evidence of hydrocarbon saturation presence based on the following observations: 1) UV fluorescence appears to be from mineral or organic material, 2) no presence of hydrocarbon odor, only organic odor, 3) no visual presence of hydrocarbon or NAPL, 4) the core material consists of very fine grained sediments and/or organic material which may yield false-positive oil (NAPL) saturation results. PTS core photography and laboratory report are enclosed as Attachments.

Attachments

Reactive Media Bench-Scale Settling Test Documentation

Organoclay Sorption Capacity Bench-Scale Test Documentation

PTS Laboratories Documentation



**Reactive Media Bench-Scale
Settling Test**

**Reactive Media Bench-Scale Settling Test
Mayflower Pipeline Incident Response, Mayflower, Arkansas**

Bench-scale laboratory tests were conducted to evaluate settling rate and characteristics of organoclay products and organoclay-sand mixtures.

Procedure

The procedure for the settling test was adapted from the U.S. Army Corps of Engineers (USACE) Settling Column Test Procedures (modified October 2002) as follows:

1. Prepare settling column. Clean the column and fill with tap water.
2. Prepare test material. Weigh out sample of media and record weight.

Organoclay Media/Mix	Target Mass
PM-199	54 g
PMFI	54 g
AquaGate	181 g
Sand (90%) and PM-199	Sand = 588 g PM-199= 65 g
Sand (90%) and PMFI	Sand = 588 g PMFI = 65 g

Note:
g = grams

3. Homogenize test material. For media mixes with organoclay and sand, thoroughly mix the organoclay and sand prior to placement.
4. Start test. Pour media slowly into 2-liter graduated cylinder filled with potable water. Media should be placed into cylinder over approximately 3 minutes.
5. Observe settling characteristics every 15 minutes for the first hour, then every 30 minutes for up to 2 hours for a total of 3 hours.
 - a. Photograph each graduated cylinder of material.
 - b. Measure and record thickness of material at base of graduated cylinder.
 - c. Record visual observations of material in suspension/floating.
 - d. Record visual observation of settled mixtures (stratification, etc.).
6. If material has not completed settling, allow material to stand overnight in graduated cylinder.
7. On the following day, record settling characteristics.
 - a. Photograph each graduated cylinder of material.
 - b. Measure and record thickness of material at base of graduated cylinder.
 - c. Record visual observations of material in suspension/floating.
 - d. Record visual observation of settled mixtures (stratification, etc.).

Reactive Media Bench-Scale Settling Test Mayflower Pipeline Incident Response, Mayflower, Arkansas

Results

Reactive media bench-scale settling tests were completed for two types of organoclay products (PM-199 and PMFI), two organoclay-sand mixtures (90% Sand – 10% PM-199 and 90% Sand – 10% PMFI), and AquaGate. Results from the settling tests are summarized below and presented in the attached test data sheets and photologs.

Comparison of Organoclay Products: PM-199 and PMFI

Comparing the two types of organoclay products, PM-199 and PMFI, results show that PMFI settles at a slightly faster rate (0.01 centimeters per minute [cm/min]) than PM-199 (0.005 cm/min). Upon adding PMFI to the potable water in the graduated cylinder, approximately 90% of the material settled to the bottom in 15 minutes. Within 35 to 40 minutes of application, PMFI finished settling, although residual material continued to float for the remainder of the test (up to 180 minutes after initial application). Upon adding PM-199 to the potable water in the graduated cylinder, approximately 80% of the material settled to the bottom in 15 minutes. PM-199 slowly settled for up to 120 minutes after application, although a majority (90%) of material settled after 60 minutes of initial application. Residual floating material persisted through the duration of the test (up to 180 minutes after initial application).

Comparison of Organoclay-Sand Mixtures: 90% Sand – 10% PM-199 and 90% Sand – 10% PMFI

For both organoclay-sand mixtures, material immediately settled to the bottom of the graduated cylinder upon initial application; however, foaming on the surface caused residual floating particles, which took longer to settle. For 45 to 60 minutes after initial application, the fine particles in both mixtures continued to settle, creating a distinct layer of fines on the surface of the organoclay-sand mixture. During this time, turbidity slowly decreased, although foaming persisted at the surface. For the PM-199-sand mixture, a majority of material finished settling after 60 minutes following initial application, whereas a majority of the PMFI-sand mixture finished settling after 120 minutes.

AquaGate

During the AquaGate settling test, the material settled immediately after application with some residual floating material on the surface. Settling conditions remained unchanged for the remainder of the test (up to 180 minutes after initial application).

Attachments

Test Data Sheets

- PM-199
- PMFI
- 90% Sand – 10% PM-199
- 90% Sand – 10% PMFI
- AquaGate

Photolog



Test Data Sheets

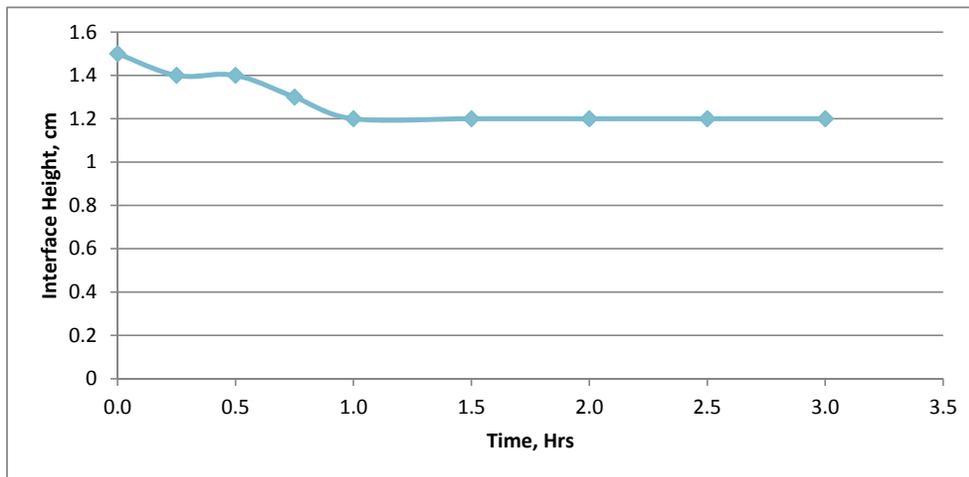
Client Name: ExxonMobil Environmental Services Company
 Project Name: Mayflower, Cove Remediation Project
 Project Location: Mayflower, AR
 Project Number: B0086022.1401.00200



Test Material: **PM-199** Tested By: Ricky Sams
 Test Start Date: 4/21/2014 Checked By: Dave Liles

Column Settling Test
Water/Solids Interface Settling Data

Date	Time	Elapsed Time, min	Elapsed Time, hrs	Water/Solids Interface Height, (cm)	Comments
4/21/2014	12:00 PM	0	0.00	1.5	Media added over the course of 7 minutes
4/21/2014	12:15 PM	15	0.25	1.4	~80% of media settled
4/21/2014	12:30 PM	30	0.50	1.4	
4/21/2014	12:45 PM	45	0.75	1.3	Still settling slowly
4/21/2014	1:00 PM	60	1.00	1.2	~10% of media remains on surface; still settling slowly
4/21/2014	1:30 PM	90	1.50	1.2	Media still slowly settling; small air bubbles are causing residual floating particles
4/21/2014	2:00 PM	120	2.00	1.2	Media still slowly settling; small air bubbles are causing residual floating particles
4/21/2014	2:30 PM	150	2.50	1.2	
4/21/2014	3:00 PM	180	3.00	1.2	Small amount of residual floating particles caused by small air bubbles; solution agitated to allow for even settling



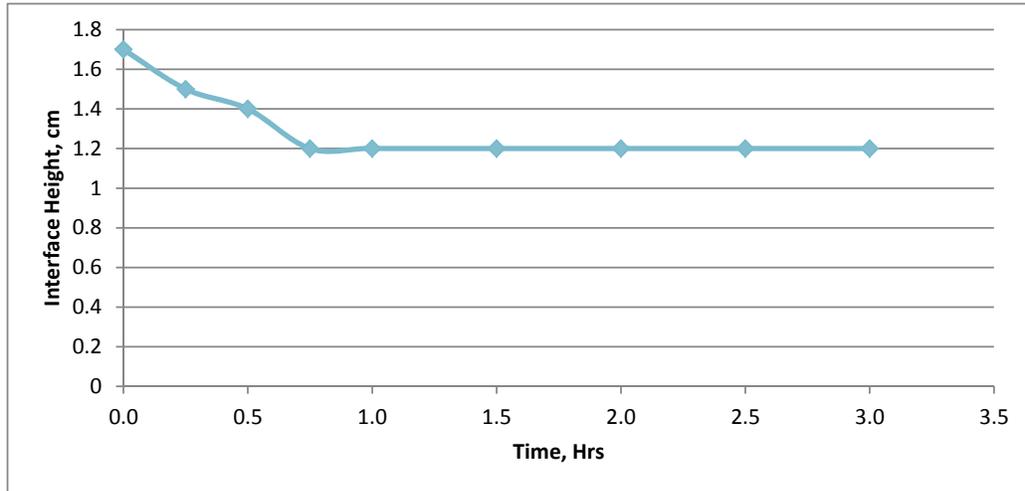
Client Name: ExxonMobil Environmental Services Company
 Project Name: Mayflower, Cove Remediation Project
 Project Location: Mayflower, AR
 Project Number: B0086022.1401.00200



Test Material: **PMFI** Tested By: Ricky Sams
 Test Start Date: 4/21/2014 Checked By: Dave Liles

Column Settling Test
Water/Solids Interface Settling Data

Date	Time	Elapsed Time, min	Elapsed Time, hrs	Water/Solids Interface Height, (cm)	Comments
4/21/2014	12:00 PM	0	0.00	1.7	Media added over the course of 7 minutes
4/21/2014	12:15 PM	15	0.25	1.5	~90% of media has settled to bottom
4/21/2014	12:30 PM	30	0.50	1.4	
4/21/2014	12:45 PM	45	0.75	1.2	Media finished settling at 35 to 40 minutes
4/21/2014	1:00 PM	60	1.00	1.2	Residual floating media on surface, done settling
4/21/2014	1:30 PM	90	1.50	1.2	Residual floating particles; media done settling
4/21/2014	2:00 PM	120	2.00	1.2	Floating, white "fuzzy" looking particles appear
4/21/2014	2:30 PM	150	2.50	1.2	
4/21/2014	3:00 PM	180	3.00	1.2	Residual floating material; solution agitated to allow for even settling



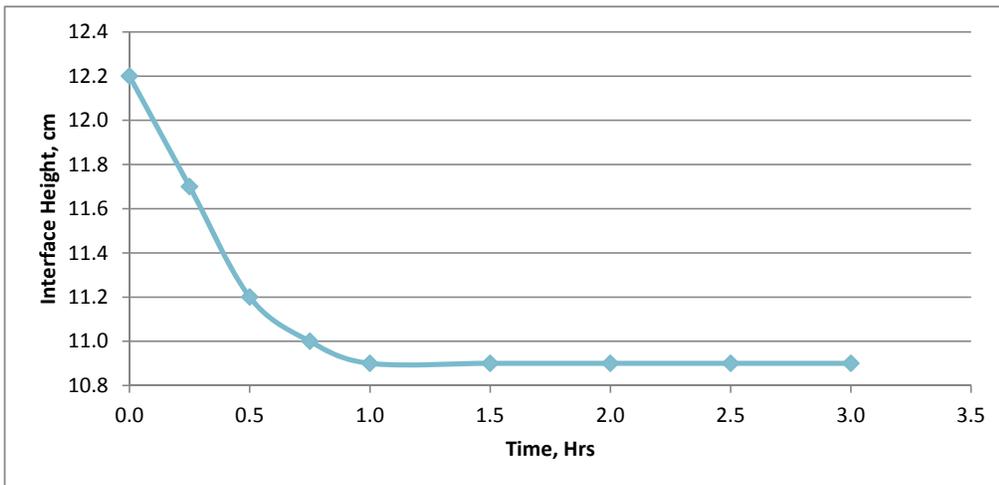
Client Name: ExxonMobil Environmental Services Company
 Project Name: Mayflower, Cove Remediation Project
 Project Location: Mayflower, AR
 Project Number: B0086022.1401.00200



Test Material: **90% Sand / 10% PM-199** Tested By: Ricky Sams
 Test Start Date: 4/22/2014 Checked By: Dave Liles

Column Settling Test
Water/Solids Interface Settling Data

Date	Time	Elapsed Time, min	Elapsed Time, hrs	Water/Solids Interface Height, (cm)	Comments
4/22/2014	3:05 PM	0	0.00	12.2	Media settled immediately; foaming on surface caused residual floating particles
4/22/2014	3:20 PM	15	0.25	11.7	Fines still settling out
4/22/2014	3:35 PM	30	0.50	11.2	Distinct layer of fines on surface of Sand/Organoclay mixture
4/22/2014	3:50 PM	45	0.75	11.0	Fines still settling; foaming on surface has not changed; turbidity decreasing
4/22/2014	4:05 PM	60	1.00	10.9	Foaming on surface has not changed; turbidity decreasing
4/22/2014	4:35 PM	90	1.50	10.9	Foaming still persists
4/22/2014	5:05 PM	120	2.00	10.9	Foaming still persists
4/22/2014	5:35 PM	150	2.50	10.9	
4/22/2014	6:05 PM	180	3.00	10.9	



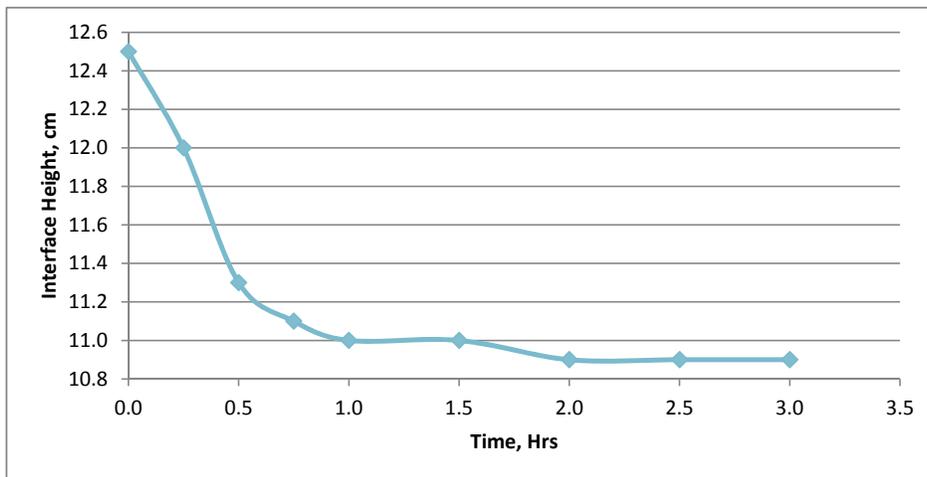
Client Name: ExxonMobil Environmental Services Company
 Project Name: Mayflower, Cove Remediation Project
 Project Location: Mayflower, AR
 Project Number: B0086022.1401.00200



Test Material: **90% Sand - 10% PMFI** Tested By: Ricky Sams
 Test Start Date: 4/22/2014 Checked By: Dave Liles

Column Settling Test
Water/Solids Interface Settling Data

Date	Time	Elapsed Time, min	Elapsed Time, hrs	Water/Solids Interface Height, (cm)	Comments
4/22/2014	3:05 PM	0	0.00	12.5	Media settled rapidly; residual floating particles due to excessive foaming
4/22/2014	3:20 PM	15	0.25	12.0	Foaming persists; fine particles still settling; fines beginning to make distinct layer on bottom
4/22/2014	3:35 PM	30	0.50	11.3	Foaming persists; fines still settling
4/22/2014	3:50 PM	45	0.75	11.1	Fines still settling; turbidity decreasing
4/22/2014	4:05 PM	60	1.00	11.0	Turbidity decreasing; foaming still persists
4/22/2014	4:35 PM	90	1.50	11.0	Foaming still persists on surface
4/22/2014	5:05 PM	120	2.00	10.9	Foaming still persists on surface
4/22/2014	5:35 PM	150	2.50	10.9	Foaming still persists on surface
4/22/2014	6:05 PM	180	3.00	10.9	Foaming still persists on surface



Client Name: ExxonMobil Environmental Services Company
 Project Name: Mayflower, Cove Remediation Project
 Project Location: Mayflower, AR
 Project Number: B0086022.1401.00200



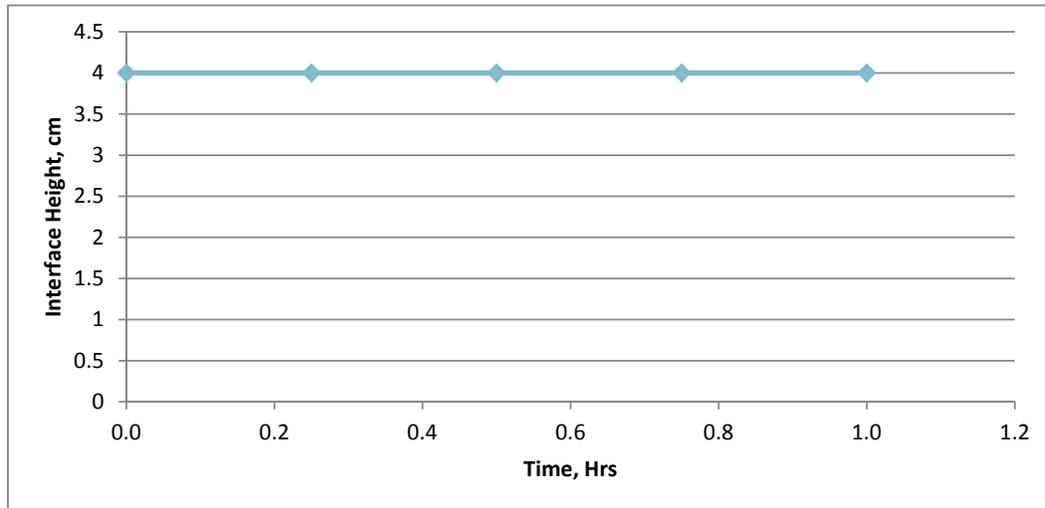
Test Material: **AquaGate** Tested By: Ricky Sams
 Test Start Date: 4/22/2014 Checked By: Dave Liles

Column Settling Test
Water/Solids Interface Settling Data

Date	Time	Elapsed Time, min	Elapsed Time, hrs	Water/Solids Interface Height, cm	Comments
4/22/2014	1:20 PM	0	0.00	4	Media settled immediately; residual floating material on surface
4/22/2014	1:35 PM	15	0.25	4	No change
4/22/2014	1:50 PM	30	0.50	4	No change
4/22/2014	2:05 PM	45	0.75	4	No change
4/22/2014	2:20 PM	60	1.00	4	No change

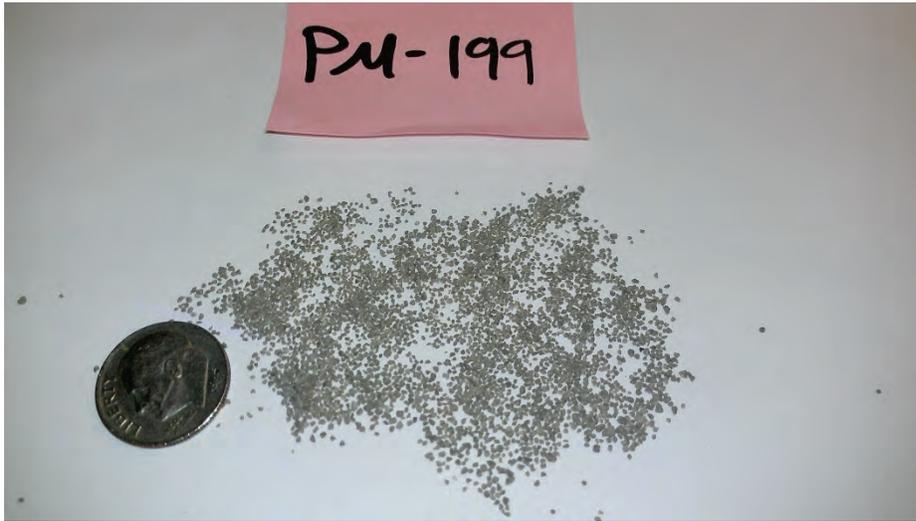
Notes:

1. Test stopped after 1 hour because media settled immediately.

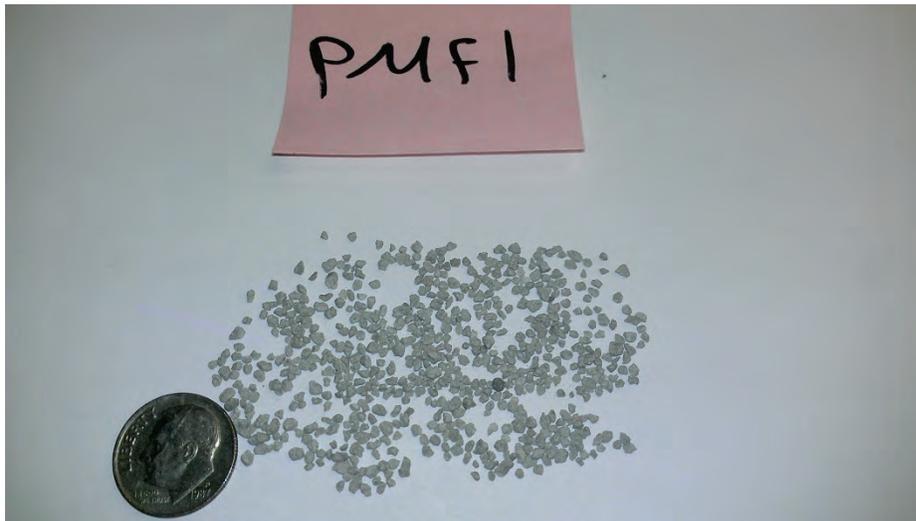




Photolog



Photograph 1
PM-199



Photograph 2
PMFI



Photograph 3
AquaGate

MAYFLOWER PIPELINE INCIDENT RESPONSE
EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY
REACTIVE MEDIA BENCH-SCALE SETTLING TEST

Organoclay Product Materials



FIGURE
1



Photograph 4

Left: 90% Sand mixed with 10% PM-199 (Organoclay); Right: 90% Sand mixed with 10% PMFI (Organoclay)



Photograph 5

Sand

MAYFLOWER PIPELINE INCIDENT RESPONSE
 EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY
 REACTIVE MEDIA BENCH-SCALE SETTLING TEST

Organoclay-Sand Mixture Materials



FIGURE

2



Photograph 6

Elapsed Time: 0 minutes

PM-199 Thickness (left): 1.5 cm

PMFI Thickness (right): 1.7 cm

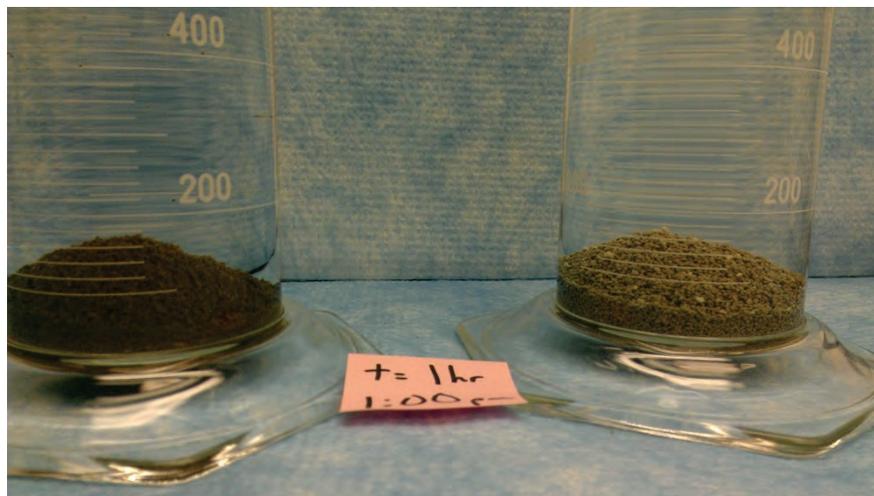


Photograph 7

Elapsed Time: 45 minutes

PM-199 Thickness (left): 1.3 cm

PMFI Thickness (right): 1.2 cm



Photograph 8

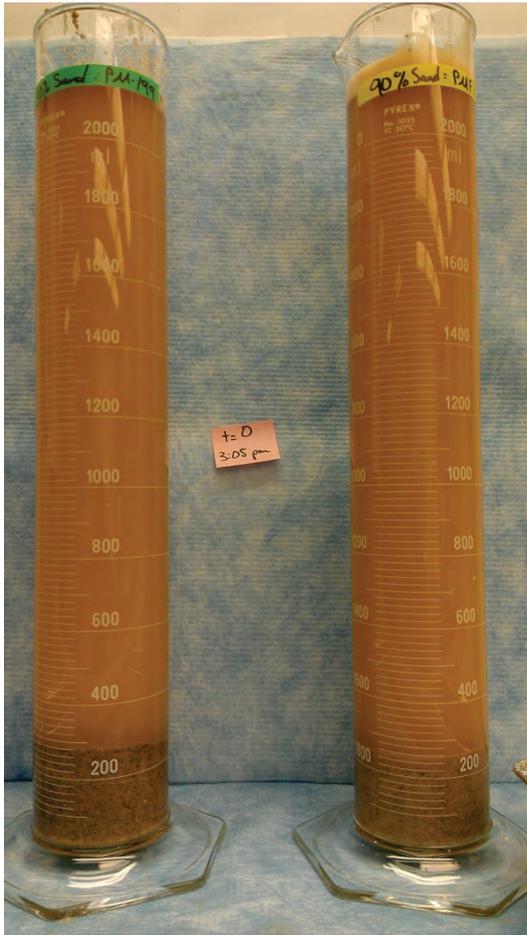
Elapsed Time: 60 minutes

PM-199 Thickness (left): 1.2 cm

PMFI Thickness (right): 1.2 cm

MAYFLOWER PIPELINE INCIDENT RESPONSE
EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY
REACTIVE MEDIA BENCH-SCALE SETTLING TEST

Comparison of PM-199 and PMFI



Photograph 9

Elapsed Time: 0 minutes

90% Sand – 10% PM-199 Thickness (left): 12.2 cm

90% Sand – 10% PMFI Thickness (right): 12.5 cm

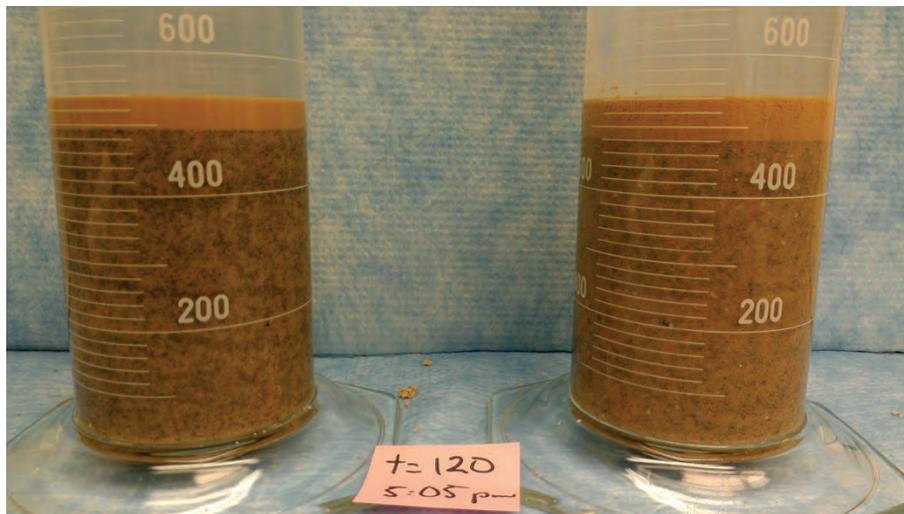


Photograph 10

Elapsed Time: 60 minutes

90% Sand – 10% PM-199 Thickness (left): 10.9 cm

90% Sand – 10% PMFI Thickness (right): 11.0 cm



Photograph 11

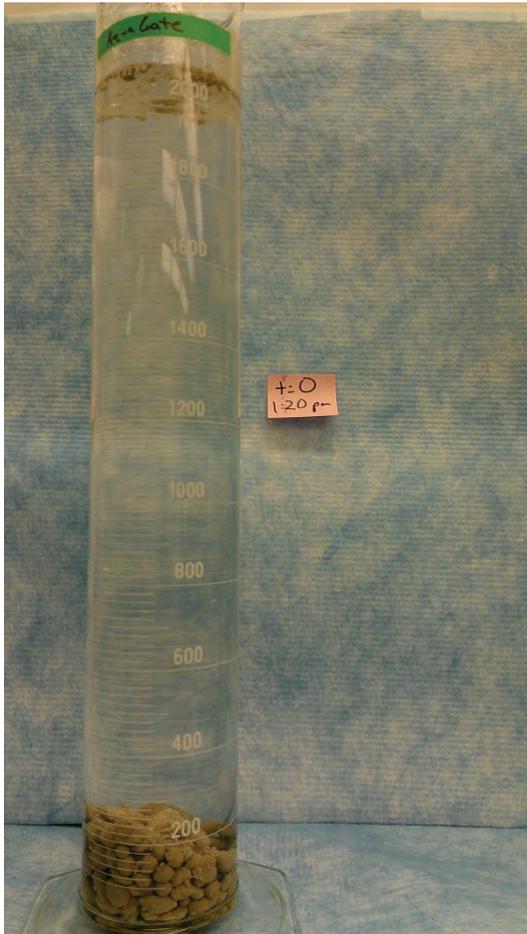
Elapsed Time: 120 minutes

90% Sand – 10% PM-199 Thickness (left): 10.9 cm

90% Sand – 10% PMFI Thickness (right): 10.9 cm

MAYFLOWER PIPELINE INCIDENT RESPONSE
EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY
REACTIVE MEDIA BENCH-SCALE SETTLING TEST

Comparison of 90% Sand – 10% PM-199 and
90% Sand – 10% PMFI



Photograph 12

Elapsed Time: 0 minutes

AquaGate Thickness: 4 cm



Photograph 13

Elapsed Time: 60 minutes

AquaGate Thickness: 4 cm



Photograph 14

Elapsed Time: 0 minutes

AquaGate Thickness: 4 cm

MAYFLOWER PIPELINE INCIDENT RESPONSE
 EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY
 REACTIVE MEDIA BENCH-SCALE SETTLING TEST

AquaGate



FIGURE

5



**Organoclay Sorption Capacity
Bench-Scale Test**

**Organoclay Sorption Capacity Bench-Scale Test, April 2014
Mayflower Pipeline Incident Response, Mayflower, Arkansas**

Bench-scale tests were conducted to determine the organoclay (OC; PM-199) sorption capacity for site-specific residual oil (non-aqueous phase liquid [NAPL]). Specifically, the proposed tests were conducted to provide an estimate of the mass of NAPL that can be sorbed by a specific mass of OC, such that the resulting material does not produce a sheen upon contacting a clean water surface.

Procedure

The procedure for the organoclay NAPL-capacity batch test is as follows:

1. Place a clean mixing bowl on a scale and record its mass to the nearest 0.1 gram (g).
2. Add approximately 20 g of OC to the mixing bowl and again record the weight to the nearest 1 g. Remove the bowl from the scale.
3. Slowly add potable water and stir into OC to produce a water-saturated OC sample.
4. Decant water above the surface of the OC and wipe off any excess moisture from the outside of the bowl.
5. Record the total weight of OC and water to the nearest 0.1 g.
6. Slowly add site-specific NAPL so that the added mass of NAPL is a selected percentage of the weight of OC (e.g., for 50% ratio of NAPL:OC, weight 10 g of NAPL).
 - a. Prepare samples of OC, water, and NAPL to achieve approximate NAPL:OC ratios as follows:
 - i. 50% (10 g NAPL, 20 g OC)
 - ii. 60% (12 g NAPL, 20 g OC)
 - iii. 70% (14 g NAPL, 20 g OC)
 - iv. 75% (15 g NAPL, 20 g OC)
 - v. 100% (20 g NAPL, 20 g OC)
 - vi. 125% (25 g NAPL, 20 g OC)
 - vii. 150% (15 g NAPL, 10 g OC)
7. Record the total weight of water-saturated OC and NAPL to the nearest 0.1 g. Remove the bowl from the scale.
8. Stir to homogenize water-saturated OC and NAPL.
9. Photograph homogenized sample.
10. Place sample in tightly sealed container.
11. Allow sample to sit in sealed container at room temperature for at least 48 hours.
12. Place clean potable water in a large stainless steel bowl.
13. Open sample container and obtain "spoonful" of homogenized sample material.
14. Holding the sample in the spoon, touch the sample to the surface of the water, lower it and raise it several times across the water surface. Look for sheen (see example photograph below).

**Organoclay Sorption Capacity Bench-Scale Test, April 2014
Mayflower Pipeline Incident Response, Mayflower, Arkansas**



15. If no sheen is observed, using latex- or nitrile-gloved hands, transfer the material into hand. Break the mixed OC/water/NAPL material apart at the surface of the water in the stainless steel bowl.
16. Note if NAPL or sheen is present on the surface of the water. Photograph water surface. Record qualitative observations of sheen using the same "Description" terms used in the field (as summarized in the table below from National Oceanic and Atmospheric Administration 2007).

Code	Description	Layer-Thickness Interval	
		microns (μm)	inches (in.)
S	Sheen (silver/gray)	0.04 - 0.30	1.6×10^{-6} – 1.2×10^{-5}
R	Rainbow	0.30 – 5.0	1.2×10^{-5} - 2.0×10^{-4}
M	Metallic	5.0 – 50	2.0×10^{-4} – 2.0×10^{-3}
T	Transitional Dark (or True) Color	50 – 200	2.0×10^{-3} – 8×10^{-3}
D	Dark (or True) Color	>200	> 8×10^{-3}

Results

Organoclay sorption capacity bench-scale tests were completed for seven ratios of NAPL:OC ranging from 50% (10 g NAPL, 20 g OC) to 150% (15 g NAPL, 10 g OC). Results from sorption capacity tests are summarized below and presented in the attached test data sheets and photolog.

After allowing the samples to sit in sealed containers at room temperature for at least 48 hours (and up to 120 hours), the following sheen observations were made:

- No surface water sheen was observed when the sample was touched to the water surface or broken up by hand at the water surface for the NAPL:OC ratios of 50% (after 48 hours), 60% (after 96 hours), 70% (after 96 hours), 75% (after 48 hours), and 100% (after 48 hours).
- A surface water sheen was observed only when the sample was broken up by hand at the water surface for the NAPL:OC ratio of 125% (very weak, silver/grey sheen after 48 hours). After allowing

**Organoclay Sorption Capacity Bench-Scale Test, April 2014
Mayflower Pipeline Incident Response, Mayflower, Arkansas**

the sample to sit in a sealed container for 96 hours, no sheen was observed when the sample was broken up by hand.

- A surface water sheen was observed when the sample was touched to the water surface and broken up by hand at the water surface for the NAPL:OC ratio of 150% (strong, silver/grey sheen after 48 hours). After allowing the sample to sit in a sealed container for 96 hours, a sheen was only observed when the sample was broken up by hand at the water surface (extremely weak sheen).

Attachments

Test Data Sheets

- 50% NAPL:OC
- 60% NAPL:OC
- 70% NAPL:OC
- 75% NAPL:OC
- 100% NAPL:OC
- 125% NAPL:OC
- 150% NAPL:OC

Photolog



Test Data Sheets

Client Name: ExxonMobil Environmental Services Company
Project Name: Mayflower, Cove Remediation Project
Project Location: Mayflower, AR
Project Number: B0086022.1401.00200



Test Material (OC): **PM-199** Tested By: Ricky Sams
NAPL:OC Ratio: **60%** Checked By: Dave Liles
Description: **12g NAPL, 20g OC**
Moisture Addition: **9.49 ml**

NAPL Sorption Tests
Sheen Observations

Date	Time	Sheen (Y/N)	Sheen Description	Elapsed Time, hrs	Comments
4/25/2014	After 24hrs	Y	"S"	24.00	Slight silver/grey sheen when broken apart. Approximately <5% of water surface coverage
4/28/2014	After 96 hrs	N	N/A	96.00	No sheen when dipped or broken apart by hand

Notes:

g = grams
hrs = hours
ml = milliliter
N = no
NAPL = non-aqueous phase liquid
N/A = not applicable
OC = organoclay
S = silver/gray
Y = yes

Client Name: ExxonMobil Environmental Services Company
 Project Name: Mayflower, Cove Remediation Project
 Project Location: Mayflower, AR
 Project Number: B0086022.1401.00200



Test Material (OC): **PM-199**
 NAPL:OC Ratio: **70%**
 Description: **14g NAPL, 20g OC**
 Moisture Addition: **9.8 ml**

Tested By: Ricky Sams
 Checked By: Dave Liles

NAPL Sorption Tests
Sheen Observations

Date	Time	Sheen (Y/N)	Sheen Description	Elapsed Time, hrs	Comments
4/25/2014	After 24hrs	Y	"S"	24.00	Silver/grey sheen when broken apart. Approximately 10-15% of water surface
4/28/2014	After 96 hrs	N	N/A	96.00	No sheen when dipped or broken apart by hand.

Notes:

g = grams
 hrs = hours
 ml = milliliter
 N = no
 NAPL = non-aqueous phase liquid
 N/A = not applicable
 OC = organoclay
 S = silver/gray
 Y = yes

Client Name: ExxonMobil Environmental Services Company
 Project Name: Mayflower, Cove Remediation Project
 Project Location: Mayflower, AR
 Project Number: B0086022.1401.00200



Test Material (OC): **PM-199**
 NAPL:OC Ratio: **75%**
 Description: **15g NAPL, 20g OC**
 Moisture Content: **10.89 ml**

Tested By: Ricky Sams
 Checked By: Dave Liles

NAPL Sorption Tests
Sheen Observations

Date	Time	Sheen (Y/N)	Sheen Description	Elapsed Time, hrs	Comments
4/24/2014	After 24hrs	Y	"S"	24.00	Very weak, silver/grey sheen when broken apart. <5% water surface coverage
4/25/2014	After 48 hrs	N	N/A	48.00	No sheen when dipped or broken apart by hand
4/28/2014	After 120 hrs	N	N/A	120.00	No sheen when dipped or broken apart by hand

Notes:

g = grams
 hrs = hours
 ml = milliliter
 N = no
 NAPL = non-aqueous phase liquid
 N/A = not applicable
 OC = organoclay
 S = silver/gray
 Y = yes

Client Name: ExxonMobil Environmental Services Company
 Project Name: Mayflower, Cove Remediation Project
 Project Location: Mayflower, AR
 Project Number: B0086022.1401.00200



Test Material (OC): **PM-199** Tested By: Ricky Sams
 NAPL:OC Ratio: **100%** Checked By: Dave Liles
 Description: **20g NAPL, 20g OC**
 Moisture Addition: **10.05 ml**

NAPL Sorption Tests
Sheen Observations

Date	Time	Sheen (Y/N)	Sheen Description	Elapsed Time, hrs	Comments
4/24/2014	After 24hrs	Y	"S"	24.00	Slight silver/grey sheen when broken apart. Approximately 5-10% of water surface coverage
4/25/2014	After 48 hrs	N	N/A	48.00	No sheen when dipped or broken apart by hand
4/28/2014	After 120 hrs	N	N/A	120.00	No sheen when dipped or broken apart by hand

Notes:
 g = grams
 hrs = hours
 ml = milliliter
 N = no
 NAPL = non-aqueous phase liquid
 N/A = not applicable
 OC = organoclay
 S = silver/gray
 Y = yes

Client Name: ExxonMobil Environmental Services Company
Project Name: Mayflower, Cove Remediation Project
Project Location: Mayflower, AR
Project Number: B0086022.1401.00200



Test Material (OC): **PM-199**
NAPL:OC Ratio: **150%**
Description: **15g NAPL, 10g OC**
Moisture Addition: **6.11 ml**

Tested By: Ricky Sams
Checked By: Dave Liles

NAPL Sorption Tests Sheen Observations

Date	Time	Sheen (Y/N)	Sheen Description	Elapsed Time, hrs	Comments
4/29/2014	After 24hrs	Y	"S"	24.00	Very prominent silver/grey sheen when dipped into water. Total surface coverage
4/30/2014	After 48 hrs	Y	"S"	48.00	Still strong silver/grey sheen when dipped into water. Total surface coverage
5/2/2014	After 96 hrs	Y	"S"	96.00	Extremely weak sheen when broken apart. <2% total surface coverage

Notes:

g = grams
hrs = hours
ml = milliliter
N = no
NAPL = non-aqueous phase liquid
OC = organoclay
S = silver/gray
Y = yes



Photolog



Photograph 1

Elapsed Time: 0 minutes

Homogenized Sample Composition:

- 20 g OC
- 10 g NAPL
- 9.17 ml water

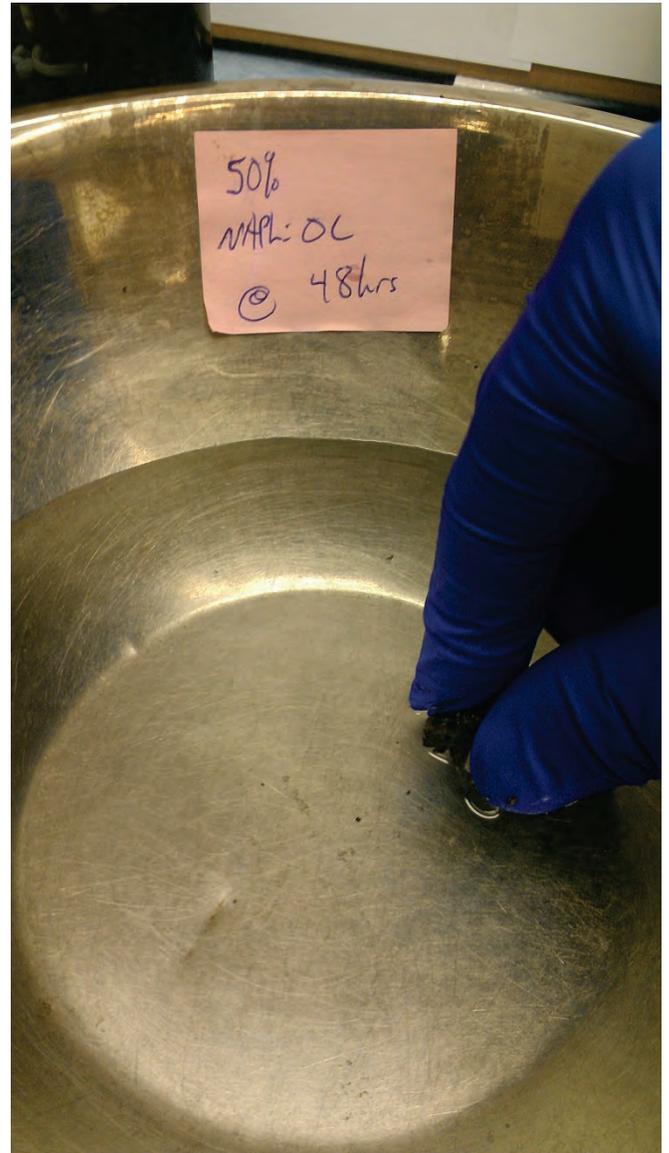
Acronyms:

g = grams

ml = milliliters

NAPL = non-aqueous phase liquid

OC = organoclay (PM-199)



Photograph 2

Elapsed Time: 48 hours

Surface Water Sheen Observed?

- Hand Dipped – No
- Broken Up By Hand - No

Sheen Description:

- Not applicable

MAYFLOWER PIPELINE INCIDENT RESPONSE
 EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY
 OC SORPTION CAPACITY BENCH-SCALE TEST

50% NAPL:Organoclay



FIGURE

1



Photograph 3

Homogenized Sample Composition:

- 20 g OC
- 12 g NAPL
- 9.49 ml water

Elapsed Time: 96 hours

Surface Water Sheen Observed?

- Hand Dipped – No
- Broken Up By Hand - No

Sheen Description:

- Not applicable

Acronyms:

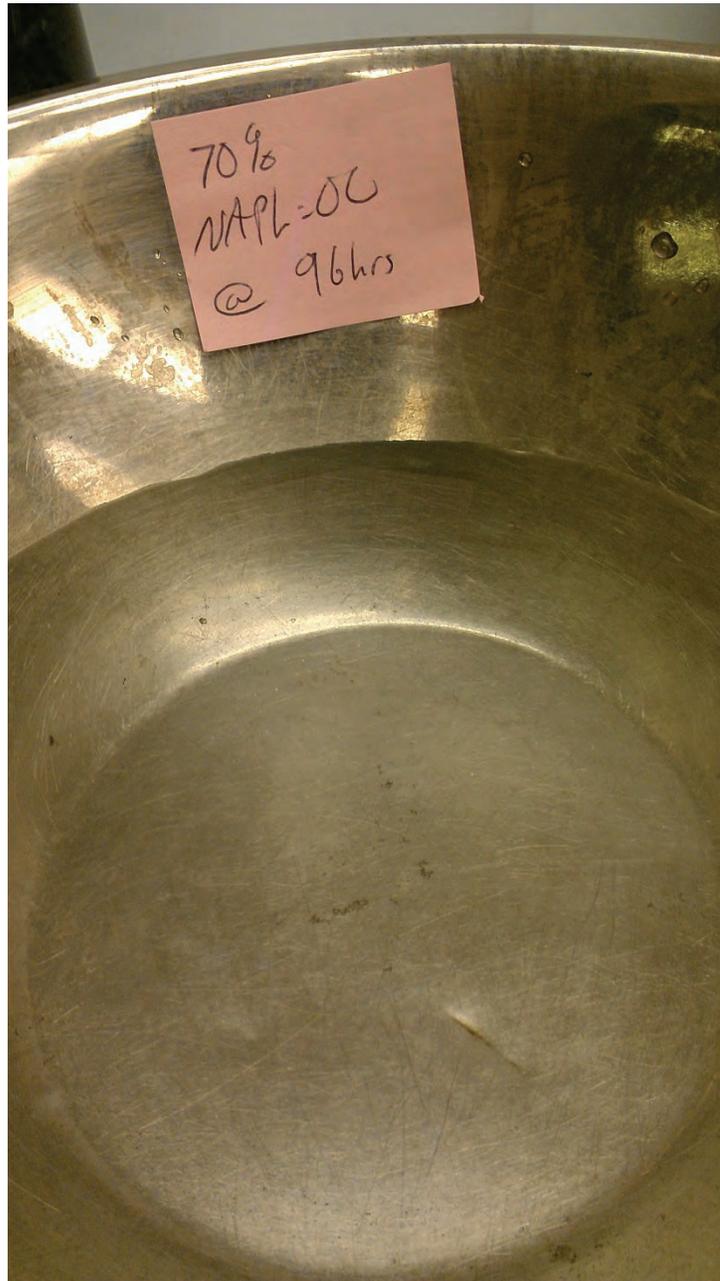
g = grams

ml = milliliters

NAPL = non-aqueous phase liquid

OC = organoclay (PM-199)

MAYFLOWER PIPELINE INCIDENT RESPONSE EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY OC SORPTION CAPACITY BENCH-SCALE TEST	
60% NAPL:Organoclay	
	FIGURE 2



Photograph 4

Elapsed Time: 0 minutes

Homogenized Sample Composition:

- 20 g OC
- 14 g NAPL
- 9.8 ml water

Elapsed Time: 96 hours

Surface Water Sheen Observed?

- Hand Dipped – No
- Broken Up By Hand - No

Sheen Description:

- Not applicable

Acronyms:

g = grams

ml = milliliters

NAPL = non-aqueous phase liquid

OC = organoclay (PM-199)

MAYFLOWER PIPELINE INCIDENT RESPONSE
 EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY
 OC SORPTION CAPACITY BENCH-SCALE TEST

70% NAPL:Organoclay



FIGURE

3



Photograph 5

Elapsed Time: 0 minutes

Homogenized Sample Composition:

- 20 g OC
- 15 g NAPL
- 10.89 ml water



Photograph 6

Elapsed Time: 48 hours

Surface Water Sheen Observed?

- Hand Dipped – No
- Broken Up By Hand - No

Sheen Description:

- Not applicable

Acronyms:

g = grams

ml = milliliters

NAPL = non-aqueous phase liquid

OC = organoclay (PM-199)

MAYFLOWER PIPELINE INCIDENT RESPONSE
 EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY
 OC SORPTION CAPACITY BENCH-SCALE TEST

75% NAPL:Organoclay



FIGURE

4



Photograph 7

Elapsed Time: 0 minutes

Homogenized Sample Composition:

- 20 g OC
- 20 g NAPL
- 10.05 ml water

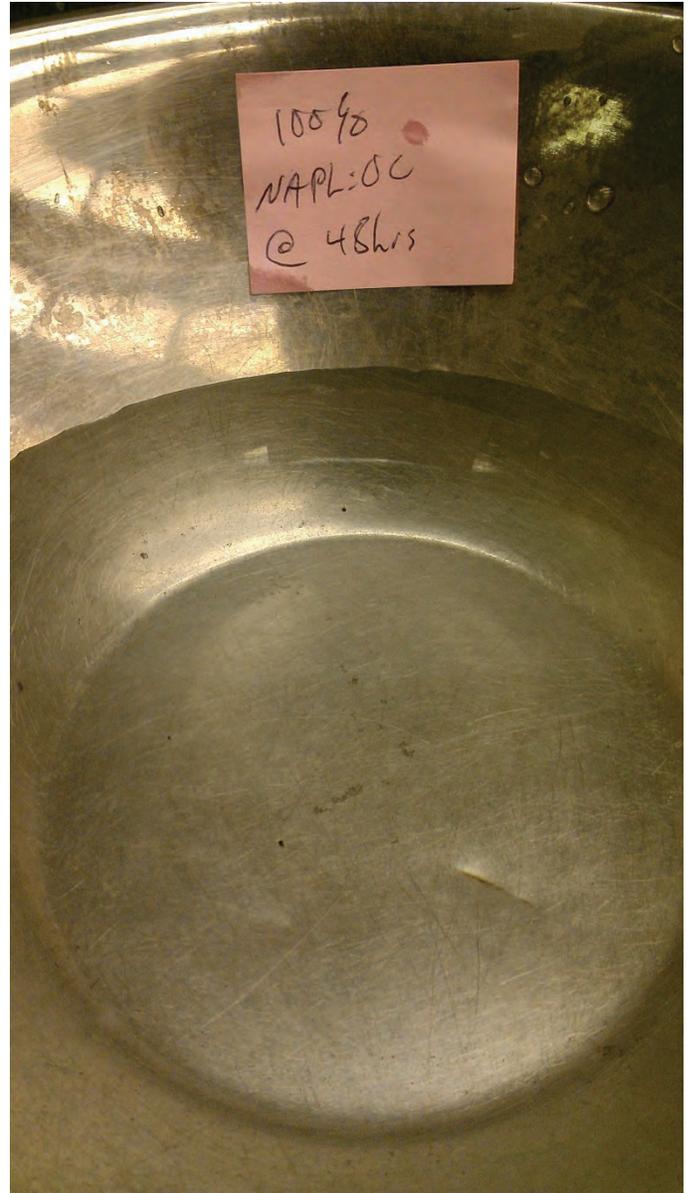
Acronyms:

g = grams

ml = milliliters

NAPL = non-aqueous phase liquid

OC = organoclay (PM-199)



Photograph 8

Elapsed Time: 48 hours

Surface Water Sheen Observed?

- Hand Dipped – No
- Broken Up By Hand - No

Sheen Description:

- Not applicable

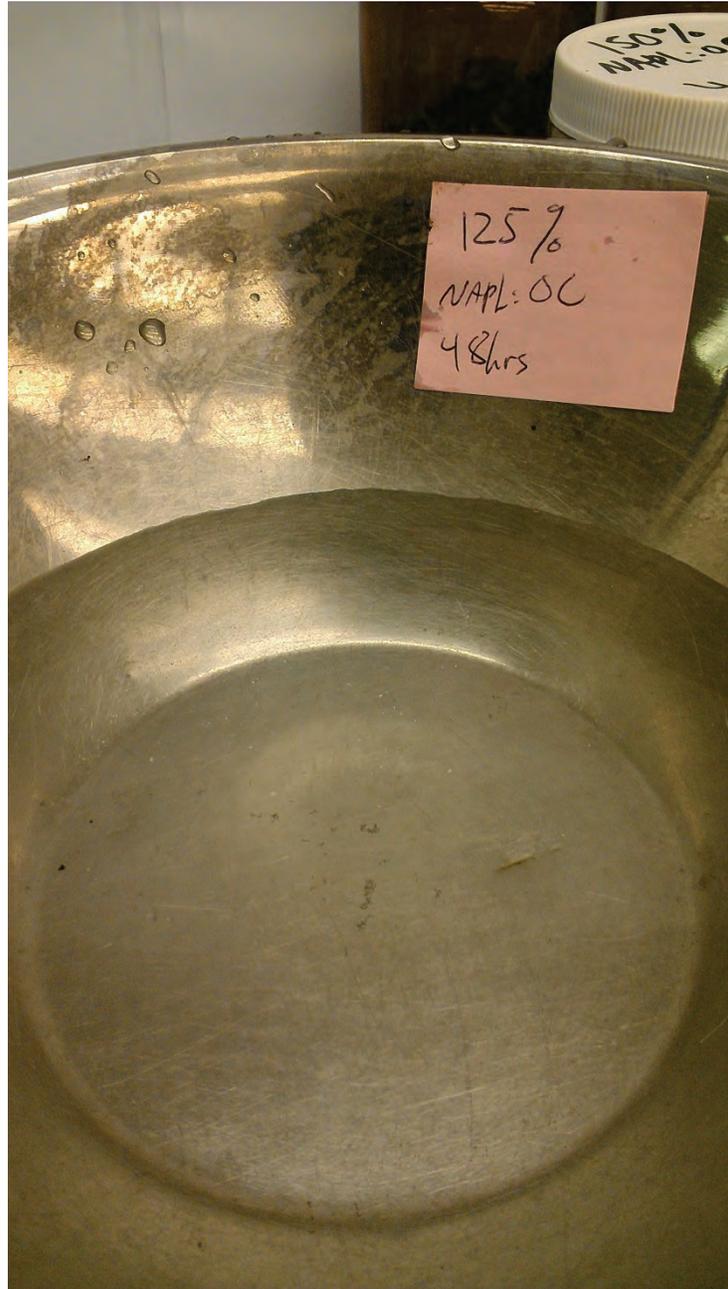
MAYFLOWER PIPELINE INCIDENT RESPONSE
 EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY
 OC SORPTION CAPACITY BENCH-SCALE TEST

100% NAPL:Organoclay



FIGURE

5



Photograph 9

Homogenized Sample Composition:

- 20 g OC
- 25 g NAPL
- 9.12 ml water

Elapsed Time: 48 hours

Surface Water Sheen Observed?

- Hand Dipped – No
- Broken Up By Hand - Yes

Sheen Description:

- Very weak, silver/grey sheen
- <5% water surface coverage

Acronyms:

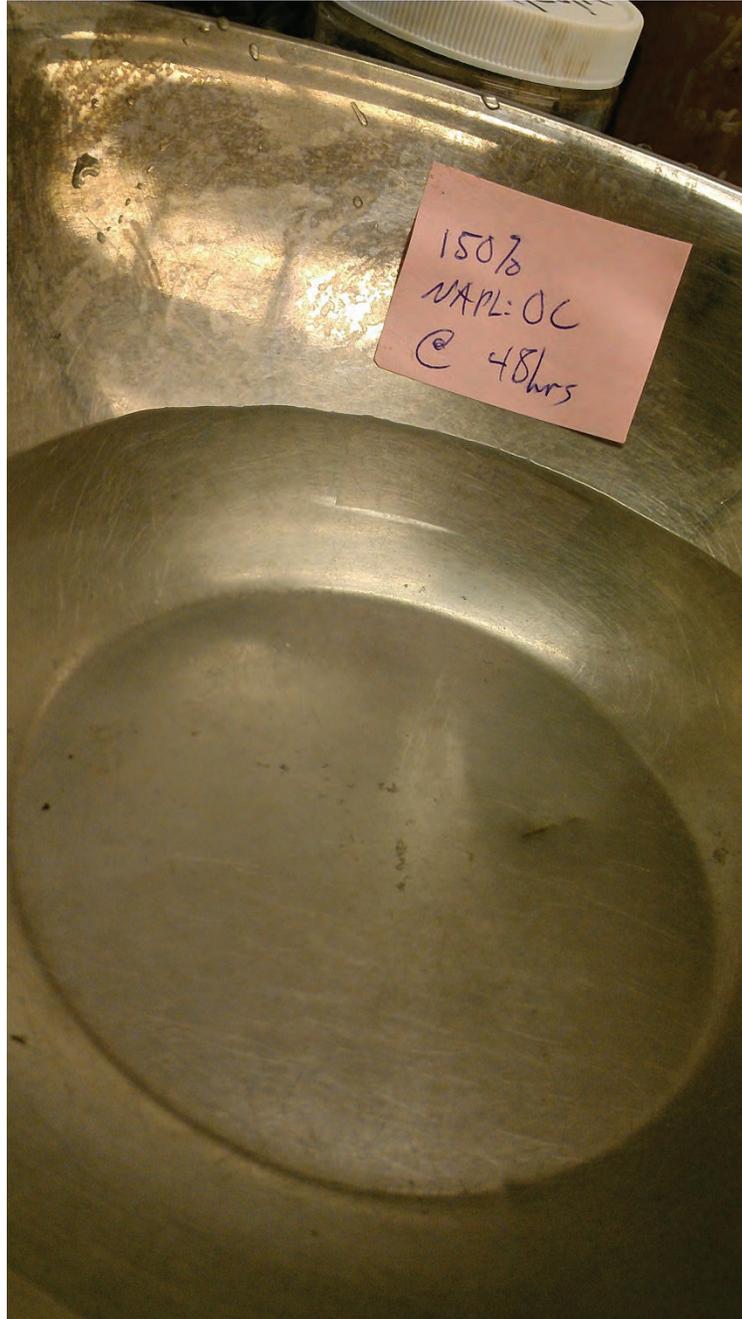
g = grams

ml = milliliters

NAPL = non-aqueous phase liquid

OC = organoclay (PM-199)

MAYFLOWER PIPELINE INCIDENT RESPONSE EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY OC SORPTION CAPACITY BENCH-SCALE TEST	
125% NAPL:Organoclay	
	FIGURE 6



Photograph 10

Homogenized Sample Composition:

- 10 g OC
- 15 g NAPL
- 6.11 ml water

Elapsed Time: 48 hours

Surface Water Sheen Observed?

- Hand Dipped – Yes

Sheen Description:

- Strong silver/grey sheen
- Total water surface coverage

Acronyms:

g = grams

ml = milliliters

NAPL = non-aqueous phase liquid

OC = organoclay (PM-199)

MAYFLOWER PIPELINE INCIDENT RESPONSE
 EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY
 OC SORPTION CAPACITY BENCH-SCALE TEST

150% NAPL:Organoclay

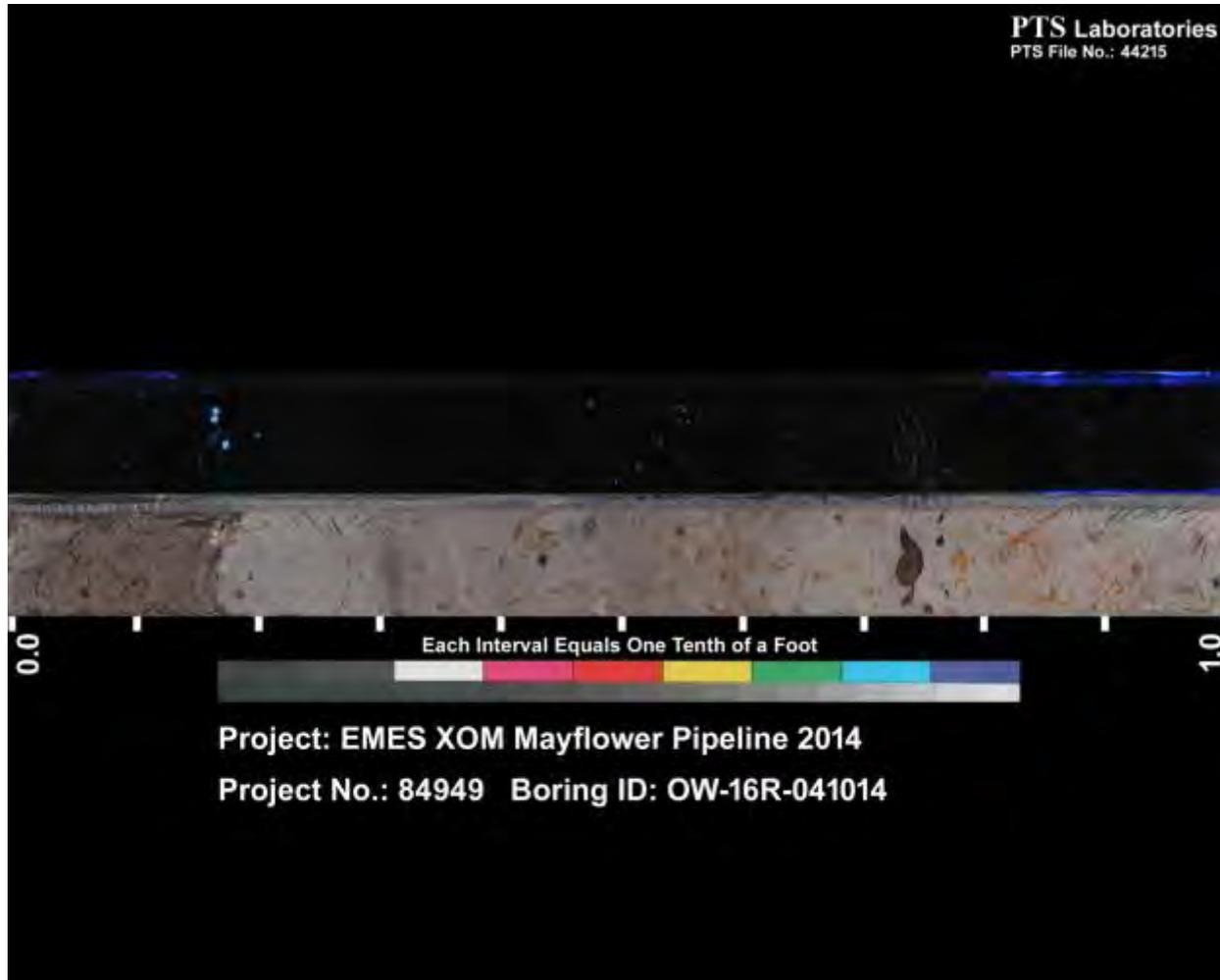


FIGURE

7



**PTS Laboratories Core
Photography Photolog**



Boring ID: OW-16R-041014	
Sampling Depth (inches)	Qualitative Sheening Amount
0 - 6	Medium Sheen
6 - 12	Lighter Sheen

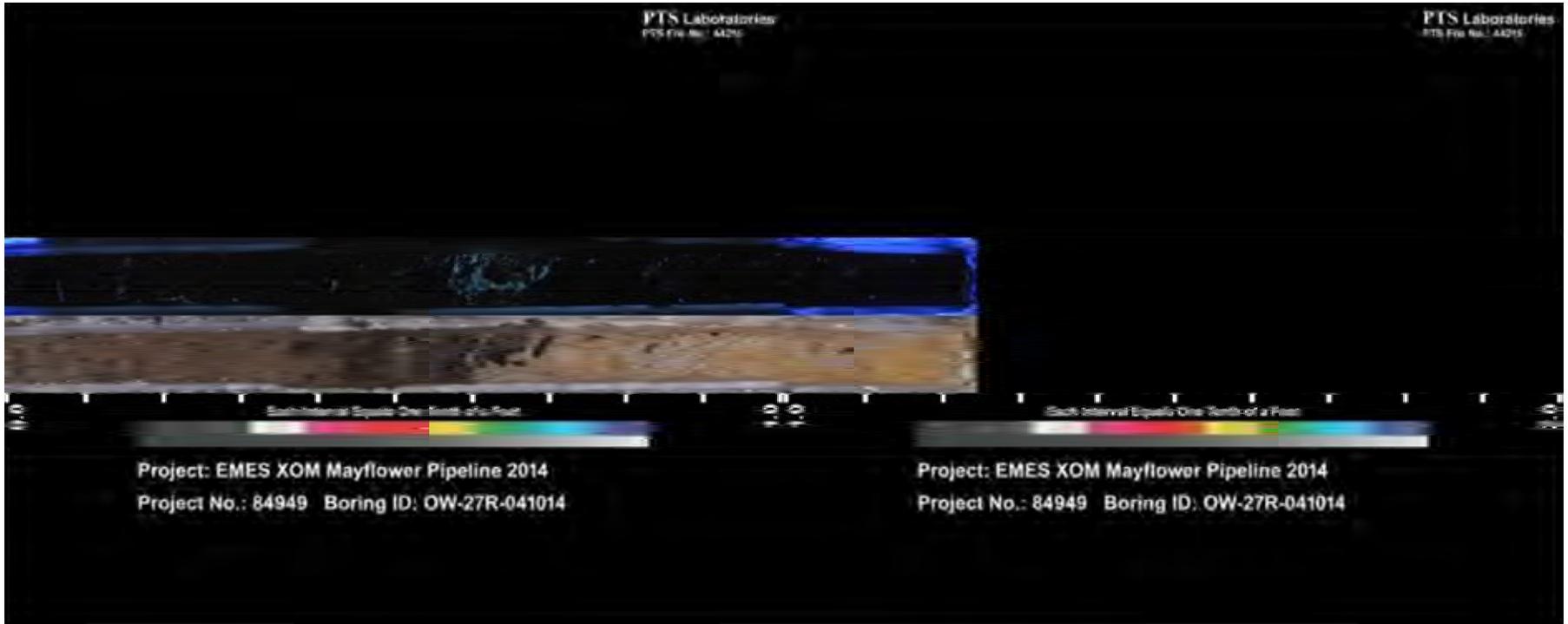
* = Varies for some samples

MAYFLOWER PIPELINE INCIDENT RESPONSE
EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY
MITIGATION ACTION PLAN

PTS LABORATORIES CORE PHOTOLOG



FIGURE
1



Boring ID: OW-27R-041014	
Sampling Depth (inches)	Qualitative Sheening Amount
0 - 6	Heavier Sheen
6 - 12 *	Lighter Sheen

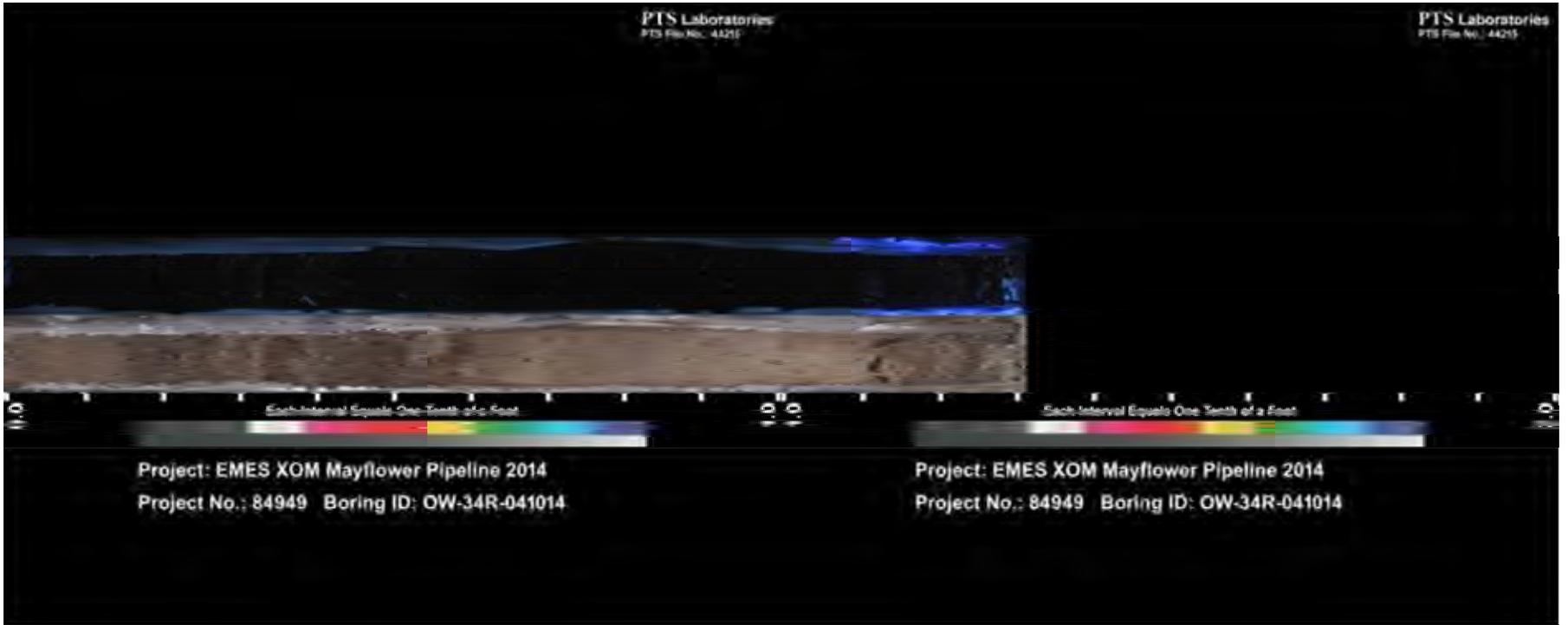
* = Varies for some samples

MAYFLOWER PIPELINE INCIDENT RESPONSE
 EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY
 MITIGATION ACTION PLAN

PTS LABORATORIES CORE PHOTOLOG



FIGURE
 2



Boring ID: OW-34R-041014	
Sampling Depth (inches)	Qualitative Sheening Amount
0 - 6	Heavier Sheen
6 - 12 *	Medium Sheen

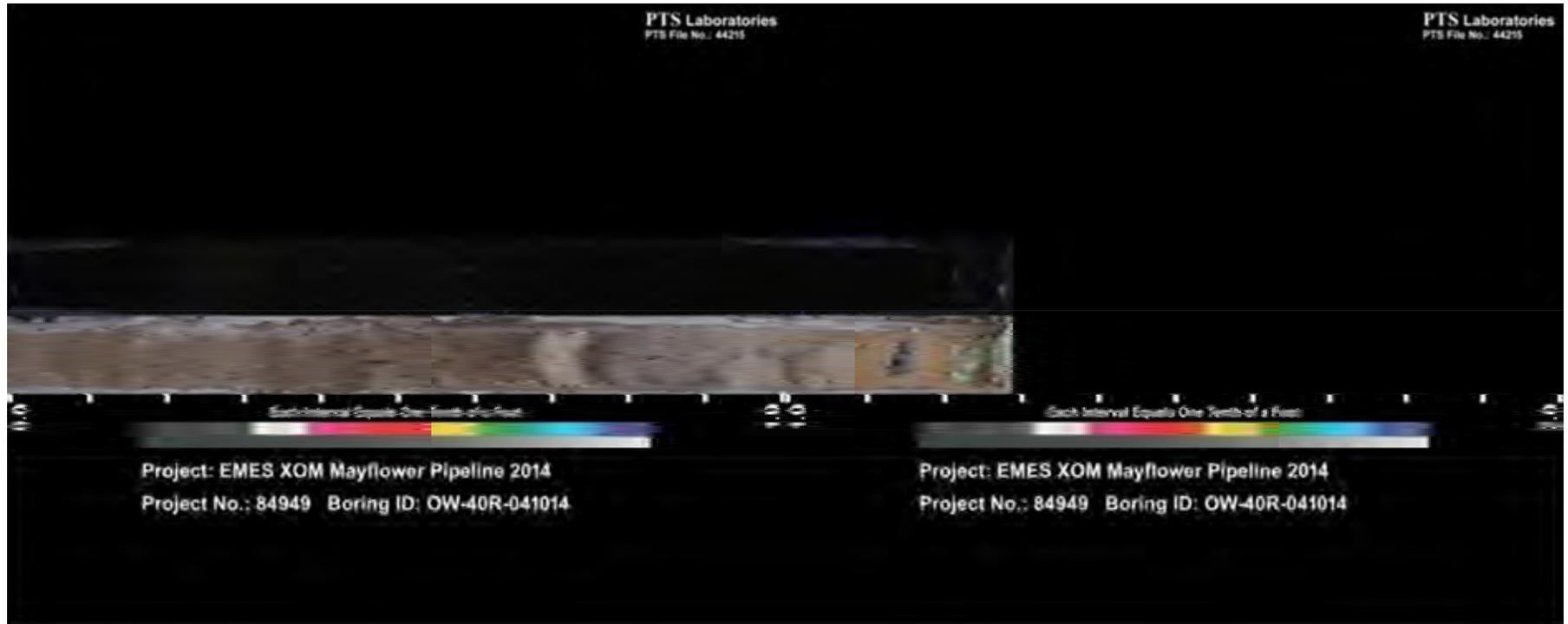
* = Varies for some samples

**MAYFLOWER PIPELINE INCIDENT RESPONSE
EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY
MITIGATION ACTION PLAN**

PTS LABORATORIES CORE PHOTOLOG



FIGURE
3



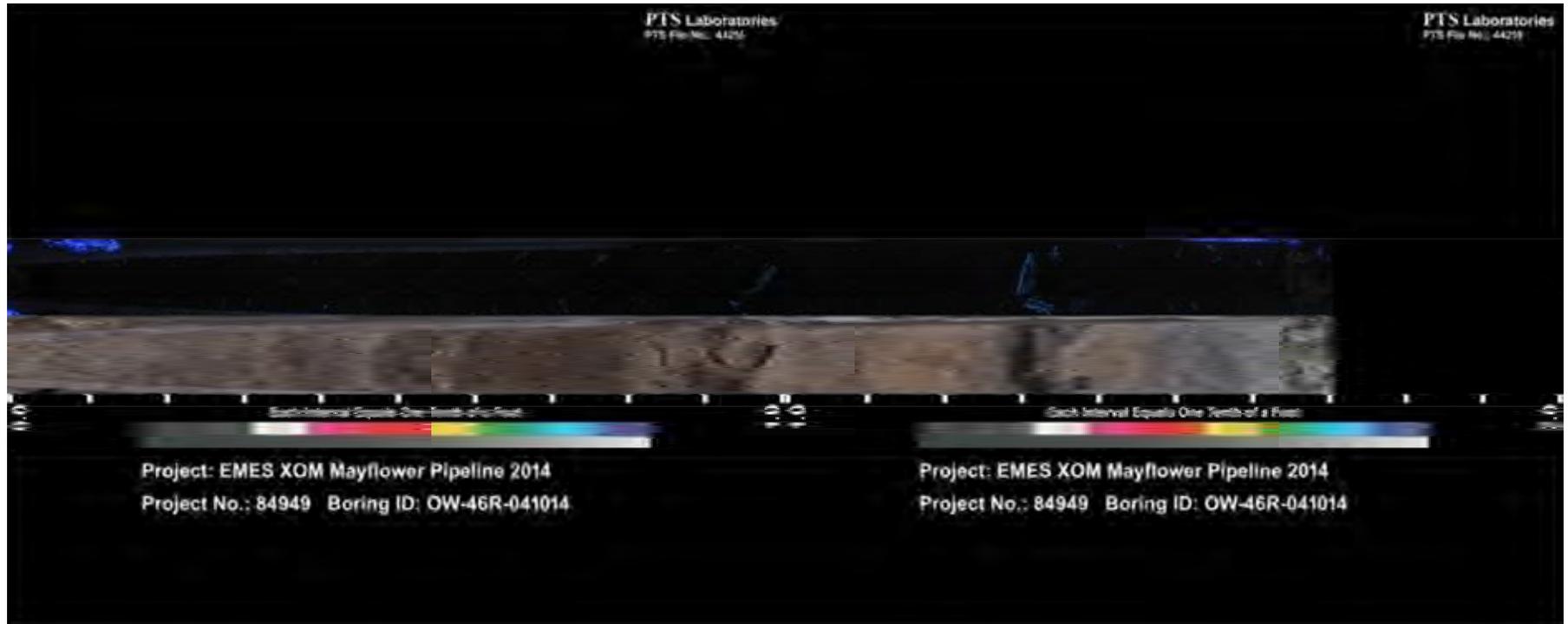
Boring ID: OW-40R-041014	
Sampling Depth (inches)	Qualitative Sheening Amount
0 - 6	Heavier Sheen
6 - 12 *	Medium Sheen

* = Varies for some samples

**MAYFLOWER PIPELINE INCIDENT RESPONSE
EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY
MITIGATION ACTION PLAN**

PTS LABORATORIES CORE PHOTOLOG





Boring ID: OW-46R-041014	
Sampling Depth (inches)	Qualitative Sheening Amount
0 - 6	Heavier Sheen
6 - 12 *	Heavier Sheen

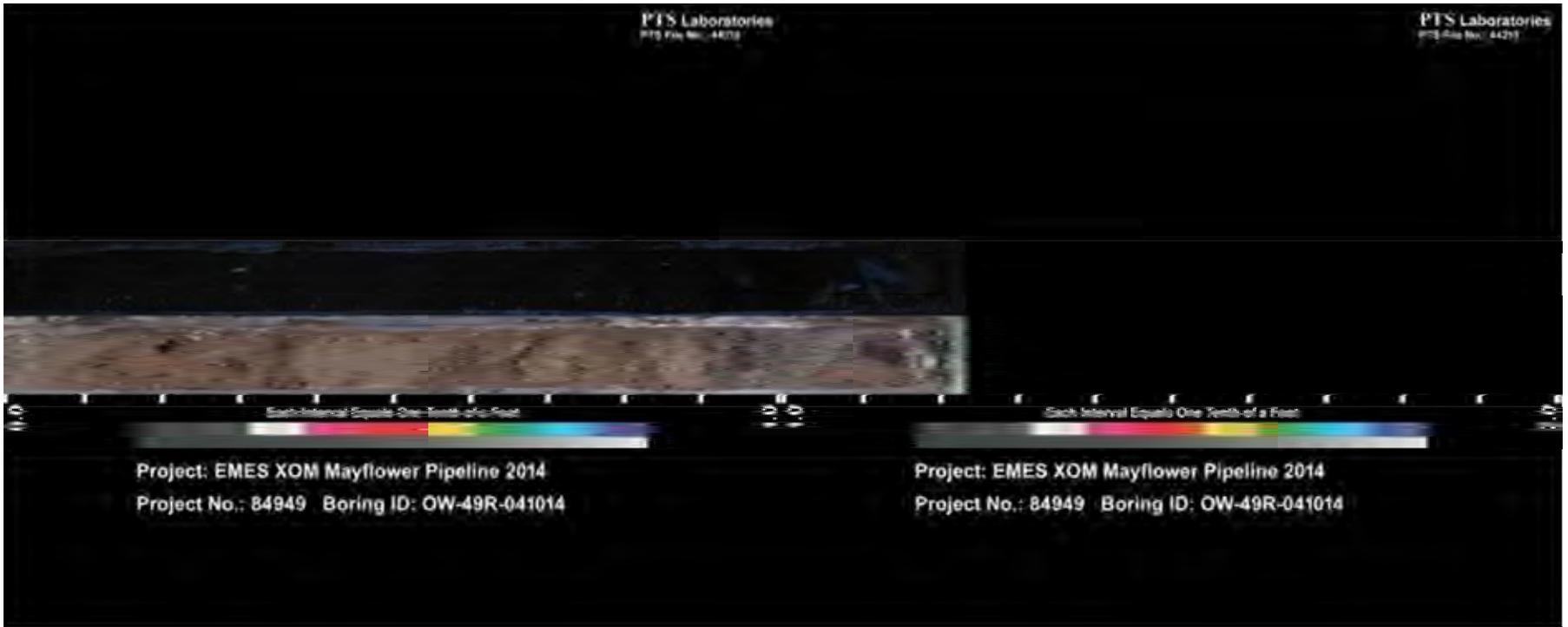
* = Varies for some samples

**MAYFLOWER PIPELINE INCIDENT RESPONSE
EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY
MITIGATION ACTION PLAN**

PTS LABORATORIES CORE PHOTOLOG



FIGURE
5



Boring ID: OW-49R-041014	
Sampling Depth (inches)	Qualitative Sheening Amount
0 - 6	Medium Sheen
6 - 12 *	Lighter Sheen

* = Varies for some samples

**MAYFLOWER PIPELINE INCIDENT RESPONSE
EXXONMOBIL ENVIRONMENTAL SERVICES COMPANY
MITIGATION ACTION PLAN**

PTS LABORATORIES CORE PHOTOLOG





PTS Laboratory Report



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

April 29, 2014

Barbara Orchard, PE
ARCADIS U.S., Inc.
1100 Olive Way, Suite 800
Seattle, WA, 98101

Re: PTS File No: 44215
Physical Properties Data
EMES XOM Mayflower Pipeline 2014; 84949

Dear Ms. Orchard:

Please find enclosed report for Physical Properties analyses conducted upon samples received from your EMES XOM Mayflower Pipeline 2014; 84949 project. All analyses were performed by applicable ASTM, EPA, or API methodologies. An electronic version of the report has previously been sent to your attention via the internet. The cores remain in frozen storage and will be held indefinitely. Please note that core storage will be billed quarterly.

PTS Laboratories appreciates the opportunity to be of service. If you have any questions or require additional information, please give me a call at (562) 347-2502.

Sincerely,
PTS Laboratories, Inc.

for
Michael Mark Brady, P.G.
District Manager

Encl.

Project Name: EMES XOM Mayflower Pipeline 2014
 Project Number: 84949

PTS File No: 44215
 Client: ARCADIS

TEST PROGRAM - 20140415

CORE ID	Depth ft.	Core Recovery ft.	Slab and Core Photo	Pore Fluid Saturation Package					Comments
Date Received: 20140411		Plugs:	1/4:3/4	Vert. 1.5"					
OW-16R-041014	NA	1.0	1	0.1-0.3					
OW-19R-041014	NA	1.2							HOLD - NO ANALYSES
OW-20R-041014	NA	1.0							HOLD - NO ANALYSES
OW-24R-041014	NA	1.3							HOLD - NO ANALYSES
OW-27R-041014	NA	1.2	2	0.1-0.3, 0.5-0.7					
OW-32R-041014	NA	1.0							HOLD - NO ANALYSES
OW-34R-041014	NA	1.3	2	0.0-0.2, 0.3-0.5					
OW-40R-041014	NA	1.2	2	0.0-0.2					
OW-46R-041014	NA	1.7	2	0.0-0.2					
OW-49R-041014	NA	1.2	2	0.0-0.2, 0.2-0.4					
TOTALS:	10 cores	12.0	11	9					12

Laboratory Test Program Notes

Contaminant identification: _____

Standard TAT for basic analysis is 10 business days.

Sample locations to be selected by ARCADIS personnel from core photography.

Pore Fluid Saturation Package: API RP40 Dean-Stark Method: Includes initial pore fluid saturations, total porosity, air-filled porosity, grain density, dry bulk density and moisture content.

Pore Fluid Saturation sample locations added 20140415 by B. Orchard/URS.

PTS File No: 44215
 Client: ARCADIS
 Report Date: 04/29/14

PHYSICAL PROPERTIES DATA - PORE FLUID SATURATIONS

Project Name: EMES XOM Mayflower Pipeline 2014
 Project No: 84949

SAMPLE ID.	DEPTH, ft.	METHODS: SAMPLE ORIENTATION (1)	API RP 40 / ASTM D2216 MOISTURE CONTENT, % weight	API RP 40 DENSITY		API RP 40 POROSITY, %Vb (2)		API RP 40 PORE FLUID SATURATIONS, % Pv (3)	
				DRY BULK, g/cc	GRAIN, g/cc	TOTAL	AIR FILLED	WATER	NAPL
OW-16R-041014	0.2	V	59.8	0.94	2.47	62.0	5.6	86.5	4.5
OW-27R-041014	0.2	V	132.3	0.54	2.29	76.4	3.9	86.2	8.8
OW-27R-041014	0.6	V	63.8	0.90	2.48	63.8	6.3	86.3	3.9
OW-34R-041014	0.1	V	125.5	0.53	2.53	79.2	13.0	80.5	3.2
OW-34R-041014	0.4	V	157.3	0.46	2.42	80.8	7.4	87.9	2.9
OW-40R-041014	0.1	V	102.4	0.63	2.58	75.4	10.1	82.5	4.2
OW-46R-041014	0.1	V	118.5	0.57	2.55	77.6	9.3	80.9	7.2
OW-49R-041014	0.1	V	119.2	0.55	2.40	77.3	11.7	80.3	4.6
OW-49R-041014	0.3	V	155.2	0.46	2.27	79.5	7.0	86.9	4.2

Note: Review of the cores shows little or no physical evidence of hydrocarbon saturation presence: 1) UV fluorescence appears to be from mineral or organic material, 2) no presence of hydrocarbon odor, only organic odor, 3) no visual presence of hydrocarbon or NAPL, 4) the core material consists of very fine grained sediments and/or organic material which may yield false-positive NAPL saturation results.

NAPL/hydrocarbon saturations determined by Dean-Stark Extraction method are based on weight difference of sample material pre-extraction versus post-extraction. Very fine grained or organic material may be lost or dissolved during extraction yielding exaggerated weight differences resulting in false positive test results. Chemical analytical test methods should be employed to verify presence of NAPL/hydrocarbon. Michael Mark Brady, P.G., Laboratory Director

(1) Sample Orientation: H = horizontal; V = vertical; R = remold
 (2) Total Porosity = all interconnected pore channels; Air Filled = pore channels not occupied by pore fluids.
 (3) Fluid density used to calculate pore fluid saturations: Water = 0.9996 g/cc, NAPL = 0.8600 g/cc.
 Vb = Bulk Volume, cc; Pv = Pore Volume, cc; ND = Not Detected

CHAIN OF CUSTODY & LABORATORY

Lab Work Order #	
------------------	--

8100 Secura Way
 Santa Fe Springs, CA 90670
 Phone (562) 907-3607 • FAX (562) 907-3610
 Attn: Michael Brady (562) 347-2502

ANALYSIS REQUEST FORM

PROJ. NO. 84949		PROJECT NAME: Mayflower Pipeline Incident																		COC Number						
SAMPLERS: TDF / LMT						Requested Analyses																				
SAMPLE ID	DATE	TIME	MATRIX	Core/Grab	# Containers	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Remarks
OW-16R-041014	4-10-14	1505	Sediment	Core	1	X	X																			0-13" / Medium
OW-17R-041014	4-10-14	1505	Sediment	Core	1	X	X																			0-13" / Medium
OW-21R-041014	4-10-14	1025	Sediment	Core	1	X	X																			0-11" / Heavy
OW-22R-041014	4-10-14	1030	Sediment	Core	1	X	X																			0-11" / Heavy
OW-27R-041014	4-10-14	1425	Sediment	Core	1	X	X																			0-15" / Heavy
OW-32R-041014	4-10-14	0945	Sediment	Core	1	X	X																			0-12" / Heavy
OW-34R-041014	4-10-14	1445	Sediment	Core	1	X	X																			0-15" / Heavy
OW-40R-041014	4-10-14	1405	Sediment	Core	1	X	X																			0-15" / Heavy
OW-46R-041014	4-10-14	1325	Sediment	Core	1	X	X																			0-23" / Heavy
OW-49R-041014	4-10-14	1120	Sediment	Core	1	X	X																			0-15" / Medium

Requested Analyses		Special Instructions/Comments:				<input type="checkbox"/> Special QA/QC Instructions			
1	PhotoLog Digital/ Core Photography white light and UV	Samples preserved with dry ice.							
2	Pore Fluid Saturation Package API RP 40	Contact ARCADIS for details on Pore Fluid Saturation Sample Interval. (Contact: Barbara Orchard; 206 726 4723; barbara.orchard@arcadis-us.com)							
Laboratory Information and Receipt									
4	Lab Name: PTS Laboratories				Sample Receipt:				
5	Shipping Tracking #								
6	Specify Turnaround Requirements:								
8	Relinquished by:	DATE	TIME	Received by:	Relinquished by:	DATE	TIME	Received by:	
9	<i>[Signature]</i>	4/10/14	1730	FedEx					
10	Relinquished by:	DATE	TIME	Received by:	Relinquished by:	DATE	TIME	Received by:	
11									