APPENDIX A

NOTICES OF INTENT TO REMEDIATE, REPORT NOTIFICATIONS AND PADEP CORRESPONDENCES

NIR Documents

Evergreen Resources Management
2 Righter Parkway, Suite 200
Wilmington, DE 19803

November 17, 2014

Mr. C. David Brown, Ph. D., PG
Department of Environmental Protection
2 East Main Street
Norristown, PA 19401

RE: Philadelphia Energy Solutions Refining & Marketing LLC (PES) Philadelphia Refinery Complex
3144 West Passyunk Avenue, Philadelphia, Philadelphia County, Pennsylvania

Dear Mr. Brown:

In accordance with the Land Recycling and Environmental Remediation Standards Act (Act 2), enclosed is the revised Notice of Intent to Remediate (NIR) for the Philadelphia Refinery Complex (site). The original NIR for the site was submitted on October 12, 2006. The purpose of this revision is to update owner and remediator information for the facility. This revision also includes a site location map depicting a change to property boundaries, most notably the exclusion of Belmont Terminal, which was covered under a separate NIR submission on October 6, 2014. It should be noted that the Belmont Terminal was not included in the original October 12, 2006 NIR, therefore, its exclusion from the revised NIR is not a change.

On August 14, 2012, Sunoco, Inc. (R&M) (Sunoco) entered into a Consent Order and Agreement with Philadelphia Energy Solutions Refining & Marketing LLC (PES) and the Pennsylvania Department of Environmental Protection (PADEP) for the Philadelphia Refinery Complex. As part of this buyer-seller agreement, Sunoco retained responsibility of remediation activities for environmental conditions existing at the time of the transfer, and PES is responsible for environmental conditions following the purchase agreement. On September 8, 2012, Sunoco conveyed the Philadelphia Refinery to PES. Effective December 30, 2013, "Philadelphia Refinery Operations, a series of Evergreen Resources Group, LLC" (Evergreen) assumed Sunoco legacy remediation liabilities with respect to the Philadelphia Refinery Complex. Evergreen will continue to manage the remediation work at the facility under the One Cleanup Program with the PADEP and United States Environmental Protection Agency (USEPA) and in accordance with 2012 Consent Order & Agreement.

Please call me at (302) 477-0192 with any questions or comments.

Best Regards,

James Oppenheim, PE
Vice President

cc: Evergreen File
Charles Barksdale, Philadelphia Energy Solutions Refining and Marketing, LLC
Jennifer Menges, Stantec Consulting Services Inc.

8000-FM-CRLG0010 Rev. 9/2010

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
COMMUNITY REVITALIZATION AND LOCAL GOVERNMENT SUPPORT

For DEP Use Only
PF #__________
Rem ID #__________

NOTICE OF INTENT TO REMEDIATE

Act 1995-2 requires four general information items to be included in the NIR: the general location, listing of contaminants, intended use of property, and proposed remediation measures. In addition, indicate the standard(s) to be obtained (if known) and attach a scaled site map (if available).

Property Name Philadelphia Energy Solutions Refining & Marketing LLC (PES) Philadelphia Refinery Complex

Former Name(s) / AKA Sunoco Inc. (R&M) Philadelphia Refinery

Address / Location 3144 Passyunk Avenue

City Philadelphia Zip Code 19145

Municipality(s)City of Philadelphia County(ies) Philadelphia

Latitude 39 º (deg). 55 ‘ (min) 13.976 “ (sec) Longitude 75 º (deg). 11 ‘ (min) 52.429 “ (sec)

Horizontal Collection Method Geographic Information Systems

Horizontal Reference Datum NAD 1983 Reference Point Visitor Entrance

☒ Wish to participate in the DEP/EPA MOA. Contact Troy Conrad at tconrad@state.pa.us for details.

EPA ID#, if known PAD049791098

DEP ID#(s), if known Multiple
(i.e., eFACTS site ID#, storage tank facility ID#, water quality permit #, watershed permit, air quality permit #, etc.)

Date Release Occurred (if known) __________

Provide a brief description of the site contamination in plain language (e.g. fuel oil spill, historical chemical industrial area contamination), the names of any know primary contaminants to be addressed, and the intended future use of the property.

The site contamination consists of impacts to soil and groundwater associated with historic petrochemical refining operations. The primary consistuents of concern in soil and groundwater are lead, 1,2-dichloroethane, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, benzene, cumene, ethylbenzene, methyl tertiary butyl ether, toluene, total xylenes, ethylene dibromide, anthracene, benzo(a)anthracene, benzo(g,h,i)perylene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, fluorene, naphthalene, phenanthrene, and pyrene. The future use of the facility is to remain industrial.

Provide a general description of proposed remediation measures.

Evergreen is submitting this Notice of Intent to Remediate (NIR) in order update an NIR previously submitted on October 6, 2006 which formally entered the property into the PA Act 2 Program. In November 2011, the facility was formally entered into the PA One Cleanup Program with the USEPA and PADEP. The purpose of this NIR revision is to update the facility ownership and remediator information. The facility has been divided into 11 Areas of Interest (AOIs). These areas consist of the Point Breeze Processing Area North Yard (AOI 8) and South Yards (AOI 1 through AOI 4); the Girard Point South Tank Field (AOI 5) and Processing Area (AOI 6 and AOI 7); the Schuylkill River Tank Farm (AOI 9); the West Yard (AOI 10); and the deep aquifer (AOI 11). Each AOI will be characterized in accordance with PA Act 2, and remedial measures will be developed to address the risk of exposure identified during the characterization activities.

Remediation Standard(s) planned (if known at this time):

☐ Unknown at this time ☐ Soil ☐ Groundwater

☐ Background ☐ Soil ☐ Groundwater
Contaminants:

☐ Statewide Health - Residential ☐ Soil ☐ Groundwater
Contaminants:

☐ Statewide Health – Non-Residential ☐ Soil ☐ Groundwater
Contaminants:

☒ Site Specific ☒ Soil ☒ Groundwater
Contaminants:

☐ Special Industrial Area* ☐ Soil ☐ Groundwater
Contaminants:

*NOTE: Specific standard or Special Industrial Area require a 30-day municipal comment period

Remediator / Property Owner / Consultant. Complete the form below for *each* recipient obtaining a release of liability upon approval of the final report. Attach additional sheets as necessary.

Remediator

Contact Person/Title Jim Oppenheim, PE/Vice President eFACTS Client ID* 314958
Relationship to Site Remediator Client Type* Limited Liability Company
(e.g. owner, remediator, participant in cleanup, consultant, etc.)
Phone Number (302) 477-0192 Email Address JROPPENHEIM@evergreenresmgt.com
Company Name Evergreen Resources Management Operations EIN or Federal ID # 46-4184955
Address (street, city, state, zip) 2 Righter Parkway, Suite 200, Wilmington, DE 19803

Property Owner

Contact Person/Title Charles Barksdale Jr./Site Environmental Director eFACTS Client ID* 298341
Relationship to Site Owner Client Type* Limited Liability Company
(e.g. owner, remediator, participant in cleanup, consultant, etc.)
Phone Number 215-339-2074 Email Address charles.barksdale@pes-companies.com
Company Name Philadelphia Energy Solutions Refining and Marketing, LLC EIN or Federal ID # 61-168974
Address (street, city, state, zip) 3144 Passyunk Ave, Philadelphia, PA 19145

Consultant

Contact Person/Title Jennifer Menges/Principal Consultant, LRS eFACTS Client ID* N/A
Relationship to Site Consultant Client Type* N/A
(e.g. owner, remediator, participant in cleanup, consultant, etc.)
Phone Number (610) 840-2540 Email Address Jennifer.Menges@stantec.com
Company Name Stantec EIN or Federal ID # N/A
Address (street, city, state, zip) 1060 Andrew Drive, Suite 140, West Chester, PA 19380

*Include eFACTS Client ID (if known) – "Client Types" below:

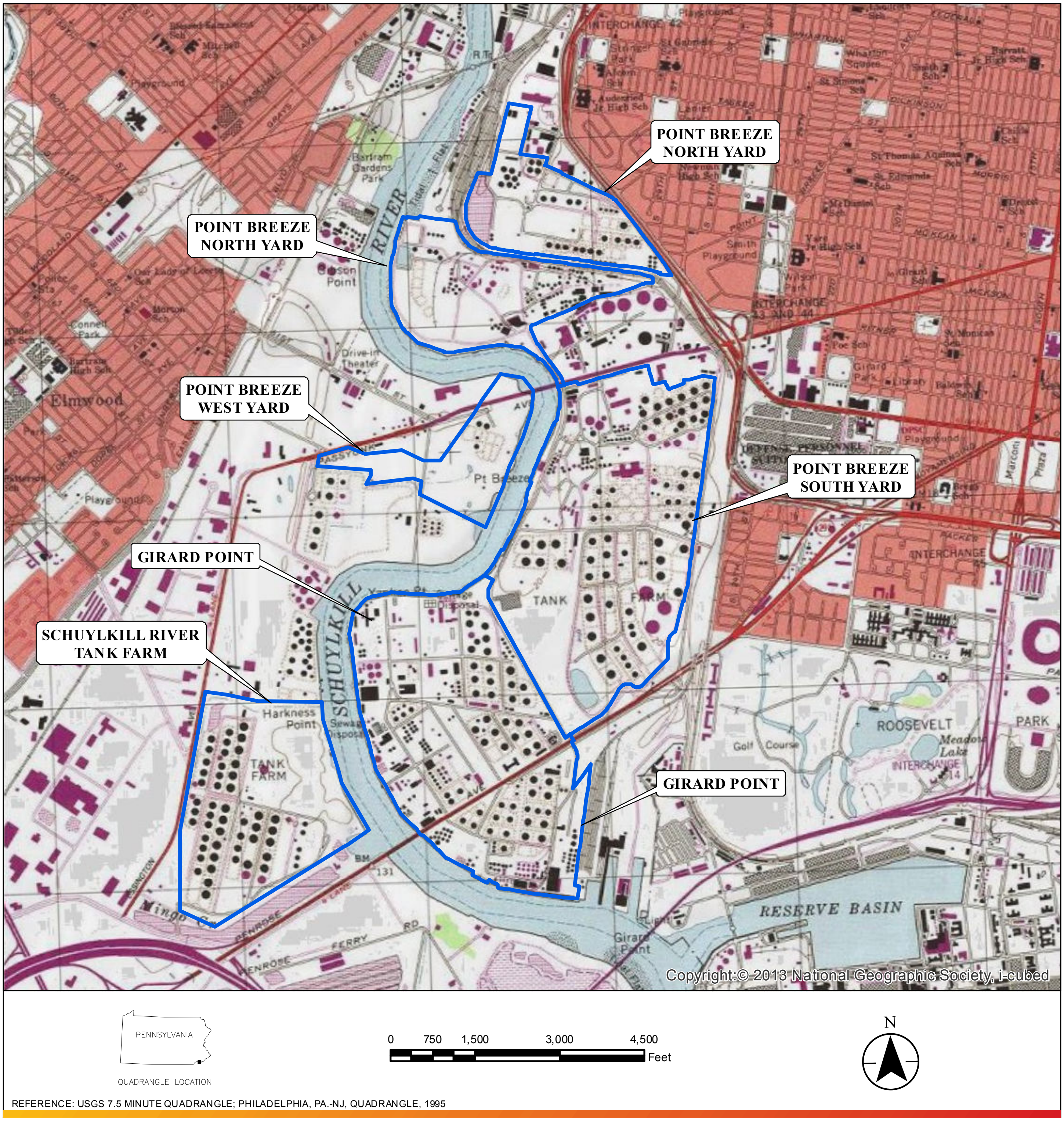
Association/Organization
Authority
County
Estate/Trust
Federal Agency
Individual
Limited Liability company
Limited Liability Partnership
Municipality
Non-Pennsylvania Government
Other (Non-Government)
Pennsylvania Corporation
Partnership-General
Partnership-Limited
School District
Sole Proprietorship
State Agency

Preparer of Notice of Intent to Remediate

Name Jim Oppenheim, PE Title Vice President
Phone Number (302) 477-0192 Email Address JROPPENHEIM@evergreenresmgt.com
Company Name Evergreen Resources Management eFACTS Client ID

Operations

Address (street, city, state, zip) 2 Righter Parkway, Suite 200, Wilmington, DE 19803



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REFERENCE: USGS 7.5 MINUTE QUADRANGLE; PHILADELPHIA, PA.-NJ, QUADRANGLE, 1995

Stantec

Stantec Consulting Services Inc.
1060 Andrew Drive, Suite 140
West Chester, Pennsylvania 19380
Tel. 610-840-2500
Fax. 610-840-2501
www.stantec.com

DRAWN BY: GWC
CHECKED BY: JKD
APPROVED BY: JLM
DATE: 11/11/2014

Prepared For:

EVERGREEN RESOURCES
MANAGEMENT OPERATIONS
PHILADELPHIA REFINERY COMPLEX
3144 PASSYUNK AVENUE
PHILADELPHIA, PA. 19145

Figure Title:

Philadelphia Refinery Complex
Site Location Map

Figure No.:

1

EVERGREEN

Evergreen Resources Management
2 Righter Parkway, Suite 200
Wilmington, DE 19803

November 17, 2014

Leigh Anne Rainford, MPH
Sanitarian Supervisor
Philadelphia Department of Public Health
Environmental Engineering Section
321 University Avenue
Philadelphia, PA 19104

RE: Philadelphia Energy Solutions Refining & Marketing LLC (PES) Philadelphia Refinery Complex
3144 West Passyunk Avenue Philadelphia, Philadelphia County

Dear Ms. Rainford:

The Land Recycling and Environmental Remediation Standards Act (Act 2) requires that a Notice of Intent to Remediate (NIR) a site be provided to the municipality in which the site is located. This notification is to inform the City of Philadelphia of the submission of an update to the original October 12, 2006 NIR. The purpose of the revised NIR is to update the facility owner and remediator information. On September 8, 2012, Sunoco Inc., (R&M) (Sunoco) conveyed the Philadelphia Refinery to Philadelphia Energy Solutions Refining & Marketing LLC (PES). As part of the transaction, Sunoco retained responsibility for remediation activities for environmental conditions existing at the time of the transfer. Effective December 30, 2013, "Philadelphia Refinery Operations, a series of Evergreen Resources Group, LLC" (Evergreen) assumed Sunoco legacy remediation liabilities with respect to the Philadelphia Refinery Complex. A copy of the revised NIR is enclosed for your reference.

Please call me at (302) 477-0192 if you have any questions concerning the proposed remediation.

Best Regards,

James Oppenheim, PE
Vice President

cc: Evergreen File
C. David Brown, PADEP
Charles Barksdale, Philadelphia Energy Solutions Refining and Marketing, LLC
Jennifer Menges, Stantec Consulting Services Inc.

Philadelphia Refinery

Sunoco Inc.
3144 Passyunk Avenue
Philadelphia PA 19145-5299
215 339 2000

October 12, 2006

Mr. Robert Day-Lewis
Pennsylvania DEP
2 East Main Street
Norristown, PA 19401

Mr. Steve O'Neil
Pennsylvania DEP
2 East Main Street
Norristown, PA 19401

Re: Sunoco Inc. (R&M) Philadelphia Refinery
Philadelphia, Philadelphia County

Dear Mr. Day-Lewis and Mr. O'Neil:

In accordance with the Land Recycling and Environmental Remediation Standards Act (Act 2), enclosed are two copies of a Notice of Intent to Remediate (NIR) for the Sunoco Inc. (R&M) Philadelphia Refinery. This NIR covers remediation being done as part of the 2003 Consent Order and Agreement (CO&A) at Point Breeze, Girard Point and Schuylkill River Tank Farm. Remediation at Belmont Terminal, which is part of the CO&A, is not part of this NIR since this site is not subject to RCRA Corrective Action. Sunoco is considering submitting a separate NIR for this area under the Act 2 program only.

This NIR is being submitted with the intent to enter the Sunoco Philadelphia Refinery into the One Cleanup Program with PaDEP and the USEPA. All remediation work at the Philadelphia refinery will be completed under the 2003 Consent Order & Agreement (CO&A), however, RCRA Corrective Action measures will be addressed concurrently with work performed under the CO&A and within the Act 2 program.

Please call me at 610-859-1881 or email me at jroppenheim@sunocoinc.com with any questions or comments.

Best Regards,

James Oppenheim, PE
Sr. Environmental Consultant

Cc: Sunoco Legal Dept.
Philadelphia Refinery Environmental Central File
David Burke, PADEP
Walter Payne, PADEP
Hon Lee, USEPA Region III
Colleen Costello, Langan

2530-FM-BWM0019 Rev. 4/2004

Will remediation be to a site-specific standard ☒ or as a special industrial area ☐? If so, the municipality or municipalities must be provided 30-day comment period. Remediator/Property Owner/Consultant. For each of these recipients of the approval of the final report, complete form below.

Remediator
Contact Person: James R. Oppenheim
Relationship to site (e.g. owner, remediator, participating in cleanup, consultant): Remediation Project Manager
Phone Number: (610) 859-1881
Company Name: Sunoco, Inc. (R&M)
Address (street, city, state, zip): 100 Green St., Marcus Hook, PA 19061
Email Address: jroppenheim@sunocoinc.com
Property Owner
Contact Person: Scott Baker
Relationship to site (e.g. owner, remediator, participating in cleanup, consultant): Environmental Manager
Phone Number: (215) 339-2074
Company Name: Sunoco, Inc. (R&M)
Address (street, city, state, zip): 3144 Passyunk Ave. Philadelphia, PA 19145
Email Address: sabaker@sunocoinc.com
Consultant
Contact Person: Colleen Costello
Relationship to site (e.g. owner, remediator, participating in cleanup, consultant): Consultant
Phone Number: (215) 864-0640
Company Name: Langan Engineering and Environmental Services
Address (street, city, state, zip): 30 South 17th St., Suite 1500, Philadelphia, PA 19103
Email Address: ccostello@langan.com

Preparer of Notice of Intent to Remediate:

Name: James Oppenheim

Address: 100 Green Street
Marcus Hook, PA 19061

Email Address: jroppenheim@sunocoinc.com

Title: Project Manager

Telephone: (610) 859-1881

Email Image File of Site Map showing property lines and general area of site(s) to be remediated to: (landrecycling@state.pa.us)

Philadelphia Refinery

Sunoco Inc.
3144 Passyunk Avenue
Philadelphia PA 19145-5299
215 339 2000

October 12, 2006

Manager
Philadelphia Department of Public Health
Environmental Health Services
321 University Avenue
Philadelphia, PA 19104

Re: Sunoco, Inc. (R&M) Philadelphia Refinery
Philadelphia, Philadelphia County

Dear Sir/Madam:

The Land Recycling and Environmental Remediation Standards Act (Act 2) requires that a Notice of Intent to Remediate (NIR) be provided to the municipality in which the site is located when a site is being remediated to a site-specific Standard. The municipality is afforded a 30-day comment period. In accordance with this provision of the Act, Sunoco, Inc. (R&M) is formally notifying you of its intent to remediate the subject site under Act 2. A copy of the NIR, which will be sent to the Pennsylvania Department of Environmental Protection (PaDEP), is enclosed. This notice will also be published in the Pennsylvania Bulletin, and a summary of the notice appeared in the Philadelphia Daily News on October 16, 2006.

Publication of this notice in the Philadelphia Daily News initiates the 30-day public and municipal comment period. During the next thirty days, your municipality may request to become involved in the development of the remediation plans for the site. If the municipality wishes to become involved in this project, please send your comments to Sunoco to my attention.

Please call me at (610) 859-1881 if you have any questions concerning the proposed remediation.

Best Regards,

James R. Oppenheim, P.E.
Senior Environmental Consultant

Cc: Sunoco Legal Dept.
Philadelphia Refinery Environmental Central File
Steve O'Neil, PaDEP
Colleen Costello, Langan

2530-FM-BWM0019 Rev. 4/2004

Will remediation be to a site-specific standard ☒ or as a special industrial area ☐? If so, the municipality or municipalities must be provided 30-day comment period.
Remediator/Property Owner/Consultant. For each of these recipients of the approval of the final report, complete form below.

Remediator
Contact Person: James R. Oppenheim
Relationship to site (e.g. owner, remediator, participating in cleanup, consultant): Remediation Project Manager
Phone Number: (610) 859-1881
Company Name: Sunoco, Inc. (R&M)
Address (street, city, state, zip): 100 Green St., Marcus Hook, PA 19061
Email Address: jroppenheim@sunocoinc.com
Property Owner
Contact Person: Scott Baker
Relationship to site (e.g. owner, remediator, participating in cleanup, consultant): Environmental Manager
Phone Number: (215) 339-2074
Company Name: Sunoco, Inc. (R&M)
Address (street, city, state, zip): 3144 Passyunk Ave. Philadelphia, PA 19145
Email Address: sabaker@sunocoinc.com
Consultant
Contact Person: Colleen Costello
Relationship to site (e.g. owner, remediator, participating in cleanup, consultant): Consultant
Phone Number: (215) 864-0640
Company Name: Langan Engineering and Environmental Services
Address (street, city, state, zip): 30 South 17th St., Suite 1500, Philadelphia, PA 19103
Email Address: ccostello@langan.com

Preparer of Notice of Intent to Remediate:

Name: James Oppenheim

Title: Project Manager

Address: 100 Green Street
Marcus Hook, PA 19061

Telephone: (610) 859-1881

Email Address: jroppenheim@sunocoinc.com

Email Image File of Site Map showing property lines and general area of site(s) to be remediated to: (landrecycling@state.pa.us)

Proof of Publication in The Philadelphia Daily News
Under Act. No 587, Approved May 16, 1929

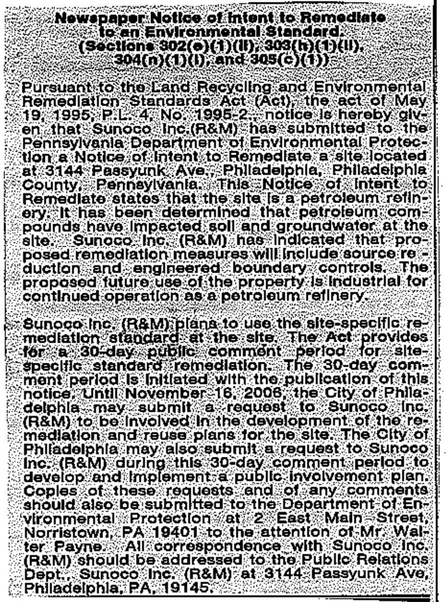
STATE OF PENNSYLVANIA
COUNTY OF PHILADELPHIA

Anna Dickerson being duly sworn, deposes and says that **The Philadelphia Daily News** is a newspaper published daily, except Sunday, at Philadelphia, Pennsylvania, and was established in said city in 1925, since which date said newspaper has been regularly issued in said County, and that a copy of the printed notice of publication is attached hereto exactly as the same was printed and published in the regular editions and issues of the said newspaper on the following dates:

October 16, 2006

Affiant further deposes and says that he is an employee of the publisher of said newspaper and has been authorized to verify the foregoing statement and that he is not interested in the subject matter of the aforesaid notice of publication, and that all allegations in the foregoing statement as to time, place and character of publication are true.

Copy of Notice of Publication



Newspaper Notice of Intent to Remediate to an Environmental Standard. (Sections 302(e)(1)(ii), 303(h)(1)(ii), 304(n)(1)(i), and 305(c)(1))

Pursuant to the Land Recycling and Environmental Remediation Standards Act (Act), the act of May 19, 1995, P.L. 4, No. 1995-2., notice is hereby given that Sunoco Inc.(R&M) has submitted to the Pennsylvania Department of Environmental Protection a Notice of Intent to Remediate a site located at 3144 Passyunk Ave., Philadelphia, Philadelphia County, Pennsylvania. This Notice of Intent to Remediate states that the site is a petroleum refinery. It has been determined that petroleum compounds have impacted soil and groundwater at the site. Sunoco Inc. (R&M) has indicated that proposed remediation measures will include source reduction and engineered boundary controls. The proposed future use of the property is industrial for continued operation as a petroleum refinery.

Sunoco Inc. (R&M) plans to use the site-specific remediation standard at the site. The Act provides for a 30-day public comment period for site-specific standard remediation. The 30-day comment period is initiated with the publication of this notice. Until November 16, 2006, the City of Philadelphia may submit a request to Sunoco Inc. (R&M) to be involved in the development of the remediation and reuse plans for the site. The City of Philadelphia may also submit a request to Sunoco Inc. (R&M) during this 30-day comment period to develop and implement a public involvement plan. Copies of these requests and of any comments should also be submitted to the Department of Environmental Protection at 2 East Main Street, Norristown, PA 19401 to the attention of Mr. Walter Payne. All correspondence with Sunoco Inc. (R&M) should be addressed to the Public Relations Dept., Sunoco Inc. (R&M) at 3144 Passyunk Ave, Philadelphia, PA, 19145.

Anna Dickerson

Sworn to and subscribed before me this 16th day of October, 2006

Mary Anne Logan
Notary Public

My Commission Expires:

NOTARIAL SEAL
Mary Anne Logan, Notary Public
City of Philadelphia, Phila. County
My Commission Expires March 30, 2009

LEGAL NOTICES

Newspaper Notice of Intent to Remediate
to an Environmental Standard.
(Sections 302(e)(1)(ii), 303(h)(1)(ii),
304(n)(1)(i), and 305(c)(1))

Pursuant to the Land Recycling and Environmental Remediation Standards Act (Act), the act of May 19, 1995, P.L. 4, No. 1995-2., notice is hereby given that Sunoco Inc.(R&M) has submitted to the Pennsylvania Department of Environmental Protection a Notice of Intent to Remediate a site located at 3144 Passyunk Ave., Philadelphia, Philadelphia County, Pennsylvania. This Notice of Intent to Remediate states that the site is a petroleum refinery. It has been determined that petroleum compounds have impacted soil and groundwater at the site. Sunoco Inc. (R&M) has indicated that proposed remediation measures will include source reduction and engineered boundary controls. The proposed future use of the property is industrial for continued operation as a petroleum refinery.

Sunoco Inc. (R&M) plans to use the site-specific remediation standard at the site. The Act provides for a 30-day public comment period for site-specific standard remediation. The 30-day comment period is initiated with the publication of this notice. Until November 16, 2006, the City of Philadelphia may submit a request to Sunoco Inc. (R&M) to be involved in the development of the remediation and reuse plans for the site. The City of Philadelphia may also submit a request to Sunoco Inc. (R&M) during this 30-day comment period to develop and implement a public involvement plan. Copies of these requests and of any comments should also be submitted to the Department of Environmental Protection at 2 East Main Street, Norristown, PA 19401 to the attention of Mr. Walter Payne. All correspondence with Sunoco Inc. (R&M) should be addressed to the Public Relations Dept., Sunoco Inc. (R&M) at 3144 Passyunk Ave, Philadelphia, PA, 19145.

Appeared in: ***Philadelphia Inquirer & Philadelphia Daily News*** on Monday, 10/16/2006

Back

PNDI Documents

AECOM

October 16, 2015

Mr. Chris Urban
Pennsylvania Fish and Boat Commission
Environmental Services Division
450 Robinson Lane
Bellefonte, PA 16823

RE: Philadelphia Refinery – Ecological Risk Assessment - AOI3
Schuylkill River, Philadelphia, PA
Species Impact Review (SIR) Request – PNDI # 20150702521292

Dear Mr. Urban:

On behalf of Philadelphia Refinery Operations, a series of Evergreen Resources Group, LLC, AECOM is conducting a Site-specific Ecological Risk Assessment (ERA) within Area of Interest 3 (AOI3) in the Philadelphia Refinery. This area is the subject of a remedial investigation. An assessment of potential impacts to sensitive ecological receptors, including threatened and endangered species, is part of this evaluation.

A search of the Pennsylvania Natural Diversity Inventory (PNDI) database was initiated by AECOM on July 2, 2015 (PNDI #s 20150702521292) and a potential impact was found within Pennsylvania Fish and Boat Commission (PFBC) jurisdiction. Based on our knowledge of threatened and endangered species in the vicinity of the project, it is assumed that the “sensitive species/threatened” identified on the PNDI receipt is the Eastern Redbelly Turtle (*Pseudemys rubriventris*). The enclosed information, along with this letter report, is being provided to request a Species Impact Review (SIR) from your office to include with the ERA documentation that will be submitted to Pennsylvania Department of Environmental Protection (PADEP). Additional information is requested from your office as part of the SIR regarding the state endangered species under PFBC’s jurisdiction.

Project/Site Description

The former Sunoco Philadelphia Refinery (currently operated by Philadelphia Energy Solutions, or PES) is located along the east and west banks of the Schuylkill River, just upstream of its confluence with the Delaware River in South Philadelphia (Figure 1). AOI3 is located on the east side of the Schuylkill River (Figures 1 and 2).

Habitat Assessment Information

A habitat assessment to determine the suitability of the undeveloped portions of AOI3 for redbelly turtle was conducted on April 29, 2015 by a Recognized, Qualified Redbelly Turtle Surveyor (RQRTS). The assessment included an evaluation of both aquatic and terrestrial habitats and looked at potential for basking, hibernation, feeding, and nesting, as well as site accessibility. A description of the different sections of AOI3 that were part of the field investigation is provided below. Relevant photographs are attached to this report, with photograph locations indicated on Figure 2.

Open Field/Wooded Area

Within AOI-3 there is a sparsely wooded area with some open fields. This area is directly connected to a large emergent wetland dominated by *Phragmites*. It is not connected to or accessible from the river, nor is it near the stormwater basins described below. Soils consisted of a loamy clay texture intermixed with rocky fill material. In the absence of any other adjoining suitable habitat, this area is unlikely to be used by redbelly turtles for nesting (*Photos 1-5*).

Schuylkill River

The Schuylkill River is known to be inhabited by Eastern redbelly turtle in the vicinity of the project site. The river provides basking, foraging, and hibernating habitat for this species (*Photos 6-8*).

Stormwater Basins

Two stormwater basins are located within AOI-3. There is no direct access from the river to these basins, as they are surrounded by the developed refinery and the river is several thousand feet away. These are unvegetated basins that periodically dry out completely. No turtles were observed using the basins on the day of the field investigation although it was a warm, sunny day in mid-afternoon at prime basking time. Therefore, it is not expected that redbelly turtles inhabit these basins (*Photos 9-12*).

Conclusions

Redbelly turtles are known to inhabit the Schuylkill River and it provides suitable basking, foraging and hibernation habitat for this species. The stormwater basins and the terrestrial portions of AOI-3 are generally inaccessible from the river and also do not provide suitable habitat for redbelly turtles to use. Therefore, it is unlikely that redbelly turtle would be encountered on site during sampling activities and ERA evaluations. Redbelly turtles are only expected to inhabit the Schuylkill River itself.

Please contact me at (610) 832-3597 regarding further information you may have about state-listed species of concern or additional data you may require.

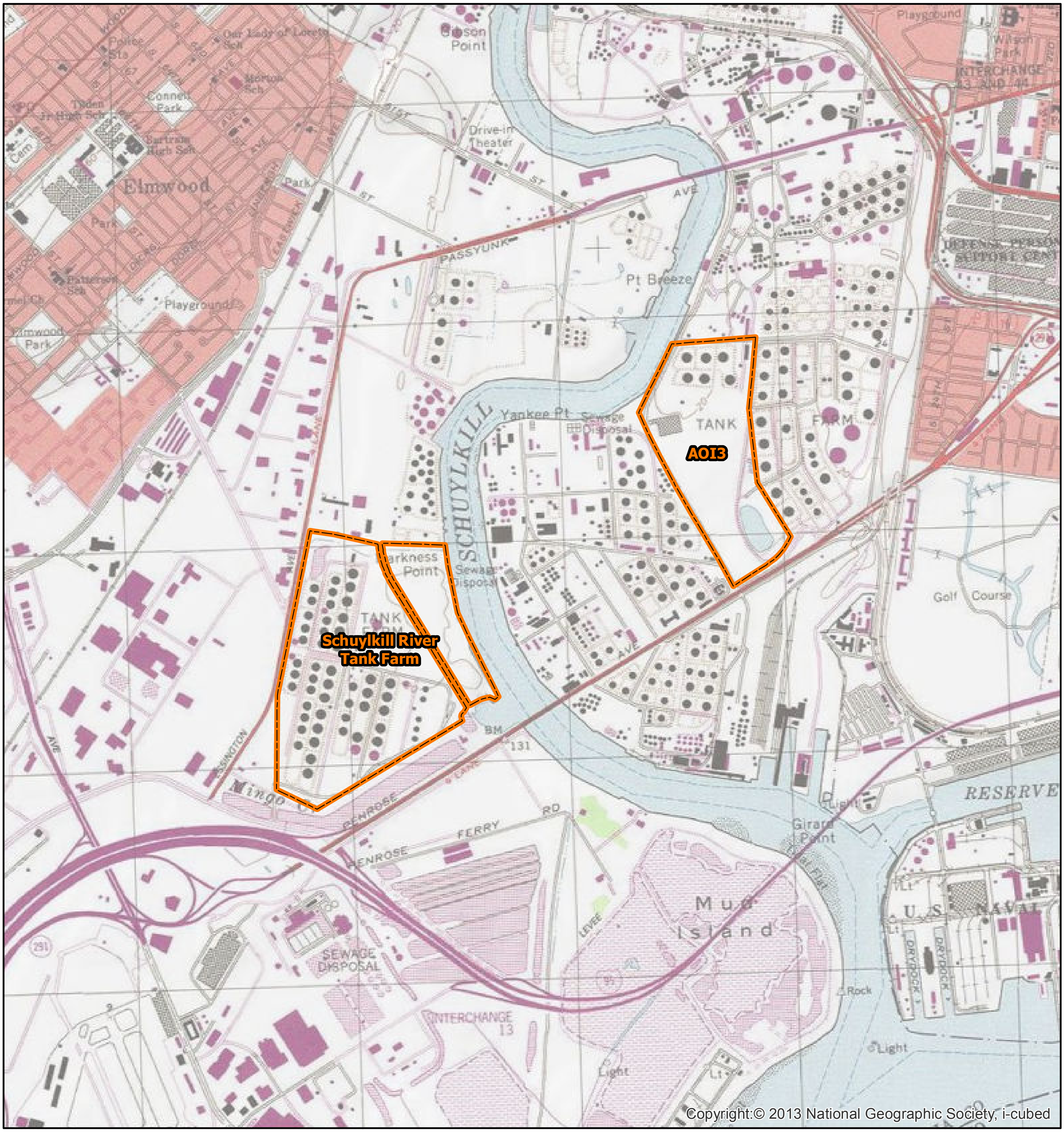
Sincerely,
AECOM

Deborah K. Poppel

Deborah K. Poppel, RQRTS
Senior Ecologist
Deborah.poppel@aecom.com
(610) 832-3597

Attachment A: Figures 1 & 2
Attachment B: Photolog
Attachment C: PNDI Receipt

Cc: James Oppenheim, PE, Evergreen Resources Group, LLC
Tiffani Doerr, PG, Aquaterra Technologies, Inc.
File 2000987



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Legend

▭ Site Boundary

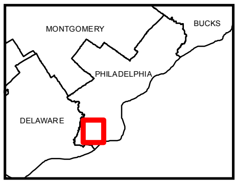
N

0 1,000 2,000 4,000
Feet

1 inch = 2,000 feet

NAD 1983 State Plane
Pennsylvania South
Lambert Conformal Conic
Unit: US Foot

Reference:
USGS 7.5' Topographic Map:
Philadelphia, PA (1995)



AECOM

625 West Ridge Pike, Suite E-100
Conshohocken, PA 19428
Phone: (610) 832-3500 Fax: (610) 832-3501

Job: 60392480

Prepared by: MAH

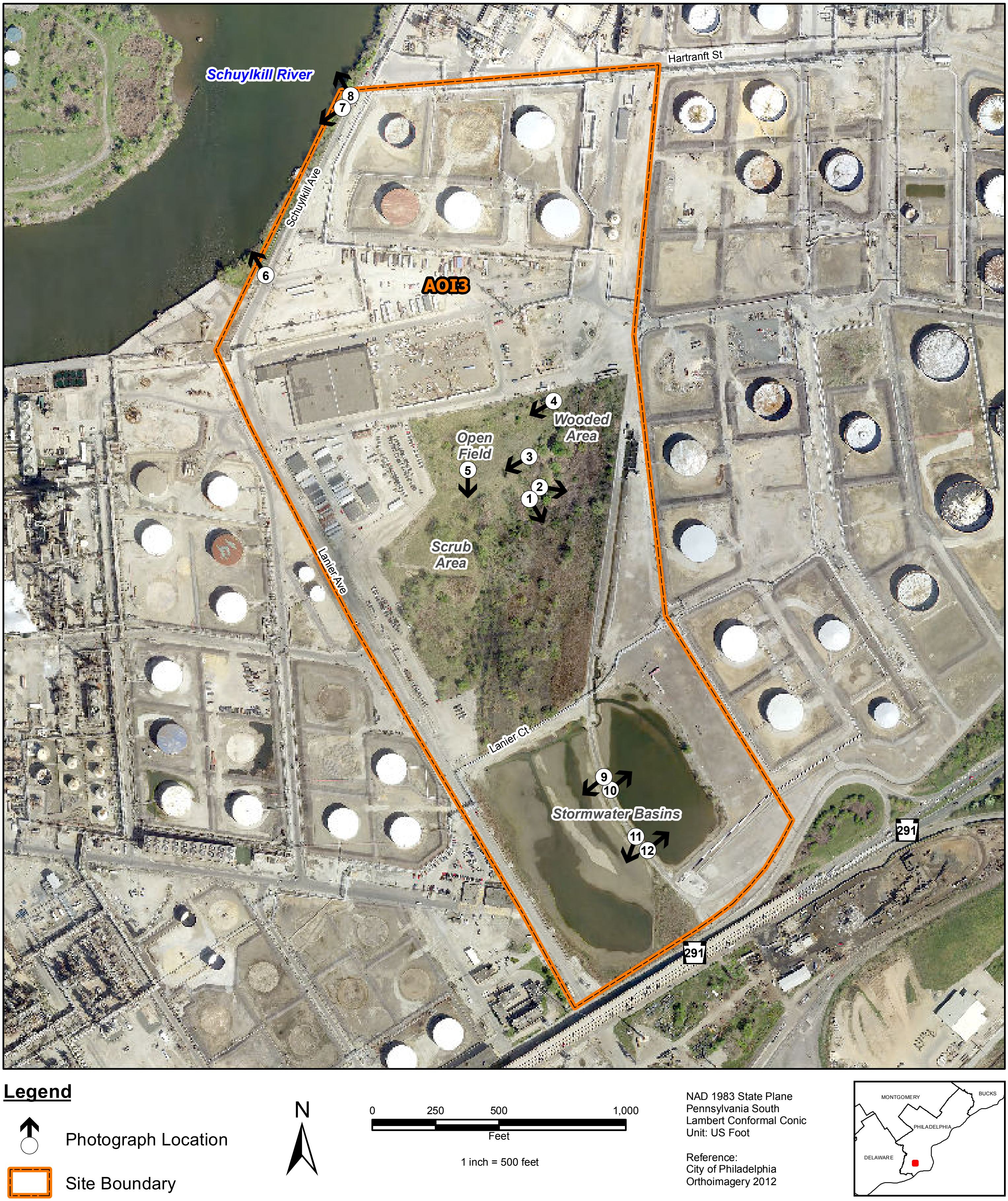
Checked by: CC

Date: 8/17/2015

FIGURE 1
Topographic Site Map

Ecological Habitat Assessment and Risk Evaluation
Philadelphia Refinery
Philadelphia, Pennsylvania

Path: S:\Projects\IMS\SUNOCO\PHILAREFINERY\Maps\Ecological Habitat Assessment and Risk Evaluation - 2015\Figure 1 - Topogaphic Site Map - 0817115.mxd



AECOM

625 West Ridge Pike, Suite E-100
Conshohocken, PA 19428
Phone: (610) 832-3500 Fax: (610) 832-3501

Job: 60392480

Prepared by: MAH

Checked by: CC

Date: 7/15/2015

FIGURE 2
AOI3 Aerial View

Ecological Habitat Assessment and Risk Evaluation
Philadelphia Refinery
Philadelphia, Pennsylvania

Path: S:\Projects\IMS\SUNOCO\PHILAREFINERY\Maps\Ecological Habitat Assessment and Risk Evaluation - 2015\Figure 2 - AOI3 - Photo Locations.mxd

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Evergreen Resources Group, LLC	Philadelphia Refinery	20000987

Photo No.	Date:
1	4/29/2015

Direction Photo Taken:

South

Description:

AOI3 Wetland area

Photo No.	Date:
2	4/29/2015

Direction Photo Taken:

southeast

Description:

AOI3 Wetland area

Client Name:	Site Location:	Project No.
Evergreen Resources Group, LLC	Philadelphia Refinery	20000987

Photo No. 3

Date: 4/29/2015

Direction Photo Taken:

West

Description:

AOI3 Fenced off open field/scrub area

Photo No. 4

Date: 4/29/2015

Direction Photo Taken:

Southwest

Description:

AOI3 Fenced off forested area

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Evergreen Resources Group, LLC	Philadelphia Refinery	20000987

Photo No. 5

Date: 4/29/2015

Direction Photo Taken:

South

Description:

AOI3 Fenced off open field/scrub area

Photo No. 6

Date: 4/29/2015

Direction Photo Taken:

Northwest

Description:

AOI3 Schuylkill River shoreline

Photo No.	Date:
7	4/29/2015

Direction Photo Taken:

West

Description:

AOI3 Schuylkill River shoreline

Photo No.	Date:
8	4/29/2015

Direction Photo Taken:

North

Description:

AOI3 Schuylkill River shoreline

AECOM	**PHOTOGRAPHIC LOG**

Client Name:	**Site Location:**	**Project No.**
Evergreen Resources Group, LLC	Philadelphia Refinery	20000987

Photo No.	**Date:**
9	4/29/2015

Direction Photo Taken:

Southwest

Description:

AOI3 Stormwater Basin area

Photo No.	**Date:**
10	4/29/2015

Direction Photo Taken:

Southeast

Description:

AOI3 Stormwater Basin area

Client Name:	Site Location:	Project No.
Evergreen Resources Group, LLC	Philadelphia Refinery	20000987

Photo No. 11

Date: 4/29/2015

Direction Photo Taken:

Southwest

Description:

AOI3 Stormwater Basin area

Photo No. 12

Date: 4/29/2015

Direction Photo Taken:

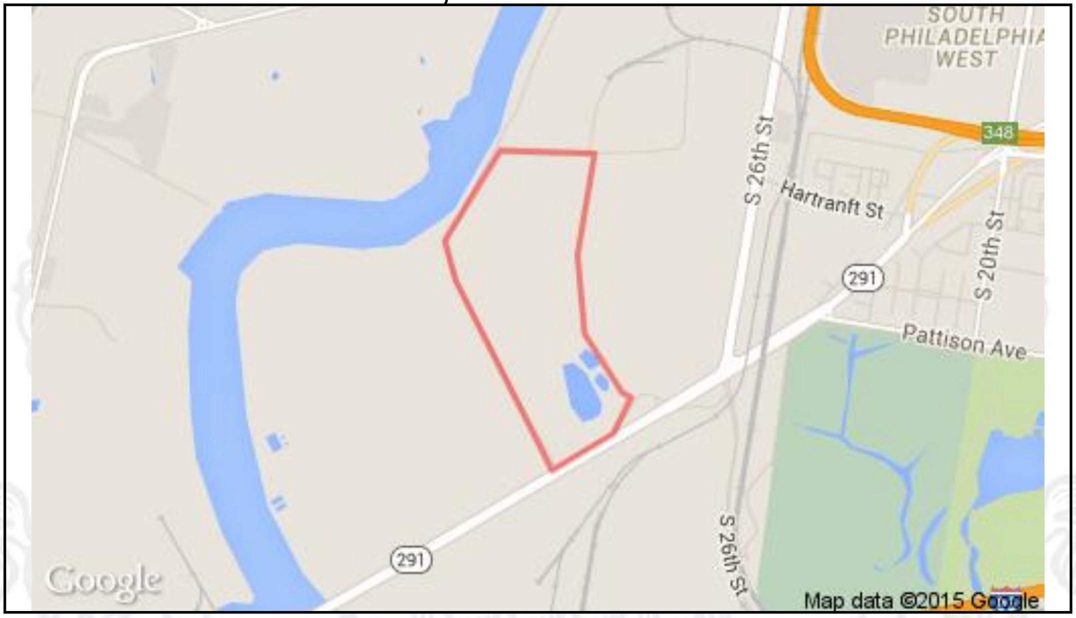
Northeast

Description:

AOI3 Stormwater Basin area

1. PROJECT INFORMATION

Project Name: **PES AOI3**
Date of review: **7/2/2015 1:27:45 PM**
Project Category: **Hazardous Waste Clean-up, Site Remediation, and Reclamation,Spill (e.g., oil, chemical)**
Project Area: **107.1** acres
County: **Philadelphia** Township/Municipality: **Philadelphia**
Quadrangle Name: **PHILADELPHIA** ~ ZIP Code: **19145**
Decimal Degrees: **39.909136 N, -75.208995 W**
Degrees Minutes Seconds: **39° 54' 32 N, W**



2. SEARCH RESULTS

Agency	Results	Response
PA Game Commission	No Known Impact	No Further Review Required
PA Department of Conservation and Natural Resources	**Conservation Measure**	**No Further Review Required, See Agency Comments**
PA Fish and Boat Commission	**Potential Impact**	**FURTHER REVIEW IS REQUIRED, See Agency Response**
U.S. Fish and Wildlife Service	No Known Impact	No Further Review Required

As summarized above, Pennsylvania Natural Diversity Inventory (PNDI) records indicate there may be potential impacts to threatened and endangered and/or special concern species and resources within the project area. If the response above indicates "No Further Review Required" no additional communication with the respective agency is required. If the response is "Further Review Required" or "See Agency Response," refer to the appropriate agency comments below. Please see the DEP Information Section of this receipt if a PA Department of Environmental Protection Permit is required.

RESPONSE TO QUESTION(S) ASKED

Q1: "Accurately describe what is known about wetland presence in the project area or on the land parcel by selecting ONE of the following. ""Project"" includes all features of the project (including buildings, roads, utility lines, outfall and intake structures, wells, stormwater retention/detention basins, parking lots, driveways, lawns, etc.), as well as all associated impacts (e.g., temporary staging areas, work areas, temporary road crossings, areas subject to grading or clearing, etc.). Include all areas that will be permanently or temporarily affected -- either directly or indirectly -- by any type of disturbance (e.g., land clearing, grading, tree removal, flooding, etc.). Land parcel = the lot(s) on which some type of project(s) or activity(s) are proposed to occur ."
Your answer is: **"5. The specific project area (that is, project layout or "footprint") has not yet been identified, but the land parcel on which the project will occur has been investigated by someone qualified to identify and delineate wetlands, and wetlands were located on the land parcel. "**

Q2: Aquatic habitat (stream, river, lake, pond, etc.) is located on or adjacent to the subject property and project activities (including discharge) may occur within 300 feet of these habitats
Your answer is: **1. Yes**

3. AGENCY COMMENTS

Regardless of whether a DEP permit is necessary for this proposed project, any potential impacts to threatened and endangered species and/or special concern species and resources must be resolved with the appropriate jurisdictional agency. In some cases, a permit or authorization from the jurisdictional agency may be needed if adverse impacts to these species and habitats cannot be avoided.

These agency determinations and responses are **valid for two years** (from the date of the review), and are based on the project information that was provided, including the exact project location; the project type, description, and features; and any responses to questions that were generated during this search. If any of the following change: 1) project location, 2) project size or configuration, 3) project type, or 4) responses to the questions that were asked during the online review, the results of this review are not valid, and the review must be searched again via the PNDI Environmental Review Tool and resubmitted to the jurisdictional agencies. The PNDI tool is a primary screening tool, and a desktop review may reveal more or fewer impacts than what is listed on this PNDI receipt. The jursidictional agencies **strongly advise against** conducting surveys for the species listed on the receipt prior to consultation with the agencies.

PA Game Commission

RESPONSE: No Impact is anticipated to threatened and endangered species and/or special concern species and resources.

PA Department of Conservation and Natural Resources

RESPONSE: Conservation Measure: In order to maintain or improve wetland habitat, conserve at least a 300-foot wide upland buffer around each wetland, a 150 foot wide buffer on each side of perennial waterways, as well as a buffer of 50 feet wide on each side of intermittent waterways. When adequately vegetated, these upland buffers will act to filter pollutants (e.g., sediment, fertilizers, pesticides, road salt), and stabilize streambanks (preventing or minimizing erosion). Avoid any construction, earth disturbance, and chemical application (e.g., fertilizer, pesticide) in the wetland and upland buffer. If other activities are being considered (e.g., timber harvesting, agricultural use, land development, streambank stabilization, tree planting, control of exotic plant species), conduct a review under those project categories.

DCNR Species: (Note: The PNDI tool is a primary screening tool, and a desktop review may reveal more or fewer species than what is listed below. After desktop review, if a botanical survey is required by DCNR, we recommend the DCNR Botanical Survey Protocols, available here: http://www.gis.dcnr.state.pa.us/hgis-er/PNDI_DCNR.aspx.)
Scientific Name: Amaranthus cannabinus
Common Name: Waterhemp Ragweed
Current Status: Special Concern Species*
Proposed Status: Special Concern Species*

Scientific Name: Echinochloa walteri
Common Name: Walter's Barnyard-grass
Current Status: Endangered
Proposed Status: Endangered

PA Fish and Boat Commission

RESPONSE: Further review of this project is necessary to resolve the potential impacts(s). Please send project information to this agency for review (see WHAT TO SEND).

PFBC Species: (Note: The PNDI tool is a primary screening tool, and a desktop review may reveal more or fewer species than what is listed below.)
Scientific Name: Sensitive Species**
Common Name:
Current Status: Threatened

Scientific Name: Sensitive Species**
Common Name:
Current Status: Endangered

U.S. Fish and Wildlife Service

RESPONSE: No impacts to **federally** listed or proposed species are anticipated. Therefore, no further consultation/coordination under the Endangered Species Act (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.* is required. Because no take of federally listed species is anticipated, none is authorized. This response does not reflect potential Fish and Wildlife Service concerns under the Fish and Wildlife Coordination Act or other authorities.

* Special Concern Species or Resource - Plant or animal species classified as rare, tentatively undetermined or candidate as well as other taxa of conservation concern, significant natural communities, special concern populations (plants or animals) and unique geologic features.
** Sensitive Species - Species identified by the jurisdictinal agency as collectible, having economic value, or being susceptible to decline as a result of visitation.

WHAT TO SEND TO JURISDICTIONAL AGENCIES

If project information was requested by one or more of the agencies above, send the following information to the agency(s) seeking this information (see AGENCY CONTACT INFORMATION).

Check-list of *Minimum* Materials to be submitted:

____**SIGNED** copy of this Project Environmental Review Receipt
____Project narrative with a description of the overall project, the work to be performed, current physical characteristics of the site and acreage to be impacted.
____Project location information (name of USGS Quadrangle, Township/Municipality, and County)
____USGS 7.5-minute Quadrangle with project boundary clearly indicated, and quad name on the map

The inclusion of the following information may expedite the review process.
____A basic site plan(particularly showing the relationship of the project to the physical features such as wetlands, streams, ponds, rock outcrops, etc.)
____Color photos keyed to the basic site plan (i.e. showing on the site plan where and in what direction each photo was taken and the date of the photos)
____Information about the presence and location of wetlands in the project area, and how this was determined (e.g., by a qualified wetlands biologist), if wetlands are present in the project area, provide project plans showing the location of all project features, as well as wetlands and streams

4. DEP INFORMATION

The Pa Department of Environmental Protection (DEP) requires that a signed copy of this receipt, along with any required documentation from jurisdictional agencies concerning resolution of potential impacts, be submitted with applications for permits requiring PNDI review. For cases where a "Potential Impact" to threatened and endangered species has been identified before the application has been submitted to DEP, the application should not be submitted until the impact has been resolved. For cases where "Potential Impact" to special concern species and resources has been identified before the application has been submitted, the application should be submitted to DEP along with the PNDI receipt. The PNDI Receipt should also be submitted to the appropriate agency according to directions on the PNDI Receipt. DEP and the jurisdictional agency will work together to resolve the potential impact(s). See the DEP PNDI policy at http://www.naturalheritage.state.pa.us.

5. ADDITIONAL INFORMATION

The PNDI environmental review website is a **preliminary** screening tool. There are often delays in updating species status classifications. Because the proposed status represents the best available information regarding the conservation status of the species, state jurisdictional agency staff give the proposed statuses at least the same consideration as the current legal status. If surveys or further information reveal that a threatened and endangered and/or special concern species and resources exist in your project area, contact the appropriate jurisdictional agency/agencies immediately to identify and resolve any impacts.

For a list of species known to occur in the county where your project is located, please see the species lists by county found on the PA Natural Heritage Program (PNHP) home page (www.naturalheritage.state.pa.us). Also note that the PNDI Environmental Review Tool only contains information about species occurrences that have actually been reported to the PNHP.

6. AGENCY CONTACT INFORMATION

PA Department of Conservation and Natural Resources
Bureau of Forestry, Ecological Services Section
400 Market Street, PO Box 8552, Harrisburg, PA. 17105-8552
Fax:(717) 772-0271

U.S. Fish and Wildlife Service
Pennsylvania Field Office
110 Radnor Rd; Suite 101, State College, PA 16801
NO Faxes Please.

PA Fish and Boat Commission
Division of Environmental Services
450 Robinson Lane, Bellefonte, PA. 16823-7437
NO Faxes Please

PA Game Commission
Bureau of Wildlife Habitat Management
Division of Environmental Planning and Habitat Protection
2001 Elmerton Avenue, Harrisburg, PA. 17110-9797
Fax:(717) 787-6957

7. PROJECT CONTACT INFORMATION

Name:___Deborah K. Poppel, RQRTS
Company/Business Name:___AECOM
Address:___625 West Ridge Pike Suite E-100
City, State, Zip:_Conshohocken, PA 19428
Phone: (610)832-3597 Fax:(610)832-3501
Email:_deborah.poppel@aecom.com

8. CERTIFICATION

I certify that ALL of the project information contained in this receipt (including project location, project size/configuration, project type, answers to questions) is true, accurate and complete. In addition, if the project type, location, size or configuration changes, or if the answers to any questions that were asked during this online review change, I agree to re-do the online environmental review.

Carrie G Cunnane on behalf of Deborah Poppel 10/16/15
applicant/project proponent signature date

Pennsylvania Fish & Boat Commission
established 1866

Division of Environmental Services
Natural Diversity Section
450 Robinson Lane
Bellefonte, PA 16823
814-359-5237

November 10, 2015

IN REPLY REFER TO
SIR# 45098

AECOM
Deborah Poppel
625 W. Ridge Pike
Conshohocken, Pennsylvania 19428

RE: Species Impact Review (SIR) – Rare, Candidate, Threatened and Endangered Species
PNDI Search No. 20150702521292
PES AOI3
PHILADELPHIA County: Philadelphia City

Dear Ms. Poppel:

This responds to your inquiry about a Pennsylvania Natural Diversity Inventory (PNDI) Internet Database search "potential conflict" or a threatened and endangered species impact review. These projects are screened for potential conflicts with rare, candidate, threatened or endangered species under Pennsylvania Fish & Boat Commission jurisdiction (fish, reptiles, amphibians, aquatic invertebrates only) using the Pennsylvania Natural Diversity Inventory (PNDI) database and our own files. These species of special concern are listed under the Endangered Species Act of 1973, the Wild Resource Conservation Act, and the Pennsylvania Fish & Boat Code (Chapter 75), or the Wildlife Code.

You evaluated the habitats on site to determine their potential to support the species of concern. According to the report, the site does not contain potential habitat for the **Atlantic Sturgeon** (*Acipenser oxyrinchus*) or **Eastern Redbelly Turtle** (*Pseudemys rubriventris*). I concur with the results of your evaluation; therefore, I do not foresee the proposed project resulting in adverse impacts to the Atlantic Sturgeon (*Acipenser oxyrinchus*) or Eastern Redbelly Turtle (*Pseudemys rubriventris*).

This response represents the most up-to-date summary of the PNDI data and our files and is valid for two (2) years from the date of this letter. An absence of recorded species information does not necessarily imply species absence. Our data files and the PNDI system are continuously being updated with species occurrence information. Should project plans change or additional information on listed or proposed species become available, this determination may be reconsidered, and consultation shall be re-initiated.

If you have any questions regarding this review, please contact Kathy Gipe at 814-359-5186 and refer to the SIR # 45098. Thank you for your cooperation and attention to this important matter of species conservation and habitat protection.

Sincerely,

Christopher A. Urban

Christopher A. Urban, Chief
Natural Diversity Section

CAU/KDG/dn

PFBC-NESU-1 (5/2/03)

COMMONWEALTH OF PENNSYLVANIA
FISH AND BOAT COMMISSION
NATURAL DIVERSITY SECTION

SPECIES IMPACT REVIEW (SIR) REQUEST FORM

A. This form provides the site information necessary to perform a computer database search for species of special concern listed under the Endangered Species Act of 1973, the Wild Resource Conservation Act, the Pennsylvania Fish and Boat Code or the Wildlife Code.

B. Use only ***one form*** for each proposed project or location. Complete the information below and **mail** form to:

Natural Diversity Section
PA Fish and Boat Commission
450 Robinson Lane
Bellefonte, PA 16823
Fax: (814) 359-5153

C. This form, a cover letter including a project narrative, and accompanying maps should be sent to the above address for environmental reviews that ***only*** concern ***reptiles, amphibians, fishes and aquatic invertebrates***. Reviews for other natural resources must be submitted to other appropriate agencies.

D. The absence of recorded information from our databases and files does not necessarily imply actual conditions on site. Future field investigations could alter this determination. The information contained in our files is routinely updated. A review is valid for one year.

E. ***Please send us only one (1) copy of your request*** – either by fax or by mail – not both. Mail is preferred to improve legibility of maps. Facsimile submission will not improve our response turn-around time.

F. ***Allow 30 days for completion of the review from the date of PFBC-NESU receipt.*** Large projects and workload may extend this review timeframe.

G. ***In any future correspondence with us following your receipt of the SIR response, please refer to the assigned SIR number at the top left of our cover letter.***

H. **FORMS THAT ARE NOT COMPLETED IN FULL WILL NOT BE REVIEWED.**

PLEASE PRINT OR TYPE: If available, provide the potential conflict **PNDI Search Number**: 20130115386605

PFBC response should be sent to:

Company/Agency: Langan Engineering & Environmental Services Form Preparer: Linda Kenney

Address: P.O. Box 1569, Doylestown, PA 18901-0219

Phone: (8:00 AM – 4:00 PM): 215-491-6500

Project Description: The project consists of approximately 107 acres. The project is currently in the Act 2 reporting process and information related to threatened/endangered species or their habitats is required.

Indicate if the project is: Transportation ☐ or Non-transportation ☒ (check one)

Will the proposed project encroach directly or indirectly (e.g., runoff) upon wetlands or waterways? Circle one for each:

Wetlands: Yes [✓ No] Unknown Waterways: [✓ Yes] No Unknown

County: Philadelphia Township/Municipality: City of Philadelphia

Name of the United States Geological Survey (U.S.G.S.) 7.5 Minute Quadrangle Map where project is located:

Philadelphia, PA Project size (in acres): 104

Attach an 8.5” by 11” photocopy (**DO NOT REDUCE**) of the section of the U.S.G.S. Quadrangle Map which identifies the project location. On this map, indicate the location of the project center (if linear, depict both ends) and outline the appropriate boundaries of the project area.

Specify latitude/longitude of the project center. **Latitude**: 39° / 54’ / 45.4” **N**

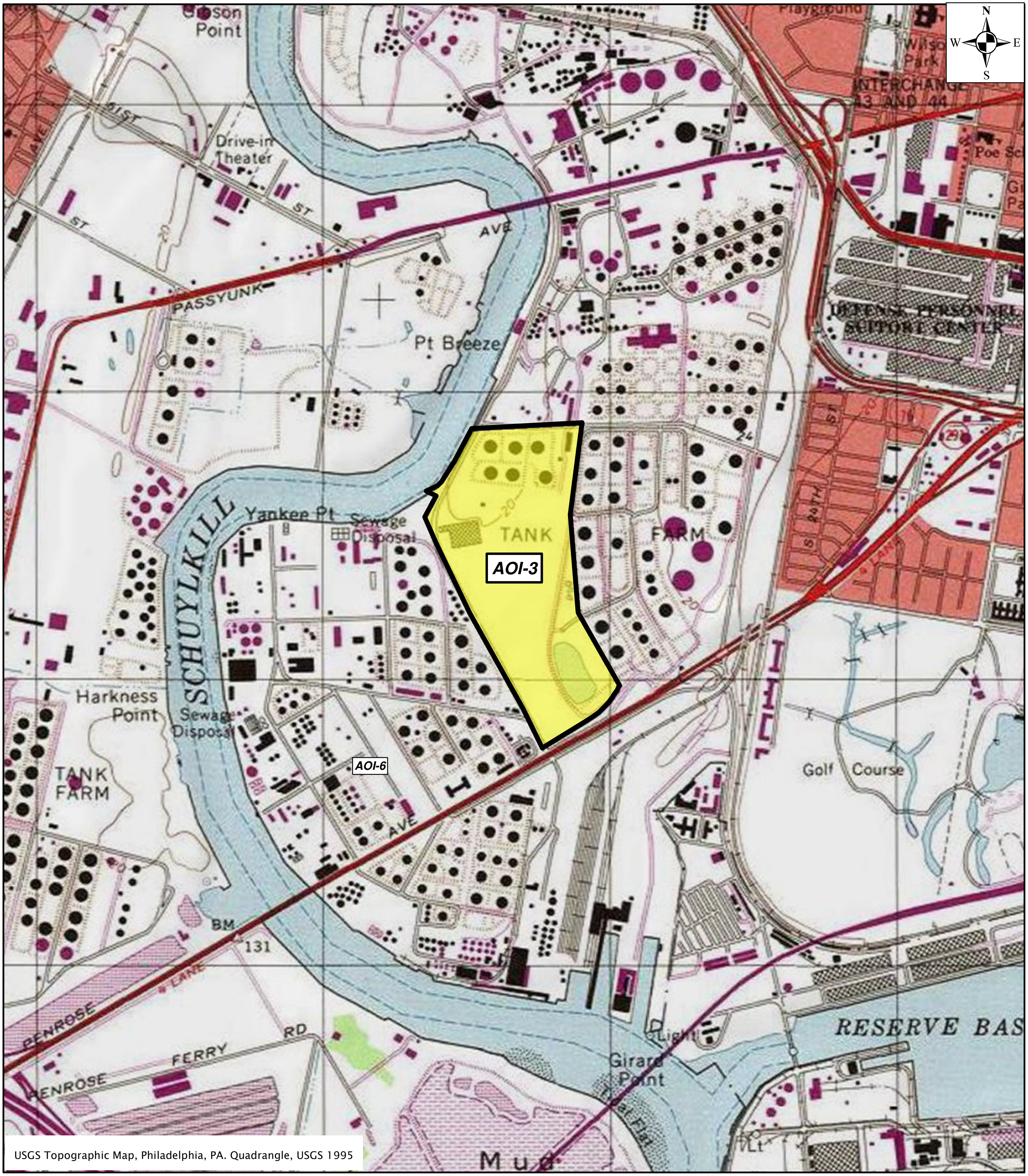
Indicate latitude/longitude in degrees-minutes-seconds format only. **Longitude**: -75° / 12’ / 5” **W**

Three steps are needed to convert from decimal to degrees-minutes-seconds: (1) Degrees will be the whole number. (2) To get minutes, multiply the decimal degree portion by 60. (3) Multiply the decimal minute portion by 60 to get seconds.

Example: (Latitude) 40.93748 = **40**° ; 0.93748 x 60 = 56.2488’ = **56**’ ; 0.2488 x 60 = 14.928 = **15**” = **40°56’15”N**
(Longitude) 75.94740 = **75**° ; 0.94740 x 60 = 56.844’ = **56**’ ; 0.844 x 60 = 50.64 = **51**’ = **75°56’51”W**

FOR PFBC USE ONLY

SIR#	Quad Name	Data Source	Search Results-Potential Species Conflict	Action



USGS Topographic Map, Philadelphia, PA. Quadrangle, USGS 1995

SUNOCO

PHILADELPHIA
ENERGY SOLUTIONS

Sunoco, Inc. (R&M)
PES Facility

3144 Passyunk Avenue
Philadelphia, PA. 19145

Figure 1: Site Location Map
AOI-3
PES Facility

Philadelphia

Pennsylvania

Job Number	Scale: 1" = 1,500'	Date
2574601	0 750 1,500 Feet	June 6, 2013

Path: \\langan.com\data\DT\data6\2574601\ArcGIS\MapDocuments\AOI 3 SCR\Figure 1- Site Location Map_6-5-13.mxd

Legend

🟥	Existing Fence
🟩	Sheet Pile Wall/Bulkhead
☐	AOI Boundary
▶ 1	Photo Location/Direction

Notes:
1. Bing Maps aerial imagery provided by © 2010 Microsoft Corporation and its data suppliers and obtained under the licensing agreement with ESRI.

Figure 2: Site Plan and Extent of Existing
Fence and Sheet Pile Wall
AOI-3
PES Facility
Philadelphia, Pennsylvania

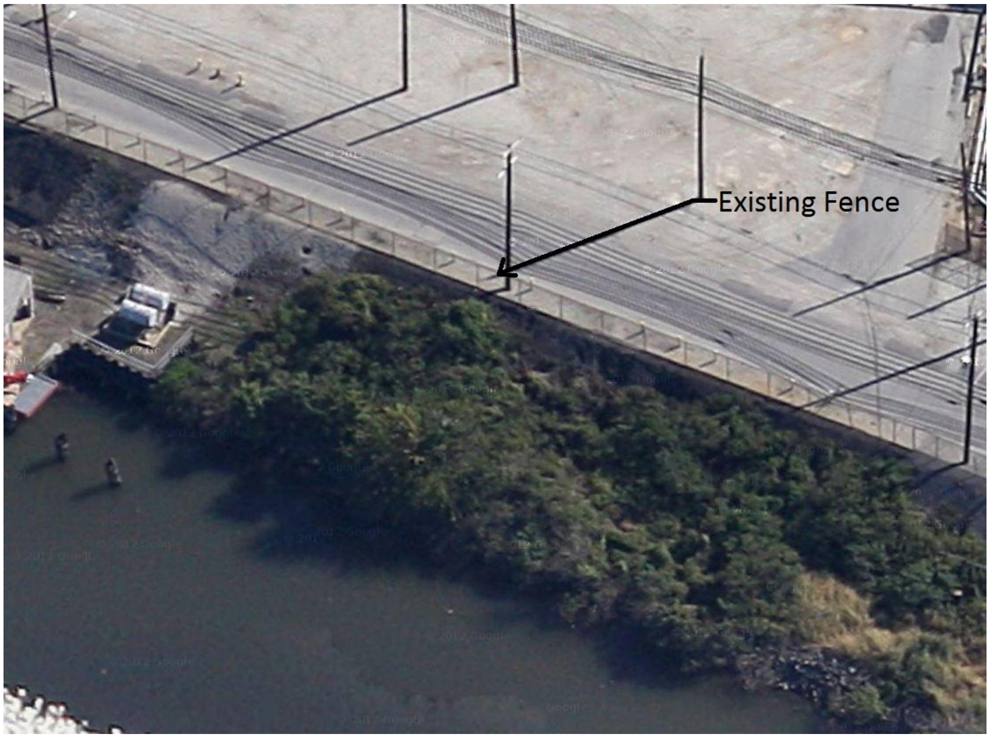
Sunoco, Inc. (R&M)
PES Facility

3144 Passyunk Avenue
Philadelphia, PA. 19145

0 400 800
Feet

SCALE: 1" = 400'
DATE: June 7, 2013
DRN. BY: MH
CKD. BY: DW
JOB#: 2574601

Path: \\langan.com\data\DT\data6\2574601\ArcGIS\MapDocuments\AOI 3 Workplan\Figure 2 - AOI-3 Extent of Sheet Pile Wall.mxd



Photograph No. 1. View of the existing fencing within AOI-3 along Schuylkill Avenue, facing east.

Photograph No. 2. View of the existing fencing within AOI-3 along Schuylkill Avenue facing east.

Photograph No. 3. View of the existing fencing within AOI-3 along Schuylkill Avenue, facing east.

1. PROJECT INFORMATION

Project Name: **Sunoco AOI-3**
Date of review: **1/15/2013 9:14:51 PM**
Project Category: **Hazardous Waste Clean-up, Site Remediation, and Reclamation,Other**
Project Area: **104.1** acres
County: **Philadelphia** Township/Municipality: **Philadelphia**
Quadrangle Name: **PHILADELPHIA** ~ ZIP Code: **19145**
Decimal Degrees: **39.912616 N, -75.201394 W**
Degrees Minutes Seconds: **39° 54' 45.4" N, -75° 12' 5" W**

2. SEARCH RESULTS

Agency	Results	Response
PA Game Commission	**Potential Impact**	**FURTHER REVIEW IS REQUIRED, See Agency Response**
PA Department of Conservation and Natural Resources	No Known Impact	No Further Review Required
PA Fish and Boat Commission	**Potential Impact**	**FURTHER REVIEW IS REQUIRED, See Agency Response**
U.S. Fish and Wildlife Service	No Known Impact	No Further Review Required

As summarized above, Pennsylvania Natural Diversity Inventory (PNDI) records indicate there may be potential impacts to threatened and endangered and/or special concern species and resources within the project area. If the response above indicates "No Further Review Required" no additional communication with the respective agency is required. If the response is "Further Review Required" or "See Agency Response," refer to the appropriate agency comments below. Please see the DEP Information Section of this receipt if a PA Department of Environmental Protection Permit is required.

3. AGENCY COMMENTS

Regardless of whether a DEP permit is necessary for this proposed project, any potential impacts to threatened and endangered species and/or special concern species and resources must be resolved with the appropriate jurisdictional agency. In some cases, a permit or authorization from the jurisdictional agency may be needed if adverse impacts to these species and habitats cannot be avoided.

These agency determinations and responses are **valid for two years** (from the date of the review), and are based on the project information that was provided, including the exact project location; the project type, description, and features; and any responses to questions that were generated during this search. If any of the following change: 1) project location, 2) project size or configuration, 3) project type, or 4) responses to the questions that were asked during the online review, the results of this review are not valid, and the review must be searched again via the PNDI Environmental Review Tool and resubmitted to the jurisdictional agencies. The PNDI tool is a primary screening tool, and a desktop review may reveal more or fewer impacts than what is listed on this PNDI receipt. The jursidictional agencies **strongly advise against** conducting surveys for the species listed on the receipt prior to consultation with the agencies.

PA Game Commission

RESPONSE: Further review of this project is necessary to resolve the potential impacts(s). Please send project information to this agency for review (see WHAT TO SEND).

PGC Species: (Note: The PNDI tool is a primary screening tool, and a desktop review may reveal more or fewer species than what is listed below.)
Scientific Name: Casmerodius albus
Common Name: Great Egret
Current Status: Endangered
Proposed Status: Endangered

PA Department of Conservation and Natural Resources

RESPONSE: No Impact is anticipated to threatened and endangered species and/or special concern species and resources.

PA Fish and Boat Commission

RESPONSE: Further review of this project is necessary to resolve the potential impacts(s). Please send project information to this agency for review (see WHAT TO SEND).

PFBC Species: (Note: The PNDI tool is a primary screening tool, and a desktop review may reveal more or fewer species than what is listed below.)
Scientific Name: Sensitive Species**
Common Name:
Current Status: Threatened
Proposed Status: Special Concern Species*

U.S. Fish and Wildlife Service

RESPONSE: No impacts to **federally** listed or proposed species are anticipated. Therefore, no further consultation/coordination under the Endangered Species Act (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.* is required. Because no take of federally listed species is anticipated, none is authorized. This response does not reflect potential Fish and Wildlife Service concerns under the Fish and Wildlife Coordination Act or other authorities.

* Special Concern Species or Resource - Plant or animal species classified as rare, tentatively undetermined or candidate as well as other taxa of conservation concern, significant natural communities, special concern populations (plants or animals) and unique geologic features.
** Sensitive Species - Species identified by the jurisdictinal agency as collectible, having economic value, or being susceptible to decline as a result of visitation.

WHAT TO SEND TO JURISDICTIONAL AGENCIES

If project information was requested by one or more of the agencies above, send the following information to the agency(s) seeking this information (see AGENCY CONTACT INFORMATION).

Check-list of *Minimum* Materials to be submitted:

____**SIGNED** copy of this Project Environmental Review Receipt
____Project narrative with a description of the overall project, the work to be performed, current physical characteristics of the site and acreage to be impacted.
____Project location information (name of USGS Quadrangle, Township/Municipality, and County)
____USGS 7.5-minute Quadrangle with project boundary clearly indicated, and quad name on the map

The inclusion of the following information may expedite the review process.
____A basic site plan(particularly showing the relationship of the project to the physical features such as wetlands, streams, ponds, rock outcrops, etc.)
____Color photos keyed to the basic site plan (i.e. showing on the site plan where and in what direction each photo was taken and the date of the photos)
____Information about the presence and location of wetlands in the project area, and how this was determined (e.g., by a qualified wetlands biologist), if wetlands are present in the project area, provide project plans showing the location of all project features, as well as wetlands and streams

4. DEP INFORMATION

The Pa Department of Environmental Protection (DEP) requires that a signed copy of this receipt, along with any required documentation from jurisdictional agencies concerning resolution of potential impacts, be submitted with applications for permits requiring PNDI review. For cases where a "Potential Impact" to threatened and endangered species has been identified before the application has been submitted to DEP, the application should not be submitted until the impact has been resolved. For cases where "Potential Impact" to special concern species and resources has been identified before the application has been submitted, the application should be submitted to DEP along with the PNDI receipt. The PNDI Receipt should also be submitted to the appropriate agency according to directions on the PNDI Receipt. DEP and the jurisdictional agency will work together to resolve the potential impact(s). See the DEP PNDI policy at http://www.naturalheritage.state.pa.us.

5. ADDITIONAL INFORMATION

The PNDI environmental review website is a **preliminary** screening tool. There are often delays in updating species status classifications. Because the proposed status represents the best available information regarding the conservation status of the species, state jurisdictional agency staff give the proposed statuses at least the same consideration as the current legal status. If surveys or further information reveal that a threatened and endangered and/or special concern species and resources exist in your project area, contact the appropriate jurisdictional agency/agencies immediately to identify and resolve any impacts.

For a list of species known to occur in the county where your project is located, please see the species lists by county found on the PA Natural Heritage Program (PNHP) home page (www.naturalheritage.state.pa.us). Also note that the PNDI Environmental Review Tool only contains information about species occurrences that have actually been reported to the PNHP.

6. AGENCY CONTACT INFORMATION

PA Department of Conservation and Natural Resources
Bureau of Forestry, Ecological Services Section
400 Market Street, PO Box 8552, Harrisburg, PA. 17105-8552
Fax:(717) 772-0271

U.S. Fish and Wildlife Service
Endangered Species Section
315 South Allen Street, Suite 322, State College, PA. 16801-4851
NO Faxes Please.

PA Fish and Boat Commission
Division of Environmental Services
450 Robinson Lane, Bellefonte, PA. 16823-7437
NO Faxes Please

PA Game Commission
Bureau of Wildlife Habitat Management
Division of Environmental Planning and Habitat Protection
2001 Elmerton Avenue, Harrisburg, PA. 17110-9797
Fax:(717) 787-6957

7. PROJECT CONTACT INFORMATION

Name: Linda Kenney
Company/Business Name: Langan Engineering
Address: PO Box 1569
City, State, Zip: Doylestown PA 18901
Phone:(215) 491-6500 Fax:(215) 491-6501
Email: lkenney@langan.com

8. CERTIFICATION

I certify that ALL of the project information contained in this receipt (including project location, project size/configuration, project type, answers to questions) is true, accurate and complete. In addition, if the project type, location, size or configuration changes, or if the answers to any questions that were asked during this online review change, I agree to re-do the online environmental review.

applicant/project proponent signature

1/15/13
date

LANGAN

Technical Excellence
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August 29, 2013

PA Fish and Boat Commission
Division of Environmental Services
450 Robinson Lane
Bellefonte, PA 16823-7437

Re: Potential PNDI Conflict
Philadelphia Energy Solutions Refining and Marketing LLC Facility
Philadelphia AOI-3
PNDI Search ID: 20130115386605
City of Philadelphia, Philadelphia County, Pennsylvania
Langan Project No.: 002574601

Dear Sir/Madam:

As environmental and regulatory compliance agent for Sunoco, Inc. (R&M) (applicant), Langan Engineering & Environmental Services (Langan) submits this request for potential conflicts associated with a search of the Pennsylvania Natural Diversity Inventory (PNDI) database. According to the PNDI search (PNDI 20130115386605), potential impacts may exist within the project site under the jurisdiction of the Pennsylvania Fish and Boat Commission. A Species Impact Review (SIR) Request Form is enclosed for your reference.

AOI 3 is located in the central portion of the Philadelphia Energy Solutions Refining and Marketing LLC (PES) Facility in Philadelphia, Pennsylvania and is known as the Impoundment Area (Figure 1). AOI 3 is bordered by Hartranft Street to the North, the #4 Tank Farm Area to the East, Penrose Avenue to the South, Girard Point Refinery to the Southwest, and the Schuylkill River to the Northwest. AOI 3 encompasses approximately 107 acres, half of which is covered by impervious surface (Figure 2). Surface water features consist of the Guard Basin/Four Pond area and the Schuylkill River. The Guard Basin/Four Pond area is an unlined storm water retention system in the southeast corner of AOI 3 and the Schuylkill River resides along the western boundary of AOI 3. Both the Schuylkill River and the Guard Basin/Four Pond area are separated from areas where work is conducted either by a roadway or chain link fence. A seven foot high chain link fence is located along Schuylkill Avenue, as shown in Figure 2. Due to the sensitive nature of the facility, photographs could not be obtained on-site. Photographs obtained from Bing Maps are provided for your reference.

The project is currently in the Act 2 reporting process and information related to threatened/endangered species or their habitats is required. We request information as to whether the project is determined to affect species of special concern under your jurisdiction, specifically addressing Act 2 reporting. If you have any questions on the enclosed materials or require any additional materials to make your determination, please feel free to contact me at (215) 491-6559.

Sincerely,
Langan Engineering and Environmental Services, Inc.

Linda Kenney, PWS, CWB
Senior Project Manager

Enclosure(s): As discussed

\\langan.com\data\DT\data6\2574601\Engineering Data\Natural Resources\2013 PNDIs\AOI-3\PAFBC AOI-3 PNDI Initial Conflict Letter.docx

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August 29, 2013

PA Game Commission
Bureau of Wildlife Habitat Management
Division of Environmental Planning and Habitat Protection
2001 Elmerton Avenue
Harrisburg, PA 17110-9797

Re: Potential PNDI Conflict
Philadelphia Energy Solutions Refining and Marketing LLC Facility
Philadelphia AOI-3
PNDI Search ID: 20130115386605
City of Philadelphia, Philadelphia County, Pennsylvania
Langan Project No.: 002574601

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Enclosure(s): As discussed

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1. Article Addressed to:

PA Fish and Boat Commission
Division of Environmental Services
450 Robinson Lane
Bellefonte, PA 16823-7437

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Cindy

Sent To
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Bureau of Wildlife Habitat Management
Street, Apt. No.; or PO Box No. Division of Environmental Planning and
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City, State, ZIP 2001 Elmerton Avenue
Harrisburg, PA 17110-9797

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Total Postage & Fees	$ 6.51

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AUG 29 2013

Cindy

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Street, Apt. No.; or PO Box No. Division of Environmental Services
450 Robinson Lane
City, State, ZIP Bellefonte, PA 16823-7437

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PA Game Commission
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Harrisburg, PA 17110-9797

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X ☐ Agent ☐ Addressee

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Pennsylvania Fish & Boat Commission

established 1866

Division of Environmental Services
Natural Diversity Section
450 Robinson Lane
Bellefonte, PA 16823

September 23, 2013

IN REPLY REFER TO
SIR# 41378

LANGAN
Linda Kenney
2700 Kelly Road
WARRINGTON, Pennsylvania 18976

RE: Species Impact Review (SIR) – Rare, Candidate, Threatened and Endangered Species
PNDI Search No. 20130115386605
Sunoco AOI-3
PHILADELPHIA County: Philadelphia City

Dear Linda Kenney:

This responds to your inquiry about a Pennsylvania Natural Diversity Inventory (PNDI) Internet Database search "potential conflict" or a threatened and endangered species impact review. These projects are screened for potential conflicts with rare, candidate, threatened or endangered species under Pennsylvania Fish & Boat Commission jurisdiction (fish, reptiles, amphibians, aquatic invertebrates only) using the Pennsylvania Natural Diversity Inventory (PNDI) database and our own files. These species of special concern are listed under the Endangered Species Act of 1973, the Wild Resource Conservation Act, and the Pennsylvania Fish & Boat Code (Chapter 75), or the Wildlife Code.

An element occurrence of a rare, candidate, threatened, or endangered species under our jurisdiction is known from the vicinity of the proposed project. However, given the nature of the proposed project, the immediate location, or the current status of the nearby element occurrence(s), no adverse impacts are expected to the species of special concern.

This response represents the most up-to-date summary of the PNDI data and our files and is valid for two (2) years from the date of this letter. An absence of recorded species information does not necessarily imply species absence. Our data files and the PNDI system are continuously being updated with species occurrence information. Should project plans change or additional information on listed or proposed species become available, this determination may be reconsidered, and consultation shall be re-initiated.

If you have any questions regarding this review, please contact Kathy Gipe at 814-359-5186 and refer to the SIR # 41378. Thank you for your cooperation and attention to this important matter of species conservation and habitat protection.

Sincerely,

Christopher A. Urban

Christopher A. Urban, Chief
Natural Diversity Section

CAU/KDG/dn

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Pennsylvania Game Commission

2001 ELMERTON AVENUE
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Division of Environmental Planning and Habitat Protection
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AUTOMATED TECHNOLOGY SERVICES	717-787-4076

www.pgc.state.pa.us

September 27, 2013 **PNDI Number(s):** 20130115386605

Ms. Linda Kenney
Langan Engineering
P.O. Box 1569
Doylestown, Pennsylvania 18901

Re: Sunoco AOI-3 – Hazardous Waste Clean-up
City of Philadelphia, Philadelphia County, Pennsylvania

Dear Ms. Kenney,

Thank you for submitting the Pennsylvania Natural Diversity Inventory (PNDI) Environmental Review Receipt Number 20130115386605 for review. The Pennsylvania Game Commission (PGC) screened this project for potential impacts to species and resources of concern under PGC responsibility, which includes birds and mammals only.

No Impact Anticipated

PNDI records indicate species or resources of concern are located in the vicinity of the project. However, based on the information you submitted concerning the nature of the project, the immediate location, and our detailed resource information, the PGC has determined that no impact is likely. Therefore, no further coordination with the PGC will be necessary for this project at this time.

This response represents the most up-to-date summary of the PNDI data files and is valid for two (2) years from the date of this letter. An absence of recorded information does not necessarily imply actual conditions on site. Should project plans change or additional information on listed or proposed species become available, this determination may be reconsidered.

Should the proposed work continue beyond the period covered by this letter, please resubmit the project to this agency as an "Update" (including an updated PNDI receipt, project narrative and accurate map). If the proposed work has not changed and no additional information concerning listed species is found, the project will be cleared for PNDI requirements under this agency for two additional years.

This finding applies to impacts to birds and mammals only. To complete your review of state and federally-listed threatened and endangered species and species of special concern, please be sure that the U.S. Fish and Wildlife Service, the PA Department of Conservation and Natural

Resources, and/or the PA Fish and Boat Commission have been contacted regarding this project as directed by the online PNDI ER Tool found at www.naturalheritage.state.pa.us.

Sincerely,

Olivia Mowery

Olivia A. Mowery
Environmental Planner
Division of Environmental Planning & Habitat Protection
Bureau of Wildlife Habitat Management
Phone: 717-787-4250, Extension 3128
Fax: 717-787-6957
E-mail:OMowery@pa.gov

A PNHP Partner

PNHP
Pennsylvania Natural Heritage Program

OAM/oam

cc: File

RIR Documents

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March 11, 2016

VIA EMAIL- MLOGAN@PHILLYNEWS.COM

Legal Advertising Department – Daily News
P.O. Box 8263 – 4th Floor
Philadelphia, PA 19101
Attn: Mary Anne Logan
215-854-5834

Re: Remedial Investigation Report
Area of Interest (AOI) 3
Philadelphia Energy Solutions (PES) Facility
3144 West Passyunk Avenue
Philadelphia, Philadelphia County, Pennsylvania
Langan Project No.: 2574602

On behalf of Evergreen Resources Group LLC (Evergreen), Langan Engineering and Environmental Services, Inc. requests that the following Public Notice be published in the Philadelphia Daily News under the legal notices section.

Notification of Submittal of a Remedial Investigation Report

Notice is hereby given that Evergreen Resources Group LLC (*Remediator), is in the process of submitting a Remedial Investigation Report to the Pennsylvania Department of Environmental Protection, Southeast Regional Office for Area of Interest 3 located at the Philadelphia Energy Solutions Refining and Marketing LLC Facility, Philadelphia County, Philadelphia, PA.*

The report is being submitted in accordance with the site-specific remediation standards established under the Land Recycling and Environmental Remediation Standards Act. This notice is made under the provision of the Land Recycling and Environmental Remediation Standards Act, the Act of May 19, 1995, P.L. #4, No. 2.

Please publish the notice as soon as possible and fax the proof of publication to me at (215) 491-6501. Please also mail the hard copy of the proof of publication and your invoice to my attention at the following address:

Langan Engineering & Environmental Services
Attn: Valentina Miller
2700 Kelly Road
Warrington, Pa. 18976

Should you have any questions or comments regarding the request, please contact me at (215) 491-6518

Sincerely,
Langan Engineering and Environmental Services, Inc.

Valentina M. Miller

Valentina M. Miller
Staff Engineer

cc: Jim Oppenheim, Evergreen
Charles Barksdale, PES

\\langan.com\data\DYL\data6\2574601\Office Data\Reports\Remedial Investigation Reports\AOI 3\Public Notices and Submittal Forms\2016_0211_AOI 3_RIR Newspaper Notification.docx

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March 11, 2016

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Lehigh Anne Rainford, MPH
Sanitation Supervisor
Philadelphia Department of Public Health
Environmental Engineering Section
321 University Avenue
Philadelphia, Pennsylvania 19104

Re: Remedial Investigation Report
Area of Interest (AOI) 3
Philadelphia Energy Solutions (PES) Facility
3144 West Passyunk Avenue
Philadelphia, Philadelphia County, Pennsylvania
Langan Project No.: 2574602

Dear Ms. Rainford:

Notice is hereby given that Evergreen Resources Group LLC (Evergreen), (Remediator), is in the process of submitting a Remedial Investigation Report to the Pennsylvania Department of Environmental Protection for AOI 3 located at the Philadelphia Energy Solutions Refining and Marketing LLC Facility, Philadelphia County, Philadelphia, PA. The report is being submitted in accordance with the site-specific remediation standards.

This notice is made under the provision of the Land Recycling and Environmental Standards Act, the Act of May 19, 1995, P.L. #4, No. 2.

Please call me at (215) 491-6500 if you have any questions concerning the proposed remediation.

Sincerely,
Langan Engineering and Environmental Services, Inc.

Valentina M. Miller

Valentina M. Miller
Staff Engineer

cc: Jim Oppenheim, Evergreen
Charles Barksdale, PES

\\langan.com\data\DYL\data6\2574601\Office Data\Reports\Remedial Investigation Reports\AOI 3\Public Notices and Submittal Forms\2016_0211_Philadelphia Department of Public Health_AOI 3 RIR Notices.docx

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Philadelphia Dept of Public Health
Environmental Engineering Section
321 University Avenue
Philadelphia, Pennsylvania 19104

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321 University Avenue
Philadelphia, Pennsylvania 19104

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Philadelphia Dept of Public Health
Environmental Engineering Section
321 University Avenue
Philadelphia, Pennsylvania 19104

9590 9403 0597 5183 5861 34

2. Article Number *(Transfer from service label)*

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Philadelphia Dept of Public Health
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321 University Avenue
City, State, ZIP+4 Philadelphia, Pennsylvania 19104

PS Form 3800, August 2006 See Reverse for Instructions

Proof of Publication in The Philadelphia Daily News
Under Act. No 587, Approved May 16, 1929

STATE OF PENNSYLVANIA
COUNTY OF PHILADELPHIA

Copy of Notice of Publication

Notification of Submittal of a Remedial Investigation Report
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Florence Devlin being duly sworn, deposes and says that **The Philadelphia Daily News** is a newspaper published daily, except Sunday, at Philadelphia, Pennsylvania, and was established in said city in 1925, since which date said newspaper has been regularly issued in said County, and that a copy of the printed notice of publication is attached hereto exactly as the same was printed and published in the regular editions and issues of the said newspaper on the following dates:

March 14, 2016

Affiant further deposes and says that she is an employee of the publisher of said newspaper and has been authorized to verify the foregoing statement and that she is not interested in the subject matter of the aforesaid notice of publication, and that all allegations in the foregoing statement as to time, place and character of publication are true.

Florence Devlin

Sworn to and subscribed before me this 14th day of March, 2016.

Mary Anne Logan
Notary Public

My Commission Expires:

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MARY ANNE LOGAN, Notary Public
City of Philadelphia, Phila. County
My Commission Expires March 30, 2017

PADEP Correspondence

pennsylvania DEPARTMENT OF ENVIRONMENTAL PROTECTION	**MEETING NOTES** C. David Brown 2 Feb 2015	**Commonwealth of Pennsylvania** **Department of Environmental Protection** **Southeast Regional Office** **Environmental Cleanup and Brownfields**

Site: **Philadelphia Energy Solutions Refinery** 3144 Passyunk Avenue Philadelphia, PA 19145	Area of Investigation: **AOI 3**	eFACTS Facility ID: 778377
	Tank Facility ID: 51-19781	NIR Date: 17 Nov 2014
Municipality: City of Philadelphia	County: Philadelphia	Location: 39.9082°N, 75.2020°W
Owner: Philadelphia Energy Solutions Refining and Marketing LLC 3144 Passyunk Ave. Philadelphia, PA 19145	Remediator: Evergreen Resources Management Operations 2 Righter Parkway, Suite 200 Wilmington, DE 19803	Consultant: Langan Engineering & Environmental Services 30 S. 17th St., Suite 1300 Philadelphia, PA 19103
Contact: Chuck Barksdale (215-339-2074)	Contact: Jim Oppenheim (302-477-0192)	Contact: Kevin McKeever (215-491-6518)

Attendees:		**Date:** 28 January 2015
DEP	David Brown	
EPA	Kevin Bilash	
Evergreen	Jim Oppenheim, Fiona Livingston	
Langan	Kevin McKeever	

We met at Langan's office to discuss Evergreen's work plans for **AOI 3** and other remedial activities at the Philadelphia Refinery. This was followed by a discussion of plans for Marcus Hook Industrial Complex AOI 4 (described separately).

Langan provided a figure showing previously obtained characterization data and proposed sampling locations in AOI 3 (also known as the Point Breeze impoundment area). Mr. McKeever noted the east–west groundwater trough in the northern area that may correlate with a filled topographic low.

There are two ASTs in AOI 3 with open historic incidents: Tank 833 (gas oil) and Tank 835 (jet stock). Shallow and deep soil sampling is planned around each of these. The three points around Tank 835 should be adequate because that incident involved a 4000-gal overfill that probably covered a large area around the tank. I recommended sampling in locations likely to have been impacted, such as beneath tank vents and in low areas of the emergency containment close to the tank.

Additional soil delineation is planned in the southeast where there were lead and benzene exceedences. It was uncertain why the benzene delineation was necessary as the 2010 sample concentration did not exceed the direct contact MSC, according to the figure. I asked that Langan verify that there was not some other exceedence at that point.

I asked about BH-13-112 which had an elevated lead concentration at 2–3′ (10,700 mg/kg). Deep soil exceedences of the site-specific lead standard are not being delineated at the facility because they do not exceed the published MSC (190,000 mg/kg). If the deep soil was excavated it would be subject to the soil management plan. Langan and Evergreen explained that generally deeper soil samples (>2′) were collected in locations where there were shallow exceedences and in each new well boring.

We discussed characterization of the ball field and tank car cleaning areas in the center of AOI 3. Very little soil data was shown on the map provided. There were extensive historical investigations of those areas. I reminded Evergreen that the RIR should include figures and tables showing pertinent historical data. We agreed that they would look through the older reports and determine if the past characterization was adequate. If, for instance, surface soil samples were lacking, they would collect additional data. Mr. Oppenheim noted that these areas are fenced, they are not in current use, and the southern portion is normally inundated. They are consulting with URS (AECOM) on the ecological evaluation of that area and also the Schuylkill River bank, which may have threated red-bellied turtle habitat.

Langan pointed out the locations of proposed calibration wells for fate-and-transport modeling. We agreed that one or more wells would also be needed to the east of the LNAPL plume centered on RW-4, in AOI 4. This should be done as part of the AOI 3 work. Mr. Oppenheim said that recovery from RW-4 had decreased, so it was shut down. They will revisit this system's operation with the cleanup plan.

I inquired about the 2010 sample data at S-280, including a significant benzene exceedence (41,000 μg/L) not shown on the figure. Flow in that area might be to the northwest, toward the river, or to the southwest, toward the groundwater trough. Evergreen agreed to install an additional well in an accessible area between S-280 and the river. [As there are no other wells in the vicinity, it will not be possible to refine the groundwater flow direction with only those two points.]

The central warehouse building on the west side of AOI 3 is above grade, with an air space between the ground and the floor. I mentioned that buildings of this construction can still experience vapor intrusion because vapors can accumulate in the enclose crawl space. Evergreen was not aware of petroleum operations in the area of the warehouse, and groundwater data don't show exceedences. A guard shack on the road along the southwest border also has no nearby identified contamination. Evergreen will check on the occupancy of the structures in the northeast corner.

Mr. Oppenheim asked if the vapor intrusion evaluation should be part of the RIR or just in a risk assessment report. I responded that there should be a VI evaluation in the RIR, including at least one round of data. When collecting indoor air data they should also obtain ambient (outdoor) air samples. The indoor air results can be compared to EPA RSLs and/or the ambient data. Sampling should be done in winter (heating season). A second round can be collected in winter or in spring/fall; summertime sampling is less desirable. If there are exceedences of RSLs then a complete VI evaluation should be provided in the RAR.

Evergreen and Langan intend to sample all of the existing monitoring wells in AOI 3 first. After installing the new wells they will sample just those. In a third event they will resample the new wells as well as any upgradient source wells for performing fate-and-transport modeling.

I pointed out a discrepancy in the cross sections included in the 2010 SCR at boring BF-108. One cross section included the Trenton Gravel there, another did not.

I asked if they planned any further LNAPL analyses. Mr. Oppenheim said that they might do some fingerprinting of plumes that had not been previously sampled.

There is one RCRA SWMU in AOI 3, the Guard Basin. Mr. Bilash said he was satisfied that the characterization that has been completed and planned is sufficient for this area.

Mr. Oppenheim stated that Evergreen intends to submit RIRs for AOIs 5, 1, 3, and 9 in 2015. The AOI 5 report is nearly complete, and they will soon be submitting the lead risk assessment report for a site-specific soil standard. One attainment sample for one remedial area in AOI 5 exceeded the new lead standard (2200 mg/kg). I pointed out that the site-specific standard can be attained by using the 95% UCL of the arithmetic mean [§250.707(c)]. Evergreen plans to apply the previously calculated lead standard (2700 mg/kg) for soil management that has been completed in AOI 8.

I informed Evergreen and Langan of pending updates to the Ch. 250 standards. There will be increases to the groundwater, soil-to-groundwater, and direct contact MSCs for 1,3,5-TMB. However, EPA is completing an IRIS assessment for trimethylbenzenes that may result in these MSCs being reduced in the subsequent Ch. 250 revision. Ethylbenzene and naphthalene direct contact MSCs will decrease significantly because of the adoption of California EPA cancer toxicity parameters. The revisions are still going through the rule-making process and should be promulgated later this year. Evergreen should be aware of potential impacts these changes may have on future attainment.

	2/2/2015
C. David Brown P.G.	Date

Pennsylvania Registered Professional Geologist No. PG005002

From: Brown, C David <cdbrown@pa.gov>
Sent: Friday, April 10, 2015 3:41 PM
To: OPPENHEIM, JIM
Cc: Kevin McKeever; Kevin Bilash (bilash.kevin@epa.gov)
Subject: RE: Evergreen/PES AOI 3 - Revised Work Plan Documents

Jim,

I have two questions on the revised AOI 3 work plan.

- The new figure shows some historic data for a section of the central vegetated area, but none for the former tank car cleaning area. You aren't proposing any new sampling there. Why have you decided not to investigate that area?

- In January we talked about placing a well(s) east of the LNAPL plume around RW-2 for calibration. The new figure doesn't show any proposed wells there. Please explain why you concluded no wells were needed.

Thanks.

-David

From: Kevin McKeever [mailto:kmckeever@langan.com]
Sent: Wednesday, April 01, 2015 1:14 PM
To: Brown, C David; Kevin Bilash (bilash.kevin@epa.gov) (bilash.kevin@epa.gov)
Cc: JAMES R OPPENHEIM (jroppenheim@evergreenresmgt.com)
Subject: Langan File Transfer - Evergreen/PES AOI 3 - Revised Work Plan Documents

David and Kevin,

Per our meeting on January 28, 2015, attached is a post and host link that includes the revised work plan figure and table for the upcoming activities in AOI 3 at the PES facility. Please contact me or Jim Oppenheim with any questions.

Thanks,

Kev

New files have been posted for you at the Langan Client Services site and can be retrieved until 4/11/2015 by clicking on the link below.

http://clients.langan.com/lph/default.aspx?postTransaction=1112933622

Figure 1 - Proposed Characterization Activities AOI-3_4-1-15.pdf
Table 1 -Summary of Proposed Site Characterization Activities for AOI 3_040115.pdf

Should you have any questions regarding the use of the Langan Client Services, please contact Langan IT (helpdesk@langan.com).

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Langan's goal is to be SAFE (Stay Accident Free Everyday)

Commonwealth of Pennsylvania
Department of Environmental Protection
2 East Main Street
Norristown, PA 19401

[date] /2011

To: Jim Oppenheim, Sunoco

cc: Walter Payne
Ayman Ghobrial
Steve O'Neil

From: David Burke (484-250-5822)

Re: Sunoco Philadelphia Refinery
Groundwater remediation program
Site Characterization Reports for AOIs 1 through 9

Technical comments have been provided to you previously for certain of the Areas of Interest (AOIs) as the Site Characterization Reports (SCRs) have been reviewed by DEP. However, for some of the SCRs, DEP has not provided any comments to date. At our meeting of March 23, 2011, you requested that DEP provide written confirmation of any and all comments on the SCRs that have been submitted by Sunoco to date. This memo is DEP's response to that request.

We note that Sunoco has informed DEP that they will revise and re-submit the SCRs for all nine of these AOIs. The new submissions will be called Remedial Investigation Reports (RIRs) to conform with the terminology used in the Land Recycling Act. In some cases, the re-submission represents an opportunity for Sunoco to provide additional information that was not available at the time the original SCR was submitted.

This memo will refer to past comments where appropriate. For the AOIs that have not been previously addressed in other comment documents, we will list issues that remain unresolved, as far as DEP can tell. We will go down the list of AOIs in chronological order according to when the SCR was submitted.

AOI-1 (first SCR submitted 6/30/05, revised SCR submitted 10/4/07):

- The most recent DEP comments on AOI-1 were provided in our memo dated 2/25/11. There were also several earlier documents that addressed various aspects of this AOI.
- In addition to the comments provided earlier, we wish to note that there is off-site contamination in one or more places adjacent to this AOI, so Sunoco's characterization and cleanup activities should continue to address these off-site areas.

AOI-4 (SCR submitted August 2005):

- The most recent DEP comments on AOI-4 were provided in our memo dated 2/25/11. Those comments include a concern about possible offsite contamination. We understand, based on recent conversation with you, that additional characterization and cleanup activities are ongoing at the southern boundary of AOI-4.

AOI-6 (SCR submitted September 2006):

- The SCR indicates that the LNAPL plume at the 27 Pump House appears to have a southern portion (that extends into AOI-5) and a northern portion (referred to as the "Tank 797 Area" or the "1700 Unit Tank Farm") that both need to be evaluated for potential additional recovery efforts. Follow-up information was to have been submitted with the quarterly reports. DEP requests that the re-submitted SCR/RIR contain an update on remedial activities as well as a summary of any evaluation that may have taken place since September 2006.

AOI-5 (SCR submitted August 2007):

- The SCR recommends further delineation of leaded tank bottom material and lead concentrations in soil in several areas and indicates that the results of these activities will be presented in an addendum to the SCR. DEP is unaware of any addendum having been provided to date.
- The SCR recommends additional soil borings at multiple locations, and indicates that the results of these activities will be presented in an addendum to the SCR. DEP is unaware of any addendum having been provided to date.
- The SCR recommends re-sampling well A-138 to assess the elevated concentration of cumene, and an evaluation of potential source areas. Results were to be presented in an addendum to the SCR. DEP is unaware of any addendum having been provided to date.
- The SCR recommends an evaluation of the need for enhancement of the recovery system at the sheet pile bulkhead ("9 berth"), and indicates that results of pump tests and recommendations will be presented in an addendum to the SCR. DEP is unaware of any addendum having been provided to date.
- Some of the above issues could legitimately be addressed in the Cleanup Plan for the AOI, instead of in an addendum to the SCR. Nevertheless, DEP requests that Sunoco use the re-submitted SCR/RIR to provide a summary of activities that may have been completed since August 2007, as well as a summary of the status of each of the issues described in the "Conclusions and Recommendations" section of the August 2007 SCR.

AOI-8 (SCR submitted September 2008):

- DEP provided comments on the SCR in a letter dated November 14, 2008. At a meeting in July 2009, Sunoco provided some information in response to DEP's comments. DEP suggests that the re-submitted SCR incorporate Sunoco's responses to DEP's November 2008 comments.

AOI-9 (SCR submitted October 2009):

- The Conclusions and Recommendations section of the SCR indicates that "activities requiring further work will be presented in a Site Characterization Report Addendum or Cleanup Plan for AOI-9." DEP suggests that certain of the recommended activities be reported on in the re-submitted SCR. These activities should include the following.
    - Further evaluation of the potential vapor intrusion into indoor air pathway for the blending area building.
    - Installation of additional monitoring wells and further evaluation of the dissolved organic compound plume at the western site boundary and, if necessary, beyond the boundary.
    - Re-sampling of lead in groundwater and additional evaluation of the mobility of this contaminant.

AOI-3 (SCR submitted September 2010):

- The SCRs for AOI-3 and AOI-2 both included evaluations of the flux of dissolved contaminants from groundwater to the tidal Schuylkill River, using a combination of modeling approaches. These evaluations have been reviewed by the Department's Water Quality Program staff, whose 4/1/2011 memo is attached to this one. As supported by the comments given in that memo, DEP requests that Sunoco provide a revised evaluation of this issue.
- The SCR indicates that Sunoco will perform additional delineation of surface soils at several locations, based on the possibility of exceedances of the site-specific standards for benzene and lead, and one actual exceedance for lead. Results of this additional delineation should be provided to DEP.
- The SCR indicates that Sunoco will investigate the source(s) of the elevated benzene concentration in groundwater at well S-280. The results of this investigation should be provided to DEP.
- The SCR reports that the LNAPL plume in the area of RW-2, S-59, S-60, and S-113 is "stable and immobile." However, the SCR does not provide significant data to support this conclusion. In addition, DEP suggests that just because a LNAPL plume is stable, it doesn't mean that the plume is not recoverable. The recovery well at RW-2 has been reasonably successful recovering LNAPL for a long time, until it was deactivated in 2009. Monitoring well S-59, located adjacent to RW-2, had an average LNAPL thickness of 2.6 feet before the recovery system was deactivated (six-year average of quarterly LNAPL thicknesses). To date, DEP has not accepted the idea that this recovery system should be turned off for good. If Sunoco intends to use the SCR to support an argument that the recovery system at RW-2 should remain inactive, we do not believe that the case has been made.

AOI-2 (SCR submitted September 2010):

- The SCRs for AOI-3 and AOI-2 both included evaluations of the flux of dissolved contaminants from groundwater to the tidal Schuylkill River, using a combination of modeling approaches. These evaluations have been reviewed by the Department's Water Quality Program staff, whose 4/1/2011 memo is attached to this one. As supported by the comments given in that memo, DEP requests that Sunoco provide a revised evaluation of this issue.
- The SCR indicates that Sunoco will perform additional delineation of surface soils at several locations, based on the possibility of exceedances of the site-specific standards for benzene and lead. Results of this additional delineation should be provided to DEP.
- The SCR indicates that Sunoco will collect soil gas samples to assess the vapor intrusion pathway for the Bio/BFW Unit building. The results of this additional sampling should be provided to DEP.
- The SCR indicates that several investigative tasks will be performed as part of a detailed evaluation of the LNAPL issue in the vicinity of the Pollock Street Sewer. DEP accepts that this issue can be addressed in the Cleanup Plan rather than in the SCR/RIR.

AOI-7 (SCR submitted September 2010):

- The SCR indicates that Sunoco will perform additional delineation of surface soils at several locations, based on the possibility of exceedances of the site-specific standards for organic compounds and lead . Results of this additional delineation should be provided to DEP.

APPENDIX B

CURRENT AND HISTORIC USE FIGURE

Legend

Existing, Historical Investigation, and Historic Use

🟥	Ballfield Historic Investigation
▨	Past Disposal Areas
▨	Impervious Surfaces
☐	RW-2 Remedial System
▨	Occupied Buildings
☐	Historic Use Areas
🟨	Solid Waste Management Unit
☐	Area of Interest (AOI) Boundary

Notes:
1. Aerial photography provided by Nearmap.com, dated 10/19/2015.
2. Area of Interest boundaries referenced from 2011 ALTA/ACSM Land Title Survey, prepared for Sunoco Inc. (R&S).

Appendix B: Current and Historic Use
AOI-3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, Pennsylvania

Philadelphia Refinery Operations
A Series of Evergreen Resources Group, LLC.
2 Righter Parkway, Suite 200
Wilmington, DE 19803

0 75 150 300 Feet

SCALE: 1" = 150'
DATE: February 16, 2017
DRN. BY: MMK
CKD. BY: ED
JOB#: 2574602

Path: \\langan.com\data\DYL\data6\2574601\ArcGIS\MapDocuments\AOI 3 RIR 2016\Appendix B - Current and Historic Use.mxd Date: 2/23/2017 User: MMking Time: 2:33:23 PM

APPENDIX C

SOIL BORING LOGS, MONITORING WELL, CONSTRUCTION SUMMARIES, GROUNDWATER PARAMETER SHEETS, GEOTECHNCIAL LABORATORY TESTING RESULTS, AND 2016 ONE MILE RADIUS WELL SEARCH FIGURE

Notes:
1. World aerial imagery basemap is provided through Langan's Esri ArcGIS software licensing and ArcGIS online. Source of aerial imagery is USDA FSA from 8/16/2015. Credits: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community.
2. Well search results provided by PaGWIS, November 2016.

Figure C-1: 2016 One Mile Radius Well Search
PES Philadelphia Refining Complex
Philadelphia, Pennsylvania

Evergreen Resources Management Operations
2 Righter Parkway, Suite 200
Wilmington, DE 19803

SCALE: 1" = 1200'
DATE: 2/23/2017
DRN. BY: MMK
CKD. BY: VM
JOB#: 2574601

Path: \\langan.com\data\DYL\data6\2574601\ArcGIS\MapDocuments\AOI 11 SCR\Appendix\Figure X - Well Search_022317.mxd

Appendix C
Groundwater Elevation Measurements
December 2009
AOI 3 Remedial Investigation Report
Philadelphia Energy Solutions Refining Complex
Philadelphia, Pennsylvania

Well ID	**Date**	**Depth to Water (ft btoc)**	**Water Level Elevation (ft amsl)**	**Depth to LNAPL (ft btoc)**	**LNAPL Elevation (ft amsl)**	**Corrected Groundwater Elevation (ft amsl)**
RW-2	12/31/2009	11.12	0.17	11.02	0.27	0.25
S-1	12/31/2009	2.39	6.36	--	--	6.36
S-10	12/31/2009	4.32	1.75	--	--	1.75
S-11	12/31/2009	4.31	2.07	--	--	2.07
S-113	12/31/2009	11.79	0.89	11.46	1.22	1.16
S-18	12/31/2009	4.12	19.37	--	--	19.37
S-19	12/31/2009	NM	NM	6.04	12.56	NM
S-2	12/31/2009	4.39	2.82	--	--	2.82
S-20	12/31/2009	18.55	1.71	--	--	1.71
S-21	12/31/2009	14.31	8.17	11.07	11.41	11.18
S-23	12/31/2009	18.64	1.64	--	--	1.64
S-24	12/31/2009	3.72	16.01	--	--	16.01
S-25	12/31/2009	13.16	-1.05	--	--	-1.05
S-3	12/31/2009	6.94	3.86	--	--	3.86
S-5	12/31/2009	3.52	2.30	3.48	2.342	2.34
S-59	12/31/2009	14.46	-1.98	11.26	1.225	0.60
S-60	12/31/2009	11.81	0.45	11.15	1.106	0.97

Appendix C
Groundwater Elevation Measurements
July 2010
AOI 3 Remedial Investigation Report
Philadelphia Energy Solutions Refining Complex
Philadelphia, Pennsylvania

Well ID	Date	Depth to Water (ft btoc)	Water Level Elevation (ft amsl)	Depth to LNAPL (ft btoc)	LNAPL Elevation (ft amsl)	Corrected Groundwater Elevation (ft amsl)
BF-100	7/13/2010	12.00	0.36	--	--	0.36
BF-103R	7/13/2010	14.25	0.32	--	--	0.32
BF-104	7/13/2010	6.54	5.20	--	--	5.20
BF-105	7/13/2010	11.66	0.25	--	--	0.25
BF-106	7/13/2010	13.32	0.30	--	--	0.30
BF-107	7/13/2010	11.96	0.40	--	--	0.40
BF-108	7/13/2010	10.85	0.13	--	--	0.13
BF-88	7/13/2010	8.81	-0.38	--	--	-0.38
BF-90	7/13/2010	2.06	5.15	--	--	5.15
BF-99	7/13/2010	10.50	0.46	--	--	0.46
RW-2	7/13/2010	11.32	-0.03	11.16	0.13	0.10
S-1	7/13/2010	2.41	4.30	--	--	4.30
S-10	7/13/2010	4.35	1.72	--	--	1.72
S-11	7/13/2010	3.17	3.22	--	--	3.22
S-113	7/13/2010	12.45	0.23	11.86	0.82	0.71
S-13	7/13/2010	7.24	-0.76	--	--	-0.76
S-14	7/13/2010	3.03	3.07	--	--	3.07
S-16	7/13/2010	22.45	1.23	--	--	1.23
S-17	7/13/2010	18.73	1.2	--	--	1.20
S-18	7/13/2010	4.24	19.25	--	--	19.25
S-19	7/13/2010	6.05	12.55	6.03	12.57	12.57
S-20	7/13/2010	19.07	1.19	--	--	1.19
S-21	7/13/2010	10.43	12.05	--	--	12.05
S-22	7/13/2010	19.20	-0.54	--	--	-0.54
S-23	7/13/2010	19.09	1.19	--	--	1.19
S-24	7/13/2010	2.57	17.16	--	--	17.16
S-25	7/13/2010	13.71	1.12	--	--	1.12
S-3	7/13/2010	7.17	3.63	--	--	3.63
S-5	7/13/2010	2.99	3.25	2.98	--	3.25
S-59	7/13/2010	9.22	3.65	8.54	4.33	4.20
S-60	7/13/2010	12.05	0.23	11.33	0.95	0.80
S-69D	7/13/2010	13.87	-0.23	--	--	-0.23
S-8	7/13/2010	0.00	6.05	--	--	6.05
S-9	7/13/2010	2.91	3.27	--	--	3.27
S-280	7/13/2010	25.68	0.84	--	--	0.84
S-280D	7/13/2010	25.91	-0.031	--	--	-0.03
S-281	7/13/2010	13.11	1.253	--	--	1.25
S-282	7/13/2010	20.65	0.138	19.81	0.978	0.82

Appendix C
Groundwater Elevation Measurements
July 2010
AOI 3 Remedial Investigation Report
Philadelphia Energy Solutions Refining Complex
Philadelphia, Pennsylvania

Well ID	Date	Depth to Water (ft btoc)	Water Level Elevation (ft amsl)	Depth to LNAPL (ft btoc)	LNAPL Elevation (ft amsl)	Corrected Groundwater Elevation (ft amsl)
S-283	7/13/2010	10.98	0.161	--	--	0.16
S-284	7/13/2010	6.30	3.206	--	--	3.21
S-284D	7/13/2010	11.64	0.475	--	--	0.48
S-285	7/13/2010	14.53	0.683	13.94	1.273	1.21
S-288	7/13/2010	15.93	3.157	--	--	3.16
S-290	7/13/2010	10.19	1.496	--	--	1.50
S-291	7/13/2010	7.99	3.997	--	--	4.00

Appendix C
Groundwater Elevation Measurements
May 2011
AOI 3 Remedial Investigation Report
Philadelphia Energy Solutions Refining Complex
Philadelphia, Pennsylvania

Well ID	Date	Depth to Water (ft btoc)	Water Level Elevation (ft amsl)	Depth to LNAPL (ft btoc)	LNAPL Elevation (ft amsl)	Corrected Groundwater Elevation (ft amsl)
BF-100	5/10/2011	11.7	0.66	--	--	0.66
BF-103R	5/10/2011	14	0.57	--	--	0.57
BF-104	5/10/2011	5.58	6.16	--	--	6.16
BF-105	5/10/2011	11.19	0.72	--	--	0.72
BF-106	5/10/2011	12.86	0.76	--	--	0.76
BF-107	5/10/2011	11.56	0.80	--	--	0.80
BF-88	5/10/2011	9.68	0.93	--	--	0.93
BF-90	5/10/2011	1.71	5.78	--	--	5.78
BF-99	5/10/2011	10.18	0.78	--	--	0.78
C-95	5/16/2011	5.67	6.58	--	--	6.58
RW-2	5/9/2011	11.3	-0.01	11.05	0.24	0.19
S-1	5/9/2011	3.8	4.95	--	--	4.95
S-10	5/9/2011	4.48	1.59	--	--	1.59
S-11	5/9/2011	4.53	1.85	--	--	1.85
S-113	5/10/2011	12.33	0.35	11.61	1.07	0.94
S-14	5/9/2011	3.7	2.04	--	--	2.04
S-16	5/9/2011	22.12	1.56	--	--	1.56
S-17	5/9/2011	18.42	-1.15	--	--	-1.15
S-18	5/9/2011	4.03	19.46	--	--	19.46
S-19	5/9/2011	5.51	13.09	5.5	13.10	13.10
S-2	5/9/2011	4.81	2.40	--	--	2.40
S-20	5/9/2011	18.67	1.59	--	--	1.59
S-21	5/9/2011	14.54	7.94	--	--	7.94
S-22	5/9/2011	19.05	-0.39	--	--	-0.39
S-23	5/9/2011	18.66	1.62	--	--	1.62
S-24	5/9/2011	3.81	15.92	--	--	15.92
S-25	5/9/2011	10.56	1.55	--	--	1.55
S-280	5/9/2011	25.3	1.22	--	--	1.22
S-281	5/9/2011	13.59	0.77	--	--	0.77
S-283	5/10/2011	10.7	0.44	--	--	0.44
S-284	5/10/2011	9.56	-0.05	--	--	-0.05
S-285	5/10/2011	17.65	-2.44	13.42	1.79	1.34
S-288	5/10/2011	15.6	3.49	--	--	3.49
S-290	5/10/2011	9.85	1.84	--	--	1.84
S-291	5/10/2011	7.65	4.34	--	--	4.34
S-3	5/9/2011	7.58	3.22	--	--	3.22
S-5	5/9/2011	4.45	1.37	--	--	1.37
S-59	5/9/2011	9.7	2.79	9.3	3.19	3.11
S-60	5/9/2011	11.9	0.36	11.25	1.01	0.87
S-9	5/9/2011	4.28	2.30	--	--	2.30

Appendix C
Groundwater Elevation Measurements
May 2012
AOI 3 Remedial Investigation Report
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Philadelphia, Pennsylvania

Well ID	Date	Depth to Water (ft btoc)	Water Level Elevation (ft amsl)	Depth to LNAPL (ft btoc)	LNAPL Elevation (ft amsl)	Corrected Groundwater Elevation (ft amsl)
BF-100	5/8/2012	12.34	0.02	–	–	12.34
BF-103R	5/8/2012	14.64	-0.07	–	–	14.64
BF-104	5/8/2012	6.90	4.84	–	–	6.90
BF-105	5/8/2012	11.97	-0.06	–	–	11.97
BF-106	5/8/2012	13.66	-0.04	–	–	13.66
BF-107	5/8/2012	12.38	-0.02	–	–	12.38
BF-88	5/8/2012	10.40	0.21	–	–	10.40
BF-90	5/8/2012	2.36	5.13	–	–	2.36
BF-99	5/8/2012	10.90	0.06	–	–	10.90
RW-2	5/8/2012	11.76	-0.47	11.51	-0.22	11.76
S-1	5/8/2012	3.55	5.20	–	–	3.55
S-10	5/8/2012	5.10	0.97	–	–	5.10
S-11	5/8/2012	4.39	1.99	–	–	4.39
S-113	5/8/2012	12.89	-0.21	12.24	0.44	12.89
S-12	5/8/2012	5.33	0.90	–	–	5.33
S-14	5/8/2012	3.81	1.93	–	–	3.81
S-16	5/8/2012	22.74	0.94	–	–	22.74
S-17	5/8/2012	16.53	0.74	–	–	16.53
S-18	5/8/2012	4.61	18.88	–	–	4.61
S-19	5/8/2012	NM	NM	6.47	12.13	NM
S-2	5/8/2012	5.04	2.17	–	–	5.04
S-20	5/8/2012	19.40	0.86	–	–	19.40
S-21	5/8/2012	16.12	6.36	–	–	16.12
S-22	5/8/2012	19.55	-0.89	–	–	19.55
S-23	5/8/2012	19.42	0.86	–	–	19.42
S-24	5/8/2012	3.81	15.92	–	–	3.81
S-25	5/8/2012	11.20	0.91	–	–	11.20
S-280	5/8/2012	26.08	0.44	–	–	26.08
S-281	5/8/2012	14.08	0.28	–	–	14.08
S-283	5/8/2012	11.33	-0.19	–	–	11.33
S-284	5/8/2012	8.96	0.55	–	–	8.96
S-285	5/8/2012	17.77	-2.56	14.05	1.16	17.77
S-288	5/8/2012	14.95	4.14	–	–	14.95
S-290	5/8/2012	10.56	1.13	–	–	10.56
S-291	5/8/2012	8.27	3.72	–	–	8.27
S-3	5/8/2012	8.42	2.38	–	–	8.42
S-5	5/8/2012	4.50	1.32	4.5	1.32	1.32
S-59	5/8/2012	11.45	1.04	11.43	1.06	11.45
S-60	5/8/2012	12.37	-0.11	11.65	0.63	12.37
S-9	5/8/2012	4.61	1.97	–	–	4.61
C-95	5/9/2012	6.44	5.81	–	–	5.81

Appendix C
Groundwater Elevation Measurements
March 2013
AOI 3 Remedial Investigation Report
Philadelphia Energy Solutions Refining Complex
Philadelphia, Pennsylvania

Well ID	Date	Depth to Water (ft btoc)	Water Level Elevation (ft amsl)	Depth to LNAPL (ft btoc)	LNAPL Elevation (ft amsl)	Corrected Groundwater Elevation (ft amsl)
BF-100	3/27/2013	12.44	-0.08	--	--	-0.08
BF-103R	3/27/2013	14.94	-0.37	--	--	-0.37
BF-104	3/27/2013	5.40	6.34	--	--	6.34
BF-105	3/27/2013	12.07	-0.16	--	--	-0.16
BF-106	3/27/2013	13.92	-0.30	--	--	-0.30
BF-107	3/27/2013	12.45	-0.09	--	--	-0.09
BF-88	3/27/2013	10.29	0.32	--	--	0.32
BF-90	3/27/2013	1.49	6.00	--	--	6.00
BF-99	3/27/2013	11.06	-0.10	--	--	-0.10
C-95	3/28/2013	6.16	6.09	--	--	6.09
RW-2	3/27/2013	12.25	-0.96	12.00	-0.71	-0.76
S-1	3/27/2013	2.77	5.98	--	--	5.98
S-10	3/27/2013	5.00	1.07	--	--	1.07
S-11	3/27/2013	2.88	3.50	--	--	3.50
S-113	3/27/2013	12.60	0.08	12.60	0.08	0.08
S-12	3/27/2013	5.60	0.63	--	--	0.63
S-14	3/27/2013	3.64	2.10	--	--	2.10
S-16	3/27/2013	22.98	0.70	--	--	0.70
S-17	3/27/2013	16.83	0.44	--	--	0.44
S-18	3/27/2013	4.10	19.39	--	--	19.39
S-19	3/27/2013	NM	NM	5.22	7.35	NM
S-2	3/27/2013	4.06	3.15	--	--	3.15
S-20	3/27/2013	19.60	0.66	--	--	0.66
S-21	3/27/2013	14.58	7.90	--	--	7.90
S-22	3/21/2013	20.19	-1.53	--	--	-1.53
S-22	3/27/2013	20.30	-1.64	--	--	-1.64
S-23	3/27/2013	19.58	0.70	--	--	0.70
S-24	3/27/2013	3.39	16.34	--	--	16.34
S-25	3/27/2013	11.39	0.72	--	--	0.72
S-280	3/27/2013	26.14	0.38	--	--	0.38
S-281	3/27/2013	14.52	-0.16	--	--	-0.16
S-283	3/27/2013	11.73	-0.59	--	--	-0.59
S-284	3/27/2013	7.74	1.77	--	--	1.77
S-285	3/27/2013	15.89	-0.68	14.40	0.81	0.65
S-288	3/27/2013	11.07	8.02	--	--	8.02
S-290	3/27/2013	10.60	1.09	--	--	1.09
S-291	3/27/2013	7.85	4.14	--	--	4.14
S-3	3/27/2013	7.72	3.08	--	--	3.08
S-5	3/27/2013	3.10	2.72	3.09	2.73	2.73
S-59	3/27/2013	10.03	2.46	10.03	2.46	2.46
S-60	3/27/2013	12.94	-0.68	12.11	0.17	-0.03
S-66	3/27/2013	NM	NM	--	--	NM
S-9	3/27/2013	3.04	3.54	--	--	3.54

Appendix C
Groundwater Elevation Measurements
July 2013
AOI 3 Remedial Investigation Report
Philadelphia Energy Solutions Refining Complex
Philadelphia, Pennsylvania

Well ID	Date	Depth to Water (ft btoc)	Water Level Elevation (ft amsl)	Depth to LNAPL (ft btoc)	LNAPL Elevation (ft amsl)	Corrected Groundwater Elevation (ft amsl)
BF-88	7/12/2013	10.16	0.447	--	--	0.45
RW-2	7/12/2013	11.9	-0.61	11.5	-0.21	-0.29
S-113	7/12/2013	12.85	-0.17	12.07	0.61	0.47
S-281	7/12/2013	14.04	0.323	--	--	0.32
S-284	7/12/2013	9.04	0.466	--	--	0.47
S-59	7/12/2013	9.69	2.795	9.53	2.955	2.92
S-60	7/12/2013	12.36	-0.104	11.64	0.616	0.46
S-17	7/25/2013	16.25	1.02	--	--	1.02
S-20	7/25/2013	19.19	1.07	--	--	1.07

Appendix C
Groundwater Elevation Measurements
December 2009
AOI 3 Remedial Investigation Report
Philadelphia Energy Solutions Refining Complex
Philadelphia, Pennsylvania

Well ID	Date	Depth to Water (ft btoc)	Water Level Elevation (ft amsl)	Depth to LNAPL (ft btoc)	LNAPL Elevation (ft amsl)	Corrected Groundwater Elevation (ft amsl)
BF-100	5/13/2014	11.21	1.15	--	--	1.15
BF-103R	5/13/2014	13.64	0.93	--	--	0.93
BF-104	5/13/2014	5.20	6.54	--	--	6.54
BF-105	5/13/2014	10.72	1.19	--	--	1.19
BF-106	5/13/2014	12.46	1.16	--	--	1.16
BF-107	5/13/2014	11.20	1.16	--	--	1.16
BF-88	5/13/2014	9.29	1.32	--	--	1.32
BF-90	5/13/2014	1.40	6.09	--	--	6.09
BF-99	5/13/2014	9.82	1.14	--	--	1.14
RW-2	5/13/2014	11.10	0.19	10.72	0.57	0.50
S-1	5/13/2014	5.09	3.66	--	--	3.66
S-10	5/13/2014	3.89	2.18	--	--	2.18
S-11	5/13/2014	3.95	2.43	--	--	2.43
S-113	5/13/2014	12.07	0.61	11.35	1.33	1.19
S-12	5/13/2014	4.23	2.00	--	--	2.00
S-14	5/13/2014	2.75	2.99	--	--	2.99
S-16	5/13/2014	21.46	2.22	--	--	2.22
S-18	5/13/2014	4.08	19.41	--	--	19.41
S-19	5/13/2014	7.49	11.11	7.48	11.12	11.12
S-2	5/13/2014	4.49	2.72	--	--	2.72
S-20	5/13/2014	18.05	2.21	--	--	2.21
S-21	5/13/2014	14.44	8.04	--	--	8.04
S-23	5/13/2014	18.04	2.24	--	--	2.24
S-24	5/13/2014	3.77	15.96	--	--	15.96
S-25	5/13/2014	9.85	2.26	--	--	2.26
S-280	5/13/2014	23.89	2.63	--	--	2.63
S-283	5/13/2014	10.77	0.37	--	--	0.37
S-284	5/13/2014	8.26	1.25	--	--	1.25
S-285	5/13/2014	15.73	-0.52	13.00	2.21	1.92
S-288	5/13/2014	11.63	7.46	--	--	7.46
S-290	5/13/2014	9.27	2.42	--	--	2.42
S-291	5/13/2014	7.37	4.62	--	--	4.62
S-3	5/13/2014	7.32	3.48	--	--	3.48
S-383	5/13/2014	11.45	1.30	--	--	1.30
S-384	5/13/2014	15.32	1.19	--	--	1.19
S-385	5/13/2014	11.58	1.33	--	--	1.33
S-386	5/13/2014	12.42	1.33	--	--	1.33
S-387	5/13/2014	3.48	3.63	--	--	3.63

Appendix C
Groundwater Elevation Measurements
December 2009
AOI 3 Remedial Investigation Report
Philadelphia Energy Solutions Refining Complex
Philadelphia, Pennsylvania

Well ID	Date	Depth to Water (ft btoc)	Water Level Elevation (ft amsl)	Depth to LNAPL (ft btoc)	LNAPL Elevation (ft amsl)	Corrected Groundwater Elevation (ft amsl)
S-5	5/13/2014	4.03	1.79	3.98	1.84	1.84
S-59	5/13/2014	8.40	4.09	8.40	4.09	4.09
S-60	5/13/2014	11.49	0.77	10.96	1.30	1.18
S-66	5/13/2014	25.80	1.23	--	--	1.23
S-9	5/13/2014	4.12	2.46	--	--	2.46
C-95	5/14/2014	6.08	6.17	--	--	6.17
S-22	5/14/2014	18.67	-0.01	--	--	-0.01
S-66	5/29/2014	23.47	3.56	--	--	3.56
S-1	5/30/2014	4.58	4.17	--	--	4.17
S-25	5/30/2014	10.09	2.02	--	--	2.02
S-3	5/30/2014	7.53	3.27	--	--	3.27

Appendix C
Groundwater Elevation Measurements
May 2015
AOI 3 Remedial Investigation Report
Philadelphia Energy Solutions Refining Complex
Philadelphia, Pennsylvania

Well ID	Date	Depth to Water (ft btoc)	Water Level Elevation (ft amsl)	Depth to LNAPL (ft btoc)	LNAPL Elevation (ft amsl)	Corrected Groundwater Elevation (ft amsl)
BF-100	5/12/2015	11.76	0.60	--	--	11.76
BF-103R	5/12/2015	14.18	0.39	--	--	14.18
BF-104	5/12/2015	5.9	5.84	--	--	5.9
BF-105	5/12/2015	11.33	0.58	--	--	11.33
BF-106	5/12/2015	13.02	0.60	--	--	13.02
BF-107	5/12/2015	11.68	0.68	--	--	11.68
BF-88	5/12/2015	9.76	0.85	--	--	9.76
BF-90	5/12/2015	1.94	5.55	--	--	1.94
BF-99	5/12/2015	10.29	0.67	--	--	10.29
RW-2	5/12/2015	11.21	0.08	10.84	0.45	11.21
S-1	5/12/2015	5.83	2.92	--	--	5.83
S-10	5/12/2015	4.13	1.94	--	--	4.13
S-11	5/12/2015	3.06	3.32	--	--	3.06
S-12	5/12/2015	4.88	1.35	--	--	4.88
S-14	5/12/2015	2.88	2.86	--	--	2.88
S-16	5/12/2015	21.86	1.82	--	--	21.86
S-17	5/12/2015	15.06	2.21	--	--	15.06
S-18	5/12/2015	4.35	19.14	--	--	4.35
S-2	5/12/2015	3.86	3.35	--	--	3.86
S-20	5/12/2015	18.21	2.05	--	--	18.21
S-21	5/12/2015	10.09	12.39	--	--	10.09
S-22	5/12/2015	19.01	-0.35	--	--	19.01
S-23	5/12/2015	18.52	1.76	--	--	18.52
S-25	5/12/2015	10.41	1.70	--	--	10.41
S-280	5/12/2015	24.81	1.71	--	--	24.81
S-283	5/12/2015	10.85	0.29	--	--	10.85
S-284	5/12/2015	8.68	0.83	--	--	8.68
S-285	5/12/2015	15.2	0.01	13.31	1.903	15.20
S-288	5/12/2015	13.45	5.64	--	--	13.45
S-290	5/12/2015	9.58	2.11	--	--	9.58
S-291	5/12/2015	8.05	3.94	--	--	8.05
S-3	5/12/2015	7.97	2.83	--	--	7.97
S-382	5/12/2015	17.33	2.99	--	--	17.33
S-383	5/12/2015	11.66	1.09	--	--	11.66
S-384	5/12/2015	15.84	0.67	--	--	15.84
S-385	5/12/2015	11.58	1.33	--	--	11.58
S-386	5/12/2015	12.84	0.91	--	--	12.84
S-387	5/12/2015	4.41	2.70	--	--	4.41

Appendix C
Groundwater Elevation Measurements
May 2015
AOI 3 Remedial Investigation Report
Philadelphia Energy Solutions Refining Complex
Philadelphia, Pennsylvania

Well ID	Date	Depth to Water (ft btoc)	Water Level Elevation (ft amsl)	Depth to LNAPL (ft btoc)	LNAPL Elevation (ft amsl)	Corrected Groundwater Elevation (ft amsl)
S-5	5/12/2015	3.24	2.58	3.16	2.662	3.24
S-59	5/12/2015	9	3.49	8.99	3.495	9.00
S-60	5/12/2015	11.54	0.72	11.1	1.156	11.54
S-9	5/12/2015	3.19	3.39	--	--	3.19
C-95	5/15/2015	6.47	5.78	--	--	6.47
S-113	5/18/2015	12.43	0.25	11.74	0.94	12.43

Appendix C
Groundwater Elevation Measurements
June 2015
AOI 3 Remedial Investigation Report
Philadelphia Energy Solutions Refining Complex
Philadelphia, Pennsylvania

Well ID	Date	Depth to Water (ft btoc)	Water Level Elevation (ft amsl)	Depth to LNAPL (ft btoc)	LNAPL Elevation (ft amsl)	Corrected Groundwater Elevation (ft amsl)
BF-100	6/5/2015	11.93	0.43	--	--	0.43
BF-101	6/5/2015	3.25	3.62	--	--	3.62
BF-103R	6/4/2015	14.45	0.12	--	--	0.12
BF-104	6/5/2015	5.56	6.18	--	--	6.18
BF-105	6/5/2015	11.56	0.35	--	--	0.35
BF-106	6/3/2015	13.40	0.22	--	--	0.22
BF-107	6/3/2015	12.08	0.28	--	--	0.28
BF-90	6/5/2015	1.95	5.54	--	--	5.54
BF-99	6/5/2015	10.62	0.34	--	--	0.34
RW-2	6/3/2015	11.69	-0.40	11.26	0.03	-0.05
S-1	6/4/2015	4.51	4.24	--	--	4.24
S-10	6/4/2015	4.66	1.41	--	--	1.41
S-11	6/4/2015	3.81	2.57	--	--	2.57
S-113	6/3/2015	12.00	0.89	11.79	0.89	1.06
S-12	6/4/2015	4.97	1.26	--	--	1.26
S-14	6/4/2015	3.03	2.71	--	--	2.71
S-16	6/3/2015	22.36	1.32	--	--	1.32
S-17	6/3/2015	15.45	1.82	--	--	1.82
S-18	6/3/2015	4.14	19.35	--	--	19.35
S-2	6/4/2015	4.05	3.16	--	--	3.16
S-20	6/4/2015	18.97	1.29	--	--	1.29
S-21	6/3/2015	12.64	9.84	--	--	9.84
S-23	6/4/2015	19.02	1.26	--	--	1.26
S-24	6/4/2015	3.67	16.06	--	--	16.06
S-25	6/4/2015	10.79	1.32	--	--	1.32
S-280	6/3/2015	25.47	1.05	--	--	1.05
S-281	6/3/2015	13.73	0.63	--	--	0.63
S-283	6/3/2015	11.25	-0.11	--	--	-0.11
S-284	6/3/2015	7.05	2.46	--	--	2.46
S-285	6/3/2015	15.46	-0.25	13.64	1.57	1.38
S-288	6/5/2015	15.27	3.82	--	--	3.82
S-290	6/3/2015	9.57	2.12	--	--	2.12
S-291	6/4/2015	8.16	3.83	--	--	3.83
S-3	6/4/2015	7.71	3.09	--	--	3.09
S-382	6/5/2015	17.39	2.93	--	--	2.93
S-383	6/5/2015	11.60	1.15	--	--	1.15
S-384	6/5/2015	15.87	0.64	--	--	0.64
S-386	6/4/2015	12.90	0.85	--	--	0.85

Appendix C
Groundwater Elevation Measurements
June 2015
AOI 3 Remedial Investigation Report
Philadelphia Energy Solutions Refining Complex
Philadelphia, Pennsylvania

Well ID	Date	Depth to Water (ft btoc)	Water Level Elevation (ft amsl)	Depth to LNAPL (ft btoc)	LNAPL Elevation (ft amsl)	Corrected Groundwater Elevation (ft amsl)
S-387	6/4/2015	4.81	2.30	--	--	2.30
S-5	6/4/2015	3.97	1.85	3.82	2.00	1.99
S-59	6/3/2015	9.32	3.17	9.31	3.18	3.17
S-60	6/3/2015	12.00	0.26	11.41	0.85	0.72
S-66	6/3/2015	29.56	2.53	--	--	2.53
S-9	6/4/2015	4.00	2.58	--	--	2.58

Appendix C
Groundwater Elevation Measurements
December 2015
AOI 3 Remedial Investigation Report
Philadelphia Energy Solutions Refining Complex
Philadelphia, Pennsylvania

Well ID	Date	Depth to Water (ft btoc)	Water Level Elevation (ft amsl)	Depth to LNAPL (ft btoc)	LNAPL Elevation (ft amsl)	Corrected Groundwater Elevation (ft amsl)
BF-100	12/8/2015	12.61	-0.25	--	--	-0.25
BF-101	12/8/2015	3.19	3.68	--	--	3.68
BF-103R	12/8/2015	14.38	0.19	--	--	0.19
BF-104	12/8/2015	6.32	5.42	--	--	5.42
BF-105	12/8/2015	12.18	-0.27	--	--	-0.27
BF-106	12/8/2015	13.80	-0.18	--	--	-0.18
BF-107	12/8/2015	12.49	-0.13	--	--	-0.13
BF-88	12/8/2015	10.50	0.11	--	--	0.11
BF-90	12/8/2015	1.89	5.60	--	--	5.60
BF-99	12/8/2015	11.04	-0.08	--	--	-0.08
RW-2	12/8/2015	12.20	-0.43	11.60	0.17	0.05
S-1	12/8/2015	5.06	3.69	--	--	3.69
S-10	12/8/2015	5.21	0.86	--	--	0.86
S-11	12/8/2015	3.86	2.52	--	--	2.52
S-113	12/8/2015	13.33	0.15	12.33	1.15	0.96
S-12	12/8/2015	5.39	0.84	--	--	0.84
S-14	12/8/2015	1.98	3.76	--	--	3.76
S-15	12/8/2015	NM	NM	--	--	NM
S-16	12/8/2015	22.97	0.71	--	--	0.71
S-18	12/8/2015	4.38	19.11	--	--	19.11
S-19	12/8/2015	NM	NM	--	--	NM
S-2	12/8/2015	4.53	2.68	--	--	2.68
S-21	12/8/2015	14.89	7.84	--	--	7.84
S-23	12/8/2015	19.64	0.64	--	--	0.64
S-24	12/8/2015	NM	NM	--	--	NM
S-25	12/8/2015	11.16	0.95	--	--	0.95
S-280	12/8/2015	25.85	0.67	--	--	0.67
S-281	12/8/2015	14.13	0.23	--	--	0.23
S-283	12/8/2015	11.50	-0.36	--	--	-0.36
S-284	12/8/2015	8.84	0.67	--	--	0.67
S-285	12/8/2015	13.96	1.27	13.94	1.29	1.29
S-288	12/8/2015	15.11	3.98	--	--	3.98
S-290	12/8/2015	9.67	2.02	--	--	2.02
S-291	12/8/2015	8.77	3.22	--	--	3.22
S-3	12/8/2015	8.25	2.55	--	--	2.55
S-382	12/8/2015	17.90	2.42	--	--	2.42
S-383	12/8/2015	12.44	0.31	--	--	0.31
S-384	12/8/2015	16.25	0.26	--	--	0.26

Appendix C
Groundwater Elevation Measurements
December 2015
AOI 3 Remedial Investigation Report
Philadelphia Energy Solutions Refining Complex
Philadelphia, Pennsylvania

Well ID	Date	Depth to Water (ft btoc)	Water Level Elevation (ft amsl)	Depth to LNAPL (ft btoc)	LNAPL Elevation (ft amsl)	Corrected Groundwater Elevation (ft amsl)
S-386	12/8/2015	13.40	0.35	--	--	0.35
S-387	12/8/2015	4.76	2.35	--	--	2.35
S-407	12/8/2015	14.55	-0.54	--	--	-0.54
S-409	12/8/2015	3.18	19.11	--	--	19.11
S-410	12/8/2015	13.36	9.08	13.19	9.25	9.24
S-411	12/8/2015	23.94	1.11	--	--	1.11
S-412	12/8/2015	13.24	-0.13	--	--	-0.13
S-413	12/8/2015	17.33	0.58	--	--	0.58
S-414	12/8/2015	21.7	0.83	--	--	0.83
S-5	12/8/2015	4.37	1.89749	3.89	1.932	2.34
S-60	12/8/2015	11.85	0.44549	11.8	0.456	0.48
S-66	12/8/2015	NM	NM	--	--	NM
S-68	12/8/2015	NM	NM	--	--	NM
S-69	12/8/2015	NM	NM	--	--	NM
S-9	12/8/2015	4.04	2.536	--	--	2.54

Appendix C
Groundwater Elevation Measurements
March 2016
AOI 3 Remedial Investigation Report
Philadelphia Energy Solutions Refining Complex
Philadelphia, Pennsylvania

Well ID	Date	Depth to Water (ft btoc)	Water Level Elevation (ft amsl)	Depth to LNAPL (ft btoc)	LNAPL Elevation (ft amsl)	Corrected Groundwater Elevation (ft amsl)
S-113	3/9/2016	12.36	-12.36	11.89	-11.89	-12.36
S-285	3/9/2016	13.78	-13.78	13.76	-13.76	-13.78
S-410	3/9/2016	13.52	-13.52	13.46	-13.46	-13.52
S-5	3/9/2016	3.63	-3.63	3.51	-3.51	-3.63
S-60	3/9/2016	12.06	-12.06	11.48	-11.48	-12.06

Appendix C
Groundwater Elevation Measurements
April 2016
AOI 3 Remedial Investigation Report
Philadelphia Energy Solutions Refining Complex
Philadelphia, Pennsylvania

Well ID	Date	Depth to Water (ft btoc)	Water Level Elevation (ft amsl)	Depth to LNAPL (ft btoc)	LNAPL Elevation (ft amsl)	Corrected Groundwater Elevation (ft amsl)
S-411	4/7/2016	24.66	-2.04	--	--	-2.04
S-414	4/8/2016	22.46	-2.45	--	--	-2.45
S-412	4/9/2016	12.8	-2.17	--	--	-2.17
S-407	4/10/2016	13.28	1.1	--	--	1.1
S-413	4/11/2016	17.44	-2.09	--	--	-2.09
S-409	4/12/2016	3.31	16.87	--	--	16.87
S-408	4/13/2016	14.56	-1.21	--	--	-1.21

Appendix C
Groundwater Elevation Measurements
Deep Wells
AOI 3 Remedial Investigation Report
Philadelphia Energy Solutions Refining Complex
Philadelphia, Pennsylvania

Well ID	Date	Depth to Water (ft btoc)	Water Level Elevation (ft amsl)	Corrected Groundwater Elevation (ft amsl)
S-69D	12/13/1995	16.22	-2.58	-2.58
S-8	12/13/1995	9.67	-3.25	-3.25
BF-90D	12/20/1995	11.66	-1.89	-1.89
S-69D	6/17/1996	14.99	-1.35	-1.35
S-8	6/17/1996	8.65	-2.23	-2.23
S-69D	9/9/1996	14.52	-0.88	-0.88
BF-90D	9/10/1996	10.45	-0.68	-0.68
S-69D	11/11/1996	14.54	-0.90	-0.90
S-8	11/11/1996	8.37	-1.95	-1.95
BF-90D	11/19/1996	10.56	-0.79	-0.79
S-69D	5/14/1997	14.69	-1.05	-1.05
S-8	5/14/1997	7.90	-1.48	-1.48
S-69D	11/10/1997	16.70	-3.06	-3.06
S-8	11/10/1997	9.70	-3.28	-3.28
BF-90D	11/13/1997	12.53	-2.76	-2.76
S-69D	5/6/1998	14.78	-1.14	-1.14
S-8	5/6/1998	8.25	-1.83	-1.83
S-69D	11/9/1998	15.60	-1.96	-1.96
S-8	11/9/1998	9.00	-2.58	-2.58
BF-90D	11/12/1998	11.55	-1.78	-1.78
S-69D	5/17/1999	15.24	-1.60	-1.60
S-8	5/17/1999	8.64	-2.22	-2.22
S-69D	11/15/1999	15.16	-1.52	-1.52
S-8	11/15/1999	8.36	-1.94	-1.94
BF-90D	11/19/1999	11.01	-1.24	-1.24
S-69D	5/15/2000	15.25	-1.61	-1.61
S-8	5/15/2000	8.61	-2.19	-2.19
S-69D	11/6/2000	14.97	-1.33	-1.33
S-8	11/7/2000	8.34	-1.92	-1.92
BF-90D	11/9/2000	10.71	-0.94	-0.94
S-69D	6/4/2001	14.78	-1.14	-1.14
S-8	6/5/2001	8.46	-2.04	-2.04
BF-90D	11/8/2001	12.01	-2.24	-2.24
S-69D	11/13/2001	16.02	-2.38	-2.38
S-8	11/13/2001	9.54	-3.12	-3.12
S-69D	5/13/2002	16.52	-2.88	-2.88
S-8	5/13/2002	10.38	-3.96	-3.96
S-69D	10/28/2002	16.95	-3.31	-3.31

Appendix C
Groundwater Elevation Measurements
Deep Wells
AOI 3 Remedial Investigation Report
Philadelphia Energy Solutions Refining Complex
Philadelphia, Pennsylvania

Well ID	Date	Depth to Water (ft btoc)	Water Level Elevation (ft amsl)	Corrected Groundwater Elevation (ft amsl)
S-8	10/28/2002	10.78	-4.36	-4.36
S-69D	4/23/2003	15.55	-1.91	-1.91
S-8	4/23/2003	8.63	-2.21	-2.21
S-8	11/3/2003	8.45	-2.03	-2.03
S-69D	11/4/2003	14.90	-1.26	-1.26
BF-90D	11/25/2003	10.17	-0.40	-0.40
S-69D	5/10/2004	14.83	-1.19	-1.19
S-8	5/10/2004	8.40	-1.98	-1.98
S-69D	10/5/2004	14.60	-0.96	-0.96
S-8	10/5/2004	8.11	-1.69	-1.69
BF-90D	10/6/2004	10.25	-0.48	-0.48
S-69D	5/10/2005	13.85	-0.21	-0.21
S-8	5/10/2005	7.42	-1.00	-1.00
BF-90D	5/20/2005	9.96	-0.19	-0.19
S-69D	5/9/2006	14.81	-1.17	-1.17
S-8	5/9/2006	8.27	-1.85	-1.85
S-13	5/9/2006	8.55	-2.19	-2.19
BF-108	5/9/2006	11.96	-0.98	-0.98
BF-90D	5/9/2006	11.79	-2.02	-2.02
S-69D	5/27/2007	14.05	-0.41	-0.41
S-8	5/27/2007	7.03	-0.61	-0.61
S-13	5/27/2007	6.10	0.26	0.26
BF-108	5/27/2007	11.11	-0.13	-0.13
BF-90D	5/27/2007		NA	NA
S-69D	11/15/2007	14.58	-0.94	-0.94
S-8	11/15/2007	8.08	-1.66	-1.66
S-13	11/15/2007	5.69	0.67	0.67
BF-108	11/15/2007	11.59	-0.61	-0.61
BF-90D	11/15/2007		NA	NA
S-69D	6/3/2008	14.56	-0.92	-0.92
S-8	6/3/2008	7.93	-1.51	-1.51
S-13	6/3/2008		NA	NA
BF-108	6/3/2008	11.62	-0.64	-0.64
BF-90D	6/3/2008	4.55	5.22	5.22
S-69D	11/25/2008	14.34	-0.70	-0.70
S-8	11/25/2008	7.67	-1.25	-1.25
S-13	11/25/2008	7.93	-1.57	-1.57
BF-108	11/25/2008	11.62	-0.64	-0.64

Appendix C
Groundwater Elevation Measurements
Deep Wells
AOI 3 Remedial Investigation Report
Philadelphia Energy Solutions Refining Complex
Philadelphia, Pennsylvania

Well ID	Date	Depth to Water (ft btoc)	Water Level Elevation (ft amsl)	Corrected Groundwater Elevation (ft amsl)
BF-90D	11/25/2008	10.02	-0.25	-0.25
S-69D	6/21/2009	14.11	-0.47	-0.47
S-8	6/21/2009	7.32	-0.90	-0.90
S-13	6/21/2009	7.57	-1.21	-1.21
BF-108	6/21/2009	11.26	-0.28	-0.28
BF-90D	6/21/2009		NA	NA
S-13	5/9/2011	7.00	-0.64	-0.64
S-280D	5/9/2011	25.85	0.03	0.03
S-8	5/9/2011	5.32	1.10	1.10
BF-108	5/10/2011	10.82	0.16	0.16
BF-90D	5/10/2011		NA	NA
S-284D	5/10/2011	11.42	0.70	0.70
S-69D	5/10/2011	13.68	-0.04	-0.04
S-69D	5/8/2012	14.10	-0.46	-0.46
S-8	5/8/2012	7.55	-1.13	-1.13
S-284D	5/8/2012	11.47	0.65	0.65
S-280D	5/8/2012	26.45	-0.57	-0.57
S-13	5/8/2012	7.42	-1.06	-1.06
BF-90D	5/8/2012	10.02	-0.25	-0.25
BF-108	5/8/2012	11.36	-0.38	-0.38
BF-108	10/25/2012	11.75	-0.77	-0.77
BF-90D	10/25/2012	10.66	-0.89	-0.89
S-280D	10/25/2012	26.27	-0.39	-0.39
S-284D	10/25/2012	12.48	-0.36	-0.36
S-69D	10/25/2012	14.67	-1.03	-1.03
BF-90D	10/26/2012	10.66	-0.89	-0.89
S-280D	10/31/2012	26.27	-0.39	-0.39
S-284D	10/31/2012	12.48	-0.36	-0.36
BF-108	11/1/2012	11.75	-0.77	-0.77
S-69D	11/1/2012	14.67	-1.03	-1.03
S-69D	3/21/2013	14.53	-0.89	-0.89
S-284D	3/21/2013	12.32	-0.21	-0.21
S-8	3/21/2013	9.16	-2.74	-2.74
S-280D	3/21/2013	26.08	-0.20	-0.20
BF-90D	3/21/2013	10.54	-0.77	-0.77
S-13	3/21/2013	8.05	-1.69	-1.69
BF-108	3/21/2013	11.71	-0.73	-0.73
BF-108	3/27/2013	11.83	-0.85	-0.85

Appendix C
Groundwater Elevation Measurements
Deep Wells
AOI 3 Remedial Investigation Report
Philadelphia Energy Solutions Refining Complex
Philadelphia, Pennsylvania

Well ID	Date	Depth to Water (ft btoc)	Water Level Elevation (ft amsl)	Corrected Groundwater Elevation (ft amsl)
BF-90D	3/27/2013	10.60	-0.83	-0.83
S-13	3/27/2013	8.16	-1.80	-1.80
S-280D	3/27/2013	26.51	-0.63	-0.63
S-8	3/27/2013	8.11	-1.69	-1.69
S-284D	3/27/2013	12.52	-0.41	-0.41
S-69D	3/27/2013	14.76	-1.12	-1.12
BF-90D	5/14/2014	9.27	0.50	0.50
S-284D	5/15/2014	11.27	0.85	0.85
S-69D	5/15/2014	13.55	0.09	0.09
S-8	5/15/2014	6.65	-0.23	-0.23
S-13	5/15/2014	6.62	-0.26	-0.26
S-280D	5/15/2014	25.50	0.38	0.38
BF-108	5/15/2014	10.47	0.51	0.51
BF-108	5/12/2015	10.81	0.17	0.17
BF-90D	5/12/2015	9.68	0.09	0.09
S-13	5/12/2015	6.97	-0.61	-0.61
S-280D	5/12/2015	24.93	0.95	0.95
S-8	5/12/2015	7.10	-0.68	-0.68
S-284D	5/12/2015	11.39	0.73	0.73
S-69D	5/12/2015	11.20	2.44	2.44
BF-108	12/8/2015	11.49	-0.51	-0.51
BF-90D	12/8/2015	10.36	-0.59	-0.59
S-13	12/8/2015	7.51	-1.15	-1.15
S-280D	12/8/2015	26.35	-0.47	-0.47
S-8	12/8/2015	7.69	-1.27	-1.27
S-284D	12/8/2015	12.07	0.05	0.05
S-69D	12/8/2015	11.84	-0.49	-0.49
S-284D	5/9/2016	11.83	0.29	0.29
S-69D	5/9/2016	11.60	-0.25	-0.25
S-8	5/9/2016	7.43	-1.01	-1.01
S-280D	5/9/2016	25.68	0.20	0.20
S-13	5/9/2016	7.49	-1.13	-1.13
BF-90D	5/9/2016	9.92	-0.15	-0.15
BF-108	5/9/2016	11.04	-0.06	-0.06

Appendix C
June 2015 Groundwater Sampling Parameters
AOI 3 Remedial Investigation Report
Philadelphia Energy Solutions Refining Complex
Philadelphia, Pennsylvania

Well ID	Well Construction Details^3		Depth to Water (feet)	Depth to Product (feet)	Product Thickness (feet)	Temp. (˚C)	DO (mg/L)	ORP (mv)	pH	Conductivity (mS/cm)	Temp. (˚C)	DO (mg/L)	ORP (mv)	pH	Conductivity (mS/cm)	Temp. (˚C)	DO (mg/L)	ORP (mv)	pH	Conductivity (mS/cm)
	Total Depth (below toc)	Well Diameter (in)				FIELD READINGS (pre-purge)					FIELD READINGS (post-purge)					FIELD READINGS (post sampling)				
BF-100	22	4	11.93	NP	NP	11.42	0.88	3	6.05	0.973	11.33	0.73	8.1	5.97	0.971	11.16	0.49	-5.7	5.98	0.966
BF-101	15.36	4	3.25	NP	NP	11.48	1.81	-37.3	6.25	0.928	11.51	1.57	-33.6	6.24	0.926	11.61	1.12	-19.1	6.01	0.925
BF-105	19	--	11.56	NP	NP	10.6	0.4	-51.5	7.29	1.318	10.43	0.18	-24.4	7.16	1.559	10.46	0.2	-10.7	7.12	1.522
BF-106	22.3	--	13.4	NP	NP	11.41	0.32	-123.7	7.07	0.991	11.42	0.27	-113.2	7.13	0.98	11.42	0.64	-85.2	7.15	0.866
BF-107	22.4	--	12.08	NP	NP	11.37	0.35	-95.8	6.34	0.491	11.42	0.75	-108.2	6.74	0.502	11.46	0.95	-70.5	6.92	0.568
BF-108	80.5	2	11.09	NP	NP	12.63	2.41	50.7	6.37	0.581	13.28	1.77	70.2	5.75	0.61	13.25	1.2	112.2	5.58	0.612
BF-99	20	4	10.62	NP	NP	11.29	1.2	-5.1	5.16	0.635	11.24	1	9.2	4.64	0.64	11.33	2.49	16.9	5.07	0.638
S-288	17	2	15.27	NP	NP	11.34	0.62	-186.9	6.44	1.476	11.41	0.46	-213.6	6.42	1.638	11.42	0.41	-223.5	6.6	0.832
BF-103R	22.65	4	14.45	NP	NP	12.39	5.58	97.1	6.05	2.927	12.3	5.21	101.1	5.92	2.901	12.49	2.41	110	5.62	2.72
BF-104	16.92	--	5.56	NP	NP	12.29	2.49	102.3	5.89	1.179	12.21	2.2	95.8	5.96	1.178	12.55	1.9	94	6.04	1.182
BF-90	12.64	4	1.95	NP	NP	12.5	0.63	-15.4	5.88	0.384	12.54	0.45	-10.3	5.8	0.382	14.31	0.86	-4.9	5.78	0.395
BF-90D	37.55	--	9.84	NP	NP	13.93	0.5	-73.7	6.5	0.607	14.22	1.67	-67.5	6.48	0.628	14.1	1.63	-38.7	6.29	0.643
RW-2	36	14	11.69	11.26	0.43	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S-1	14	--	4.51	NP	NP	14.09	1.89	-93.5	6.25	2.243	14.78	1.1	-65.3	6.3	2.489	14.11	0.68	-103.9	6.26	2.504
S-10	24.49	--	4.66	NP	NP	13.46	0.31	-57.4	6.05	0.118	13.45	0.21	-69	6.09	0.118	13.46	0.21	-80.3	6.16	0.119
S-11	7.65	4	3.81	NP	NP	19.36	0.86	71.4	5.7	0.112	19.7	0.65	70.7	5.69	0.11	17.61	0.38	33.6	5.85	0.122
S-113	25	2	12	11.79	0.21	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S-12	25.1	2	4.97	NP	NP	13.28	1.8	-67	6.05	0.128	13.05	0.51	-75	6.03	0.127	13.03	0.39	-71.8	5.94	0.127
S-13	67.51	2	7.5	NP	NP	14.15	0.62	109.7	5.28	0.548	13.96	0.53	128.8	4.94	0.468	13.96	0.46	135	4.94	0.47
S-14	6.94	4	3.03	NP	NP	18.69	0.44	-112.1	6.89	0.904	19.55	0.43	-88.4	6.77	0.843	18.53	0.36	-69.3	6.57	0.847
S-16	37.84	2	22.36	NP	NP	14.41	1.61	-46.2	5.77	0.929	14.36	1.14	-41.8	5.69	0.929	14.43	0.62	-54	5.76	0.773
S-17	22.09		15.45	NP	NP	13.39	0.57	-64.5	6.09	0.73	13.72	0.82	-51.2	12.22	0.701	13.48	0.65	-61.6	NS	1.312
S-18	17.2	4	4.14	NP	NP	12.83	0.53	-46.5	6.05	1.304	12.78	0.5	-45	6.08	1.301	14.25	0.42	-45.4	6.14	1.164
S-2	12.46		4.05	NP	NP	14.02	0.68	-68.9	6.56	1.329	15.1	2.38	-29.5	6.35	1.237	15.44	2.56	-9.1	6.37	1.095
S-20	34.82	2	18.97	NP	NP	13.73	0.5	-58.2	6.32	0.904	13.58	0.52	-54.4	6.15	0.871	13.61	0.41	-54	6.18	0.907
S-22	80.3	2	19.45	NP	NP	14.42	0.42	-15.3	6.02	0.355	14.3	0.28	-64.1	6.21	0.805	14.32	0.24	-83.6	6.35	0.807
S-220	--	--	19.94	19.43	0.51	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S-23	27.46	4	19.02	NP	NP	13.54	0.5	-53.6	6.4	0.843	13.47	0.68	-44.5	6.29	0.844	13.52	0.68	-37.2	6.14	0.904
S-25	17.47		10.79	NP	NP	13.73	10.78	-8.5	10.42	0.411	13.6	10.65	4.5	10.52	0.402	13.49	9.92	-6.5	10.43	0.328
S-280	27.9	2	25.47	NP	NP	14.58	4.6	-56	5.97	0.738	14.69	2.52	-50.8	5.98	0.74	14.78	2.7	-21.2	6.04	0.754
S-280D	63.47	4	26.22	NP	NP	16.69	0.77	-12	5.79	0.461	16.7	0.62	-44.1	5.95	0.495	16.73	0.43	-50.1	6.03	0.525
S-281	25.12	2	13.73	NP	NP	14.04	1.25	15.9	5.81	0.551	14.05	0.85	9.5	5.66	0.558	14.07	0.61	-1.2	5.72	0.574
S-282	--	--	20.55	19.95	0.6	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S-283	23.8	2	11.25	NP	NP	15.65	2.87	10.8	6.34	0.151	15.6	1.26	15.9	6.18	0.148	15.59	0.57	29.9	6.04	0.145
S-284	19.8	2	7.05	NP	NP	13.98	1.7	-53.6	6.85	0.981	14.85	1.34	-64.4	6.74	0.948	14.38	1.21	-69.3	6.69	0.945
S-284D	82	4	11.89	NP	NP	15.97	0.43	-33.4	6.25	2.046	15.56	0.55	11.2	5.98	1.4	15.56	0.29	45.5	5.82	1.225
S-285	20	2	15.46	13.64	1.82	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Appendix C
June 2015 Groundwater Sampling Parameters
AOI 3 Remedial Investigation Report
Philadelphia Energy Solutions Refining Complex
Philadelphia, Pennsylvania

Well ID	Well Construction Details[3]		Depth to Water (feet)	Depth to Product (feet)	Product Thickness (feet)	Temp. (˚C)	DO (mg/L)	ORP (mv)	pH	Conduc-tivity (mS/cm)	Temp. (˚C)	DO (mg/L)	ORP (mv)	pH	Conduc-tivity (mS/cm)	Temp. (˚C)	DO (mg/L)	ORP (mv)	pH	Conduc-tivity (mS/cm)
	Total Depth (below toc)	Well Diameter (in)				FIELD READINGS (pre-purge)					FIELD READINGS (post-purge)					FIELD READINGS (post sampling)				
S-290	24.21	2	9.57	NP	NP	12.74	0.65	-54.5	6.29	2.677	12.77	0.53	-56.2	6.3	2.645	12.68	0.42	-63.2	6.26	2.673
S-291	21.84	2	8.16	NP	NP	13.1	0.59	-101.3	7.04	0.864	17.7	0.54	-82.7	6.77	1.032	17.08	0.92	-74.6	6.68	1.062
S-3	14.5	--	7.71	NP	NP	14.48	1.32	-54.2	6.04	0.128	13.73	2.69	-25.9	5.99	0.141	13.63	1.65	-25.6	6.04	1.009
S-382	21.86	4	17.39	NP	NP	12.38	1.9	-99.3	5.99	0.762	12.38	1.94	-100.5	5.99	0.761	12.46	1.18	-119.6	6.24	0.986
S-383	15.55	4	11.6	NP	NP	13.26	0.42	-52.2	5.8	1.3	13.5	0.32	-72.5	5.79	1.221	13.82	0.54	5.5	5.85	1.252
S-384	25.11	4	15.87	NP	NP	14.42	0.7	2.2	5.64	0.413	14.49	0.91	13.2	5.52	0.407	14.38	1.1	-24.5	5.61	0.439
S-386	24.46	4	12.9	NP	NP	13.99	1.52	-19.2	5.75	0.704	13.91	1.13	-21.7	5.71	0.702	13.97	0.98	-63.6	5.82	0.75
S-387	13.3	4	4.81	NP	NP	13.93	0.61	-1.3	5.96	0.752	16.11	0.59	-13.9	5.88	0.683	14.7	2.07	-10.6	5.9	0.147
S-59	31	--	9.32	9.31	0.01	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S-60	17	--	12	11.41	0.59	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S-69D	62.35	2	11.6	NP	NP	16.45	1.25	68.8	5.93	0.994	16.39	0.75	70.2	5.9	0.972	16.33	0.46	67.9	5.88	0.95
S-8	59.3	2	7.34	NP	NP	14.5	0.32	-62.9	6.68	0.279	14.43	0.32	-53.5	6.72	0.285	14.41	0.37	-63.4	6.5	0.353
S-9	9.62	4	4	NP	NP	16.19	0.5	-18.3	5.81	0.615	16.04	0.4	-18.3	5.8	0.616	16.45	0.36	-16.1	5.8	0.614
S-291	20	2	8.16	3.82	4.34	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

-- - Information not provided
NP - No product measured in well
NS - Not sampled

Table D-1
Summary of August 2013 Groundwater Sampling Field Parameters
AOI-3
PES Refining Complex
Philadelphia, Pennsylvania

Well Information					Pre-Purge					Post purge				
Location ID	Depth to Bottom (ft bgs)	Depth to Water (ft btic)[1]	Depth to Product (ft btic)	Product Thickness (ft)	COND	DO	ORP	PH	TEMP	COND	DO	ORP	PH	TEMP
					us/cm	mg/l	mV	su	deg c	us/cm	mg/l	mv	su	deg c
S-382	26.25	19.71	NP	NP	0.487	0.1	-109.8	7.93	16.42	0.554	2.89	-49.2	6.19	16.67
S-383	15.3	11.92	NP	NP	0.968	1.44	-87.1	6.66	15.57	NS	NS	NS	NS	NS
S-384	24	15.55	NP	NP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S-385	25.2	11.97	NP	NP	2.77	1.04	-114.8	6.35	17.35	2.087	1.24	-88	7.88	13.86
S-386	24	12.72	NP	NP	0.734	0.7	-125.9	6.22	14.3	0.753	0.59	-149.2	6.587	14.3
S-387	16	3.41	NP	NP	0.299	0.93	48	6.47	22.73	0.341	0.28	-5.7	6.48	22.84
BF-101	13	NM	NP	NP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BF-100	21.95	11.81	NP	NP	1.056	1.02	-46	9.22	12.52	1.084	1.41	-74.4	10.09	12.92
BF-103R	14	14.11	NP	NP	1.583	0.49	80.4	6.36	18.37	1.947	0.7	118.5	6.18	18.11
BF-104	NM	5.81	NP	NP	0.955	0.29	114.6	3.38	19.05	1.036	0.49	73.9	6.38	18.49
BF-105	18.93	11.21	NP	NP	0.592	6.3	92	7.17	16.16	2.23	7.5	-44.6	8.84	14.36
BF-106	NM	12.95	12.95	NM	0.918	1.1	-104.4	8.84	15.71	0.855	1.32	-155	8.2	15.05
BF-107	NM	11.63	NP	NP	0.736	0.622	-23.5	5.25	16.03	NS	NS	NS	NS	NS
BF-88	14.5	9.71	NP	NP	0.511	0.09	35.9	5.93	19.21	0.491	0.16	35.1	6.16	19.46
BF-90	12.5	9.73	NP	NP	0.421	1.39	91.3	6.38	17.35	1.542	5.69	-2	4.44	17.68
BF-99	19.5	10.22	NP	NP	0.726	1.44	-220.6	7.86	16.28	0.668	0.36	-63.4	16.59	16.64
RW-2	36	11.42	10.98	0.44	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S-1	14	5.29	NP	NP	1.111	0.38	-106.9	12.69	15.95	0.879	0.86	-192.9	11.17	16.77
S-10	24.45	3.99	NP	NP	0.707	13.52	-118.4	6.86	15.89	0.676	12.58	-105.7	6.77	17.16
S-11	12	2.66	NP	NP	0.922	2.97	-45.9	6.48	25.19	0.73	3.76	-31.8	6.7	21.7
S-113	25	12.56	SHEEN NM	NM	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S-12	25.18	4.42	NP	NP	0.834	5.44	-145.3	6.76	15.92	0.765	4.48	-122.4	6.81	16.13
S-14	6.82	2.18	NP	NP	0.311	3.56	-80.1	7.32	24.52	0.346	2.96	-84.3	7.19	22.81
S-15	10	NM	NP	NP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S-16	38	21.86	NP	NP	0.965	7.87	-19.7	4.53	15.04	0.994	11.21	-136.4	0.37	15.56
S-17	25	15.65	NP	NP	1.124	5.57	-102.3	6.69	16.44	1.144	6.18	-118.6	6.92	15.91
S-18	17.15	4.1	NP	NP	1.592	0.05	-64	6.87	18.76	1.556	0.16	-87	6.82	18.66
S-19	16	>6.15	6.15	PRODUCT	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S-2	10	NM	NP	NP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S-20	36	18.51	NP	NP	0.786	12.59	-84.5	5.91	15.47	0.803	14.15	129.5	6.86	16.02
S-21	13	14.71	NP	NP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S-23	27.25	18.51	NP	NP	0.929	10.26	-118.2	6.72	15.9	0.926	11.67	-93	6.73	15.9
S-24	18.15	3.78	NP	NP	NS	NS	NS	Can't	NS	NS	NS	NS	NS	NS
S-25	17.37	10.36	NP	NP	0.282	2.65	-113.6	12.51	15.08	0.28	2.56	-86.6	11.25	14.99
S-3	18.15	7.35	NP	NP	1.089	0.51	-90.5	6.95	21.56	0.892	0.97	-81.6	8	22.15
S-5	9	2.81	2.73	0.08	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S-59	31	9.29	9.14	0.15	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S-60	17	11.81	11.19	0.62	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S-66	30	NM	NP	NP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S-68	15	NM	NP	NP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S-69	16	NM	NP	NP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S-7	26	NM	NP	NP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S-9	9.5	2.87	NP	NP	0.705	6.53	-20.5	6.4	25.38	0.859	6.77	-50.2	6.4	25.61
S-280	27.8	24.58	NP	NP	0.757	0.68	-84.4	7.54	15.39	NS	NS	NS	NS	NS
S-281	25	NM	NP	NP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S-283	23.7	10.86	NP	NP	1.466	2.19	46.14	5.62	16.6	1.51	2.71	81.2	5.83	15.79
S-284	20	8.7	NP	NP	0.292	0.14	-93.9	7.03	22.3	0.829	0.47	-146.2	7.18	19.76
S-285	20	15.87	13.35	2.52	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S-288	15	NM	NP	NP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S-290	20	9.49	NP	NP	2.164	1.23	-59.3	7.54	15.86	2.155	1.8	-28.3	7.34	14.18
S-291	20	7.66	NP	NP	0.541	4.52	-102.8	7.17	19.43	0.568	3.39	-151.1	7.32	21.11

Notes:

1. Measured prior to purging

Groundwater quality readings collected using a YSI
A minimum of 3 well volumes were purged at each well location, unless well went dry during purging
All wells were sampled using poly bailers
ft btic - Feet below top of inner casing
ft bgs - Feet below ground surface
mg/L - Milligrams per Liter
deg c - Degrees celsius
mV - Milli volts
uS/cm - Micro siemens per centimeter
su - Standard units
NM - Not measured
NP - No measurable (>0.01 ft) product
NS-P - Not sampled due to measurable (>0.01 ft) product

GeoStructures
Bashar S. Qubain, Ph.D., P.E.
Eric J. Seksinsky, P.G., P.E.
Jianchao Li, P.E.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project No. G15-104
November 30, 2015

Ms. Tiffani Doerr, PG
Aquaterra Technologies, Inc.
122 S. Church St.
West Chester, PA 19381

Re: Geotechnical Laboratory Testing Results
Philadelphia Refinery AOI-3

GeoStructures received four (4) *Shelby tube* soil samples from Aquaterra on October 29, 2015 (see attached chain of custody form). The soil parameters determined are as follows: moisture content; fraction organic carbon by loss on ignition; bulk density and dry density; and effective and total porosity. Refer to the testing summary below and the attached Shelby tube extrusion logs for sample descriptions and test results.

Laboratory Testing Summary

Sample ID	Test Specimen Depth	Visual Description & Remarks	Moist Bulk Density (pcf)[1]	Dry Bulk Density (pcf)[1]	Total Porosity[2] (%)	Effective Porosity[2] (%)	Water Content[3] (%)	Fraction Organic Carbon[4] (%)
S-412 10’-12’	10.7’-11.5’	Dk. brown silty, clayey sand with gravel	122.9	109.9	24.8	8.3	11.8	4.8
S-412 12’-14’	12.6’-13.4’	Dark brown silty sand with gvl., trace clay	123.6	105.4	29.0	6.6	17.3	3.0
S-411 10’-12’	10.5’-11.3’	Brown clay with sand	112.9	92.6	33.4	14.9	21.9	4.1
S-411 14’-16’	15.2’-15.7’	Brown clay with sand and gravel	112.9	93.1	31.9	10.4	21.3	5.4

[1] ASTM D7263
[2] ASTM D425M.
[3] ASTM D2216
[4] ASTM D2974, Method D.

We appreciate your request for services. Please call if you have any questions.

Sincerely,

Eric J. Seksinsky

Eric J. Seksinsky, P.G., P.E.
Associate

Analysis Request/ Environmental Services Chain of Custody

Client: Aquaterra Technologies
Project Name/#: PH Ref AOI-3
Project Manager: Tiffani Doerr
Sampler: NS/LM NOELLE STROIK
Name of State where samples were collected: PA

For Lab Use Only
FSC:
SCR:

					Matrix				**Analyses Requested**										
Sample Identification	**Date Collected**	**Time Collected**	**Grab**	**Composite**	**Soil**	**Water** (Potable ___ NPDES ___)	**Other**	**Total # of Containers**	Bulk Density	Effective Porosity	FOC							**Remarks**	Temperature of samples upon receipt (if applicable)
AOI3_S-412_10-12_101915	10/19/15	900	X		X			1	X	X	X							Can you please note if any of the tubes change lithologies? (e.g. top half is silt & bottom is S&G).	
AOI3_412_12-14_101915	10/19/15	1130	X		X			1	X	X	X								
AOI3_S-411_10-12_102015	10/20/15	1030	X		X			1	X	X	X								
AOI3_S-411_14-16_102015	10/20/15	1200	X		X			1	X	X	X								

Turnaround Time Requested (TAT) (please Ccircle): [✓ Normal] Rush

Date results are needed: ____________

Rush results requested by (please circle): Phone Fax

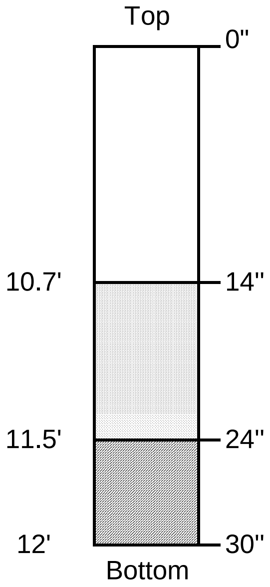
Phone #: ____________ Fax #: ____________

Relinquished by:	Date	Time	Received by:	Date	Time
Noelle Stroik	10/28/15	0800	Aquaterra STORAGE	10/28/15	0800
	10/29/15	1110	Blake Fisk	10/29	1110

Environmental Engineers and Consultants
Copies: Original should accompany samples to laboratory. A photocopy should be retained by the client.

SHELBY TUBE LOG

Project Name:	Philadelphia Refinery AOI-3			Boring No.:	AOI-3 S-412
Project No.:	G15-104	Sample No.:	10-12_101915	Depth:	10.0 - 12.0
Sample Length (prior to ejection):		Sample Length (after ejection):		Ejected By: VM	Date: 11/2/2015



Description

Open tube.

Dark brown silty, clayey sand with gravel (sc-sm).

Cobble at 11.5'

Light brown, gray, red gravelly clay with sand (cl).

Notes:

Lower 3 in. of the tube are bent.

SHELBY TUBE LOG

Project Name: Philadelphia Refinery AOI-3

Boring No.: AOI-3 S-412

Project No.: G15-104

Sample No.: 12-14_101915

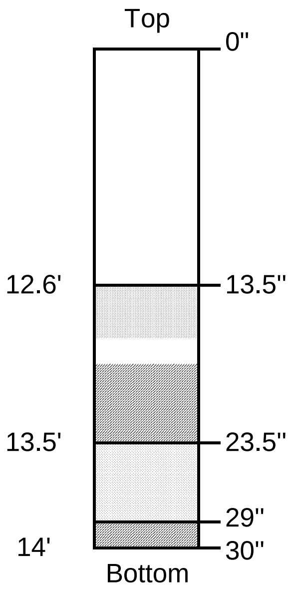
Depth: 12.0 - 14.0

Sample Length (prior to ejection):

Sample Length (after ejection):

Ejected By: VM

Date: 11/2/2015



Description

Open tube.

Dark brown silty sand with gravel (sm).

Grayish brown sandy clay with gravel (cl).

Light gray, brown poorly graded sand (sp-sm).

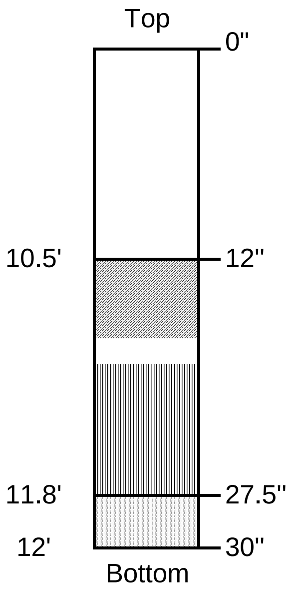
Light brown, gray sandy clay (cl).

Notes:

Lower 2 in. of the tube are bent.

SHELBY TUBE LOG

Project Name: Philadelphia Refinery AOI-3				Boring No.: AOI-3 S-411	
Project No.: G15-104	Sample No.: 10-12_102015			Depth: 10.0 - 12.0	
Sample Length (prior to ejection):	Sample Length (after ejection):		Ejected By: VM	Date: 11/2/2015	



Description

Open tube.

Brown clay with sand (cl).

Grayish brown silt (ml).

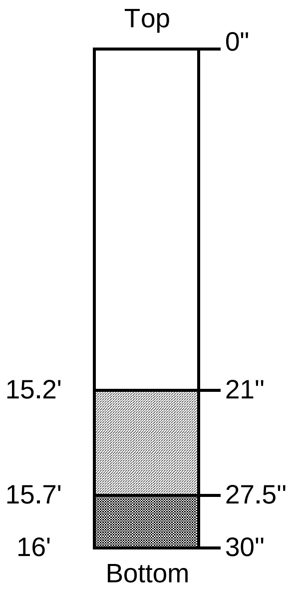
Brown silty sand (sm).

Notes:

GeoStructures

SHELBY TUBE LOG

Project Name:	Philadelphia Refinery AOI-3			Boring No.:	AOI-3 S-411
Project No.:	G15-104	Sample No.:	14-16_102015	Depth:	14.0 - 16.0
Sample Length (prior to ejection):		Sample Length (after ejection):		Ejected By: VM	Date: 11/2/2015



Description

Open tube.

Brown clay with sand and gravel (cl).

Same with concrete fragments

Notes:

Lower 3 in. of the tube are bent.

PROJECT: **Philadelphia Energy Solutions**
LOCATION: **AOI-3**
PROJECT NUMBER:

WELL / PROBEHOLE / BOREHOLE NO:
BH-16-1 PAGE 1 OF 1

DRILLING / INSTALLATION:
STARTED **2/9/16** COMPLETED: **2/9/16**
DRILLING COMPANY: **Aquaterra**
DRILLING EQUIPMENT: **Hand Auger**
DRILLING METHOD: **Hand Auger**
SAMPLING EQUIPMENT: **Hand Auger**

NORTHING (ft):
LAT:
GROUND ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
STATIC DTW (ft): **Not Encountered**
WELL CASING DIA. (in): **---**
LOGGED BY: **LM**

EASTING (ft):
LONG:
TOC ELEV (ft):
WELL DEPTH (ft): **---**
BOREHOLE DEPTH (ft): **2.0**
BOREHOLE DIA. (in): **2**
CHECKED BY: **TD**

Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)
	▨		**GRAVEL** ; medium-grained; Fill (slag)	■					
	▥		**CLAYEY SILT** ; orange	■	0800 BH-16-1 _0-2			0.0	
			Borehole terminated at 2 feet.						

PROJECT: **Philadelphia Energy Solutions**
LOCATION: **AOI-3**
PROJECT NUMBER:

WELL / PROBEHOLE / BOREHOLE NO:
BH-16-2
PAGE 1 OF 1

DRILLING / INSTALLATION:
STARTED **2/9/16** COMPLETED: **2/9/16**
DRILLING COMPANY: **Aquaterra**
DRILLING EQUIPMENT: **Hand Auger**
DRILLING METHOD: **Hand Auger**
SAMPLING EQUIPMENT: **Hand Auger**

NORTHING (ft):
LAT:
GROUND ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
STATIC DTW (ft): **Not Encountered**
WELL CASING DIA. (in): **---**
LOGGED BY: **LM**

EASTING (ft):
LONG:
TOC ELEV (ft):
WELL DEPTH (ft): **---**
BOREHOLE DEPTH (ft): **2.0**
BOREHOLE DIA. (in): **2**
CHECKED BY: **TD**

Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)
	🟧		**GRAVEL** ; white; medium-grained	■					
	🟩		**SILT AND CLAY** ; black and orange	■	0900 BH-16-2 _0-2			0.0	
			Borehole terminated at 2 feet.						

PROJECT: **Philadelphia Energy Solutions**
LOCATION: **AOI-3**
PROJECT NUMBER:

WELL / PROBEHOLE / BOREHOLE NO:
BH-16-3 PAGE 1 OF 1

DRILLING / INSTALLATION:
STARTED **2/9/16** COMPLETED: **2/9/16**
DRILLING COMPANY: **Aquaterra**
DRILLING EQUIPMENT: **Hand Auger**
DRILLING METHOD: **Hand Auger**
SAMPLING EQUIPMENT: **Hand Auger**

NORTHING (ft):
LAT:
GROUND ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
STATIC DTW (ft): **Not Encountered**
WELL CASING DIA. (in): **---**
LOGGED BY: **LM**

EASTING (ft):
LONG:
TOC ELEV (ft):
WELL DEPTH (ft): **---**
BOREHOLE DEPTH (ft): **2.0**
BOREHOLE DIA. (in): **2**
CHECKED BY: **TD**

Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)
	▨		**GRAVEL** ; white; medium-grained	■					
	▥		**CLAYEY SILT** ; orangeish brown	■	1000 BH-16-3 _0-2			0.0	
			Borehole terminated at 2 feet.						

PROJECT: **Philadelphia Energy Solutions**
LOCATION: **AOI-3**
PROJECT NUMBER:

WELL / PROBEHOLE / BOREHOLE NO:
BH-16-4 PAGE 1 OF 1

DRILLING / INSTALLATION:
STARTED **2/9/16** COMPLETED: **2/9/16**
DRILLING COMPANY: **Aquaterra**
DRILLING EQUIPMENT: **Hand Auger**
DRILLING METHOD: **Hand Auger**
SAMPLING EQUIPMENT: **Hand Auger**

NORTHING (ft):
LAT:
GROUND ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
STATIC DTW (ft): **Not Encountered**
WELL CASING DIA. (in): **---**
LOGGED BY: **LM**

EASTING (ft):
LONG:
TOC ELEV (ft):
WELL DEPTH (ft): **---**
BOREHOLE DEPTH (ft): **2.0**
BOREHOLE DIA. (in): **2**
CHECKED BY: **TD**

Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)
	▨		**GRAVEL** ; white; medium-grained	■					
	▨		**CLAY** ; black to orange; Fill (slag)	■	1100 BH-16-4 _0-2			0.0	
			Borehole terminated at 2 feet.						

PROJECT: **Philadelphia Energy Solutions**
LOCATION: **AOI-3**
PROJECT NUMBER:

WELL / PROBEHOLE / BOREHOLE NO:
BH-16-5 PAGE 1 OF 1

Aquaterra
Technologies, Inc.

DRILLING / INSTALLATION:
STARTED **2/10/16** COMPLETED: **2/10/16**
DRILLING COMPANY: **Aquaterra**
DRILLING EQUIPMENT: **Hand Auger**
DRILLING METHOD: **Hand Auger**
SAMPLING EQUIPMENT: **Hand Auger**

NORTHING (ft):
LAT:
GROUND ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
STATIC DTW (ft): **Not Encountered**
WELL CASING DIA. (in): **---**
LOGGED BY: **LM**

EASTING (ft):
LONG:
TOC ELEV (ft):
WELL DEPTH (ft): **---**
BOREHOLE DEPTH (ft): **2.0**
BOREHOLE DIA. (in): **2**
CHECKED BY: **TD**

Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)
	▨		**GRAVEL** ; black; Fill (slag)	■					
	🟩		**SILTY CLAY** ; brownish orange	■	0800 BH-16-5 _0-2			0.0	
			Borehole terminated at 2 feet.						

PROJECT: **Philadelphia Energy Solutions**
LOCATION: **AOI-3**
PROJECT NUMBER:

WELL / PROBEHOLE / BOREHOLE NO:
BH-16-10 PAGE 1 OF 1

DRILLING / INSTALLATION:
STARTED **3/1/16** COMPLETED: **3/1/16**
DRILLING COMPANY: **Aquaterra**
DRILLING EQUIPMENT: **Hand Auger**
DRILLING METHOD: **Hand Auger**
SAMPLING EQUIPMENT: **Hand Auger**

NORTHING (ft):
LAT:
GROUND ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
STATIC DTW (ft): **Not Encountered**
WELL CASING DIA. (in): **---**
LOGGED BY: **LM**

EASTING (ft):
LONG:
TOC ELEV (ft):
WELL DEPTH (ft): **---**
BOREHOLE DEPTH (ft): **2.0**
BOREHOLE DIA. (in): **2**
CHECKED BY: **TD**

Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)
	▨		SLAG	█	1300 AOI3_ BH-16-10 _0-2			0.1	
	▨		**CLAY** ; orangeish brown	█					
			Borehole terminated at 2 feet.						

PROJECT: **Philadelphia Energy Solutions**
LOCATION: **AOI-3**
PROJECT NUMBER:

WELL / PROBEHOLE / BOREHOLE NO:

BH-16-11

PAGE 1 OF 1

DRILLING / INSTALLATION:
STARTED **3/1/16** COMPLETED: **3/1/16**
DRILLING COMPANY: **Aquaterra**
DRILLING EQUIPMENT: **Hand Auger**
DRILLING METHOD: **Hand Auger**
SAMPLING EQUIPMENT: **Hand Auger**

NORTHING (ft):
EASTING (ft):
LAT:
LONG:
GROUND ELEV (ft):
TOC ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
WELL DEPTH (ft): **---**
STATIC DTW (ft): **Not Encountered**
BOREHOLE DEPTH (ft): **2.0**
WELL CASING DIA. (in): **---**
BOREHOLE DIA. (in): **2**
LOGGED BY: **LM**
CHECKED BY: **TD**

Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)
	▨		SLAG	■	1400 AOI3_ BH-16-11 _0-2			0.1	
	▨		**CLAY** ; orangeish brown	■					
			Borehole terminated at 2 feet.						

PROJECT: **Philadelphia Energy Solutions**
LOCATION: **AOI-3**
PROJECT NUMBER:

WELL / PROBEHOLE / BOREHOLE NO:
BH-16-6 PAGE 1 OF 1

DRILLING / INSTALLATION:
STARTED **3/1/16** COMPLETED: **3/1/16**
DRILLING COMPANY: **Aquaterra**
DRILLING EQUIPMENT: **Hand Auger**
DRILLING METHOD: **Hand Auger**
SAMPLING EQUIPMENT: **Hand Auger**

NORTHING (ft):
LAT:
GROUND ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
STATIC DTW (ft): **Not Encountered**
WELL CASING DIA. (in): **---**
LOGGED BY: **LM**

EASTING (ft):
LONG:
TOC ELEV (ft):
WELL DEPTH (ft): **---**
BOREHOLE DEPTH (ft): **2.0**
BOREHOLE DIA. (in): **2**
CHECKED BY: **TD**

Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)
	▨		**CLAY** ; orangeish brown to dark brown	■	0900 AOI3_ BH-16-6 _0-2			0.1	
			Borehole terminated at 2 feet.						

PROJECT: **Philadelphia Energy Solutions**
LOCATION: **AOI-3**
PROJECT NUMBER:

WELL / PROBEHOLE / BOREHOLE NO:
BH-16-7 PAGE 1 OF 1

Aquaterra Technologies, Inc.

DRILLING / INSTALLATION:
STARTED **3/1/16** COMPLETED: **3/1/16**
DRILLING COMPANY: **Aquaterra**
DRILLING EQUIPMENT: **Hand Auger**
DRILLING METHOD: **Hand Auger**
SAMPLING EQUIPMENT: **Hand Auger**

NORTHING (ft):
LAT:
GROUND ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
STATIC DTW (ft): **Not Encountered**
WELL CASING DIA. (in): **---**
LOGGED BY: **LM**

EASTING (ft):
LONG:
TOC ELEV (ft):
WELL DEPTH (ft): **---**
BOREHOLE DEPTH (ft): **2.0**
BOREHOLE DIA. (in): **2**
CHECKED BY: **TD**

Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)
	▨		**SANDY CLAY** ; orangeish brown	■	1000 AOI3_ BH-16-7 _0-2			0.1	
			Borehole terminated at 2 feet.						

PROJECT: **Philadelphia Energy Solutions**
LOCATION: **AOI-3**
PROJECT NUMBER:

WELL / PROBEHOLE / BOREHOLE NO:
BH-16-8 PAGE 1 OF 1

DRILLING / INSTALLATION:
STARTED **3/1/16** COMPLETED: **3/1/16**
DRILLING COMPANY: **Aquaterra**
DRILLING EQUIPMENT: **Hand Auger**
DRILLING METHOD: **Hand Auger**
SAMPLING EQUIPMENT: **Hand Auger**

NORTHING (ft):
LAT:
GROUND ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
STATIC DTW (ft): **Not Encountered**
WELL CASING DIA. (in): **---**
LOGGED BY: **LM**

EASTING (ft):
LONG:
TOC ELEV (ft):
WELL DEPTH (ft): **---**
BOREHOLE DEPTH (ft): **2.0**
BOREHOLE DIA. (in): **2**
CHECKED BY: **TD**

Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)
	▨		**GRAVELLY CLAY** ; orangeish brown	■	1100 AOI3_ BH-16-8 _0-2			0.1	
			Borehole terminated at 2 feet.						

PROJECT: **Philadelphia Energy Solutions**
LOCATION: **AOI-3**
PROJECT NUMBER:

WELL / PROBEHOLE / BOREHOLE NO:
BH-16-9 PAGE 1 OF 1

DRILLING / INSTALLATION:
STARTED **3/1/16** COMPLETED: **3/1/16**
DRILLING COMPANY: **Aquaterra**
DRILLING EQUIPMENT: **Hand Auger**
DRILLING METHOD: **Hand Auger**
SAMPLING EQUIPMENT: **Hand Auger**

NORTHING (ft):
LAT:
GROUND ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
STATIC DTW (ft): **Not Encountered**
WELL CASING DIA. (in): **---**
LOGGED BY: **LM**

EASTING (ft):
LONG:
TOC ELEV (ft):
WELL DEPTH (ft): **---**
BOREHOLE DEPTH (ft): **2.0**
BOREHOLE DIA. (in): **2**
CHECKED BY: **TD**

Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)
	▩		Slag	■	1200 AOI3_ BH-16-9 _0-2			0.1	
	▨		**CLAY** ; orangeish brown	■					
			Borehole terminated at 2 feet.						

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SUBSURFACE BORING LOG

BOREHOLE NO. **BH-10-01**

Page 1 of 1

PROJECT: **Sunoco - Philadelphia Refinery**
SITE LOCATION: **AOI-3**
JOB NO.:
LOGGED BY: **Shaun Sykes**
DATES DRILLED: **4/26/10**

DRILLING CO.: **Total Quality Drilling**
DRILLING METHOD **Hollow Stem Auger**
SAMPLING METHOD **Split Spoon**
TOTAL DEPTH: **16'**

DEPTH (feet)	SAMPLE INTERVAL	PID (ppm)	LITHOLOGY DESCRIPTION	LITH-OLOGY	COMMENTS
0					
	1'-2'	7.7	(BC=6-7-17-32) Gravel, medium brown, sandy silt (2') Black, coarse sand and gravel, trace silt, strong odor		Hand cleared to 8'
		487			
			Hand cleared to 8' - Fill, black cinders and 7+ in cobbles to 3'. Whole bricks and fill material to 8'.		
-5					
		796	25% recovery (BC=8-10-40-43) Brown/gray, fine sand, very moist to wet, odor		
		917			
-10		1021	100% recovery (BC=4-19-12-10) Same as above (11') Black brown, coarse sand, strong odor		Sample (1'-2') submitted to laboratory for analysis
		988			
		712	50% recovery (BC=14-18-8-8) Brown/red, fine sand, trace clay, strong odor, moist		
		412			
		98.7	50% recovery (BC=8-20-16-14) Brown/red, fine sand and gravel, trace clay, strong odor, very moist		
-15		96.2			

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SUBSURFACE BORING LOG

BOREHOLE NO. **BH-10-02**
Page 1 of 1

PROJECT: **Sunoco - Philadelphia Refinery**
SITE LOCATION: **AOI-3**
JOB NO.:
LOGGED BY: **Shaun Sykes**
DATES DRILLED: **4/26/10**

DRILLING CO.: **Total Quality Drilling**
DRILLING METHOD **Hollow Stem Auger**
SAMPLING METHOD **Split Spoon**
TOTAL DEPTH: **16'**

DEPTH (feet)	SAMPLE INTERVAL	PID (ppm)	LITHOLOGY DESCRIPTION	LITH-OLOGY	COMMENTS
0					
	1'-2'	2.1	(BC=6-7-17-32) Gravel, medium brown, sandy silt (2') Dark brown, sand/silt/gravel, slightly moist		Hand cleared to 8'
		7.9			
			Fill: Cinders, brick and concrete, dry.		
-5					
		27.9	100% recovery (BC=6-3-2-3) Brown/black/gray, fine sand, moist		
		36.2			
-10		46.9	50% recovery (BC=4-4-4-5) Black, fine sand and gravel, strong odor, increasing clay content		Sample (1'-2') submitted to laboratory for analysis
		293			
		33.9	75% recovery (BC=4-5-6-4) Same as above (12.5') Light gray, medium sand, moist to wet, strong odor		
		103			
		76.9	25% recovery (BC=5-6-4-5) Same as above		
-15		82.3			

SUBSURFACE BORING LOG

BOREHOLE NO. **BH-10-03**

Page 1 of 1

PROJECT: **Sunoco - Philadelphia Refinery**

SITE LOCATION: **AOI-3**

JOB NO.:

LOGGED BY: **Shaun Sykes**

DATES DRILLED: **4/26/10**

DRILLING CO.: **Total Quality Drilling**

DRILLING METHOD **Hollow Stem Auger**

SAMPLING METHOD **Split Spoon**

TOTAL DEPTH: **16'**

DEPTH (feet)	SAMPLE INTERVAL	PID (ppm)	LITHOLOGY DESCRIPTION	LITH-OLOGY	COMMENTS
0			25% recovery Gravel, dark brown, silty sand	∧	
	1'-2'	0.0			Hand cleared to 8'
		0.0	Cleared to 8' - Fill: brown clayey gravel - oil/black at 2'. Large cobbles starting at 2'. Water pouring into hole at ~3.5'. Soft, black cinders, clay and sand 4.5'-8'. Water came up to 2.5' after clearing.		
-5					
		102	25% recovery (BC=4-6-5-2) Gravel, dark brown, coarse sand and silt, trace clay	▨	
		321			
-10		526	100% recovery (BC=7-4-5-8) Dark brown/black, fine sandy clay with gravel, strong odor, very moist to wet		Sample (1'-2') submitted to laboratory for analysis
		627			
		815	100% recovery (BC=6-2-3-5) Same as above, (13') Black, increased clay content and gravel , SPH sheen on spoon, strong odor		
		797			
		304	100% recovery (BC=1-2-3-4) Same as above, SPH		
-15		291			

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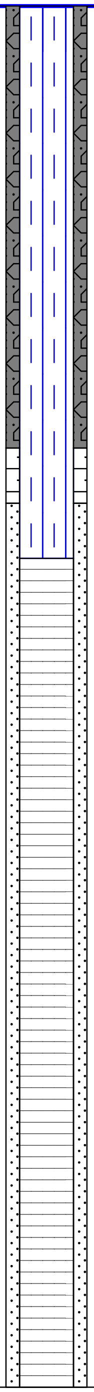
MONITORING WELL LOG: S-280

PROJECT: **Sunoco-Philadelphia Refinery**
SITE LOCATION: **AOI-3**
JOB NO.:
LOGGED BY: **S. Sykes**
DATES DRILLED: **4/28/10**
TOTAL DEPTH: **25'**

DRILLING CO.: **Total Quality Drilling**
DRILLING METHOD: **Hollow Stem Auger**
SAMPLING METHOD: **Split Spoon**
SCREEN/RISER DIAMETER: **4"**
WELLBORE DIAMETER: **6"**
ELEVATION: **N/A**

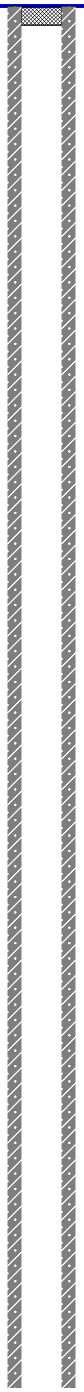
Depth (feet)	OVM (ppm)	USCS	LITHOLOGY	COMMENTS	WELL CONSTRUCTION	WELL DIAGRAM
0				Hand cleared to 8'		
	0.0		BC = 4-5-5-6, 75% Recovery - Gravel, light brown/orange/dark brown sandy silt, dry	Sample collected from (1'-2') submitted to the laboratory for analysis		
	220					
			Dark brown moist sand and gravel, large rock @ 4', all fill, water at bottom			
-5					10' PVC Riser	
	0.0		BC = 6-5-6-5, Full Recovery - (8') Brown/orange/gray very fine sand, trace clay, moist, slightly micaceous		Bentonite 8-9'	
	0.0				Sand 9-25'	
-10	0.0		BC = 4-7-7-8, 50% Recovery - Same as above, color change to all gray, slightly micaceous			
	0.0					
	0.0		BC = 6-5-7-6, Full Recovery - Same as above, some gravel			
	0.0					
	0.0		BC = 7-8-8-6, Full Recovery - Orange/gray very fine sand, trace clay, moist, slightly micaceous			
-15	0.0					
	0.0		BC = 5-6-8-8, Full Recovery - Same as above, increased clay content			
	0.0					
	0.0		BC = 6-7-7-6, Full Recovery - Same as above, gray/orange fine sand with clay, moist, slightly micaceous			
	0.0					
-20	0.0		BC = 7-8-8-9 - Same as above		15' PVC Screen	
	0.0					
	0.0		BC = 6-6-8-5 - Same as above			
	0.0					
	0.0			Hollow stem auger terminal depth = 25'		
-25						

Aquaterra Technologies, Inc.

MONITORING WELL LOG: S-280 D

PROJECT:	**Sunoco-Philadelphia Refinery**	DRILLING CO.:	**ECDI**
SITE LOCATION:	**AOI-3**	DRILLING METHOD:	**Hollow Stem Auger & Mud Rotary**
JOB NO.:		SAMPLING METHOD:	**Split Spoon**
LOGGED BY:	**Tiffani Doerr/Shaun Sikes**	SCREEN/RISER DIAMETER:	**4-inch**
DATES DRILLED:	**5/11/10-5/14/10**	WELLBORE DIAMETER:	**6.25"**
TOTAL DEPTH:	**61'**	ELEVATION:	**NA**

Depth (feet)	OVM (ppm)	USCS	LITHOLOGY	COMMENTS	WELL CONSTRUCTION	WELL DIAGRAM
0			Fill Material Surface to 1' - black/brown sandy gravel. Brick layer from 1.5' to 2.5'.	Hand cleared to 10'		
-5				PID malfunction, limited field sceening data		
			Rest of fill to 10' is large gravel w/ sandy and clay, brown, no odors.			
-10			(BC=6-8-9-6) Orange-brown and gray brown very fine sandy SILT, trace round gravels		Grout/bentonite slurry (0'-49')	
			(BC=8-10-12-15) Same as above, all orange-brown color from 12'-13', all gray-brown color 13'-14'.			
			(BC=8-12-12-15) Same as above, Orange brown SAND and GRAVEL, angular to subround, few fines.			
-15						
			(BC=8-12-16-15) Tight sand and gravel, overall orange brown color, gravels multicolored up to 0.5 inch.			



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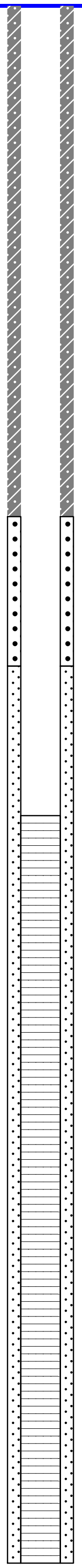
MONITORING WELL LOG: S-280 D

Depth (feet)	OVM (ppm)	USCS	LITHOLOGY	COMMENTS	WELL CONSTRUCTION	WELL DIAGRAM
			(BC=10-13-10-14) Same as above			
-20			(BC=11-12-15-13) Same as above, less gravel and more sand, brown in color, moist			
			(BC=6-8-6-7) Orange brown fine SAND.			
			Light gray-brown, very fine sandy CLAY, wet.			
			(BC=6-9-15-15) Red-brown SAND and GRAVEL with fine to coarse sand and gravel up to 1 inch, some clays			
-25						
			(BC=7-10-12-13) Same as above			
			(BC=6-8-5-5) Light brown to orange-brown slightly plastic, fine SAND.			
-30	0.2		(BC=12-10-11-13) Medium brown, medium SAND and GRAVEL, slight odor (chemical). Gray fine CLAY lenses.			
	0.6					
	0.5		(BC=24-23-31-40) Same as above, same gray fine silt/clay lense holding odor. All else, red brown, medium-coarse sand with some gravel			
	0.5					
	0.2		(BC=24-23-31-40) Same as above, grades to brown-orange fine SAND, plastic silty fine sand			
-35	0.1					
	0.1		(BC=16-27-11-12) Orange-gray CLAY with some fine sand			
	0.3		(BC=5-4-4-6) Same as above			
			(BC=2-2-3-5) Dark gray clay with trace fine sand, trace organics			
-40						

MONITORING WELL LOG: S-280 D

Depth (feet)	OVM (ppm)	USCS	LITHOLOGY	COMMENTS	WELL CONSTRUCTION
	0.1		(BC=3-2-3-4) Same as above, dark gray clay		
	0.3		Few fine sandy layers and trace organics, organic odor		
			(BC=2-2-1-4) Gray fine sandy clay, some silt, trace organics, grading into gray fine sand, some clay with trace silt		
-45			(BC=1-2-5-7) Gray fine sandy clay, some silt grading into light-dark brown fine sand with trace fine subrounded gravel		
			(BC=4-4-3-3) Gray fine clayey SAND, some silt with fine coarse subrounded gravel, trace amounts of course brown sand		
			(BC=2-3-2-3) Orange-gray alternating fine sands, slightly plastic, trace subrounded gravels		
-50			(BC=1-1-1-1) Gray, loose fine sand more plastic clays than above, no gravel		#00 Sand (47'-49')
			(BC=7-7-12-12) Same as above, more clay content		#1 Sand (49'-61')
-55			(BC=7-9-12-12) Dark gray loose sand with mica flakes throughout, trace clay and fine subrounded, subangular gravel, degrading into dark gray fine silty sand with trace clay, moist		
			(BC=7-12-21-30) Dark gray-brown fine SAND and GRAVEL, trace silt, moist to wet		
			(BC=25-23-18-25) Red-brown medium dense sand, some fine to coarse subrounded gravel, mica flakes throughout, trace rounded quartzite, wet	Rods broke during rheeming - lost roller bit and >20' rods down hole.	Screen (51'-61')
-60			(BC=12-30-41-16) Red-brown medium dense fine to coarse sand, some fine to coarse subangular gravel	Grout hole up to 61' and install well.	
			Very stiff CLAY		

WELL DIAGRAM



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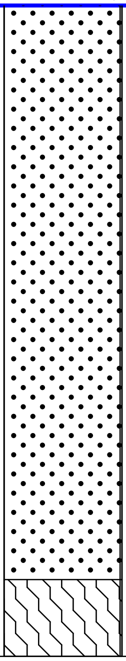
MONITORING WELL LOG: S-280 D

Depth (feet)	OVM (ppm)	USCS	LITHOLOGY	COMMENTS	WELL CONSTRUCTION	WELL DIAGRAM
-65			(BC=25-17-21-17) Reddish-brown to yellowish-brown medium dense fine to coarse SAND, some fine to coarse subrounded GRAVEL, wet			
-70			(BC=27-28-43-51) Same as above, roller bit past tough gravel layer, large quartzite in spoon.			
-75			(BC=5-15-14-10) Light brown-gray coarse sand with fine gravel, no odor			
-80			(BC=60-58-59-50/1) Green-gray large quartzite grading into coase sand with gravel, green and red silty fine sand lense, decomposed rock			

MONITORING WELL LOG: S-280 D

Depth (feet)	OVM (ppm)	USCS	LITHOLOGY	COMMENTS	WELL CONSTRUCTION	WELL DIAGRAM
-85			(BC=46-120/5) Large, pink-gray-yellow quartzite, coarse sand layer, overall gray appearance			
-90				Mud rotary terminal depth = 93'		
			(BC=58-66) @ 92' White clay and muscovite with white quartz fragments, top of weathered bedrock, wissahickon schist.			

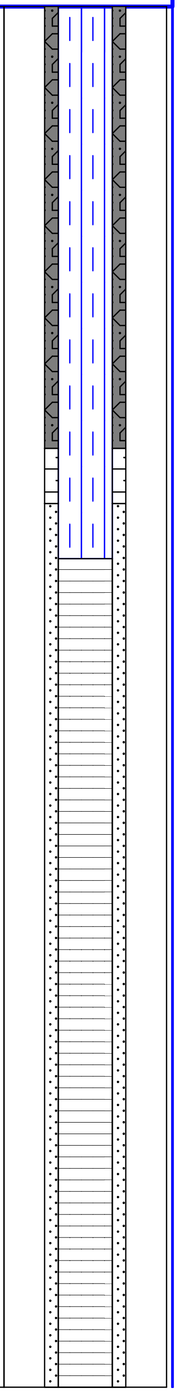
MONITORING WELL LOG: S-281

PROJECT: **Sunoco-Philadelphia Refinery**
SITE LOCATION: **AOI-3**
JOB NO.:
LOGGED BY: **S. Sykes**
DATES DRILLED: **5/13/2010**
TOTAL DEPTH: **25'**

DRILLING CO.: **Parratt Wolff**
DRILLING METHOD: **Hollow Stem Auger**
SAMPLING METHOD: **Split Spoon**
SCREEN/RISER DIAMETER: **4"**
WELLBORE DIAMETER: **6"**
ELEVATION: **N/A**

Depth (feet)	OVM (ppm)	USCS	LITHOLOGY	COMMENTS	WELL CONSTRUCTION
0				Hand cleared to 8'	
			Asphalt, gray/brown sandy clay with gravel fill, dry to 8'		
-5					10' PVC Riser
	16.5		Full recovery - (8') Brown sandy silt (trace clay), moist, no odor		Bentonite 8-9'
	48.8				Sand 9-25'
-10	14.5		50% recovery - Same as above, micaceous with some silt		
	96.6				
	366		25% recovery - Same as above		
	490				
	212		25% recovery - Spoon refusal (augered through), large gravels, coarse sand, trace brown clay, wet		
-15	-				
	-		No recovery		
	-				
	1348		Full recovery - Medium sands (brown, red, white) and some small gravels, wet, strong odor		
	1367				
-20	1386		50% recovery - Gray medium sands (some red/brown/white) and small gravels, wet, strong odor		15' PVC Screen
	1030				
	1383		Full recovery - (22') Same as above (23') Medium-fine gray sand, some gravel, wet, strong odor		
	1306				
	1106		25% recovery - Same as above	Hollow stem auger terminal depth = 25'	
-25					

WELL DIAGRAM

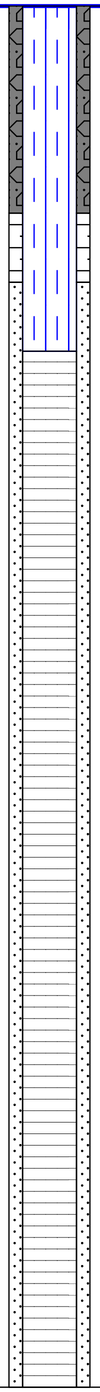


Page 1 of 1

MONITORING WELL LOG: S-282

PROJECT:	**Sunoco-Philadelphia Refinery**	DRILLING CO.:	**Total Quality Drilling**
SITE LOCATION:	**AOI-3**	DRILLING METHOD:	**Hollow Stem Auger**
JOB NO.:		SAMPLING METHOD:	**Split Spoon**
LOGGED BY:	**S. Sykes**	SCREEN/RISER DIAMETER:	**4"**
DATES DRILLED:	**4/27/10**	WELLBORE DIAMETER:	**6"**
TOTAL DEPTH:	**20'**	ELEVATION:	**N/A**

Depth (feet)	OVM (ppm)	USCS	LITHOLOGY	COMMENTS	WELL CONSTRUCTION	WELL DIAGRAM
				Hand cleared to 8'		
	0.0		Gray sand and gravel to 3'	Sample collected from (1'-2') submitted to the laboratory for analysis		
	0.0				5' PVC Riser	
			Large gravel/rocks 3-4" dia. and sand, no odors, all fill		Bentonite 3-4'	
					Sand 4-20'	
-5						
	0.0		50% recovery - Dark brown/gray fine sand, very moist			
	0.0					
-10	0.0		50% recovery - Same as above		15' PVC Screen	
	0.0					
	0.0		25% recovery - (12') gray very fine sand, micaceous, very moist (13') Black, same as above			
	0.0					
	7.6		Brown/black silty sand, odor, very moist to wet			
-15	8.9					
	127		25% recovery - Black coarse sand and gravel, trace clay, strong odor, wet			
	239					
	356		100% recovery - Black coarse sand and gravel, trace clay, strong odor, wet			
	337			Hollow stem auger terminal depth = 20'		
-20						



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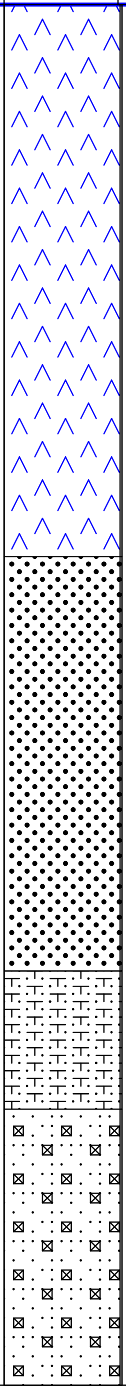
MONITORING WELL LOG: S-282

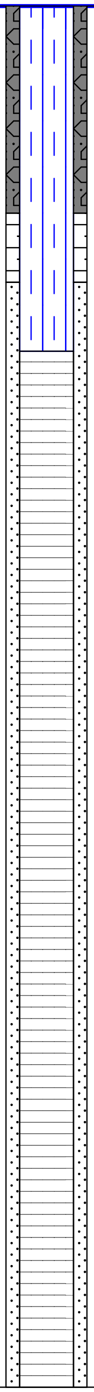
Page 1 of 1

PROJECT: **Sunoco-Philadelphia Refinery**
SITE LOCATION: **AOI-3**
JOB NO.:
LOGGED BY: **S. Sykes**
DATES DRILLED: **4/27/10**
TOTAL DEPTH: **20'**

DRILLING CO.: **Total Quality Drilling**
DRILLING METHOD: **Hollow Stem Auger**
SAMPLING METHOD: **Split Spoon**
SCREEN/RISER DIAMETER: **4"**
WELLBORE DIAMETER: **6"**
ELEVATION: **N/A**

Depth (feet)	OVM (ppm)	USCS	LITHOLOGY	COMMENTS	WELL CONSTRUCTION	WELL DIAGRAM
0				Hand cleared to 8'		
	0.0		Gray sand and gravel to 3'	Sample collected from (1'-2') submitted to the laboratory for analysis		
	0.0					
					5' PVC Riser	
			Large gravel/rocks 3-4" dia. and sand, no odors, all fill		Bentonite 3-4'	
					Sand 4-20'	
-5						
	0.0		50% recovery - Dark brown/gray fine sand, very moist			
	0.0					
-10	0.0		50% recovery - Same as above		15' PVC Screen	
	0.0					
	0.0		25% recovery - (12') gray very fine sand, micaceous, very moist (13') Black, same as above			
	0.0					
	7.6		Brown/black silty sand, odor, very moist to wet			
-15	8.9					
	127		25% recovery - Black coarse sand and gravel, trace clay, strong odor, wet			
	239					
	356		100% recovery - Black coarse sand and gravel, trace clay, strong odor, wet			
	337			Hollow stem auger terminal depth = 20'		
-20						





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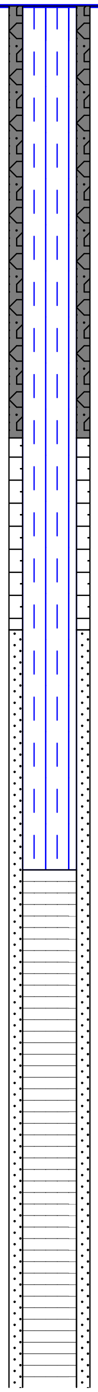
MONITORING WELL LOG: S-283

PROJECT: **Sunoco-Philadelphia Refinery**
SITE LOCATION: **AOI-3**
JOB NO.:
LOGGED BY: **Shaun Sykes**
DATES DRILLED: **5/17/2010**
TOTAL DEPTH: **24'**

DRILLING CO.: **Parratt Wolff**
DRILLING METHOD: **Hollow Stem Auger**
SAMPLING METHOD: **Split Spoon**
SCREEN/RISER DIAMETER: **4"**
WELLBORE DIAMETER: **6"**
ELEVATION: **N/A**

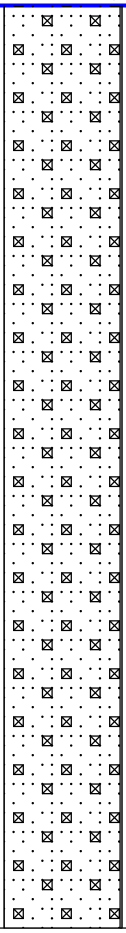
Depth (feet)	OVM (ppm)	USCS	LITHOLOGY	COMMENTS	WELL CONSTRUCTION
				Hand cleared to 8'	
			Cleared to 8' - Fill: orange brown silty sand with gravel, few large brick/concrete block. Dry.		
-5					9' PVC Riser
	0.0		60% recovery - Orange, medium sand with medium gravel, no odor		Bentonite 4.5-6.5'
	0.0				Sand 6.5-24'
-10	0.0		60% recovery - Orange, medium sand with large gravel assorted colors, moist, no odor		
	0.0				
	0.0		70% recovery - Orange medium sand with layer of coarse sand, moist, no odor, micaceous (13') layer of red sand throughout		
	0.0				
	1.6		40% recovery - Same as above,		

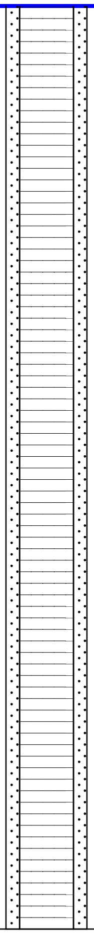
WELL DIAGRAM



MONITORING WELL LOG: S-283

Depth (feet)	OVM (ppm)	USCS	LITHOLOGY	COMMENTS	WELL CONSTRUCTION	WELL DIAGRAM
-15	2.6		wet (15') Orange/gray, medium sand with medium gravel, odor, wet, SPH shine on soil			
	0.0		100% recovery - Orange/gray, medium to coarse sand with gravel, wet, odor, staining downward (17') Orange, micaceous			
	0.0					
	5.5		Grayish orange, medium to coarse sand with small gravel, micaceous, wet, odor (19') Orange medium sand with small gravel, no odor			
	1.8					
-20	1.0		70% recovery - Brownish orange medium to coarse sand, wet, odor, coarsing downward (21') Orange, coarse sand with medium gravel, wet, no odor, micaceous		15' PVC Screen	
	0.2					
	0.8		90% recovery - Orange, medium sand, micaceous, wet, odor, few large gravel			
	0.0					





Page 1 of 1

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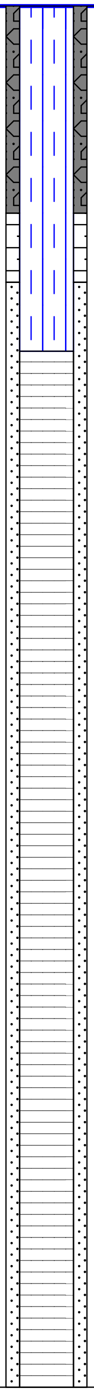
MONITORING WELL LOG: S-284

PROJECT:	**Sunoco-Philadelphia Refinery**	DRILLING CO.:	**Parratt Wolff**
SITE LOCATION:	**AOI-3**	DRILLING METHOD:	**Hollow Stem Auger**
JOB NO.:		SAMPLING METHOD:	**Split Spoon**
LOGGED BY:	**S. Sykes**	SCREEN/RISER DIAMETER:	**4"**
DATES DRILLED:	**5/13/2010**	WELLBORE DIAMETER:	**6"**
TOTAL DEPTH:	**20'**	ELEVATION:	**N/A**

Depth (feet)	OVM (ppm)	USCS	LITHOLOGY	COMMENTS	WELL CONSTRUCTION
0				Hand cleared to 8'	
	0.9		Gravel, black/gray/dark brown silty sand, compact, dry	Sample collected from (1'-2') submitted to the laboratory for analysis	
	1.3				
			Cleared to 8' - Light brown sandy clay and gravel, some brick and concrete fill.		Bentonite 3-4'
					Sand 4-20'
-5					5' PVC Riser
	1018		25% recovery - Gray/brown/white coarse sands and gravels, wet, strong odor		
	1058				
-10	1003		100% recovery - Same as above		
	662				
	992		100% recovery - Same as above		
	741				
	222		25% recovery - Same as above		
-15	138				15' PVC Screen
	272		75% recovery - (16') Same as above (17') Brown coarse sand and large gravels and silt, wet		
	35.6				
	4.2		(18') Same as above (19') Fine sand and gravel, gold/gray, wet, odor		
	3.9			Hollow stem auger terminal depth = 20'	
-20					

WELL DIAGRAM



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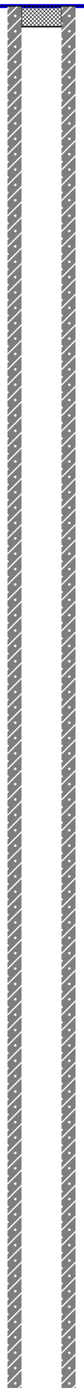
MONITORING WELL LOG: S-284 D

PROJECT: **Sunoco-Philadelphia Refinery**
SITE LOCATION: **AOI-3**
JOB NO.:
LOGGED BY: **Tiffani Doerr/Shaun Sikes**
DATES DRILLED: **5/17/10-5/24/10**
TOTAL DEPTH: **78'**
DRILLING CO.: **ECDI**
DRILLING METHOD: **Hollow Stem Auger & Mud Rotary**
SAMPLING METHOD: **Split Spoon**
SCREEN/RISER DIAMETER: **4-inch**
WELLBORE DIAMETER: **6.25"**
ELEVATION: **NA**

Depth (feet)	OVM (ppm)	USCS	LITHOLOGY	COMMENTS	WELL CONSTRUCTION	WELL DIAGRAM
			Fill Material to 10' - Light brown sandy clay and gravel, some brick and larger concrete block fill.	Hand cleared to 8'		
-5						
-10			(BC=10-12-13-8) 6" Recovery - Loose, saturated, olive-brn, coarse SAND w/ GRAVEL up to 1/2". Various color and composition, sub-round, strong odor.		Grout/bentonite slurry (0'-59')	
	147					
			(BC=6-8-9-8) No Recovery - lg green qtzite gravel in tip of spoon.			
			(BC=4-5-7-9) 6" Recovery - same as above w/clay lense, slight odor.			
-15	33.7					
			(BC=7-7-8-9) No Recovery - loose sands and gravel?			

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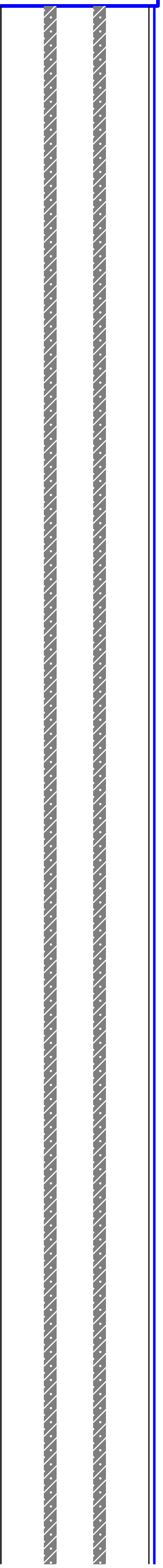
MONITORING WELL LOG: S-284 D

Depth (feet)	OVM (ppm)	USCS	LITHOLOGY	COMMENTS	WELL CONSTRUCTION	WELL DIAGRAM
	0.6		(BC=10-12-10-16) 12" Recovery - same in top 6". Bottom 6" yellow-brn med sand getting coarser w/few small gravles at bottom.			
	0.4					
-20	0.0		(BC=5-3-3-4) Top 2" orange very fine sandy CLAY, bottom 20" medium gray clay w/thin very fine lt gray sand layers.			
	0.1					
	0.0		(BC=4-3-6-6) Gray CLAY, some organics.			
	0.0					
	0.0		(BC=4-7-7-5) Same as above, slightly brown hue to CLAY, more organics.			
-25	0.0					
			(BC=5-7-12-10) 8" Recovery - top 1" gray sand w/few fine gravels, rest is orange medium SAND.			
	7.1					
	4.7		(BC=9-11-21-13) Same as above, but coarser SAND, dense, dark orange to red-brn w/ trace fine Gravels.			
	0.3					
-30			(BC=6-24-28-16) 3" Recovery - orange med-coarse SAND, one 2"+ gravel in tip of spoon.			
	0.0					
	0.0		(BC=4-5-8-12) Dark gray soft CLAY, trace red-brn fine sand, trace organics, moist.			
	0.0					
	0.0		(BC=10-12-12-12) 16" Recovery - reddish brn to orange medium dense fine-coarse SAND, trace sub-rounded qtz gravels, wet.			
-35	0.0					
	0.0		(BC=46-24-7-7) 4" Recovery - dark gray-brn, coarse subangular to subrounded			

MONITORING WELL LOG: S-284 D

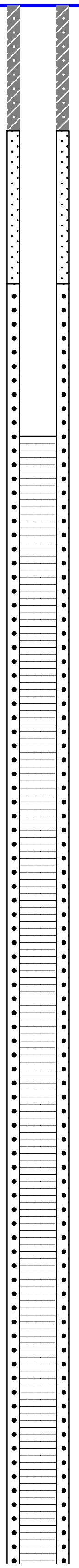
Depth (feet)	OVM (ppm)	USCS	LITHOLOGY	COMMENTS	WELL CONSTRUCTION	WELL DIAGRAM
	0.0		GRAVEL (possible fall-in).			
	0.0		(BC=6-16-21-19) 6" Recovery - same as above.			
	0.0		(BC=19-11-10-10) 12" Recovery - black stained fine-coarse SAND w/ trace sub-round gravel, petroleum odor. Lower half same composition, but orange, no staining or odors.			
-40	146					
	0.0					
	0.6		(BC=17-28-14-10) Same as above - fine-med sand, orange-lt brn.			
	1.4					
			(BC=19-16-14-13) 9" Recovery - Lt brn med-coarse SAND w/trace fine sub-round gravels, chemical odor.			
-45	60.5					
			(BC=12-13-13-14) 6" Recovery - Lg qtzite gravel in tip of spoon. Finer lt brn sand grading into coarse sand w/ some fine gravels.			
	2.2					
	9.0		(BC=12-15-15-17) 12" Recovery - Med-coarse SAND w/trace fine gravels, lt brn at top, orange at bottom - petroleum odors in top 6".			
	1.6					
-50			(BC=4-17-46-15) 8" Recovery - No odor, orange-brn med-coarse SAND and GRAVEL (up to 1/2"). Few red-brn clayey fine sand lenses.			
	0.3					
	0.5		(BC=14-29-34-39) 12" Recovery - coarse SAND and some GRAVEL (fine to 1"), very dense, orange. Fine red-brn clayey sand nodule - completely degraded gravel.			
	0.4					
			(BC=29-55-50-27) 6" Recovery - same as above, slight petroleum odor.			
-55	1.4					
			(BC=15-17-29-21) 6" Recvoery - same as above, no odor.			
	0.0					



MONITORING WELL LOG: S-284 D

Depth (feet)	OVM (ppm)	USCS	LITHOLOGY	COMMENTS	WELL CONSTRUCTION
	0.0		(BC=5-12-39-31) 6" Recovery - same as above, less gravel (trace round, <1/2"), more fines (silt & clay in sand matrix).		#00 Sand (59'-61')
-60					
					#1 Sand (61'-78')
			Drill to 65' - driller noted 2 tough drilling layers through gravels.		
					Screen (63'-78')
-65	0.0		(BC=56-102-17-24) 10" Recovery - Fine orange-brn SAND, some gravel in top 3".		
	0.0				
-70			(BC=9-52-46-43) 4" Recovery - orange-brn SAND and GRAVEL (50/50), no odor.		
	0.1				
-75			Cuttings: orange sand and gravel (up to 1/2") quartz.		

WELL DIAGRAM



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MONITORING WELL LOG: S-284 D

Depth (feet)	OVM (ppm)	USCS	LITHOLOGY	COMMENTS	WELL CONSTRUCTION	WELL DIAGRAM
			Same as above.			
-80			Top of weathered schist at 81.5' - collected spoon - 2" recovery - white clay and qtz grains with mica flakes (up to 1/4").	Mud Rotary terminal depth = 82'		

Page 1 of 1

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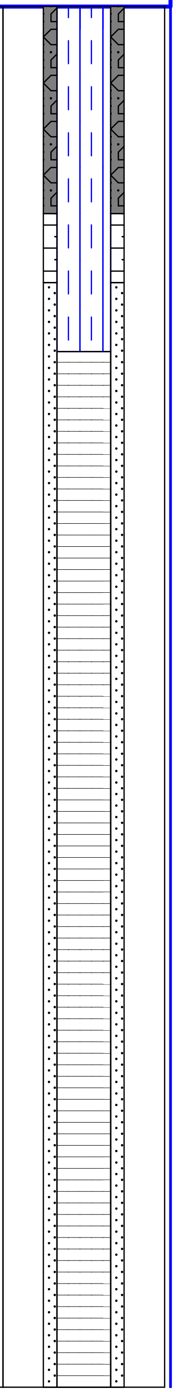
MONITORING WELL LOG: S-285

PROJECT: **Sunoco-Philadelphia Refinery**
SITE LOCATION: **AOI-3**
JOB NO.:
LOGGED BY: **S. Sykes**
DATES DRILLED: **4/27/10**
TOTAL DEPTH: **20'**

DRILLING CO.: **Total Quality Drilling**
DRILLING METHOD: **Hollow Stem Auger**
SAMPLING METHOD: **Split Spoon**
SCREEN/RISER DIAMETER: **4"**
WELLBORE DIAMETER: **6"**
ELEVATION: **N/A**

Depth (feet)	OVM (ppm)	USCS	LITHOLOGY	COMMENTS	WELL CONSTRUCTION
				Hand cleared to 8'	
	0.0		Top 2' - Small gravel and cinders	Sample collected from (1'-2') submitted to the laboratory for analysis	
	3.7				
					5' PVC Riser
			2-5' - Large rock, sands and gravels		Bentonite 3-4'
			Wood from 4-8', black oil stained from 2-8'		Sand 4-20'
-5					
	6.2		BC = 6-4-3-5, 25% Recovery - Black/dark brown coarse sand and gravel, wet, slight odor		
	5.3				
-10	7.1		BC = 7-2-5-8, 25% Recovery - Same as above		15' PVC Screen
	2.7				
	7.8		BC = 6-3-5-5 - (12') Gray/brown finde sand, some clay, slight odor (13') Brown/golden sand and gravel, strong odor		
	357				
	402		Same as above		
-15	444				
	582		BC = 6-7-7-8 - Same as above, visible SPH, strong odor		
	613				
	566		BC = 6-8-8-8 - Same as above		
	712			Hollow stem auger terminal depth = 20'	
-20					

WELL DIAGRAM



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MONITORING WELL LOG: S-286

PROJECT:	**Sunoco-Philadelphia Refinery**	DRILLING CO.:	**Parratt Wolff**
SITE LOCATION:	**AOI-3**	DRILLING METHOD:	**Hollow Stem Auger**
JOB NO.:		SAMPLING METHOD:	**Split Spoon**
LOGGED BY:	**Shaun Sykes**	SCREEN/RISER DIAMETER:	**4"**
DATES DRILLED:	**4/27/2010**	WELLBORE DIAMETER:	**6"**
TOTAL DEPTH:	**11'**	ELEVATION:	**N/A**

Depth (feet)	OVM (ppm)	USCS	LITHOLOGY	COMMENTS	WELL CONSTRUCTION	WELL DIAGRAM
				Hand cleared to 8'		
	0.0		Gravel, light brown/orange, compact sandy silt and gravel.			
	1.2		2'-8' oil-soaked large rocks and wood.			
-5						
	10.2		25% recovery (BC=8-10-12-10) Black, coarse sand and gravel, organic material, wet, slight odor			
	21.3			Refusal encountered prior to reaching depth. No well installed.		
-10						
	22.7		25% recovery (BC=7-12-20-8) Same as above	Hollow stem auger terminal depth = 11'		

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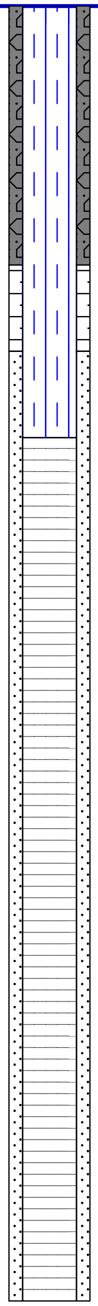
MONITORING WELL LOG: S-288

Page 1 of 1

PROJECT: **Sunoco-Philadelphia Refinery**
SITE LOCATION: **AOI-3**
JOB NO.:
LOGGED BY: **S. Sykes**
DATES DRILLED: **6/17/10**
TOTAL DEPTH: **15'**

DRILLING CO.: **Parratt Wolff**
DRILLING METHOD: **Hollow Stem Auger**
SAMPLING METHOD: **Split Spoon**
SCREEN/RISER DIAMETER: **4"**
WELLBORE DIAMETER: **6"**
ELEVATION: **N/A**

Depth (feet)	OVM (ppm)	USCS	LITHOLOGY	COMMENTS	WELL CONSTRUCTION	WELL DIAGRAM
				No hand clearing - no access with vac truck.		
	0.0		50% recovery - Grass, gravel, dark brown sandy silt, brick, dry	Sample collected from (1'-2') submitted to the laboratory for analysis		
	0.0		No recovery		5' PVC Riser	
					Bentonite 3-4'	
	369		25% recovery - Dark brown/black sandy silt, moist, strong odor		Sand 4-15"	
-5	568					
	509		75% recovery - (6') Same as above (7') Black sandy/silty clay, very moist/wet, strong odor with some mixed gravels			
	910					
	469		100% recovery - (8') Same as above (9') Dark brown/black sandy silt, trace clay, wet, strong odor			
	460					
-10	42.1		100% recovery - (10') Same as above (11') Brown silty/sandy clay, moist, slight odor		10' PVC Screen	
	40.9					
	36.9		100% recovery - (12') Same as above (13') Dark gray/brown silty/sandy clay, moist, slight odor			
	14.4					
	10.9		25% recovery - Same as above	Hollow stem auger terminal depth = 16'		
-15	8.1					



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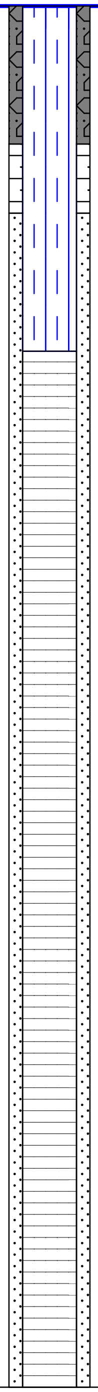
MONITORING WELL LOG: S-290

Page 1 of 1

PROJECT:	**Sunoco-Philadelphia Refinery**	DRILLING CO.:	**Parratt Wolff**
SITE LOCATION:	**AOI-3**	DRILLING METHOD:	**Hollow Stem Auger**
JOB NO.:		SAMPLING METHOD:	**Split Spoon**
LOGGED BY:	**Shaun Syles**	SCREEN/RISER DIAMETER:	**4"**
DATES DRILLED:	**4/27/2010**	WELLBORE DIAMETER:	**6"**
TOTAL DEPTH:	**20'**	ELEVATION:	**N/A**

Depth (feet)	OVM (ppm)	USCS	LITHOLOGY	COMMENTS	WELL CONSTRUCTION
0				Hand cleared to 8'	
	0.0		Gravel, light brown/orange, sandy silt (2') Dark brown, coarse sandy silt and gravel		
	0.0		Wet, brown, clayey gravel fill, some staining, cinders. Water at 5' during clearing.		
-5					5' PVC Riser
	76.2		25% recovery (BC=5-4-8-9) Gray, fine sand, trace clay, moist, odor.		Bentonite 2-3'
	98.3				Sand 3-20'
-10	102		25% recovery (BC=5-4-4-3) Same as above, with gravel		
	-				
	99.2		100% recovery (BC=4-3-7-5) Gray/black, very fine sand, trace clay, slight odor, very moist		
	101				
	134		100% recover (BC=5-6-6-8) Black fine sand and gravel, strong odor		
-15	62.1		Brown fine sand and gravel, trace silt		
	-		40% recovery (BC=3-4-6-7) Same as above, wet		
	56.7				
	-		25% recovery (BC=5-7-8-9) Brown/gray, fine sand and gravel, trace clay, wet	Hollow stem auger terminal depth = 20'	
	36.9				15' PVC Screen
-20					

WELL DIAGRAM



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Page 1 of 1

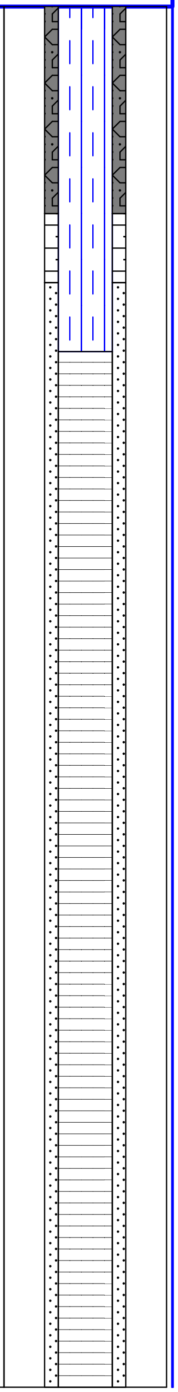
MONITORING WELL LOG: S-291

PROJECT: **Sunoco-Philadelphia Refinery**
SITE LOCATION: **AOI-3**
JOB NO.:
LOGGED BY: **Shaun Sykes**
DATES DRILLED: **4/26/2010**
TOTAL DEPTH: **20'**

DRILLING CO.: **Parratt Wolff**
DRILLING METHOD: **Hollow Stem Auger**
SAMPLING METHOD: **Split Spoon**
SCREEN/RISER DIAMETER: **4"**
WELLBORE DIAMETER: **6"**
ELEVATION: **N/A**

Depth (feet)	OVM (ppm)	USCS	LITHOLOGY	COMMENTS	WELL CONSTRUCTION
0				Hand cleared to 5' - large wood block at 5'.	
	0.0		25% recovery - Light brown, sandy silt, gravel, dark brown, silt and gravel		
			Fill to 5' - Large angular gravel and cobbles (5+ in) w/ tight sandy clay matrix, med brown, no odors.		
-5					5' PVC Riser
	796		100% recovery - Black, coarse sand, wood, strong petroleum odor, wet		Bentonite 12-14'
	1217				Sand 14-20'
-10	517		100% recovery - Black/gray, fine sandy clay, very moist, wood particles, same as above		
	421				
	121		100% recovery - Brown/red, fine sandy clay, wood particles, moist, same as above		
	106				
	79		100% recovery - Brown/black, fine sandy clay and large gravels, moist, odor		
-15	64				
	73		100% recovery - Same as above, brown/tan, sand and gravel, some clay, very moist		
	82				
	62		25 % recovery - Same as above		
	56			Hollow stem auger terminal depth = 20'	15' PVC Screen
-20					

WELL DIAGRAM



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Log of Boring **BH-13-105** Sheet 1 of 1

Project: Sunoco PES Facility			Project No.: 25746012		
Location: Philadelphia, Pa			Elevation and Datum: --		
Drilling Company: Total Quality Drilling			Date Started: 7/30/13	Date Finished: 7/30/13	
Drilling Equipment: Stainless Steel Hand Auger, Hydrovac Truck			Completion Depth: 8 ft	Rock Depth: NE	
Size and Type of Bit			Number of Samples	Disturbed: 4	Undisturbed	Core
Casing Diameter (in): NA		Casing Depth (ft): NA	Water Level (ft.)	First ▽ NE	Completion ▼	24 HR. ▼
Casing Hammer: NA	Weight (lbs): NA	Drop (in): NA	Drilling Foreman: Mike Kavlunas		
Sampler: Hand Auger			Inspecting Engineer: Patrick Troy		
Sampler Hammer: NA	Weight (lbs): NA	Drop (in): NA			

MATERIAL SYMBOL	Elev. (ft)	Sample Description	PID Reading (ppm)	Depth Scale	Sample Data: Number	Sample Data: Type	Sample Data: Recov. (in)	Sample Data: Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
⠿		Sandy SILT, some fine light brown subangular gravel (dry)	0.0	0	1	HA	12			Began boring at 13:16.
▦		Bricks, FILL		1		HA	12			
▦				2		HA	12			
▨		CLAY, trace gravel and light brown silt (moist)	0.1	3	2	HA	12			
▨		Orange brown CLAY, some grey mottling, trace fine sand (moist)	0.0	4	3	HA	12			
▥		Orange-brown SILT, some mottled gray clay (moist)		5		HA	12			
▥			0.0	6		HA	12			
▥		Orange mottled gray-brown SILT with trace fine sand (moist)		7		HA	12			Black and red staining observed from 7 to 9 ft bgs.
▥				8	4	HA	12			Collected AOI3_BH-13-105_8-9_73013 at 14:21
				9						Ended boring at 8 ft bgs at 14:22.
				10						

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Log of Boring **BH-13-106** Sheet 1 of 1

Project: Sunoco PES Facility
Project No.: 25746012
Location: Philadelphia, Pa
Elevation and Datum: --
Drilling Company: Total Quality Drilling
Date Started: 7/31/13
Date Finished: 7/31/13
Drilling Equipment: Stainless Steel Hand Auger, Hydrovac Truck
Completion Depth: 10 ft
Rock Depth: NE
Size and Type of Bit:
Number of Samples: Disturbed 6 Undisturbed Core
Casing Diameter (in): NA
Casing Depth (ft): NA
Water Level (ft.): First ▽ 10 Completion ▼ 24 HR. ▼
Casing Hammer: NA Weight (lbs): NA Drop (in): NA
Drilling Foreman: Mike Kavlunas
Sampler: Hand Auger
Inspecting Engineer: Patrick Troy
Sampler Hammer: NA Weight (lbs): NA Drop (in): NA

MATERIAL SYMBOL	Elev. (ft)	Sample Description	PID Reading (ppm)	Depth Scale	Sample Data Number	Sample Data Type	Sample Data Recov. (in)	Sample Data Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
▩		Gravel FILL and hard/packed cover Gravel FILL with coarse sand, some grey clay with orange mottling (wet)		0		HA	12			Began boring at 11:38.
▩			0.0	1	1	HA	12			Perched groundwater observed at 1ft bgs.
▨		Red-brown silty CLAYwith red-orange mottling (moist to wet)	0.0	2	2	HA	12			
▨				3		HA	12			
▥		SILT, some fine coarse sand, trace fine gravel (wet)	0.0	4	3	HA	12			
▥				5		HA	12			
▩		Fine to coarse gravel and coarse sand FILL	4.0	6	4	HA	12			
▩				7		HA	12			
▩			32.4	8	5	HA	12			Collected sample AOI3_BH-13_107_9-9.5_73113 and AOI3_DUP2_73113 at 12:41.
▩		▽	417	9	6	HA	6			Ended boring at 10 ft bgs due to groundwater.
				10						

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Log of Boring **BH-13-107** Sheet 1 of 1

Project Sunoco PES Facility		Project No. 25746012	
Location Philadelphia, Pa		Elevation and Datum --	
Drilling Company Total Quality Drilling		Date Started 7/30/13	Date Finished 7/30/13
Drilling Equipment Stainless Steel Hand Auger, Hydrovac Truck		Completion Depth 13 ft	Rock Depth NE
Size and Type of Bit		Number of Samples: Disturbed 6	Undisturbed; Core
Casing Diameter (in) NA	Casing Depth (ft) NA	Water Level (ft.): First ∇ 12	Completion ▼; 24 HR. ▼
Casing Hammer NA; Weight (lbs) NA	Drop (in) NA	Drilling Foreman Mike Kavlunas	
Sampler Hand Auger		Inspecting Engineer Patrick Troy	
Sampler Hammer NA; Weight (lbs) NA	Drop (in) NA		

MATERIAL SYMBOL	Elev. (ft)	Sample Description	PID Reading (ppm)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
		Gray fine coarse gravel FILL		0		HA	12			
		Asphalt layer Grey fine coarse gravel FILL		1		HA	12			Began boring at 9:15.
		Brown silty fine coarse sand, fine course gravel, crushed brick, and concrete FILL (dry)	5.0	2	1	HA	12			
				3		HA	12			
			14.7	4	2	HA	12			
				5		HA	12			
		Soft grey-green SILT, trace sand (moist-wet)	27.5	6	3	HA	12			
				7		HA	12			
		Soft dark grey SILT, some fine coarse sand (wet)	63.3	8	4	HA	12			Observed product in soil pores and a strong oily smell from 8 to 9 ft bgs.
				9		HA	12			Collected sample AOI3_BH-13-107_10-11 at 11:30.
		Medium dense grey fine sandy SILT (wet)	102	10	5	HA	12			
		∇		11		HA	12			Traces of product observed in soil pores from 12 to 13 ft bgs.
		Soft brown-grey clayey fine SAND (wet)	69.7	12	6	HA	12			
				13						End boring at 13 ft bgs due to groundwater at 13:15.
				14						
				15						
				16						
				17						
				18						
				19						
				20						

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Log of Boring **BH-13-108** Sheet 1 of 1

Project Sunoco PES Facility			Project No. 25746012		
Location Philadelphia, Pa			Elevation and Datum --		
Drilling Company Total Quality Drilling			Date Started 7/30/13		Date Finished 7/30/13
Drilling Equipment Stainless Steel Hand Auger, Hydrovac Truck			Completion Depth 3 ft		Rock Depth NE
Size and Type of Bit			Number of Samples	Disturbed 2	Undisturbed	Core
Casing Diameter (in) NA		Casing Depth (ft) NA	Water Level (ft.)	First ▽ NE	Completion ▼	24 HR. ▼
Casing Hammer NA	Weight (lbs) NA	Drop (in) NA	Drilling Foreman Mike Kavlunas		
Sampler Hand Auger					
Sampler Hammer NA	Weight (lbs) NA	Drop (in) NA	Inspecting Engineer Patrick Troy		

MATERIAL SYMBOL	Elev. (ft)	Sample Description	PID Reading (ppm)	Depth Scale	Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
▨		Gravel FILL, some sand		0		HA	12			Began boring at 10:42. Encounter concrete obstruction and step off approximately 10 ft.
▨		Brown fine to coarse sand and red-brown fine to coarse gravel FILL (moist)	0.2	1	1	HA	12			Collected sample AOI3-BH-13-108_1-2-73013 at 10:59.
⁘		Orange-brown coarse SAND (wet)		2	2	HA	12			Perched groundwater observed at 2 ft bgs.
				3						Ended boring at 3 ft bgs at 11:49.
				4						
				5						

LANGAN Log of Boring **BH-13-112** Sheet 1 of 1

Project Sunoco PES Facility		Project No. 25746012	
Location Philadelphia, Pa		Elevation and Datum --	
Drilling Company Total Quality Drilling		Date Started 7/29/13	Date Finished 7/29/13
Drilling Equipment Stainless Steel Hand Auger, Hydrovac Truck		Completion Depth 4 ft	Rock Depth NE
Size and Type of Bit		Number of Samples: Disturbed 3	Undisturbed; Core
Casing Diameter (in) NA	Casing Depth (ft) NA	Water Level (ft.): First ▽ 4	Completion ▼; 24 HR. ▼
Casing Hammer NA; Weight (lbs) NA	Drop (in) NA	Drilling Foreman Mike Kavlunas	
Sampler Hand Auger		Inspecting Engineer Patrick Troy	
Sampler Hammer NA; Weight (lbs) NA	Drop (in) NA		

MATERIAL SYMBOL	Elev. (ft)	Sample Description	PID Reading (ppm)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
		Gravel FILL		0		HA	12			
		Brown fine to coarse silty SAND, trace gravel (moist)								
			0.0	1	1	HA	12			Collected sample AOI3_BH-13-112_1-2_72913 at 13:25
		Dark grey CLAY, some silt (moist)	0.3	2	2	HA	12			Collected sample AOI3_BH-13-112_2-3_72913 at 13:34
				3		HA	12			
		▽ Light brown silty CLAY (moist)	0.2	4	3	HA	12			Groundwater encountered at 4 ft bgs. Ended boring at 5 ft bgs due to groundwater at 13:49.
				5						

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Log of Boring **BH-13-113** Sheet 1 of 1

Project Sunoco PES Facility		Project No. 25746012	
Location Philadelphia, Pa		Elevation and Datum --	
Drilling Company Total Quality Drilling		Date Started 7/29/13	Date Finished 7/29/13
Drilling Equipment Stainless Steel Hand Auger, Hydrovac Truck		Completion Depth 5 ft	Rock Depth NE
Size and Type of Bit		Number of Samples	Disturbed 3 / Undisturbed / Core
Casing Diameter (in) NA	Casing Depth (ft) NA	Water Level (ft.)	First ∇ 5 / Completion ▼ / 24 HR. ▼
Casing Hammer NA	Weight (lbs) NA / Drop (in) NA	Drilling Foreman Mike Kavlunas	
Sampler Hand Auger			
Sampler Hammer NA	Weight (lbs) NA / Drop (in) NA	Inspecting Engineer Patrick Troy	

MATERIAL SYMBOL	Elev. (ft)	Sample Description	PID Reading (ppm)	Depth Scale	Sample Data Number	Sample Data Type	Sample Data Recov. (in)	Sample Data Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
▨		Grey fine to coarse gravel FILL		0		HA	12			Began boring at 11:50.
▨				1		HA	12			
		Grey SILT, some fine to coarse sand, trace clay (moist)	13.5	2	1	HA	12			Perched groundwater encountered at 2 ft bgs.
		Grey fine to coarse SAND, some silt (dry)	558	3	2	HA	12			Collected samples AOI3_BH-13-113_72913 and AOI3_DUP_SO_001_72913.
			8.7	4	3	HA	12			Groundwater encountered at 4 ft bgs. Ended boring at 5 ft bgs due to groundwater.
		∇		5						

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Log of Boring **BH-13-114** Sheet 1 of 1

Project: Sunoco PES Facility		Project No.: 25746012	
Location: Philadelphia, Pa		Elevation and Datum: --	
Drilling Company: Total Quality Drilling		Date Started: 7/29/13	Date Finished: 7/29/13
Drilling Equipment: Stainless Steel Hand Auger, Hydrovac Truck		Completion Depth: 4 ft	Rock Depth: NE
Size and Type of Bit		Number of Samples: Disturbed 2	Undisturbed Core
Casing Diameter (in): NA	Casing Depth (ft): NA	Water Level (ft.): First ∇ 4	Completion ▼ 24 HR. ▼
Casing Hammer: NA	Weight (lbs): NA Drop (in): NA	Drilling Foreman: Mike Kavlunas	
Sampler: Hand Auger		Inspecting Engineer: Patrick Troy	
Sampler Hammer: NA	Weight (lbs): NA Drop (in): NA		

MATERIAL SYMBOL	Elev. (ft)	Sample Description	PID Reading (ppm)	Depth Scale	Sample Data Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
		Gravel FILL Dark grey gravel FILL, some fine to coarse sand (wet)		0	1	HA	12			Began boring at 10:52.
			0.0	1		HA	12			Collected sample AOI3_BH-13-114_0-1_72913 at 10:52.
		Light brown silty clay FILL, trace gravel (moist)	0.0	2	2	HA	12			Collected sample AOI_BH-13-114_2-3_72913 at 12:08.
		Dark grey, fine coarse sandy gravel FILL (wet)		3		HA	12			Cobbles encountered throught boring.
		∇	0.0	4						Ended boring at 4 ft bgs due to groundwater at 12:38.
				5						

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Log of Boring **BH-13-115** Sheet 1 of 1

Project: Sunoco PES Facility
Project No.: 25746012
Location: Philadelphia, Pa
Elevation and Datum: --
Drilling Company: Total Quality Drilling
Date Started: 7/29/13
Date Finished: 7/29/13
Drilling Equipment: Stainless Steel Hand Auger, Hydrovac Truck
Completion Depth: 6 ft
Rock Depth: NE
Size and Type of Bit:
Number of Samples: Disturbed 2 Undisturbed Core
Casing Diameter (in): NA
Casing Depth (ft): NA
Water Level (ft.): First ∇ 5 Completion ▼ 24 HR. ▼
Casing Hammer: NA Weight (lbs): NA Drop (in): NA
Drilling Foreman: Mike Kavlunas
Sampler: Hand Auger
Inspecting Engineer: Patrick Troy
Sampler Hammer: NA Weight (lbs): NA Drop (in): NA

MATERIAL SYMBOL	Elev. (ft)	Sample Description	PID Reading (ppm)	Depth Scale	Sample Data Number	Sample Data Type	Sample Data Recov. (in)	Sample Data Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
▩		Grey fine to coarse gravel FILL		0		HA	12			Began boring at 10:10.
▩				1		HA	12			
▩		Light brown, fine to coarse sandy clay FILL, some silt and fine course gravel FILL (dry)	0.1	2	1	HA	12			Collected AOI3_BH-13-115_2-3_72913.
▩				3		HA	12			
▨		Light brown silty CLAY, some fine to coarse sand (moist)	0.0	4	2	HA	12			
▨		∇		5		HA	12			Groundwater encountered at 5 feet bgs.
				6						Ended boring at 6 feet bgs due to groundwater at 11:15.
				7						
				8						
				9						
				10						

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Log of Boring **S-382** Sheet 1 of 2

Project: Sunoco PES Facility

Project No.: 25746012

Location: Philadelphia, Pa

Elevation and Datum: --

Drilling Company: Total Quality Drilling

Date Started: 7/26/13

Date Finished: 8/2/13

Drilling Equipment: Stainless Steel Hand Auger, Hydrovac Truck, Split Spoon, Hollow Stem Auger

Completion Depth: 28 ft

Rock Depth: NE

Size and Type of Bit:

Number of Samples: Disturbed 8 Undisturbed Core

Casing Diameter (in): 4

Casing Depth (ft):

Water Level (ft.): First ▽ 10 Completion ▼ 24 HR. ▼

Casing Hammer: Weight (lbs): Drop (in):

Drilling Foreman: Mike Kavlunas

Sampler: Hand Auger, Split Spoon

Inspecting Engineer: Yavuz Gungor

Sampler Hammer: Weight (lbs): Drop (in):

Depth Scale	Elev. (ft)	Sample Description	PID Reading (ppm)	Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
0		Gravel FILL			HA	12			Began boring at 10:30 on 7/26/13.
1		Brown gravelly SILT, some sand (dry)			HA	6			
			1.7	1	HA	6			Collected sample AOI3_S-382_1.5-2_72613 at 10:50.
2					HA	12			
3		Brown silty SAND (dry)		2	HA	12			Collected sample AOI3_S-382_3-4_72613 at 11:00.
4		Light brown SAND (dry)			HA	12			
5			0.0	3	HA	12			Collected sample AOI3_S-382_5-6_72613 at 11:09.
6		Brown fine to coarse SAND (moist)	0.1	4	HA	12			Collected sample AOI3_S-382_6-7_72613 at 12:10.
7					HA	12			
8					HA	12			
9		▽			HA	12			Paused boring at 9 ft bgs on 7/26/13. Resumed boring at 8:00 on 8/1/13.
10		Stiff gray silty CLAY (wet)	0.0		SS	14	0 0 0 0	0	No blow counts recorded during the split spoon sampling.
12		Brown sandy GRAVEL (moist)	0.0		SS	18	0 0 0 0	0	Perched groundwater observed at 10 ft bgs.
14		Silty CLAY, some sandy gravel (moist)	0.0		SS	6	0 0 0 0	0	
16		Brown SAND, some gravel, trace silt (wet)			SS	NR	0 0 0 0	0	
18			0.0		SS	16	0 0 0 0	0	
20									

LANGAN Log of Boring **S-382** Sheet 2 of 2

Project	Project No.
Sunoco PES Facility	25746012
Location	**Elevation and Datum**
Philadelphia, Pa	--

MATERIAL SYMBOL	Elev. (ft)	Sample Description	PID Reading (ppm)	Depth Scale	Sample Data					Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
					Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	
				20						
			0.0	21		SS	18	0 0 0 0	0	
				22						
			0.0	23		SS	24	0 0 0 0	0	
				24						
			0.0	25		SS	20	0 0 0 0	0	
				26						
			0.0	27		SS	16	0 0 0 0	0	
				28						Ended boring at 28 ft bgs at 10:00 on 8/1/13.
				29						
				30						
				31						
				32						
				33						
				34						
				35						
				36						
				37						
				38						
				39						
				40						
				41						
				42						
				43						
				44						
				45						

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Log of Boring S-383 Sheet 1 of 1

Project Sunoco PES Facility		Project No. 25746012	
Location Philadelphia, Pa		Elevation and Datum --	
Drilling Company Total Quality Drilling		Date Started 7/26/13	Date Finished 8/6/13
Drilling Equipment Stainless Steel Hand Auger, Hydrovac Truck, Split Spoon, Hollow Stem Auger		Completion Depth 16 ft	Rock Depth NE
Size and Type of Bit		Number of Samples	Disturbed 8 / Undisturbed / Core
Casing Diameter (in) 4	Casing Depth (ft)	Water Level (ft.)	First ▽ 9 / Completion ▼ / 24 HR. ▼
Casing Hammer / Weight (lbs) / Drop (in)		Drilling Foreman Mike Kavlunas	
Sampler Hand Auger, Split Spoon		Inspecting Engineer Yavuz Gungor	
Sampler Hammer / Weight (lbs) / Drop (in)			

MATERIAL SYMBOL	Elev. (ft)	Sample Description	PID Reading (ppm)	Depth Scale	Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
		White-grey fine to coarse gravel FILL (dry) Loose dark brown fine to medium SAND, some coarse sand and silt (dry)	0.0	0	1	HA	12			Began boring at 10:10 on 4/26/13.
				1		HA	12			
				2		HA	12			
		Soft grey-brown SILT (dry)	0.0	3		HA	12			Collected sample AOI-3_S-383_0-1_072613 at 10:30.
				4		HA	12			
		Soft brown fine sandy SILT (dry-moist)	1.4	5	2	HA	12			Collected sample AOI-3_5-6_72613 at 10:45.
				6		HA	12			
		Medium dense grey SILT, trace fine sand (moist)	0.6	7		HA	12			
		▽		8		HA	12			
		Grey coarse SAND and fine coarse GRAVEL (wet)	0.3	9		HA	12			Groundwater encountered at 9 ft bgs.
		Sandy GRAVEL (wet)	55	10		SS	16	0 0 0 0	0	Paused boring at 10 ft bgs on 7/26/13. Resumed boring at 10:00 on 8/6/13. Odors and black staining observed at 10 ft bgs.
			80	12		SS	22	0 0 0 0	0	No blow counts recorded during the split spoon sampling.
			42.5	14		SS	20	0 0 0 0	0	
				16						Ended boring at 16 ft bgs due to large cobbles on 7/26/13.
				17						
				18						
				19						
				20						

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LANGAN Log of Boring **S-384** Sheet 1 of 2

Project: Sunoco PES Facility		Project No.: 25746012	
Location: Philadelphia, Pa		Elevation and Datum: --	
Drilling Company: Total Quality Drilling		Date Started: 7/22/13	Date Finished: 7/31/13
Drilling Equipment: Stainless Steel Hand Auger, Hydrovac Truck, Split Spoon, Hollow Stem Auger		Completion Depth: 24 ft	Rock Depth: NE
Size and Type of Bit:		Number of Samples: Disturbed 4	Undisturbed: Core:
Casing Diameter (in): 4	Casing Depth (ft):	Water Level (ft.): First ▽ 10	Completion ▼ 24 HR. ▼
Casing Hammer: Weight (lbs):	Drop (in):	Drilling Foreman: Mike Kavlunas	
Sampler: Hand Auger, Split Spoon			
Sampler Hammer: Weight (lbs):	Drop (in):	Inspecting Engineer: Yavuz Gungor	

Depth Scale	Elev. (ft)	Sample Description	PID Reading (ppm)	Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
0		Gravel FILL			HA	12			Began boring at 8:25 on 7/22/13.
1		Dark brown sandy SILT, some gravel, trace clay (dry)			HA	12			Collected sample AOI3_S-384_1-2_72213 at 8:30.
2		Gravel and sandy SILT, some clay (moist)			HA	12			
3					HA	12			Collected sample AOI3_S-384_2-3_72213 at 9:05.
4		Brown clayey SILT, trace sand (moist)			HA	12			
5					HA	12			Collected sample AOI3_S-384_5-6_72213 at 10:00.
6		Greyish brown clayey SILT, trace sand (moist)			HA	12			
7					HA	12			Collected sample AOI3_S-384_6-7_72213 at 10:10.
8					HA	12			
9		Light grey clayey SILT (moist) ▽			HA	12			Collected sample AOI3_S-384_9-10_72213 at 10:20.
10		Dark brown sandy angular GRAVEL (wet)	0.0		SS	10	0 0 0 0	0	Paused boring at 10 ft bgs at 10:30 on 7/22/13. Resumed boring at 12:30 on 7/30/13.
12			35.1		SS	12	0 0 0 0	0	No blow counts recorded during the split spoon sampling.
14		Dark brown sandy angular GRAVEL, some silt (wet)	40.2		SS	12	0 0 0 0	0	Strong odor observed at 13 ft bgs.
16		Dark gray sandy GRAVEL (wet)	51.6		SS	16	0 0 0 0	0	Paused boring at 17 ft bgs due to LEL >10 at 13:30 on 7/30/13. Resumed boring at 11:00 on 7/31/13.
18			41.2		SS	12	0 0 0 0	0	
20									

Project	Project No.
Sunoco PES Facility	25746012
Location	**Elevation and Datum**
Philadelphia, Pa	--

MATERIAL SYMBOL	Elev. (ft)	Sample Description	PID Reading (ppm)	Depth Scale	Sample Data Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
				20		SS	16	0 0 0 0	0	
			46.4	21						
				22		SS	NR	0 0		
				23						Ended boring at 23 ft bgs at 14:30 on 7/31/13.
				24						
				25						
				26						
				27						
				28						
				29						
				30						
				31						
				32						
				33						
				34						
				35						
				36						
				37						
				38						
				39						
				40						
				41						
				42						
				43						
				44						
				45						

Project	Sunoco PES Facility	Project No.	25746012		
Location	Philadelphia, Pa	Elevation and Datum	--		
Drilling Company	Total Quality Drilling	Date Started	7/26/13	Date Finished	7/31/13
Drilling Equipment	Stainless Steel Hand Auger, Hydrovac Truck, Split Spoon, Hollow Stem Auger	Completion Depth	10 ft	Rock Depth	NE
Size and Type of Bit		Number of Samples	Disturbed 8	Undisturbed	Core
Casing Diameter (in) 4	Casing Depth (ft)	Water Level (ft.)	First ∇ 4	Completion ▼	24 HR. ∇
Casing Hammer	Weight (lbs) / Drop (in)	Drilling Foreman	Mike Kavlunas		
Sampler	Hand Auger, Split Spoon				
Sampler Hammer	Weight (lbs) / Drop (in)	Inspecting Engineer	Yavuz Gungor		

MATERIAL SYMBOL	Elev. (ft)	Sample Description	PID Reading (ppm)	Depth Scale	Sample Data Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
		Grey fine to coarse gravel FILL (dry) Brown silt FILL, some fine coarse sand, trace brick (dry)		0		HA	12			Began boring on 7/26/13.
			0.3	1	1	HA	12			12:15 Collected sample AOI3_S-385_1-2_72613
		Dark grey silt FILL, some fine coarse sand (moist)	7.1	2	2	HA	12			12:35 Collect sample AOI3_S-385_2-3_72613
		∇		3		HA	12			
		Dark grey-black silty fine coarse sand with trace clay and fine coarse gravel FILL (wet)	0.4	4		HA	12			Groundwater was encountered at 4 ft bgs.
				5		HA	12			
		Dark grey silt FILL, some fine coarse sand and fine course gravel (wet)	1.9	6		HA	12			
		Dark grey large cobbles, coarse sand and gravel FILL (wet)	0.3	7		HA	12			Ended boring at 7 ft bgs on 7/26/16. Attempted redrilling of boring to 10 ft bgs on 7/30/13. After encountering a large cobble and a large pipe, successfully advanced to 10 feet.
				8		HA	12			
				9		HA	12			
		Brown coarse SAND (wet)	0.0	10 11		SS	6	0 0 0 0	0	Ended boring at 10 ft bgs on 7/30/16. Resumed boring on 7/31/13.
		Dark brown clayey SILT, some organic material	0.0	12 13		SS	16	0 0 0 0	0	No blow counts recorded during the split spoon sampling.
			0.0	14 15		SS	24	0 0 0 0	0	
			0.0	16 17		SS	21	0 0 0 0	0	
		Dark brown SAND (wet)	4.25	18 19		SS	6	0 0 0 0	0	Odor observed from 18 to 20 ft bgs.
				20						

LANGAN Log of Boring **S-385** Sheet 2 of 2

Project	Project No.
Sunoco PES Facility	25746012
Location	**Elevation and Datum**
Philadelphia, Pa	--

MATERIAL SYMBOL	Elev. (ft)	Sample Description	PID Reading (ppm)	Depth Scale	Sample Data Number	Sample Data Type	Sample Data Recov. (in)	Sample Data Penetr. resist BL/6in	Sample Data N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
		ORGANIC MATERIAL, some silt (wet)	8.1	20		SS	16	0 0 0 0	0	
		Silty SAND, some organic material (wet)	11.50	21						
				22		SS	20	0 0 0 0	0	
			4.20	23						
				24		SS	20	0 0 0 0	0	
			0.3	25						
				26						Ended boring at 26 ft bgs on 7/31/16.
				27						
				28						
				29						
				30						
				31						
				32						
				33						
				34						
				35						
				36						
				37						
				38						
				39						
				40						
				41						
				42						
				43						
				44						
				45						

LANGAN

Log of Boring **S-386** Sheet 1 of 2

Project Sunoco PES Facility		Project No. 25746012	
Location Philadelphia, Pa		Elevation and Datum --	
Drilling Company Total Quality Drilling		Date Started 7/22/13	Date Finished 7/29/13
Drilling Equipment Stainless Steel Hand Auger, Hydrovac Truck, Split Spoon, Hollow Stem Auger		Completion Depth 24 ft	Rock Depth NE
Size and Type of Bit		Number of Samples: Disturbed 8; Undisturbed; Core	
Casing Diameter (in) 4	Casing Depth (ft)	Water Level (ft.): First ▽ 11; Completion ▼; 24 HR. ▼	
Casing Hammer; Weight (lbs); Drop (in)		Drilling Foreman Mike Kavlunas	
Sampler Hand Auger, Split Spoon		Inspecting Engineer Yavuz Gungor	
Sampler Hammer; Weight (lbs); Drop (in)			

MATERIAL SYMBOL	Elev. (ft)	Sample Description	PID Reading (ppm)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
		Brown, fine coarse sand and silt, some fine coarse gravel and crushed concrete FILL. (dry)	0.0	0		HA	6			
					1	HA	6			Collected sample AOI3_S-386_0.5-1.0_072213 at 11:55.
				1		HA	12			
				2		HA	12			At 2 ft bgs a 1 inch asphalt/tar layer, glass, and debris was observed.
		Dark brown fine to coarse SAND and SILT, some fine coarse gravel (dry)		3		HA	12			Paused boring at 3 feet on 7/22/13. Resumed boring on 7/23/13.
			4.4	4		HA	12			
				5		HA	12			
			4.3	6		HA	12			
				7		HA	12			
		Black silty fine coarse SAND, trace fine coarse gravel (moist)	4.8	8	2	HA	12			Wood debris observed at 8 ft bgs. Collected sample AOI3_S-386_8-9_072313 at 11:00.
				9		HA	12			
		Black coarse SAND, some wood (moist) ▽	5.5	10 11		SS	11	0 0 0 0	0	Paused boring at 10 ft bgs on 7/23/13. Resumed drilling on 7/29/13. 8 inches of rainfall occurred the night before. Strong odor observed from 10 to 12 ft bgs.
		Gray clayey SILT (wet)	0.0	12 13		SS	10	0 0 0 0	0	
			0.0	14 15		SS	8	0 0 0 0	0	No blow counts recorded during the split spoon sampling.
		Mottled gray silty CLAY (wet)	0.0	16 17		SS	20	0 0 0 0	0	
		Coarse grey SAND (wet)		18 19		SS	18	0 0 0 0	0	
				20						

LANGAN

Log of Boring **S-386** Sheet 2 of 2

Project Sunoco PES Facility	Project No. 25746012
Location Philadelphia, Pa	Elevation and Datum --

MATERIAL SYMBOL	Elev. (ft)	Sample Description	PID Reading (ppm)	Depth Scale	Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
			0.0	20		SS	NR	0 0 0 0	0	
				21						
				22		SS	12	0 0 0 0	0	
			0.0	23						
				24						Ended boring at 24 ft bgs on 7/29/13.
				25						
				26						
				27						
				28						
				29						
				30						
				31						
				32						
				33						
				34						
				35						
				36						
				37						
				38						
				39						
				40						
				41						
				42						
				43						
				44						
				45						

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Log of Boring **S-387** Sheet 1 of 1

Project	Sunoco PES Facility	Project No.	25746012
Location	Philadelphia, Pa	Elevation and Datum	--
Drilling Company	Total Quality Drilling	Date Started	7/31/13
		Date Finished	7/31/13
Drilling Equipment	Stainless Steel Hand Auger, Hydrovac Truck, Split Spoon, Hollow Stem Auger	Completion Depth	16 ft
		Rock Depth	NE
Size and Type of Bit		Number of Samples	Disturbed 6 Undisturbed Core
Casing Diameter (in)	4	Water Level (ft.)	First ▽ 4 Completion ▼ 24 HR. ▼
Casing Depth (ft)			
Casing Hammer		Weight (lbs)	
Drop (in)		Drilling Foreman	Mike Kavlunas
Sampler	Hand Auger, Split Spoon	Inspecting Engineer	Yavuz Gungor
Sampler Hammer		Weight (lbs)	
Drop (in)			

MATERIAL SYMBOL	Elev. (ft)	Sample Description	PID Reading (ppm)	Depth Scale	Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
■ ▩		Asphalt Dark grey gravel FILL with some large cobbles (wet/moist)		0	1	HA	12			Began boring at 9:47.
▩				1		HA	12			Collected sample AOI3_2-387_1-2_73113 at 10:20.
▦		Dark grey sandy gravel FILL, some asphalt (wet)	0.0	2	2	HA	12			
▨		Dark grey silty CLAY, trace coarse sand (wet) ▽	0.0	3		HA	12			Collected sample AOI3_2-387_3-4_73113 at 10:35.
▨				4		HA	12			
▨				5		HA	12			Groundwater encountered at 4 ft bgs.
▨				6		HA	12			
▨				7		HA	12			
▨				8		HA	12			
▨				9		HA	12			
▥		Dark grey sandy SILT (wet)	6.5	10		SS	20	0 0 0 0	0	Ended hand auger at 10 ft bgs and began split spoon at 10:40.
▥			8.2	12		SS	8.2	0 0 0 0	0	No blow counts recorded during the split spoon sampling.
▥			2.0	14		SS	4	0 0 0 0	0	
				16						End boring at 16 ft bgs due to refusal.
				17						
				18						
				19						
				20						

LANGAN

WELL CONSTRUCTION SUMMARY

Well No. S-382

Project Sunoco PES Facility	Project No. 25746012	
Location Philadelphia, Pa	Elevation And Datum --	
Drilling Agency Total Quality Drilling	Date Started 8/1/2013	Date Finished 8/1/2013
Drilling Equipment Hollow Stem Auger	Driller Mike Kavalunas	
Size And Type of Bit	Inspector Pat Troy	

Method of Installation

Well S-382 was installed using an 8-inch diameter hollow stem auger on 8/1/2013. The boring was advanced to 28 ft bgs and 15 ft screen and 15 ft of riser were installed. Filter sand was installed to 11 ft bgs. and bentonite seal was installed to 1 ft bgs. Then the well casing was installed and concreted in place.

Method of Well Development

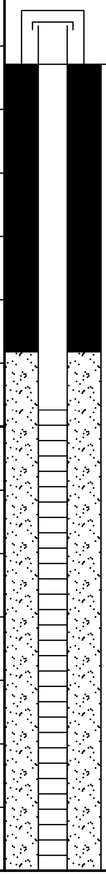
Type of Casing PVC	Diameter 4 inch	Type of Backfill Material
Type of Screen PVC	Diameter 4 inch	Type of Seal Material Bentonite
Borehole Diameter	8 inch	Type of Filter Material Filter Sand

	Elevation	Depth
Top of Casing		
Top of Seal		0' bgs
Top of Filter		10' bgs
Top of Screen		12' bgs
Bottom of Filter		28' bgs
Bottom of Well		28' bgs
Screen Length	16.0'	Slot Size 0.020

GROUNDWATER ELEVATIONS (ft)

(Measured from the Top of Casing)

Elevation	DTW	Date

Well Details	Soil / Rock Classification	Depth (ft)
	Fill	
	USCS Silt	
	USCS Silty Sand USCS Well-graded Sand	
	USCS Well-graded Sand	10
	USCS Low Plasticity Clay	12
	USCS Well-graded Sandy Gravel	
	USCS Low Plasticity Clay	
	USCS Poorly-graded Sand with Silt	28

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WELL CONSTRUCTION SUMMARY

Well No. S-383

Project Sunoco PES Facility	Project No. 25746012
Location Philadelphia, Pa	Elevation And Datum --
Drilling Agency Total Quality Drilling	Date Started 8/6/2013 Date Finished 8/6/2013
Drilling Equipment Hollow Stem Auger	Driller Mike Kavalunas
Size And Type of Bit	Inspector Pat Troy

Method of Installation

Well S-383 was installed using an 8-inch diameter hollow stem auger on 8/6/2013. The boring was advanced to 16 ft bgs and 8 ft screen and 10 ft of riser were installed. Filter sand was installed to 6 ft bgs. and bentonite seal was installed to ground surface. Then the well casing was installed and concreted in place.

Method of Well Development

Type of Casing PVC	Diameter 4 inch	Type of Backfill Material
Type of Screen PVC	Diameter 4 inch	Type of Seal Material Bentonite
Borehole Diameter	8 inch	Type of Filter Material Filter Sand

	Elevation	Depth
Top of Casing		
Top of Seal		0' bgs
Top of Filter		6' bgs
Top of Screen		8' bgs
Bottom of Filter		16' bgs
Bottom of Well		16' bgs

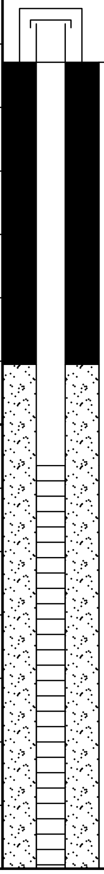
Screen Length 8.0'

Slot Size 0.020

GROUNDWATER ELEVATIONS (ft)
(Measured from the Top of Casing)

Elevation	DTW	Date

Well Details



Soil / Rock Classification	Depth (ft)
Fill	
USCS Well-graded Sand	
USCS Silt	
USCS Sandy Silt	6
USCS Silt	8
USCS Poorly-graded Gravelly Sand	
USCS Poorly-graded Gravel	16

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WELL CONSTRUCTION SUMMARY

Well No. S-384

Project Sunoco PES Facility	Project No. 25746012
Location Philadelphia, Pa	Elevation And Datum --
Drilling Agency Total Quality Drilling	Date Started 7/31/2013 Date Finished 7/31/2013
Drilling Equipment Hollow Stem Auger	Driller Mike Kavalunas
Size And Type of Bit	Inspector Pat Troy

Method of Installation

Well S-384 was installed using an 8-inch diameter hollow stem auger on 7/29/2013. The boring was advanced to 24 ft bgs and 15 ft screen and 9 ft of riser were installed. Filter sand was installed to 7 ft bgs. and bentonite seal was installed to ground surface. Then the well casing was installed and concreted in place.

Method of Well Development

Type of Casing PVC	Diameter 4 inch	Type of Backfill Material
Type of Screen PVC	Diameter 4 inch	Type of Seal Material Bentonite
Borehole Diameter	8 inch	Type of Filter Material Filter Sand

	Elevation	Depth
Top of Casing		
Top of Seal		0' bgs
Top of Filter		7' bgs
Top of Screen		9' bgs
Bottom of Filter		24' bgs
Bottom of Well		24' bgs

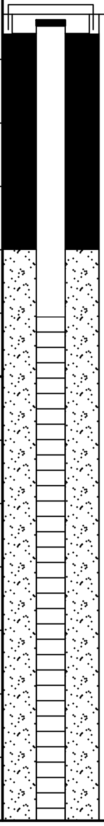
Screen Length	Slot Size
15.0'	0.020

GROUNDWATER ELEVATIONS (ft)

(Measured from the Top of Casing)

Elevation	DTW	Date

Well Details



Soil / Rock Classification	Depth (ft)
Fill	
USCS Sandy Silt	
USCS Sandy Silt	
USCS Silt	
USCS Silt	7
	9
USCS Silt	
USCS Well-graded Sandy Gravel	
USCS Well-graded Sandy Gravel	
USCS Well-graded Sandy Gravel	
	24

LANGAN

WELL CONSTRUCTION SUMMARY

Well No. S-385

Project Sunoco PES Facility	Project No. 25746012
Location Philadelphia, Pa	Elevation And Datum --
Drilling Agency Total Quality Drilling	Date Started 7/31/2013 Date Finished 7/31/2013
Drilling Equipment Hollow Stem Auger	Driller Mike Kavalunas
Size And Type of Bit	Inspector Pat Troy

Method of Installation

Well S-385 was installed using an 8-inch diameter hollow stem auger on 7/31/2013. The boring was advanced to 26 ft bgs and 15 ft screen and 15 ft of riser were installed. Filter sand was installed to 9 ft bgs. and bentonite seal was installed to ground surface. Then the well casing was installed and concreted in place.

Method of Well Development

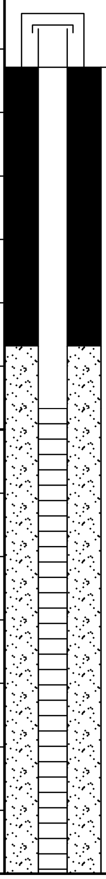
Type of Casing PVC	Diameter 4 inch	Type of Backfill Material
Type of Screen PVC	Diameter 4 inch	Type of Seal Material Bentonite
Borehole Diameter	8 inch	Type of Filter Material Filter Sand

Top of Casing	Elevation	Depth
Top of Seal	Elevation	Depth 0' bgs
Top of Filter	Elevation	Depth 9' bgs
Top of Screen	Elevation	Depth 11' bgs
Bottom of Filter	Elevation	Depth 26' bgs
Bottom of Well	Elevation	Depth 26' bgs
Screen Length 15.0'		Slot Size 0.020

GROUNDWATER ELEVATIONS (ft)
(Measured from the Top of Casing)

Elevation	DTW	Date
Elevation	DTW	Date
Elevation	DTW	Date
Elevation	DTW	Date
Elevation	DTW	Date
Elevation	DTW	Date

Well Details



Soil / Rock Classification	Depth (ft)
Fill Fill Fill Fill Fill	
Fill	9
USCS Well-graded Sand	11
USCS Silt	
USCS Poorly-graded Sand	
USCS Low Plasticity Organic silt or clay	
USCS Silty Sand	26

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WELL CONSTRUCTION SUMMARY

Well No. S-386

Project Sunoco PES Facility	Project No. 25746012
Location Philadelphia, Pa	Elevation And Datum --
Drilling Agency Total Quality Drilling	Date Started 7/29/2013
	Date Finished 7/29/2013
Drilling Equipment Hollow Stem Auger	Driller Mike Kavalunas
Size And Type of Bit	Inspector Pat Troy

Method of Installation

Well S-386 was installed using an 8-inch diameter hollow stem auger on 7/29/2013. The boring was advanced to 24 ft bgs and 15 ft screen and 9 ft of riser were installed. Filter sand was installed to 7 ft bgs. and bentonite seal was installed to ground surface. Then the well casing was installed and concreted in place.

Method of Well Development

Type of Casing PVC	Diameter 4 inch	Type of Backfill Material
Type of Screen PVC	Diameter 4 inch	Type of Seal Material Bentonite
Borehole Diameter	8 inch	Type of Filter Material Filter Sand

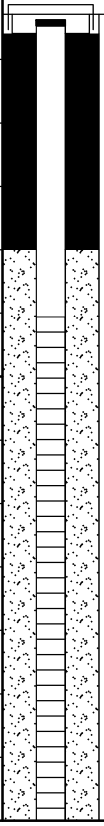
	Elevation	Depth
Top of Casing		
Top of Seal		0' bgs
Top of Filter		7' bgs
Top of Screen		9' bgs
Bottom of Filter		24' bgs
Bottom of Well		24' bgs

Screen Length	Slot Size
15.0'	0.020

GROUNDWATER ELEVATIONS (ft)
(Measured from the Top of Casing)

Elevation	DTW	Date

Well Details



Soil / Rock Classification	Depth (ft)
Fill	
USCS Poorly-graded Sand with Silt	7
USCS Poorly-graded Sand	9
USCS Poorly-graded Sand	
USCS Silt	
USCS Low Plasticity Clay	
USCS Poorly-graded Sand	24

LANGAN

WELL CONSTRUCTION SUMMARY

Well No. S-387

Project: Sunoco PES Facility

Project No.: 25746012

Location: Philadelphia, Pa

Elevation And Datum: --

Drilling Agency: Total Quality Drilling

Date Started: 8/5/2013

Date Finished: 8/5/2013

Drilling Equipment: Hollow Stem Auger

Driller: Mike Kavalunas

Size And Type of Bit:

Inspector: Pat Troy

Method of Installation

Well S-387 was installed using an 8-inch diameter hollow stem auger on 8/1/2013. The boring was advanced to 28 ft bgs and a 10 ft screen and 6 ft of riser were installed. Filter sand was installed to 11 ft bgs. and bentonite seal was installed to 1 ft bgs. Then the well casing was installed and concreted in place.

Method of Well Development

Type of Casing: PVC

Diameter: 4 inch

Type of Backfill Material:

Type of Screen: PVC

Diameter: 4 inch

Type of Seal Material: Bentonite

Borehole Diameter: 8 inch

Type of Filter Material: Filter Sand

	Elevation	Depth
Top of Casing		
Top of Seal		0' bgs
Top of Filter		4' bgs
Top of Screen		6' bgs
Bottom of Filter		16' bgs
Bottom of Well		16' bgs

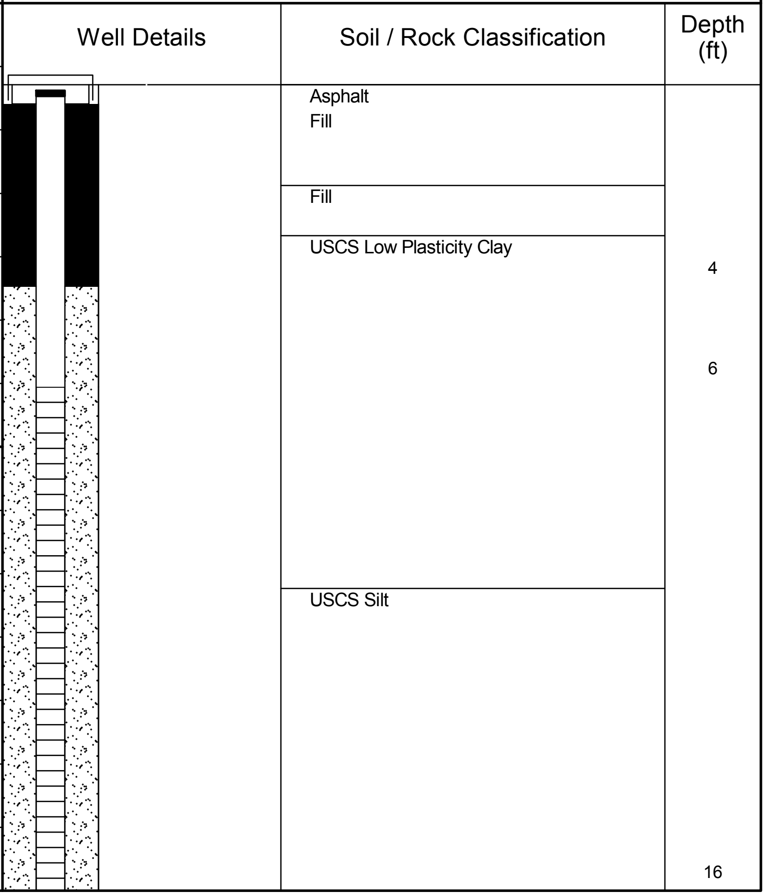
Screen Length: 10.0'

Slot Size: 0.020

GROUNDWATER ELEVATIONS (ft)

(Measured from the Top of Casing)

Elevation	DTW	Date
Elevation	DTW	Date
Elevation	DTW	Date
Elevation	DTW	Date
Elevation	DTW	Date
Elevation	DTW	Date



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S-1

C.V.M. industries

geotechnical division inc.

post office box 2 • huntingdon valley, pennsylvania

215-947-2555

Client ARCO REFINERY

Project WELLS AND TEST BORINGS

Location PHILADELPHIA, PA

Project No. -

Boring No. SM-5.1 Depth 30.0'

Elevation

Spoon Size 2" Casing Size

Core Size Bit No.

Hammers:

Spoon, weight 140 # Drop 30"

Drive, weight Drop

Date Started 8-1-85

Driller SB

Helper WGH

Inspector

Job No. 3115

Ground Water Data:

0 HRS: WATER AT 10"

TOTAL PIPE: 13.0'

Date Completed 8-1-85

Depth	Casing Blows	STRATA CLASSIFICATION	SAMPLING DATA Depth	No.	Blows per 6"	REMARKS
		BLACK AND GREY FINE SAND. TRACE SOME SILT 5.0'	0.0 - 2.0	S-1	2 - 1 1 - 6	INSTALLED PIPE TO 10.0'
			3.0 - 5.0	S-2	4 - 2 1 - 1	
		DARK GREY TO BLACK SILT TRACE SOME CLAY. (VERY moist) 30.0'				DRILLED FIRST HOLE TO 30.0' SOIL IS VERY MOIST. HOWEVER, WE COULD NOT GET A WATER LEVEL. SAMPLE HOLE OFFSET APPROXIMATELY 2.0-4.0' FROM WELL ON 8-5-85
		COMPLETE AT 30.0'				

SHEET NO. .... OF ....

S-2

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215-947-2555

Client ARCO REFINERY
Project WELLS AND TEST BORINGS
Location PHILADELPHIA, PA.
Project No. -
Boring No. SM-49 Depth 10.0'
Elevation
Spoon Size 2" Casing Size
Core Size Bit No.
Hammers:
Spoon, weight 140# Drop 30"
Drive, weight Drop
Date Started 7-31-85

Driller S.B.
Helper WGH
Inspector MC
Job No. 3115

Ground Water Data:
O. HRS:
WATER AT 6' 2½"
TOTAL PIPE - 13.0'

Date Completed 7-31-85

Depth	Casing Blows	STRATA CLASSIFICATION	SAMPLING DATA Depth	No.	Blows per 6"	REMARKS
		MISCELLANEOUS SOIL FILL.	0.5-		7-5	
			2.5-	S-1	3-2	
		MOSTLY FINE SAND 5.5'				SAMPLE HOLE OFFSET APPROXIMATELY 2.0-4.0' OF WELL ON 8-5-85
		DARK GREY SANDY SILT 10.0'				
		COMPLETE AT 10.0'				THIS WELL TEST BORING OFFSET BECAUSE OF SM-47 BEING MOVED. (FROM PRELIMINARY LOCATION MAP)

SHEET NO. .... OF ....

3-3

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geotechnical division inc.
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215-947-2555

Client ARCO REFINERY
Project WELLS AND TEST BORINGS
Location PHILADELPHIA, PA
Project No. -
Boring No. SM-47 Depth 15.0'
Elevation
Spoon Size 2" Casing Size
Core Size Bit No.
Hammers:
Spoon, weight 140# Drop 30"
Drive, weight Drop
Date Started 7-31-85

Driller SB
Helper WGH
Inspector MC
Job No. 3115

Ground Water Data:
TOTAL PIPE - 18.0'

Date Completed 7-31-85

Depth	Casing Blows	STRATA CLASSIFICATION	SAMPLING DATA Depth	No.	Blows per 6"	REMARKS
		TAN SAND FILL 5.5'	0.0 -		4-3	
			2.0 -	S-1	3-2	
			3.0 -		1-1	
			5.0	S-2	2-3	
		TAN SILTY SOIL. MAY BE FILL 15.0'				THIS WELL TEST BORING OFFSET TO AVOID REMOVING FENCE AND OVERHEAD WIRES
		COMPLETE AT 15.0'				SAMPLE HOLE OFFSET APPROXIMATELY 2.0-4.0'

SHEET NO. .... OF ....

ENSR

5-5

Sheet 1 of 1

Project No. 6445-017 Date - Start 2-12-92 Finish 2-12-92 Boring B-4

Project Name Sun Oil Drilling Co. EMPIRE

Location Gaurd Basin (SWMU-3) Drilling Method 6 1/4 HSA

Total Depth 9' Inspector J. Rice Reviewer Charles E Martin

Remarks

Depth Feet	Sample				Graphic Log	Lithologic Description	Equipment Installed
	Type & No.	Blows per 6 In.	Depth Range	Rec.			
5						No samples Taken	
					9'		
10						Total depth 9'	

M890278

Project No: 6445-017 Client: SUN OIL Site: Philadelphia

WELL NO. MW-4

Well Location: Guard Basin

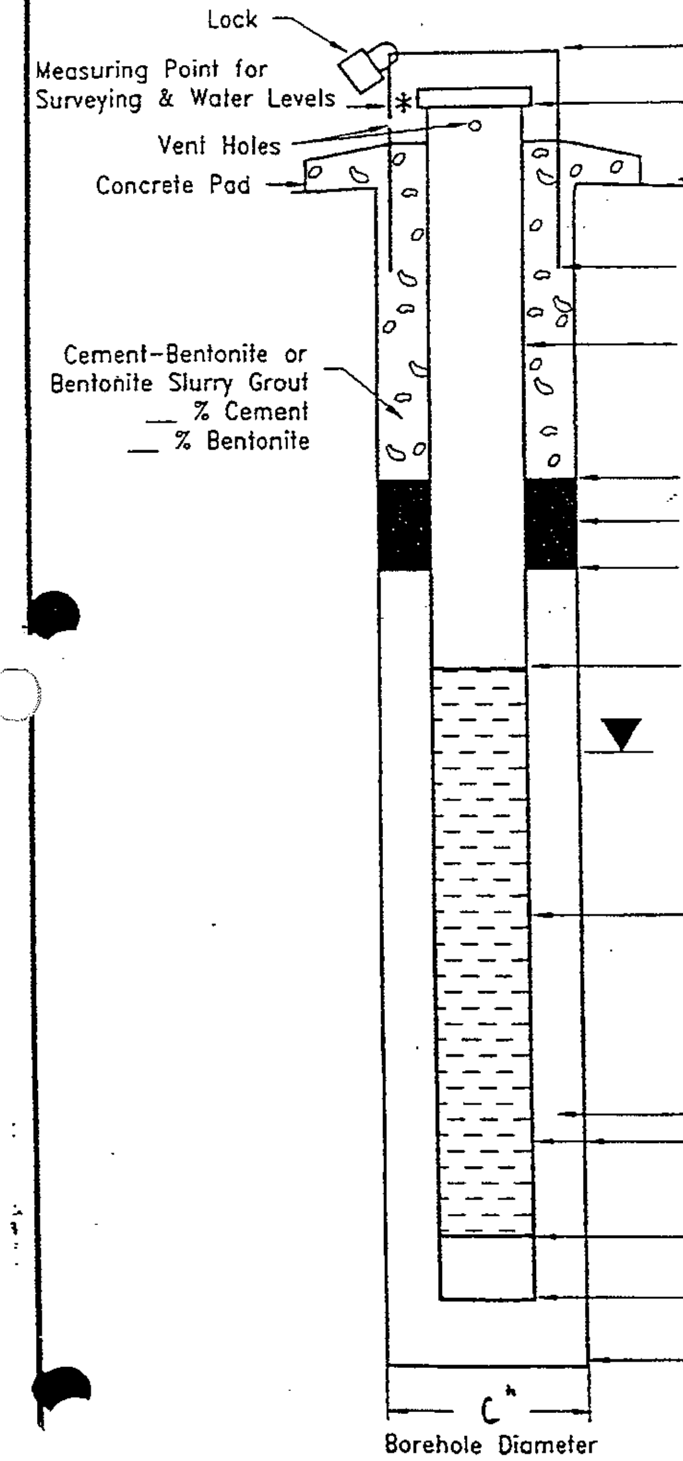
Date Installed: 2/15/92

ractor: EMPIRE Method: 6 1/4 HSA

Inspector: J. Rice

5-5

MONITORING WELL CONSTRUCTION DETAIL



		Depth from G.S. (feet)	Elevation (NGVD)
Top of Steel Guard Pipe		0	
Top of Riser Pipe		0	
Ground Surface (G.S.)		0.00	
Bottom of Steel Guard Pipe		6"	
Riser Pipe:			
Length	4		
Inside Diameter (ID)	4"		
Type of Material	PVC		
Top of Bentonite Seal		2'	
Bentonite Seal Thickness	1		
Top of Sand		3'	
Top of Screen		4'	
Stabilized Water Level			
Screen:			
Length	5'		
Inside Diameter (ID)	4"		
Slot Size	0.020		
Type of Material	PVC		
Type/Size of Sand	Silica / #1		
Sand Pack Thickness	1"		
Bottom of Screen		9'	
Bottom of Tail Pipe:			
Length	.5'		
Bottom of Borehole	5/27/93	9'	

Approved:

* Describe Measuring Point:

Signature Date

ENSR

S-6

ENSR

Sheet 1 of 3

Project No. 6445-017 Date - Start 2/27/92 Finish 3/2/92 Boring B-10
Project Name Sun Oil Drilling Co. Empire
Location Guard Basin (SWMU-3) Drilling Method Mud Rotary
Total Depth 90.3' Inspector BEM Reviewer Charles E Martin
Remarks

Depth Feet	Sample				Graphic Log Sample	Lithologic Description	Equipment Installed
	Type & No.	Blows per 6 In.	Depth Range	Rec.			
0						Asfalt Road	
	~~A~~		~~[illegible]~~			Drilled Through fill material (Ash, SilT, Gravel, sand)	
5	~~B~~		~~[illegible]~~				
					FI	FILL	
10	A	1-8 0-8	10-12	24"	310AA	SilT, Trace ClaY, Brown GreY, SofT Oil. odor, weT	Sample chemical + GeoTech
	B	2-8 12-17	12-14	6"	ML	As Above Trace med Gravel	
15							
20					GP/SP		
	C	8-9 12-29	20-22	10"	310BA	Gravel, Fine, and SilT and F. Sand Loose, Brown, moisT, PoorlY Sorted Trace Cobbles	Chemical + GeoTech
25	D	12-28 32-38	25-27	0"	GP	Large Gravel, PossiblY cobbles rough Drilling	
30	E	7-4 4-10	30-32	3"	310CA CL	ClaY, SofT, med Plastic, Yellow weT. ~~NOT enough for sample SVOC~~	Chemical
	—	⌢	33-35	18"	Tube		Shelby Tube
35	F	5-5 10-20	35-37	8"	310CA CL	As Above, Damp, Thin colored stratagraphic layers	Chemical

5-6

ENSR Project 6445-017 BORING LOG (continued) Boring B 10 Sheet 2 of 3

Depth Feet	Sample: Type & No.	Blows per 6 In.	Depth Range	Rec.	Graphic Log	Lithologic Description	Equipment Installed
						B-10 contioned	
40 ~~35~~							
	G	18-24 98/6"	41-43	14"	CL	Clay, STIFF, Low Plastic, Grey Brown moist	
45 ~~40~~	H	24-27 24/6"	45-47	10"		As Above	
50	I	24-28 27/3"	50-52	10"	CL	Clay, STIFF, mod Plastic, Grey, moist	
55	J	56/6"	55-57	8"	CL	Clay, hard, Trace Coal Fragments, Dark Grey, damp.	
60	K	50/6	60-62	1"	SW	Sand, Fine To Corse, Some F. Gravel and Clay, loose, wet, Brown	
65	L	50/6"	65-67	6"	310DA	Sand, Fine To Corse, Some F.-M. Gravel Trace Clay, Dense, Brown To Yellow, wet	Chemical + GeoTech
70	M	50/8"	70-72	6"	SW	As Above	
75	N	50/8"	75/76	5"	SW	As Above	
80	O	50/6"	80-82	1"	GP	Gravel, med To Crse, Some F. Sand Dense, Brown, Wet	

2.0

M890248

5-6

ENSR Project Sun Oil Boring B-10 Sheet 3 of 3

Depth Feet	Sample				Graphic Log	Lithologic Description	Equipment Installed
	Type & No.	Blows per 6 In.	Depth Range	Rec.			
85	P	50/8"	85-87	8"	SW	Sand, Fine, Well Sorted, Brown Loose, wet	
90	Q	50/4"	90-92	4"	90'	Sand, Fine and Rock Fragments Trace Clay, Damp-Dry (Bedrock)	
						BOH = ~~92.0'~~ 90.3'	

A01 3

S-7

Project No: 6445-017 Client: SUN OIL Site: PHIL., PA.

WELL No: MW-26

Well Location: Guard Basin (SWMU-3), N of B-10

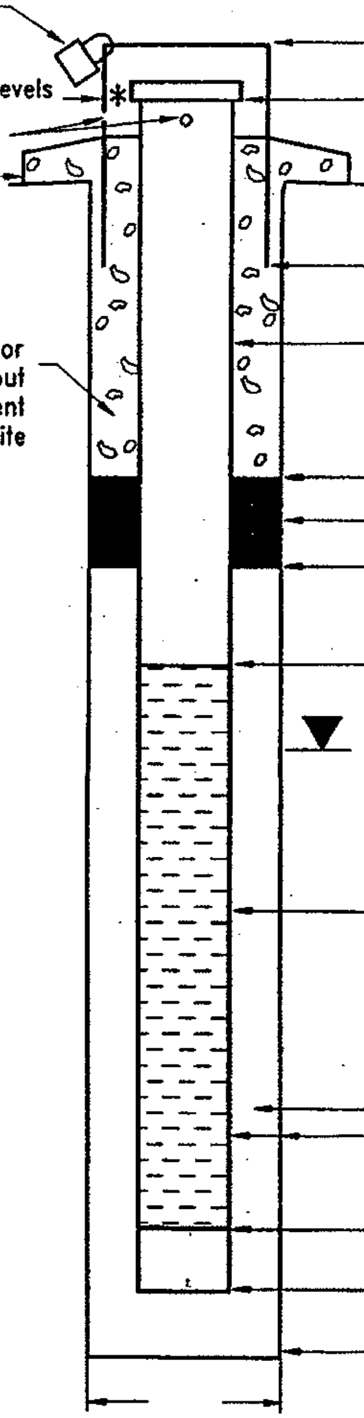
Date Installed: 3/16/92

Contractor: EMPIRE

Method: MUD ROTARY

Inspector: C. MART

MONITORING WELL CONSTRUCTION DETAIL



95 % Cement
5 % Bentonite

		Depth from G.S. (feet)	Elevation (NGVD)
Top of Steel Guard Pipe		FLUSH	
Top of Riser Pipe		~0.3	
Ground Surface (G.S.)		0.00	
Bottom of Steel Guard Pipe		1.5'	
Riser Pipe:			
Length	12		
Inside Diameter (ID)	2"		
Type of Material	PVC		
Top of Bentonite Seal		12	
Bentonite Seal Thickness	3"		
Top of Sand		14	
Top of Screen		16	
Stabilized Water Level			
Screen:			
Length	10'		
Inside Diameter (ID)	2"		
Slot Size	~~.010~~ ,020		
Type of Material	PVC		
Type/Size of Sand	#2		
Sand Pack Thickness	3"		
Bottom of Screen		25.75'	
Bottom of Tail Pipe:		26	
Length	.25'		
Bottom of Borehole		26'	

5 bags sand

Approved:

* Describe Measuring Point: top of PVC

C. Martin
Signature

4/1/92
Date

ENSR.

ENSR BORING LOG S-8

Sheet 1 of 3

Project No. 6445-017 Date - Start 2/12/92 Finish 2/19/92 Boring B-2

Project Name SUN-OIL Drilling Co. EMPIRE Co.

Location Guard Basin - SWMO No. 3 Drilling Method MUD ROTARY

Total Depth 91' Inspector C. Martin Reviewer

Remarks S 13:30

Depth Feet	Sample				Graphic Log	Lithologic Description	Equipment Installed HNU
	Type & No.	Blows per 6 in.	Depth Range	Rec.			
	NS		0-2			2" asphalt — FILL —	
	S-1	11-14-9-12	2-4'	12"	Fill/SW	Brown F-M SAND, some C Sand and C Gravel (to 1" ø)	
5	S-2	5-10-8-10	4-6'	8"	ML	Gray SILT w/ some Clay and C Sand.	
	S-3	5-7-4-4	6-8	0		(No rec.; C Gravel, wash only)	0 in mud tub
	S-4	1-1-1-1	8-10	0		(No rec, mud too thin, will be thickened)	
10	S-5	WOR/1/1/0	10-12	3"	CL	Gray CLAY, some Silt (very soft)	3
	S-6	WOH/1/5/6	12-14	8"	13' ~~ML~~ CL 14'	Gray/brown SILT w/ Clay, C gravel, little organics	3
15	S-7	N.Rec.	14-16	10"	SW	Brown F-C SAND w/ Gravel (to 1" ø), some Silt (mod. HC. odor)	25
	S-8	14-42-45-42	16-18	12"	SW	brown F-M SAND w/ some Silt and C Gravel (½"-1"), HC odor (Sheen in tub)	18
	S-9	16-26-27-40	18-20	12"		- same -	4
20	S-10	22-28-57-58	20-22	14"		- same -	4.5
	S-11	22-52-42-52	22-24	12"	22/23 SW/SP	gray M SAND w/ some C Sand, little F Sand Red/br M-C SAND	
25	S-12	17-20-30-45	24-26	12"		— same — (dense, tr. clay in spoon tip)	
	S-13	17-34-40-43	26-28	0		No rec. (only wash gravel)	
	S-14	15-23-21-22	28-30	3"	SW	Red/br F-M SAND, & some C Sand, gravel, Silt, tr. Clay	
30	S-15	4-6-9-9	30-32	4"	30 CH	Yellow CLAY, tr. C sand (very plastic)	
	S-16	WOR/WOR/1-1	32-34	0		No recovery (clay smear in spoon)	
35	S-17	NR	34-36	0'		"	
	S-18	11/14/15/25	36-38	14"	CH	RED CLAY ~~& some~~ Silt, (some Yel clay)	
	ST-1	—	38-40			(Shelby tube — no rec)	

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ENSR Project 6445-017 BORING LOG (continued) Boring B-2 Sheet 2 of

Depth Feet	Sample				Graphic Log	Lithologic Description	Equipment Installed
	Type & No.	Blows per 6 In.	Depth Range	Rec.			
40							
	ST-2	—	41-43'	~12"		CLAY	
	S-19	WOH-7-7	43-45	4"	CL	RED CLAY (V. Soft)	
45	S-20	20-28-28-39	45-47	16"	CH	Brown/gray CLAY (M. Dense)	
	S-21	19-23-30-39	47-49	12"		- Same -	
50	S-22	WOR	50-52	10"	CH	dk Gray CLAY (~~Soft~~)	
	S-23	NR	52-54	12"	CH	dk Gray CLAY w/ some Silt, black wood frags (V. dense)	
55	S-24	WOR/50/6"	54-56	12"		- same -	
	S-25	NR	56-58	12	ML 57	yel/light gray SILT w/ CLAY br Med SAND	
	S-26	50/6"	58-60	6"	GP	C GRAVEL w/ M-C Sand	
60	S-27	50/6"	60-62	2"		(Qtz cobble only)	
	S-28	50/6"	62-64	6"	GP	C GRAVEL (Qtz) (to 1.5" ø), some M-C Sand	
65	S-29	35/50/6"	64-66'	8"		M-C SAND w/ C Gravel (Qtz)	
	S-30	50/6"	66-68	6"	SP	C SAND w/ C Gravel	
	S-31	50/6"	68-70	6"		brown M-C SAND w/ some C Gravel (to 1" ø)	
70	S-32	50/6"	70-72	6"	GP	C GRAVEL (Qtz to 1.5" ø)	
	S-33	50/6"	72-74	6"		C GRAVEL (wash ?)	
75	S-34	50/6"	74-76	6"	GP	C GRAVEL w/ C SAND	
	S-35	50/6"	76-78	2"		- same - (cobble in spoon)	
	S-36	35/50/6"	78-80	8"	79 SW	brown C SAND, some F-M Sand, tr Gravel, Silt	
80	S-37	18-35-50/2	80-82	8"		Lt br/tan M-SAND, some F/C Sand, li C Gravel, some Silt	
	S-38	50/6"	82-84	6"	SW	- same -	
85	S-39	—	84-86	2"		Gravel only (poor rec.)	
	S-40	50/6"	86-88	3"	SW	lt br M-C SAND w/ C Gravel, tr silt	
	S-41	50/6"	88-90	2"	88 CL/BR	tan CLAY w/ Silt and some C Sand, micaceous (possibly wthrd rock)	

Ge
B-2
62-6
3020
D

S-8

ENSR Project 6445-017 Boring B-2 Sheet 3 of

Depth Feet	Sample				Graphic Log	Lithologic Description	Equipment Installed
	Type & No.	Blows per 6 In.	Depth Range	Rec.			
	S-42	—	90-91	12"	BR	Wthrd mica schist (?)	
						Bottom of Boring @ 91'	
95							

M890248

Project No: [illegible] Client: SUN Site: SUN OIL

WELL NO: MW-2

Date Installed: 2/19/92

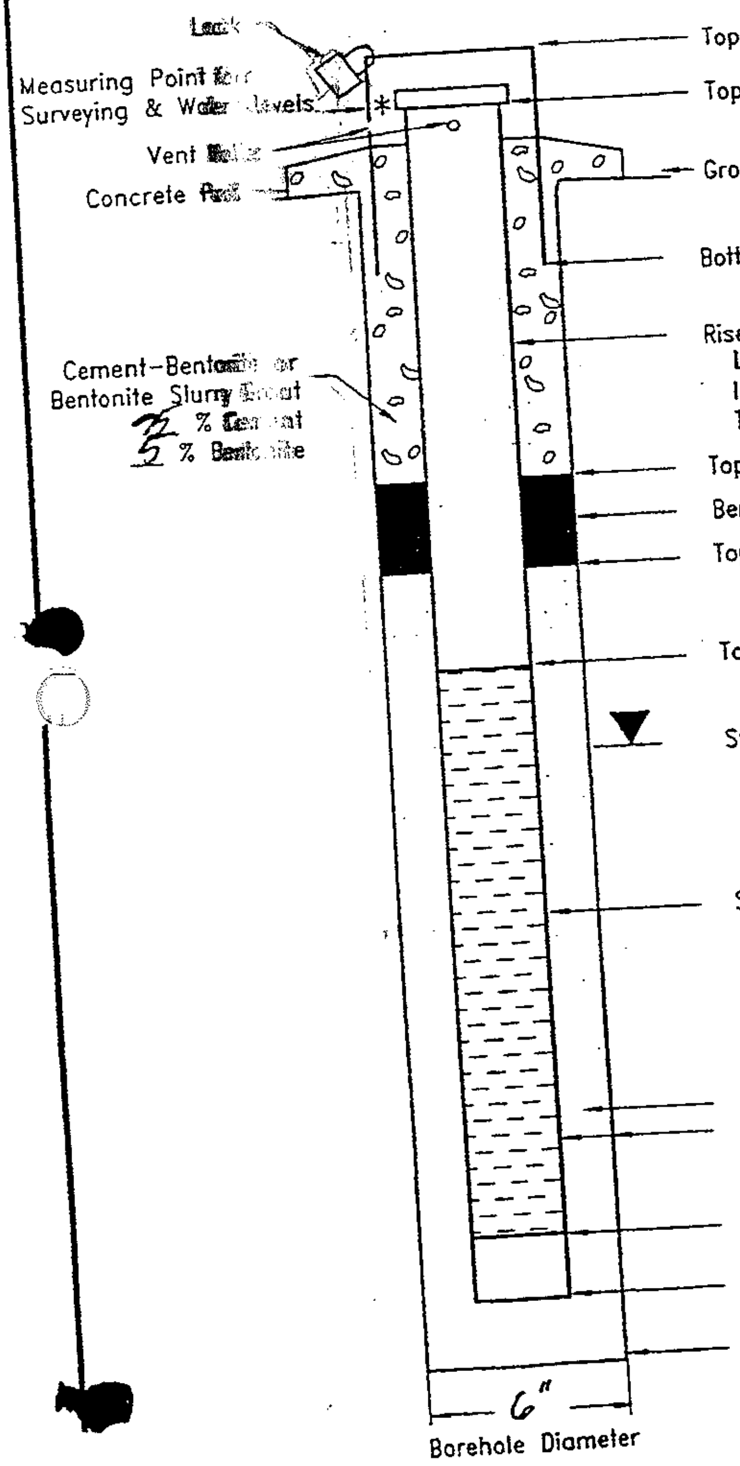
Well Location: [illegible] BASIN (B-2) SWMU-3

Inspector: C MARTIN

Contractor: EN[illegible]RE Method: MUD ROTARY

5-8

MONITORING WELL CONSTRUCTION DETAIL



		Depth from G.S. (feet)	Elevation (NGVD)
Top of Steel Guard Pipe		FLUSH	
Top of Riser Pipe		-.5	
Ground Surface (G.S.)		0.00	
Bottom of Steel Guard Pipe		1'	
Riser Pipe: Length	60'		
Inside Diameter (ID)	2"		
Type of Material	PVC		
Top of Bentonite Seal		54'	
Bentonite Seal Thickness	3'		
Top of Sand		57'	
Top of Screen		60'	
Stabilized Water Level			
Screen: Length	10'		
Inside Diameter (ID)	2"		
Slot Size	.020		
Type of Material	PVC		
Type/Size of Sand	No 2 Morie		
Sand Pack Thickness	2"		
Bottom of Screen		69.5'	
Bottom of Tail Pipe:		70'	
Length	.5		
Bottom of Borehole		91'	

Approved: _______ _______
Signature Date

ENSR®

* Describe Measuring Point:

ENSR

S-9

Sheet 1 of 1

Project No. 6445-017 Date - Start 2-11-92 Finish 2-11-92 Boring B-1

Project Name Son O' [illegible] Drilling Co. EMPIRE

Location SMMU-3 Drilling Method 6 1/4 HSA

Total Depth 12' Inspector J. Rice/C. Martin Reviewer Charles E. Martin

Remarks

Depth Feet	Sample				Graphic Log	Lithologic Description	HNU ~~Equipment Installed~~
	Type & No.	Blows per 6 In.	Depth Range	Rec.			
5	S-1	5 6-5-3	5-7'	14"	FI	Black-Brown-Red SAND and CINDER FILL (slight odor)	0 2
					9'		
10	S-2	wo2-wo2-1-1	10-12'	24"	OL	Brownish-gray CLAY w/ silt, trace organics	17
					12'	Bot. of Boring @ 12'	
15							
20							
25							
30							
35							

Project No: 6445-017 Client: SUN Oil Site: Philadelphia PA

WELL No: MW-1

Well Location: Guard Basin

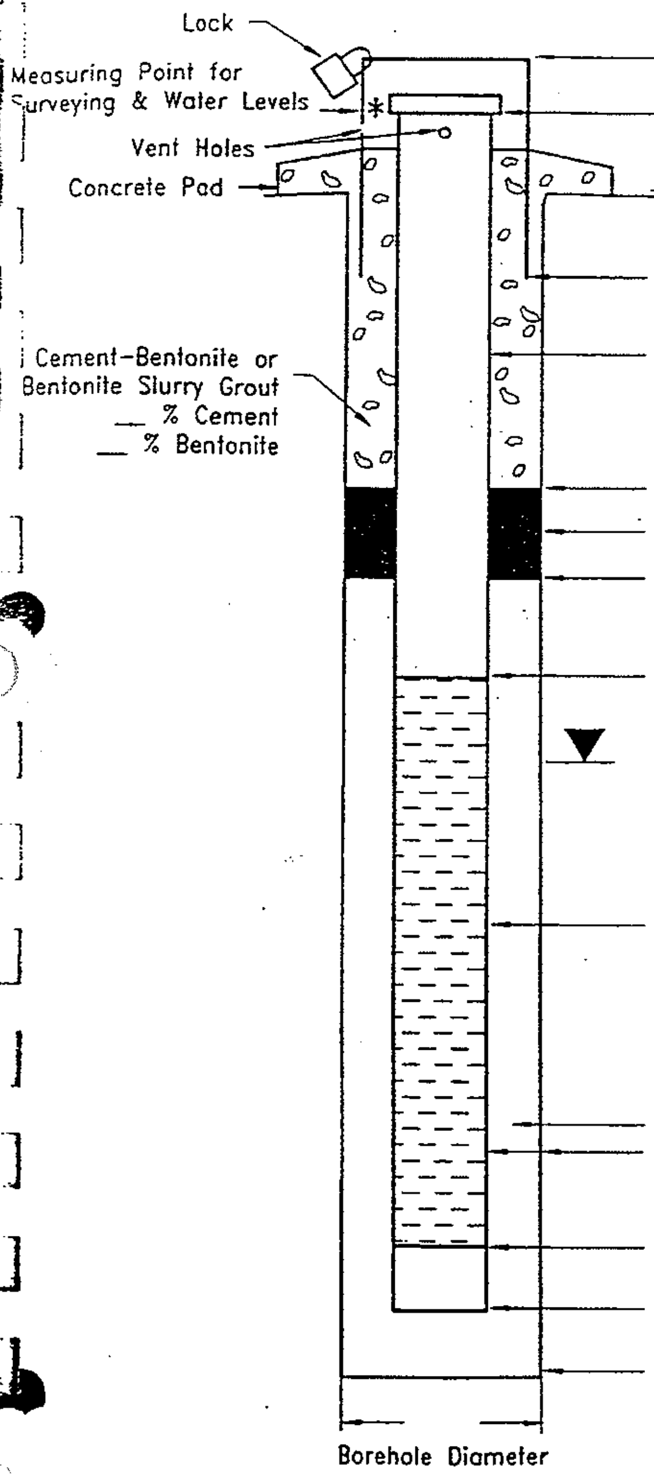
Date Installed: 2/12/92

ractor: EMPIRE Method: 6 1/4 HSA

Inspector: J. Ra/C.M

S-9

MONITORING WELL CONSTRUCTION DETAIL



		Depth from G.S. (feet)	Elevation (NGVD)
Top of Steel Guard Pipe		0	
Top of Riser Pipe		0	
Ground Surface (G.S.)		0.00	
Bottom of Steel Guard Pipe		6''	
Riser Pipe:			
Length	5'		
Inside Diameter (ID)	4''		
Type of Material ,	PVC		
Top of Bentonite Seal		3'	
Bentonite Seal Thickness	1'		
Top of Sand		4'	
Top of Screen		5'	
Stabilized Water Level			
Screen:			
Length	5'		
Inside Diameter (ID)	4''		
Slot Size	0.02		
Type of Material	PVC		
Type/Size of Sand	Silica /		
Sand Pack Thickness	1''		
Bottom of Screen		10'	
Bottom of Tail Pipe:			
Length	.5'		
Bottom of Borehole		12'	

JH
5/27/93

Approved:

* Describe Measuring Point:

Signature Date

ENSR.

ENSR

BORING LOG S40

Sheet 1 of 1

Project No. 6445-017 Date - Start 3/16/92 Finish 3/17/92 Boring B-23

Project Name SUN OIL Drilling Co. EMPIRE

Location GUARD BASIN (SWMU-3) Drilling Method MUD ROTARY

Total Depth 25.5' Inspector C. MARTIN/T. Rice Reviewer C. Martin

Remarks

Depth Feet	Sample				Graphic Log	Lithologic Description	Equipment Installed
	Type & No.	Blows per 6 in.	Depth Range	Rec.			
						8" sand bit to 12'	
						6' casing installed to 12'	
					25.5'		
						Total depth 25.5'	
						No Samples Collected Refer to B-29 log for Soil information	

M890278

Project No: 6445-617 Client: SUN OIL Site: Phil, PA.

WELL No: MW-23

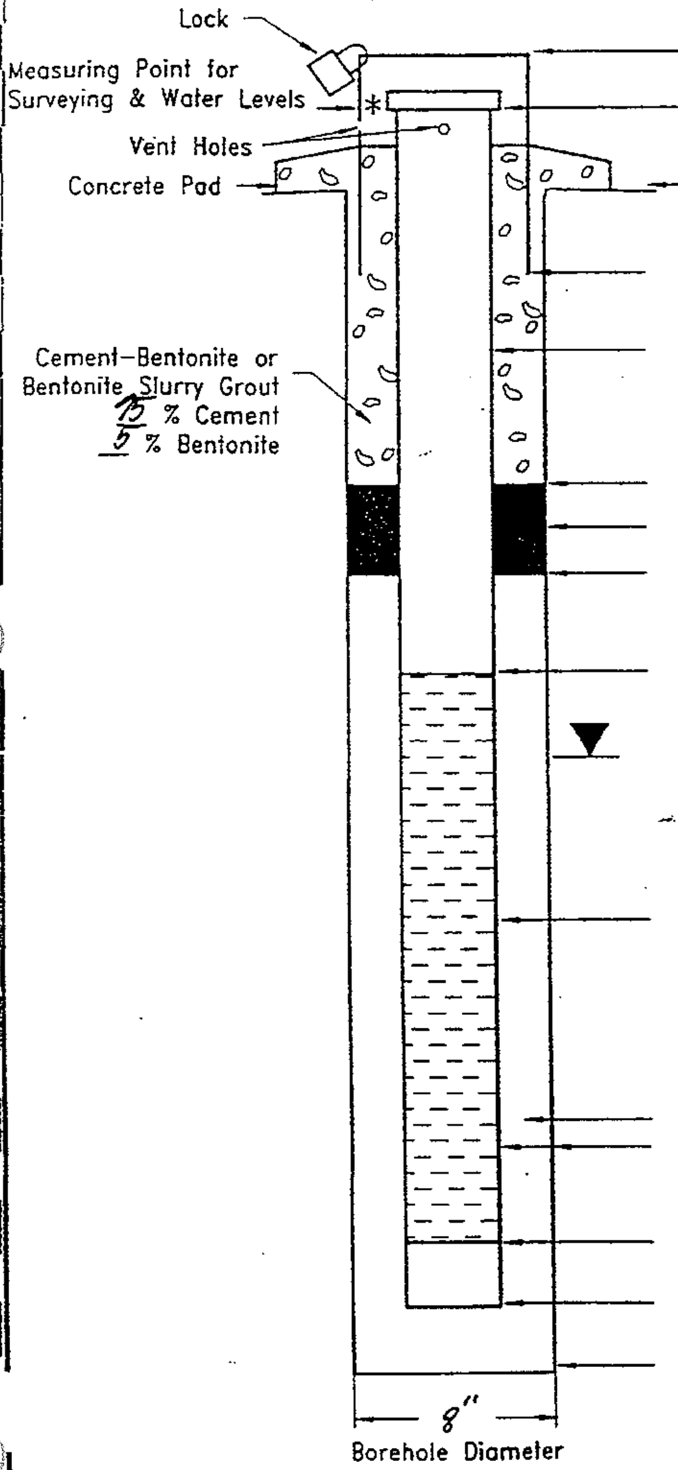
Well Location: Guard Basin (Sumo-3)

Date Installed: 3/17/92

tractor: Empire Method: Mud Rotary Inspector: T. Rice

S-10

MONITORING WELL CONSTRUCTION DETAIL



		Depth from G.S. (feet)	Elevation (NGVD)
Top of Steel Guard Pipe		Flush	
Top of Riser Pipe		3' ~~-0.3~~	
Ground Surface (G.S.)		0.00	
Bottom of Steel Guard Pipe		1.5'	
Riser Pipe:			
Length	11.5'		
Inside Diameter (ID)	2"		
Type of Material	PVC		
Top of Bentonite Seal	pellets + grout	11.5	
Bentonite Seal Thickness	3"		
Top of Sand		13.5'	
Top of Screen		15.5'	
Stabilized Water Level			
Screen:			
Length	10'		
Inside Diameter (ID)	2"		
Slot Size	~~.010~~ .020		
Type of Material	PVC		
Type/Size of Sand	#2		
Sand Pack Thickness	3"		
Bottom of Screen		25.25'	
Bottom of Tail Pipe:		25.50'	
Length	25'		
Bottom of Borehole		25.5'	

* Describe Measuring Point: Top of PVC

Approved:

C. Martin
Signature

4/1/92
Date

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S-11

ENSR

Sheet 1 of 1

Project No. 5445-017 Date - Start 3-13-92 Finish [illegible] Boring B-3

Project Name [illegible] Drilling Co. EMPIRE

Location SWMU-3 Drilling Method 6 ¼ HSA

Total Depth 12' Inspector J. Rice Reviewer Charles S Martin

Remarks

Depth Feet	Sample				Graphic Log	Lithologic Description	Equipment Installed	
	Type & No.	Blows per 6 In.	Depth Range	Rec.				
	S-1	13-14-14	0.5-2	8	FI	Black-Brown FILL (sand + gravel, some silt)	1	
	S-2	12-13-9-5	2-4	12		brown FILL (med to cs SAND, some gravel	1	3C3A
5	S-3	2-2-3-7	4-6	3		black med SAND + GRAVEL (FILL) (hydrocarbon odor)	50	
	S-4	9-4-3-2	6-8	20	WT ▽ FI/OL	12" brown CLAY-SILT 8" FILL (cinders) (hydrocarbon odor)	58	3C3B
	S-5	1-1-2-2	8-10	24	OL	gray-brown CLAY, some silt, fine organics and fine sand	11	
10	S-6		10-12	24		gray-brown CLAY and SILT, some fine sand	5	
						EOB 12'		
15								

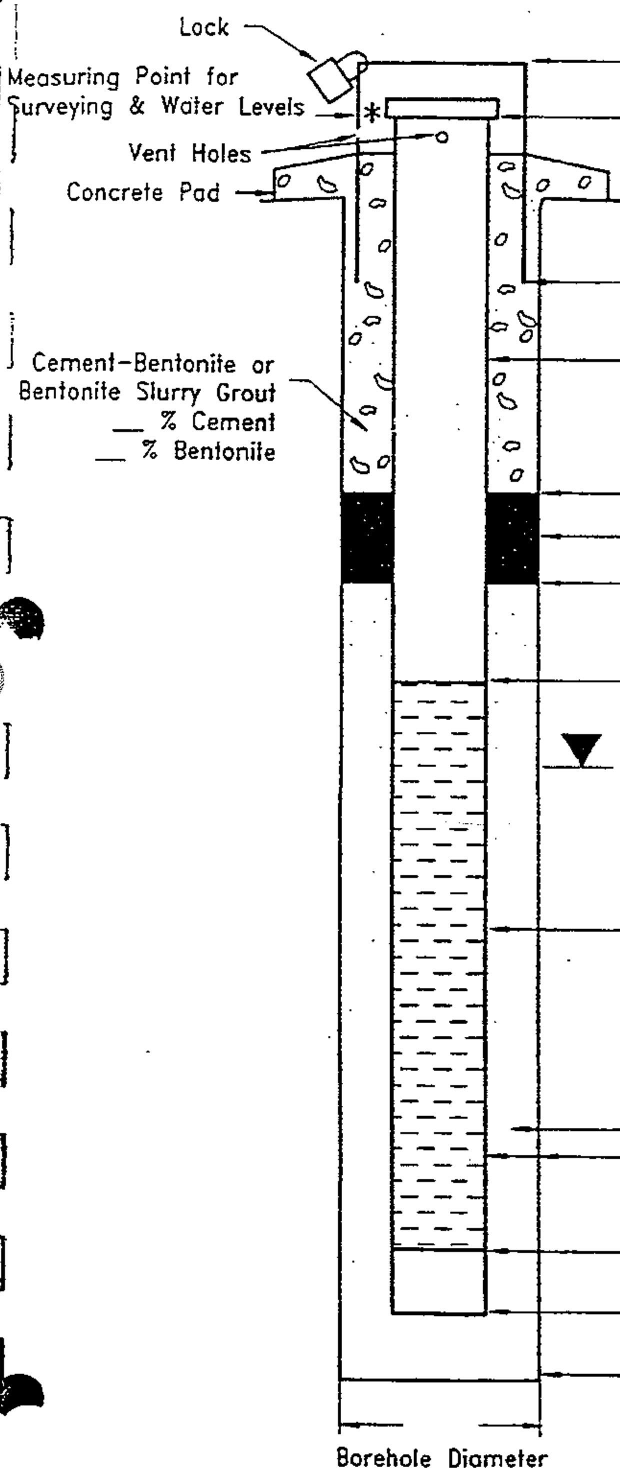
Project No: 6445-017 Client: Sun O.l Site: ~~Sun Oil~~ Philadelphia WELL No: MW-3

Well Location: Guard Basin Date Installed: 2/11/92

tractor: EMPIRE Method: 6 1/4 HSA Inspector: J. Ru

5-11

MONITORING WELL CONSTRUCTION DETAIL



		Depth from G.S. (feet)	Elevation (NGVD)
Top of Steel Guard Pipe		0	
Top of Riser Pipe		0	
Ground Surface (G.S.)		0.00	
Bottom of Steel Guard Pipe		6"	
Riser Pipe:			
Length	4'		
Inside Diameter (ID)	4"		
Type of Material	PVC		
Top of Bentonite Seal		2'	
Bentonite Seal Thickness	1'		
Top of Sand		3'	
Top of Screen		4'	
Stabilized Water Level			
Screen:			
Length	5'		
Inside Diameter (ID)	4"		
Slot Size	0.020		
Type of Material	PVC		
Type/Size of Sand	silica/#1		
Sand Pack Thickness	1"		
Bottom of Screen		9'	
Bottom of Tail Pipe:			
Length	.5'		
Bottom of Borehole	5/27/92	12'	

Approved:

* Describe Measuring Point:

Signature Date

ENSR

ENSR

Sheet 1 of 1

Project No. 6445-017 Date - Start 3/17/92 Finish 3/18/92 Boring B-24

Project Name Sun Oil Drilling Co. Empire S-12

Location ~~Phila~~ Guard Basin Drilling Method Mud Rotary

Total Depth 25' Inspector T. Rice Reviewer C. Martin

Remarks

Depth Feet	Sample				Graphic Log	Lithologic Description	Equipment Installed
	Type & No.	Blows per 6 In.	Depth Range	Rec.			
0							
5						Drilled to 10' Pushed 6" casing another 2' into clay. Left 2' of riser (6")	
10							
							12' of 6" casing
15							
20	S-1 S-2	—	18-21			loose medium grain Sand detect Petro. odor	324AA 324AB (dupe)
					25'	Total depth of Boring 25.0' ~~No samples collected~~ Refer to B-9 Log for Soil Information 1 Sample Collected at 18' – 21' + Duplicate	

U890278

Project No: 6445-017 Client: Sun oil Site: Phil, PA.

WELL No: B-24

Well Location: Guard Basin

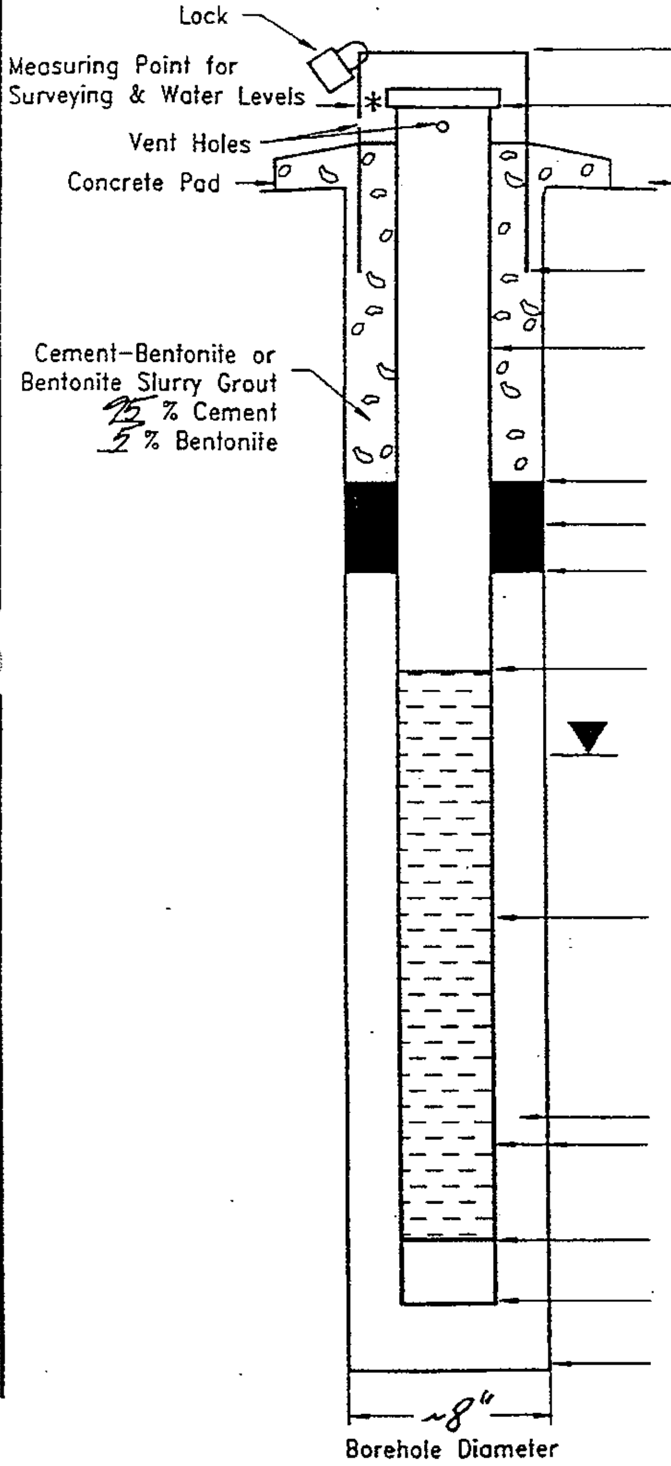
Date Installed: 3/18/92

tractor: Empire Method: Mud rotary

Inspector: T. Rice

S-12

MONITORING WELL CONSTRUCTION DETAIL



		Depth from G.S. (feet)	Elevation (NGVD)
Top of Steel Guard Pipe	1.72	Flush = 2' above grade	
Top of Riser Pipe	1.58	2¾" - Above grade	
Ground Surface (G.S.)		0.00	
Bottom of Steel Guard Pipe		10' below grade	
Riser Pipe:			
Length	11'		
Inside Diameter (ID)	2"		
Type of Material	PVC		
Top of Bentonite Seal		11'	
Bentonite Seal Thickness	2'		
Top of Sand		13'	
Top of Screen		15'	
Stabilized Water Level			
Screen:			
Length	10'		
Inside Diameter (ID)	2"		
Slot Size	~~.010~~ .020		
Type of Material	PVC		
Type/Size of Sand	#2		
Sand Pack Thickness	3"		
Bottom of Screen		24.75'	
Bottom of Tail Pipe:		25'	
Length	.25'		
Bottom of Borehole		26'	

* Describe Measuring Point: top of PVC

Approved:

C Martin
Signature

4/1/92
Date

ENSR.

ENSR 5-13

Sheet 1 of 2

Project No. 6445-017 Date - Start 2-20-92 Finish 2/26/92 Boring 3-9

Project Name Sun Oil - Philadelphia Drilling Co. Empire

Location Guard Basin (SWMU-3) Drilling Method Mud rotary

Total Depth 85.5' Inspector G. Anderson → 50 feet Reviewer Charles E. Martin

Remarks Water encountered at ~4 feet. Samples B & C were containerized as single sample for lab analyses (@ [illegible]

Mud rotary drilled an open hole to feet

Depth Feet	Sample				Graphic Log	Lithologic Description	Equipment Installed
	Type & No.	Blows per 6 In.	Depth Range	Rec.			
	A 2" SS	4 5 9 11	0 - 2	18"		Crushed stone to 1 foot Silty clay fill to 2 feet	
	B 2" SS	6 8 14 11	2-4	12"		Brown med-coarse sand to 4 feet, loose	Chemical Analyses (30+AR)
5	C 2" SS	4 6 7 5	4-6	12"	▽ FI	Cinder FILL; well graded sand with silt & gravel, saturated; medium dense	
10	D 2" SS	weight of rods	10-12	10"	ML	SILT with fine sand; trace clay; grey; saturated; loose (Driller notes rough drilling (cobbly).	Geotechnical
15	E 2" SS	50 50/5"	15-16	6"	SW	Silty SAND with gravel; cobbly; extremely dense; saturated.	Geotechnical
20	F 2" SS	25 27 50/5"	20-21½	0"		no recovery;	
						(Driller notes easier drilling from 23-24, possible sand seam)	
25	G 2" SS	3 14 20 50	25-27	5"	SP	Poorly graded med-cse. SAND with gravel, light brown, saturated, very dense Rough drilling to 30 feet	
30	H 2" SS	10 11 ~~22~~ 27	30-32	0"		no recovery Rods dropped to 25 feet so there is ~5 feet of slough at bottom of hole before drilling to 35 feet	
35	I 2" SS	14 30 ~~28~~ 30	35-37	8"	SP	Poorly graded med-cse. Sand and fine Gravel (sample may be slough; hard to distinguish)	

M890278

ENSR Project ~~[illegible]~~-217 **BORING LOG** (continued) S-13 Boring [illegible] Sheet 2 of 2

Depth Feet	Sample				Graphic Log	Lithologic Description	Equipment Installed
	Type & No.	Blows per 6 In.	Depth Range	Rec.			
						Dr[illegible] [illegible] due to gravel falling to bottom of hole (i.e. slough)	
40	J 2" SS	9 11 18 18	40-42	0"	SW/SP	no recovery	
						Cuttings coming up with mud is sand & gravel; no clay cuttings. Driller said cobbly zones seem to be interbedded with more sandy zones.	
45	K 2" SS	14 20 22 20	45-47	0"		no recovery	
						Driller indicates clay at 48-49 feet. Drilling mud is turning a reddish color	
50	L 3" SS	15 24 40 50/5	50-52	0"	CL	CLAY no recovery - spoon was filled with stones that had accumulated on bottom of hole because they weren't being carried up by mud.	
55	M 2" SS	12 22 39 55	55-57	6"	CL Sample 3098A	Clay, V. Stiff, med Plastic, Grey moist, Trace M. Gravel	chemical All
60	—	—	60-62	20"	CH	Clay, hard, Damp, Yellow.	Shelby Spoon
	N	50/8"	62-64	8"		Sand, Well Sorted, Fine Grain, moist Yellow, Dense	Geotechnical
65							
70	O	50/8"	70-72	8"	SW	Sand and Gravel, Fine to med, Some Clay, Yellow/Brown, Dense, Wet	
75	P	50/8"	75-77	8"	SW	As Above, No clay	
						clay	
80	Q	50/6"	80-82	6"	CH	Clay, hard, Brown, Yellow, Damp	
85							

M89024B

Project No: 6445-017 Client: Site:

WELL NO. MW-9

Well Location: Gaard Basin

Date Installed: 2/26/92

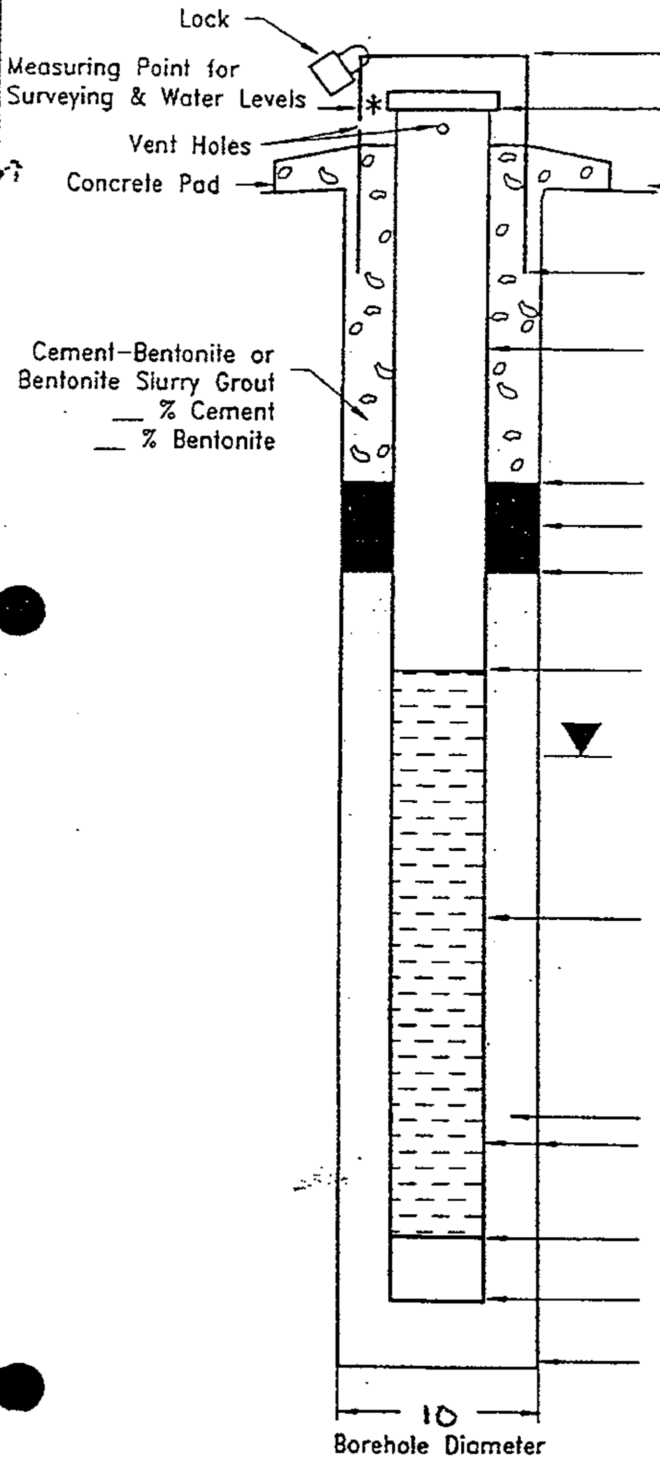
Contractor: Empire

Method: Mud Rotary

Inspector: BEM

5-13

MONITORING WELL CONSTRUCTION DETAIL



		Depth from G.S. (feet)	Elevation (NGVD)
Top of Steel Guard Pipe		1.54	
Top of Riser Pipe	JH 5/27/93	1.70	
Ground Surface (G.S.)		0.00	
Bottom of Steel ~~Guard~~ Casing Pipe		58.0	
Riser Pipe:			
Length	65′		
Inside Diameter (ID)	2″		
Type of Material	PVC		
Top of Bentonite Seal		58	
Bentonite Seal Thickness	3′		
Top of Sand		626	
Top of Screen		65.0	
Stabilized Water Level		65	
Screen:			
Length	10′		
Inside Diameter (ID)	2″		
Slot Size	.020		
Type of Material	PVC		
Type/Size of Sand	O Morie		
Sand Pack Thickness	4′		
Bottom of Screen		75.0	
Bottom of Tail Pipe:			Bentonite
Length	2″		
Bottom of Borehole		85.0	

Approved:

* Describe Measuring Point:

Black mark on PVC Riser

Signature

Date

ENSR.

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5-14

Sheet 1 of 1

Project No. 2445-017 Date - Start 2-18-92 Finish 2-18-92 Boring B-2

Project Name Sun Philadelphia Drilling Co. Empire

Location Guard Basin (SWMU-3) Drilling Method 6¼" HSA

Total Depth 12 feet Inspector R. Miller Reviewer Charles E Martin

Remarks

Depth Feet	Sample				Graphic Log	Lithologic Description	Equipment Installed
	Type & No.	Blows per 6 In.	Depth Range	Rec.			
5	1	2-3 2-5	5-7	10"	FI	Fill- SilT, Sand + F. Gravel Brown, Loose damp To moisT, odor	
10	2	1-1 31-50	10-12	12"	a 12'	SilT, Trace m. Gravel in TiP, SofT Brown, weT To moisT.	
						B.O.b. = 12	
15							
20							
25							
30							

M89C278

MW 8

Well Location: Guard Basin

Date Installed: 2/18/92

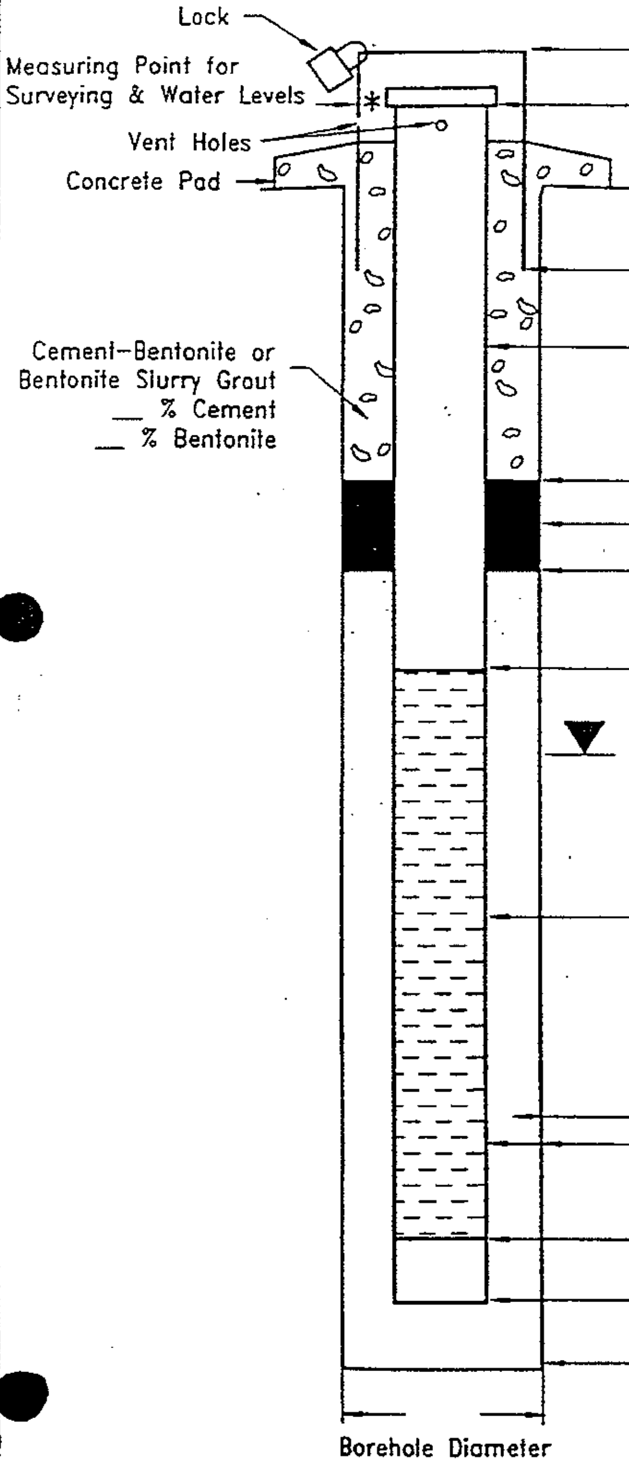
Contractor: Empire

Method: 6 1/4" HSA

Inspector:

S-14

MONITORING WELL CONSTRUCTION DETAIL



		Depth from G.S. (feet)	Elevation (NGVD)
Top of Steel Guard Pipe		1.69	
Top of Riser Pipe	JH 5/27/03	1.39	
Ground Surface (G.S.)		0.00	
Bottom of Steel Guard Pipe			
Riser Pipe:			
Length	9 ft		
Inside Diameter (ID)	4 in		
Type of Material	PVC		
Top of Bentonite Seal		4 ft	
Bentonite Seal Thickness	2 ft		
Top of Sand		6 ft	
Top of Screen		7 ft	
Stabilized Water Level			
Screen:			
Length	5 ft		
Inside Diameter (ID)	4 in		
Slot Size	0.020		
Type of Material	PVC		
Type/Size of Sand	#0 Morie		
Sand Pack Thickness			
Bottom of Screen		12	
Bottom of Tail Pipe:			
Length	0 ft		
Bottom of Borehole		12	

Approved:

* Describe Measuring Point:

Signature

Date

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S-15

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215-947-2555

Client ARCO REFINERY
Project WELLS AND TEST BORINGS
Location PHILADELPHIA, PA.
Project No. - -
Boring No. SM-52 Depth 10.0'
Elevation
Spoon Size 2" Casing Size
Core Size Bit No.
Hammers:
Spoon, weight 140 # Drop 30"
Drive, weight Drop
Date Started 7-31-85

Driller SB
Helper WGH
Inspector MC
Job No. 3115

Ground Water Data:
0 HRS: WATER AT 4.0'
TOTAL PIPE: 13.0'

Date Completed 7-31-85

Depth	Casing Blows	STRATA CLASSIFICATION	SAMPLING DATA Depth	No.	Blows per 6"	REMARKS
		TAN SOIL FILL 3.5'				
		ASH - CINDER FILL ± 7.0'	3.5- 5.5	S-1	1 - 4 10 - 13	SAMPLE HOLE OFFSET APPROXIMATELY 2.0-4.0' OF WELL ON 8-2-85.
		GREY ORANGE SILT 10.0'				
		COMPLETE AT 10.0'				

SHEET NO. .... OF ....

ENSR BORING LOG S16

Sheet 1 of 1

Project No. 6445-017 Date - Start 3/18/92 Finish 3/20/92 Boring B-25

Project Name Sun Oil Drilling Co. Empire

Location B-25 Near B-7 Drilling Method Mud Rotary

Total Depth 37' Inspector J. Rice Reviewer C. Martin

Remarks

Depth Feet	Sample				Graphic Log	Lithologic Description	Equipment Installed
	Type & No.	Blows per 6 in.	Depth Range	Rec.			
5							
						22'/6" Casing installed ~~to~~ 2' sticking above ground refer to data from MW-7 for Soil Information	
15							
	S-1	—	20-22	—		Gravel Fill Slight Petro. odor HNU reading (3)	
25							
	S-2	—	26-28			End of Fill Medium to Fine Sand appears saturated with product, strong Petro. odor Sample taken	325AA
35							
					37	EOB 37'	

M890278

Project No: 6445-017 Client: Sun Oil Site: Phil, PA

WELL No: B-25

Well Location: Gravel Berm above Guard Basin (Near B-11)

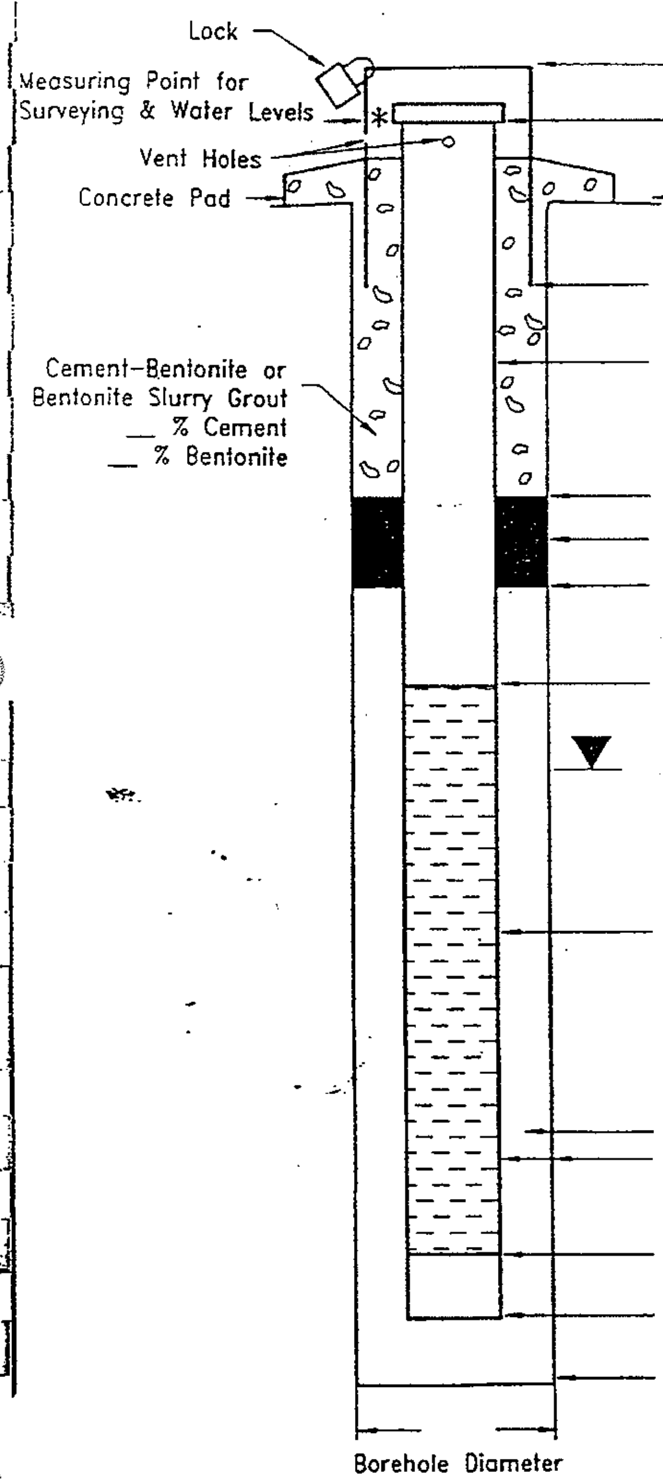
Date Installed: 3/20/92

'ractor: Empire Method: Mud Rotary

Inspector: T Rice

5-16

MONITORING WELL CONSTRUCTION DETAIL



		Depth from G.S. (feet)	Elevation (NGVD)
Top of Steel Guard Pipe	2.09	2' above grade	
Top of Riser Pipe	1.79	~1.7	
Ground Surface (G.S.)		0.00	
Bottom of Steel Guard Pipe		20'	
Riser Pipe:			
Length			
Inside Diameter (ID)	2"		
Type of Material	PVC		
Top of Bentonite Seal		20'	
Bentonite Seal Thickness	4'		
Top of Sand		24'	
Top of Screen		26'	
Stabilized Water Level			
Screen:			
Length	10'		
Inside Diameter (ID)	2"		
Slot Size	~~.010~~ .020		
Type of Material	PVC		
Type/Size of Sand	#2		
Sand Pack Thickness			
Bottom of Screen		35.75'	
Bottom of Tail Pipe:		36'	
Length	.25'		
Bottom of Borehole		37'	

Approved:

* Describe Measuring Point: top of PVC

C. Martin 4/1/92
Signature Date

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S-17

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Client ARCO
Project WELL INSTALLATION
Location PHILADELPHIA, PA
Project No. 9200
Boring No. SM-30 Depth 25.0'
Elevation
Spoon Size Casing Size
Core Size Bit No.
Hammers:
Spoon, weight Drop
Drive, weight Drop
Date Started 12-14-84

Driller SB
Helper WGH
Inspector MC
Job No. 2890

Ground Water Data:
1ST ENCOUNTERED - 18.0'
0 HRS.: WATER AT 18'7"

TOTAL PIPE - 28.0'

Date Completed 12-14-84

Depth	Casing Blows	STRATA CLASSIFICATION	Depth	SAMPLING DATA No.	Blows per 6"	REMARKS
		FILL 8.0'				SOIL HAS SLIGHT ODOR
		DARK GREY SILT AND CLAY MICA CRYSTALS 12.0'				
		SLIGHT PINK COLOR AND GREY FINE SAND AND GRAVEL. 18.0'				
		DARK GREY SAND, SILT AND GRAVEL. 25.0'	SATURATED ZONE			
		COMPLETE AT 25.0'				

SHEET NO. OF

ENSR 5-18

Sheet 1 of 1

Project No. 3445-017 Date - Start 2-17-92 Finish 2-17-92 Boring B-7

Project Name Sun Oil Drilling Co. Empire

Location Lined Basin (SWMU-3) Drilling Method 3¼ H.S.A

Total Depth 18 Feet Inspector G. Anderson B. Miller Reviewer Charles E Martin

Remarks 140# hammer, 2" spoon, Sample #3 submitted for [illegible] analysis (307AA) encountered water @ 4'

Depth Feet	Sample Type & No.	Blows per 6 In.	Depth Range	Rec.	Graphic Log	Lithologic Description	HNu ~~Equipment Installed~~ Headspace
	1	4, 10, 14, 37	0-2	12"	FI	← 6"-1½' Silty clay Fill: trace s&g, damp, med. soft brown with some black topsoil. Broken stone at bottom of spoon.	
	2	35, 29, 18, 12	2-4	2"		— Broken stone fragments in spoon	
5	3	11, 12, 5, 5	4-6	6"	Sample A	Sand & gravel, some silt (cobbly), saturated, brown, petro odor, sheen [illegible] — free product (dark brown).	
	4	5, 5, 4, 4	6-8	6"		as above	
	5	3, 4, 8, 12	8-10	8"	FI	← no free product, slight odor as above. Bottom 3" was a brown saturated silt	
10	6	5-6 3-2	10-12	10"		AS Above. FILL	
	7	7-2 12-25	12-14	10"	FI	SilT, Some clay, Trace F. Gravel, Soft Brown grading To Black, WET. odor	
15	8	10-10 9-8	14-16	10	Sample B 16-18	As Above. FILL	
	10	1-1 2-2	16-18	24"	18	SilT Above, grading moist To Damp. Increasing in clay%	307
20						EOB @ 18 ft	

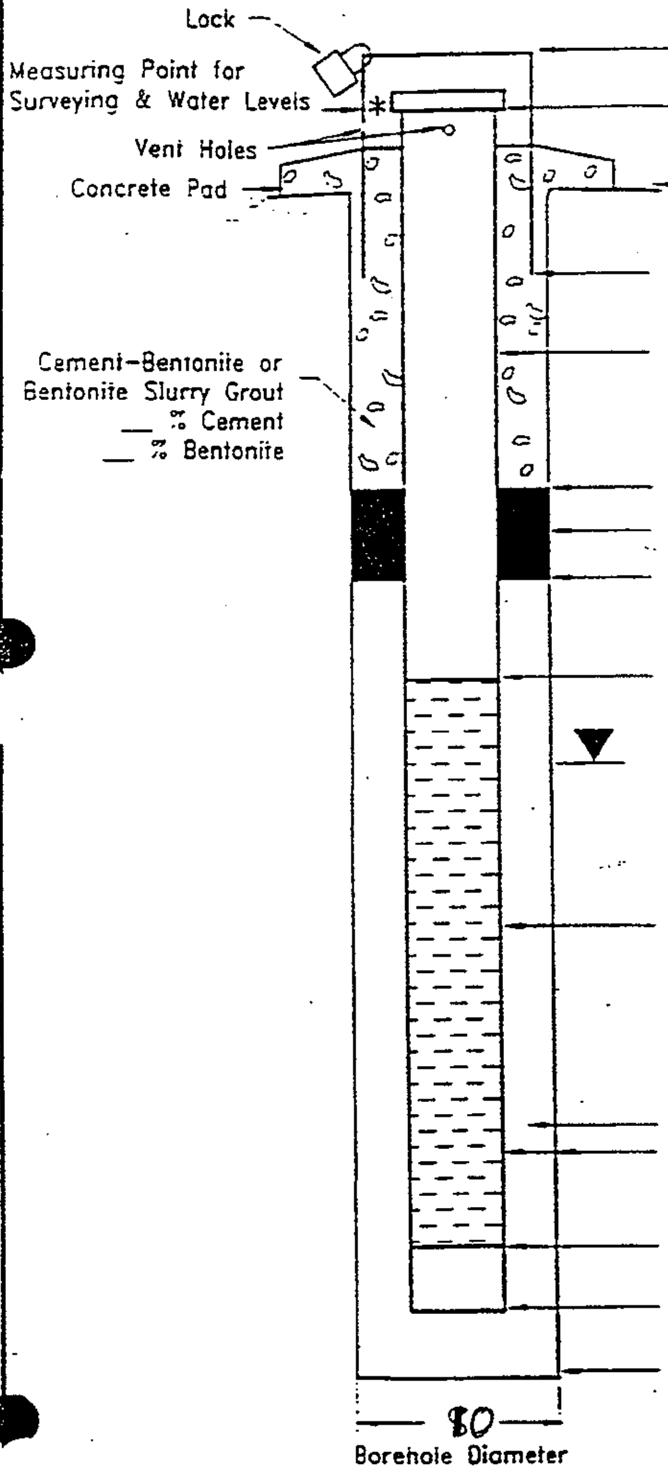
M890278

Well Location: MW-7 Date Installed: 2/18/92

Contractor: EmPire Method: Auger Inspector: Be-M

5-18

MONITORING WELL CONSTRUCTION DETAIL



Cement–Bentonite or Bentonite Slurry Grout
___ % Cement
___ % Bentonite

		Depth from G.S. (feet)	Elevation (NGVD)
Top of Steel Guard Pipe		1.88	
Top of Riser Pipe	JH 5/27/93	1.1-0	
Ground Surface (G.S.)		0.00	
Bottom of Steel Guard Pipe			
Riser Pipe:			
Length	7?		
Inside Diameter (ID)	4"		
Type of Material	PVC		
Top of Bentonite Seal		2'	
Bentonite Seal Thickness	2"		
Top of Sand		4'	
Top of Screen		65'	
Stabilized Water Level			
Screen:			
Length	10		
Inside Diameter (ID)	4"		
Slot Size	.020		
Type of Material	PVC		
Type/Size of Sand	0# Morie		
Sand Pack Thickness	3"		
Bottom of Screen		15'	
Bottom of Tail Pipe:		16'	
Length	.5'		
Bottom of Borehole	JH 5/27/93	18	BentoniTeTo 16', sand 18'

80
Borehole Diameter

Approved:

* Describe Measuring Point: ______

Signature ______ Date ______

ENSR.

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S-19

Sheet 1 of 1

Project No. 6445-017 Date - Start 2-13-92 Finish 2-14-92 Boring B-6

Project Name SUN OIL Drilling Co. EMPIRE

Location Philadelphia Pa Drilling Method 6¼ HSA

Total Depth 5' Inspector J. Rice Reviewer Charles E Martin

Remarks abandoned due to obstruction @ 5' (CM)

Boring moved to alternate location.

Depth Feet	Sample				Graphic Log	Lithologic Description	Equipment Installed
	Type & No.	Blows per 6 In.	Depth Range	Rec.			
					FI	Cuttings Dk Brown med SAND + GRAVEL FILL (Petro odor)	
5	S-1	100/6"	5-7		3" 5' 300 lb	Black Cinder FILL (Petro odor + sheen) Refusal @ 5'	
10						(Boring abandoned)	
15							
20							
25							

M890278

ENSR

BORING LOG

S-19

Sheet 1 of 1

Project No. 6445-017 Date - Start 2-17-92 Finish 2-17-92 Boring B-6A

Project Name Sun Oil Philadelphia Drilling Co. Empire

Location Land Farm (SWMU-3) Drilling Method 6¼" HSA

Total Depth 16 feet Inspector L. Anderson
S. Miller Reviewer Charles S. Martin

Remarks water @ 5" upon completion

Boring attempt # 2 CM

Depth Feet	Sample Type & No.	Sample Blows per 6 In.	Sample Depth Range	Sample Rec.	Graphic Log	Lithologic Description	Equipment Installed
					FI	Blank drill - no samples taken 0 to 10' HNu: 5ppm in augers 0ppm in BZ 4ppm @ 65 FILL	
5							
10							
	S-1	NR	10-12	15"	FI/OL	Black silt/clay-like material, m. stiff trace plant matter, strong petro odor; v. damp-saturated FILL	
15	S-2	NR	14-16	17"	FI/OL 16'	Black silt/clay-like material, m. stiff trace plant matter. cinders v. damp-sat ~~(strong petro odor)~~	
						EOB @ 16 feet	
20							

Project No: 5775-017 Client: [illegible] Site: [illegible]

WELL NO: MW-6

Well Location: Guard Basin

Date Installed: 2/17/92

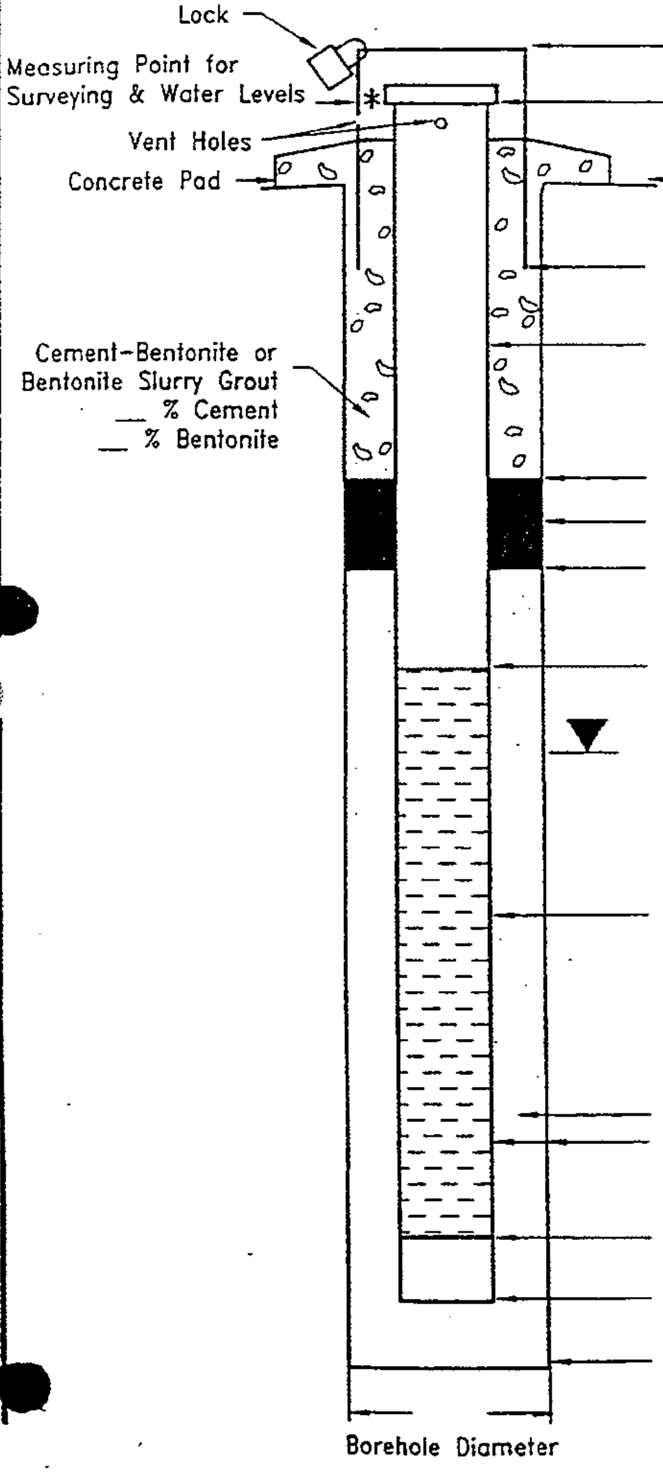
Contractor: Empire

Method: Auger

Inspector: BEM

5-19

MONITORING WELL CONSTRUCTION DETAIL



		Depth from G.S. (feet)	Elevation (NGVD)
Top of Steel Guard Pipe		1.73	
Top of Riser Pipe	JH 5/27/93	1.26	
Ground Surface (G.S.)		0.00	
Bottom of Steel Guard Pipe			
Riser Pipe:			
Length	2		
Inside Diameter (ID)	4"		
Type of Material	PVC		
Top of Bentonite Seal		1	
Bentonite Seal Thickness	2		
Top of Sand		3	
Top of Screen		4'	
Stabilized Water Level			
Screen:			
Length	10 ft		
Inside Diameter (ID)	4"		
Slot Size	.020		
Type of Material	PVC		
Type/Size of Sand			
Sand Pack Thickness			
Bottom of Screen			
Bottom of Tail Pipe:		14'	
Length	.5'		
Bottom of Borehole	JH 5/27/93	16	

Approved:

Signature

Date

Describe Measuring Point:

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5-20

Sheet 1 of 1

Project No. 6445-017 Date - Start 3/20/92 Finish 3/23/92 Boring B-26

Project Name Sun Oil Drilling Co. Empire

Location SWMU-3 (Guard Basin) Drilling Method Mud Rotary

Total Depth ______ Inspector T. Rice / C. Martin Reviewer C. Martin

Remarks 11.5' N of B-11 (MW-11)

Depth Feet	Sample				Graphic Log	Lithologic Description	Equipment Installed
	Type & No.	Blows per 6 in.	Depth Range	Rec.			
0							
5						Mud rotary drill w/ 6" bit	
10						No samples taken. Refer to B-11 for log info -	
15						6" casing installed to 19.5'	
20							
25						(well set 25-35')	
30							
35							
					36	EOB.	

M890278

Project No: 6445-017 Client: Sun Oil Site: Phil, PA.

WELL No: W-26

Well Location: SWMU-3 (Guard Basin)

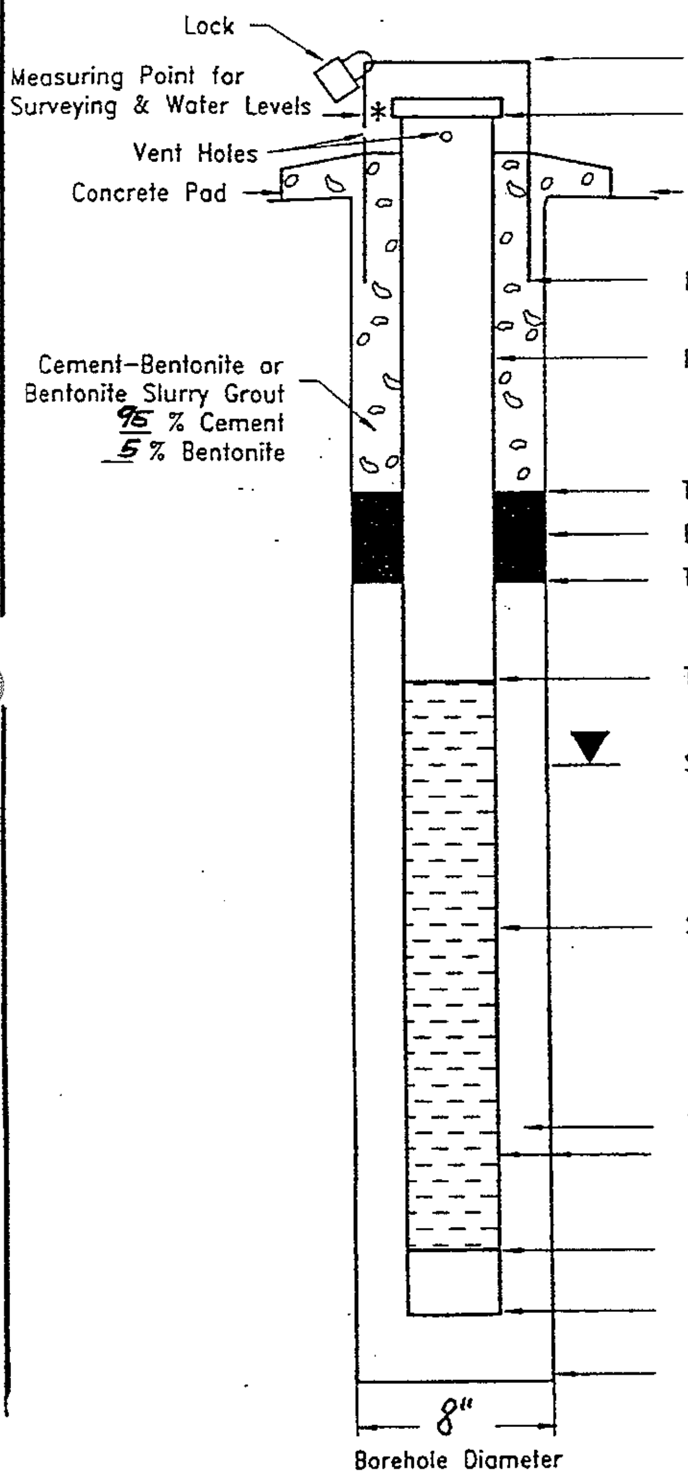
Date Installed: 3/23/92

tractor: Empire Method: Mud Rotary

Inspector: T. Rice

5-20

MONITORING WELL CONSTRUCTION DETAIL



		Depth from G.S. (feet)	Elevation (NGVD)
Top of Steel Guard Pipe	2.65 ~~3'6"~~ 2'8"	~~2.5' above grade~~	
Top of Riser Pipe	2.50 ~~2'2"~~	~~2.5' above~~	
Ground Surface (G.S.)		0.00	
Bottom of Steel Guard Pipe		19.5'	
Riser Pipe:			
Length	27'		
Inside Diameter (ID)	2"		
Type of Material	PVC		
Top of Bentonite Seal		21	
Bentonite Seal Thickness	3"		
Top of Sand		23	
Top of Screen		25	
Stabilized Water Level			
Screen:			
Length	10'		
Inside Diameter (ID)	2"		
Slot Size	~~.045~~ .020		
Type of Material	PVC		
Type/Size of Sand	#2		
Sand Pack Thickness	3"		
Bottom of Screen		34.75	
Bottom of Tail Pipe:		35	
Length	.25'		
Bottom of Borehole		36	

Approved:

* Describe Measuring Point:
top of PVC

C. Martin
Signature

4/1/92
Date

ENSR

S-21

C.V.M. industries

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Client ARCO
Project WELL INSTALLATION
Location SOUTH YARD, PHILADELPHIA, PA.
Project No.
Boring No. SM-43 Depth 13.0'
Elevation
Spoon Size Casing Size
Core Size Bit No.
Hammers:
Spoon, weight Drop
Drive, weight Drop
Date Started 3-18-85

Driller SB
Helper WGH
Inspector MC
Job No. 2890

Ground Water Data:
1ST. ENCOUNTERED: 5.0'
TOTAL PIPE - 16.0'

Date Completed 3-18-85

Depth	Casing Blows	STRATA CLASSIFICATION	SAMPLING DATA Depth	SAMPLING DATA No.	Blows per 6"	REMARKS
		MISCELLANEOUS FILL. 5.0'				FREE FLOWING FLUID AT 5.0' FILLING HOLE.
		GRANULAR TYPE SOIL 13.0'	HIGHLY SATURATED WITH PRODUCT.			MAY BE AN ABANDONED PIPE OR DRAIN THAT WAS DRILLED INTO
		COMPLETE AT 13-0'				

SHEET NO. .... OF ....

ENSR

S-22

Sheet 1 of 2

Project No. 6445-017 Date - Start 3-4-92 Finish 3-9-92 Boring B-11

Project Name SUN OIL Drilling Co. EMPIRE

Location GUARD BASIN (SWMU-3) Drilling Method Mud Rotary

Total Depth 88' Inspector BEM Reviewer Charles E. Martin

Remarks

Depth Feet	Sample				Graphic Log	Lithologic Description	Equipment Installed
	Type & No.	Blows per 6 In.	Depth Range	Rec.			
0					FI	Drilling through Fill Material	
5	1	2-3 6-7	5-7	20"	—	SiLT, SOFT, Brown, moisT PeTro. odor	
10	2	25-18 18-23	10-12	15"	311AA SW	Sand, Fine, well sorTed, Brown Loose, moisT, PeTro Odor	Chemical
15	3	21-27 31-28	15-17	9"	GP	Gravel, med. To Crse. Some Sand F. Dense, Brown, moisT	
					SW	Sand As Above, odor; Natural?	
20	4	8-19 19-20	20-22	10"	Geo.	Sand, As Above, Odor med. Dense	GeoTech.
25	5	24-34 31-18	25-27	12"	311BA	Sand. Fine. well sorTed, Loose, Grey, weT. No odor	Chemical
30	6	19-42 50/3"	30-32	0"	—	No Recovery Cobble in Tip	
35	7	34-24 80-26	35-37	10"	SP	Sand. Fine To Med. Loose. White/Grey Trace F. Gravel. WeT	
40							

M890278

S-22

ENSR Project 6445-017 Boring B-11 Sheet 2 of 2

Depth Feet	Sample				Graphic Log	Lithologic Description	Equipment Installed
	Type & No.	Blows per 6 In.	Depth Range	Rec.			
	8	50—30 40	40-42	10"	—	Sand, Fine, Loose, White/Grey Well Sorted, wet	
					SP		
45	9	41—24 27—39	45-47	12"	—	Sand, med To Crse, Loose Grey, well Sorted wet, Petro. Odor,	
50	10	19-30 31/5"	50-52	1"	CL	Clay, V. Stiff, Yellow To Red, mottled med-Plastic, moist,	
55						Drilled Through To 56.0'	55.0' Bottom of Casing
					CL		
	—	—	57-59	18"	Shelby Tube	Clay, ~~hard,~~ Red+White, med-Plastic Damp-Dry at Tip	Shelby Tube
60	11	50- 50/4"	60-62	20"	311CA	Clay, V. Hard, Red+White mottled Brittle, Dry.	Chemical MS+MSD
					CL		
65	12	50 50/2"	65-67	4"	—	Sand, V. Fine to Powder, White Dense, Damp.	
					SP	very hard	
70	13	50/4"	70-72	4"	—	Sand, Fine, med dense, moist, brown layers, weathered rock?	
75	14	50/6"	75-77	6"	311DA	Sand, med-corse, med dense, wet Brown, Petro. odor	Chemical VOC's
					SP		
80	15	50/8"	80-82	8"	311DA	Sand, Med-Corse, Clay Binder hard, White, damp, Mica+Quartz	Chemical SVOC's
85	18	50/6"	85-82	6"	—	Sand, Med Corse, Trace Clay, Red, hard ~~wet, slight odor~~	
						B.O.H. (Stopped - Very hard drilling)	

Project No: ____ Client: [illegible] Site: [illegible]

WELL NO: MW-11

Well Location: Gaurd Basin

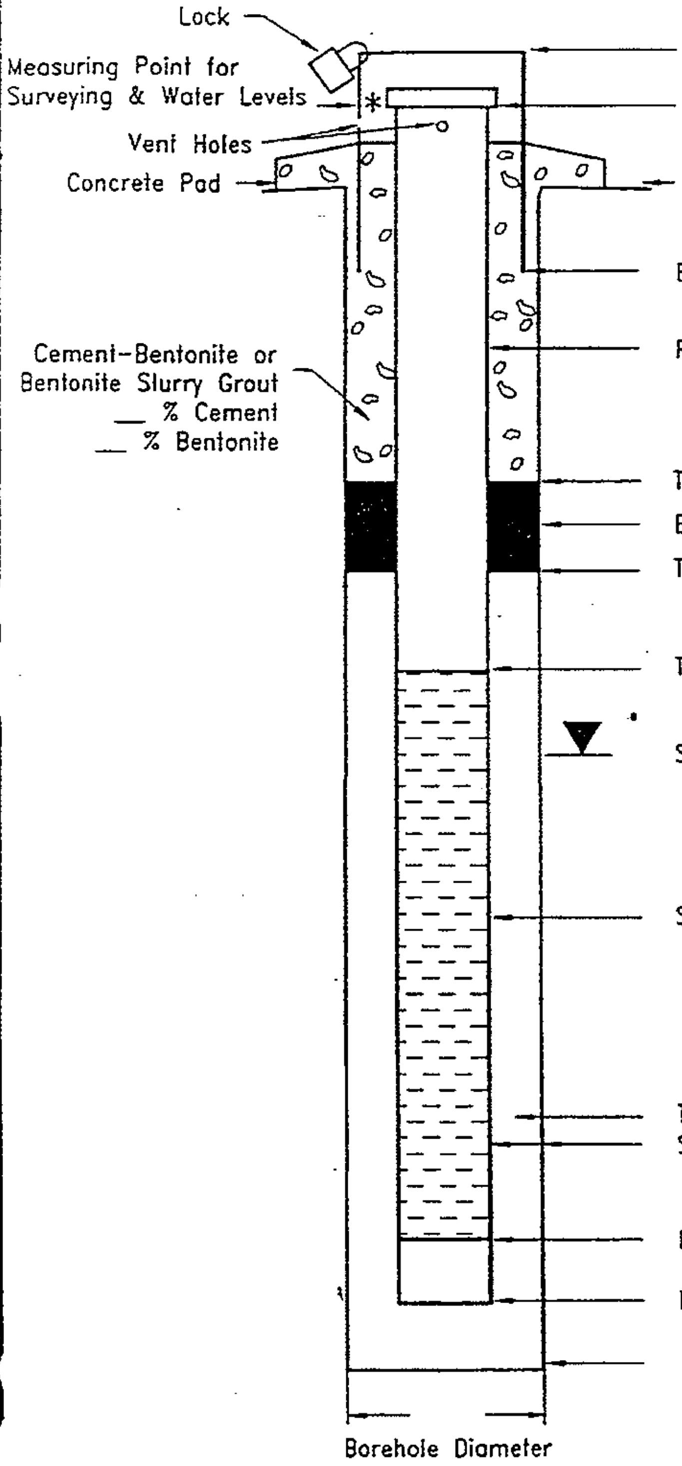
Date Installed: 3/19/92

Contractor: ____ Method: ____

Inspector: BEM

5-22

MONITORING WELL CONSTRUCTION DETAIL



		Depth from G.S. (feet)	Elevation (NGVD)
Top of Steel Guard Pipe		1.55	
Top of Riser Pipe	JH 5/27/93	1.35	
Ground Surface (G.S.)		0.00	
Bottom of Steel Guard Pipe			
Top of Bentonite Seal		59.0'	
Top of Sand		64.0'	
Top of Screen		70.0	
Stabilized Water Level		[illegible]	
Bottom of Screen		80.0	
Bottom of Tail Pipe:		80.5'	
Bottom of Borehole	JH 5/27/93	98.0'	

Riser Pipe:
Length 72'
Inside Diameter (ID) 2"
Type of Material PVC

Bentonite Seal Thickness 5'

Screen:
Length 10.0'
Inside Diameter (ID) 2"
Slot Size .020
Type of Material ~~[illegible]~~ PVC

Type/Size of Sand .0 Morie
Sand Pack Thickness 3"

Bottom of Tail Pipe: Length .5'

Approved:

* Describe Measuring Point: ____

Signature ____ Date ____

ENSR

ENSR

5-23

Sheet 1 of 1

Project No. 6445-017 Date - Start 2-13-92 Finish 2-13-92 Boring B-5

Project Name SUN OIL Drilling Co. EMPIRE

Location SWMU-3 Drilling Method 6 1/4 HSA

Total Depth 26' Inspector J. Rice Reviewer Charles S Martin

Remarks

Depth Feet	Sample				Graphic Log	Lithologic Description	HNu ~~Equipment Installed~~	
	Type & No.	Blows per 6 In.	Depth Range	Rec.				
	S-1	14-10-8-8	0-2'	12	FI	dk. brown FILL (fine sand - silt, some gravel)	5.2	
	S-2	9-11-9-7	2-4	13	2 FI	black FILL (silt + clay like material, fine fines?) (Petro odor)	72	
5	S-3	8-7-6-5	4-6	12			100	
	S-4	5-6-5-5	6 8	18		2" brown med sand + gravel seam	92	
	S-5	8-4-5-5	8-10	12			80	
10								
	S-6	4-7-11-10	10-12	12	10.5 FI/SM	lt. brown fine SAND + SILT (FILL)	8.2	
	S-7	3-3-7-10	12-14	12	14		9.4	
15	S-8	17-12-8-8	14-16	12			4.8	
	S-9	13-16-14-20	16-18	12	FI	lt. brown medium to cs. SAND + GRAVEL, some silt (fill) (Petro ODOR)	5.0	
	S-10	17-17-20-15	18-20	8	▽		9.5	305AA
20	S-11	13-10-13-10	20-22	24			—	305AB (dupe.)
	S-12	7-6-5-7	22-24	12	22 SW	gray fine to cs. SAND (Petro ODOR)	3.0	
25	S-13	13-17-18-26	24-26	18	26'		1.8	
						EOB 26'		
30								

M890278

S-25

C.V.M. industries

geotechnical division inc.
post office box 2 • huntingdon valley, pennsylvania
215-947-2555

Client ARCO
Project WELL INSTALLATION
Location SOUTH YARD, PHILADELPHIA, PA.
Project No.
Boring No. SM-44 Depth 18.0'
Elevation
Spoon Size Casing Size
Core Size Bit No.
Hammers:
Spoon, weight Drop
Drive, weight Drop
Date Started 3-18-85

Driller SB
Helper WGH
Inspector MC
Job No. 2890

Ground Water Data:
1ST. DRILLED - APPROX 14.0' (MOIST)
AFTER DRILLING - WATER 16'10"
TOTAL PIPE - 20.0'

Date Completed 3-18-85

Depth	Casing Blows	STRATA CLASSIFICATION	Depth	SAMPLING DATA No.	Blows per 6"	REMARKS
		STONE FILL 1"				
		BROWN SILTY SAND TO SILTY CLAY. 5.0'				
		BROWN FINE SAND AND GRAVEL. 18.0'				DAMP AT 14.0'
		COMPLETE AT 18.0'				

SHEET NO. .... OF ....

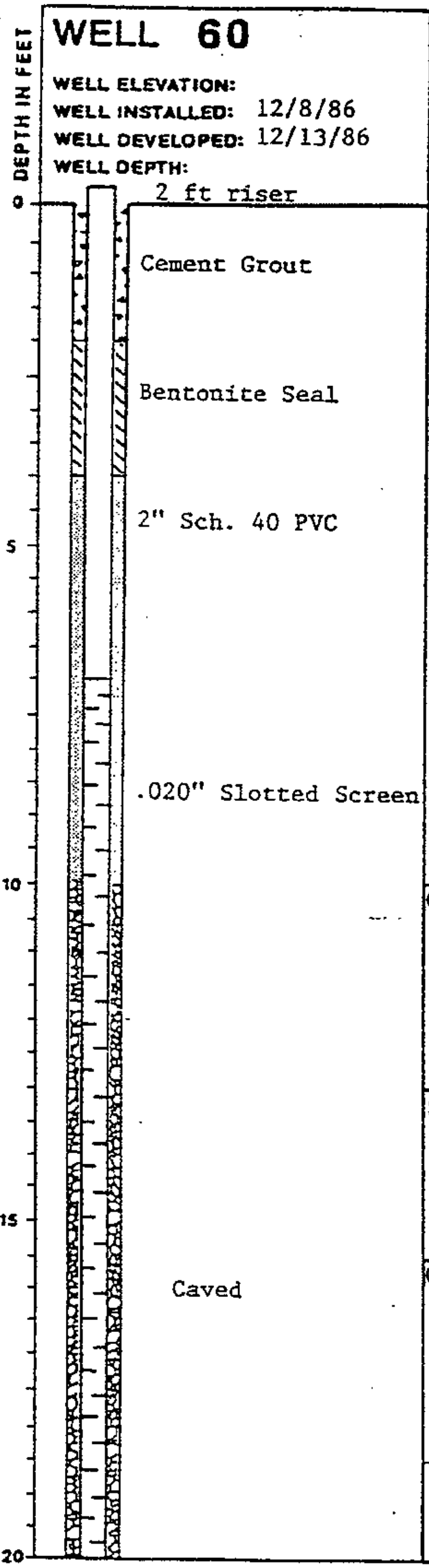
S-59

WELL 60

WELL ELEVATION:
WELL INSTALLED: 12/8/86
WELL DEVELOPED: 12/13/86
WELL DEPTH:

BORING 60

SURFACE ELEVATION:
DRILLING METHOD: H.S.A.
BORING DEPTH:



USCS				BLOWS	% RETAINED	SAMPLE NO.	SAMPLE DEPTH	SAMPLE TYPE
ML	SILT: with trace of sand - some H.C. odors; dark brown							
GM	GRAVELLY FILL: 1/4 to 1" gravel and fine to coarse sand with some silt; dark brown			14 11 12 -	70	1		
	Same, saturated with H.C.			79 19 14	30	2		
SM	SAND: medium to coarse sand with some silt, gravel - high H.C. content; gray			5 11 11	30	3		
GM	GRAVELLY FILL: 1/4" to 1" gravel with medium to coarse sand - H.C. & water; varied			7 13 21 44	75	4		
				15 49 35 34	30	5		
SP	SAND: fine to medium sand - wet, gray			7				

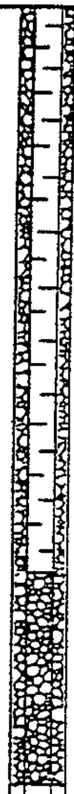
Drilled by CVM Inc.
Logged by J. Lundberg
Client ARCO
Job No. 502-158-02
Page 1 of 2

EEI ENGINEERING ENTERPRISES, INC.

5-59

WELL 60 Cont.

BORING 60 Cont.



DEPTH IN FEET	SOIL TYPE USCS	BORING 60 Cont.	BLOWS	% RETAINED	SAMPLE NO.	SAMPLE DEPTH	SAMPLE TYPE
20	SP	Fine gravel with medium to coarse sand	9 7 6	90	6		
					N/S		
	SW	SAND: very coarse sand with little finer grains and a trace of gravel; gray	11 15 14 15	20	7		
25	SW	SAND: same as above with more fine to medium grain size; brown	10 11 10 12	50	8		
					N/S		
30	SW	SAND: fine to very coarse sand with little silt, trace gravel; brown	13 10 10 13	60	9		
		T.D. = 31 ft.					
35							
40							

EEI ENGINEERING ENTERPRISES, INC.

3-60

C.V.M. industries

geotechnical division inc.
post office box 2 • huntingdon valley, pennsylvania
215-947-2555

Client ARCO
Project WELL INSTALLATION
Location PHILADELPHIA, PA
Project No.
Boring No. SM-18 Depth 17.0'
Elevation
Spoon Size Casing Size
Core Size Bit No.
Hammers:
Spoon, weight Drop
Drive, weight Drop
Date Started 12-17-84

Driller SB
Helper WGH
Inspector MC
Job No. 2890

Ground Water Data:
0 HRS: WATER AT 12.8'
TOTAL PIPE - 20.0'

Date Completed 12-17-84

Depth	Casing Blows	STRATA CLASSIFICATION	SAMPLING DATA			REMARKS
			Depth	No.	Blows per 6"	
		ASH - CINDER FILL. 3.0'				3' STICK-UP
		LIGHT ORANGE FINE SAND TRACE CLAY. 5.5'				
		MULTI-COLORED FINE TO COARSE SAND, AND GRAVEL 17.0'				NOTE: DRILLED TO 25.0' FOUND WATER AT 22.0' WATER ADJUSTED TO 12.8'. PUT WELL IN ACCORDING TO WATER LEVEL
		COMPLETE AT 17.0'				

SHEET NO. .... OF ....

5-66

C.V.M. industries

geotechnical division inc.
post office box 2 • huntingdon valley, pennsylvania
215-947-2555

Client ARCO
Project WELL INSTALLATION
Location PHILADELPHIA, PA
Project No. 9200
Boring No. SM-17 Depth 30.0'
Elevation
Spoon Size Casing Size
Core Size Bit No.
Hammers:
Spoon, weight Drop
Drive, weight Drop
Date Started 12-14-84

Driller SB
Helper WGH
Inspector MC
Job No. 2890

Ground Water Data:
1ST ENCOUNTERED - 26.0'
0 HRS: WATER AT 26'4"

TOTAL PIPE: 33.0'

Date Completed 12-14-84

Depth	Casing Blows	STRATA CLASSIFICATION	Depth	SAMPLING DATA No.	Blows per 6"	REMARKS
		MISCELLANEOUS FILL. 8.0'				3' STICK-UP
		TAN SILT AND FINE SAND SOME CLAY. 13.0'				
		TAN TO MULTI-COLORED FINE TO COARSE SAND AND GRAVEL. 26.0'				
		TAN FINE TO COARSE SAND, GRAVEL AND SOME SILT 30.0'				
		COMPLETE AT 30.0'				

SHEET NO. .... OF ....

S-68

C.V.M. industries

geotechnical division inc.
post office box 2 • huntingdon valley, pennsylvania
215-947-2555

Client ARCO
Project WELL INSTALLATION
Location PHILADELPHIA, PA.
Project No. 9200
Boring No. SM-23 Depth 15.0'
Elevation
Spoon Size Casing Size
Core Size Bit No.
Hammers:
Spoon, weight Drop
Drive, weight Drop
Date Started 12-20-84

Driller SB
Helper WGH
Inspector MC
Job No. 2890

Ground Water Data:
0 HRS - WATER AT 11.5'
TOTAL PIPE - 18.0'

Date Completed 12-20-84

Depth	Casing Blows	STRATA CLASSIFICATION	SAMPLING DATA Depth	SAMPLING DATA No.	SAMPLING DATA Blows per 6"	REMARKS
		QUICKTOP				
		MISCELLANEOUS FILL 1.0'				
		TAN SANDY SILT 10.0'				3' STICK-UP
		TAN SANDY SILT AND TRACE GRAVEL. 15.0'				
		COMPLETE AT 15.0'				

SHEET NO. .... OF ....

S-69

C.V.M. industries **geotechnical division inc.**
post office box 2 • huntingdon valley, pennsylvania
215-947-2555

Client ARCO
Project WELL INSTALLATION
Location PHILADELPHIA, PA.
Project No. 9200
Boring No. SM-26 Depth 15.9'
Elevation
Spoon Size Casing Size
Core Size Bit No.
Hammers:
Spoon, weight Drop
Drive, weight Drop
Date Started 12-20-84

Driller SB
Helper WGH
Inspector MC
Job No. 2890

Ground Water Data:
0 HRS: WATER AT 13.3'
TOTAL PIPE - 19.4'

Date Completed 12-20-84

Depth	Casing Blows	STRATA CLASSIFICATION	SAMPLING DATA Depth	SAMPLING DATA No.	SAMPLING DATA Blows per 6"	REMARKS
		BLACKTOP				
		MISCELLANEOUS FILL. 4.0'				4.0' STICK-UP
		TAN ORANGE SILTY CLAY. TRACE TO SOME VERY FINE SAND. 14.0'				
		MULTI-COLORED FINE TO COARSE SAND AND GRAVEL. 15.9'				
		COMPLETE AT 15.9'				

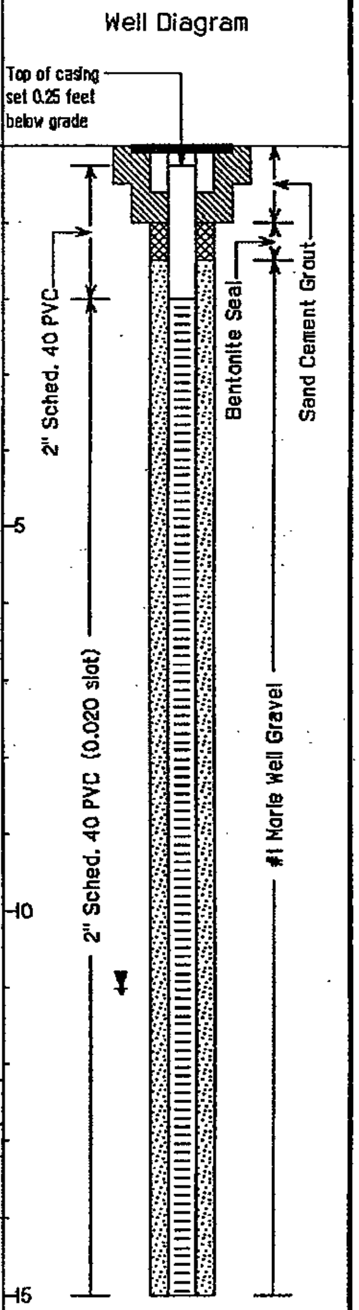
SHEET NO. .... OF ....

Handex®
Handex Of Maryland

WELL LOG: S-112

Permit #: *N/A*
Drill Date: *July 24, 1996*
Use: *Monitoring*
Location: *3144 Passyunk Avenue, Philadelphia, PA*
Owner Loc #: *Philadelphia Refinery*
Owner: *Sun Company, Inc.*
Handex Loc #: *110535*
Owner Address: *Philadephia, PA*
BORING - Depth: *40 ft.* Diameter: *7 in.*
Drilling Method: *Hollow-Stem Auger*
CASING - Length: *1.75 ft.* Diameter: *2 in.*
Sampling Method: *Split Spoon*
SCREEN - Length: *35.0 ft.* Diameter: *2 in.*
Static Water Level: *10.78 ft.* *(July 24, 1996)*
WELL - Depth: *37.0 ft.*

Depth (ft.)	Sample ID	Sample Depth	Blows/6 in.		Graphic Log	Geologic Description
5						Light brown Silty CLAY, dry to moist, low plasticity
						Tan Silty CLAY, moist, low plasticity
10						Gray to orange Silty CLAY, moist, lp
						Brown to orange Silty CLAY, trace fine Sand, moist, mp
	112-1		4-3-4-5			Brown Silty CLAY, little fine Sand, moist, mp
						Brown f,m (+),c SAND, trace fine Gravel, moist
						Reddish brown SILT, little fine Sand, moist
	112-2		5-9-9-5			Orange brown fine, medium (+) to coarse SAND, trace fine Gravel, moist
						Brown Silty CLAY, little fine Sand
15						NO SAMPLE (spoon refusal)



Geologist: Arsin Sahba
Driller: Dan Fincham - NFE

Handex®
Handex Of Maryland

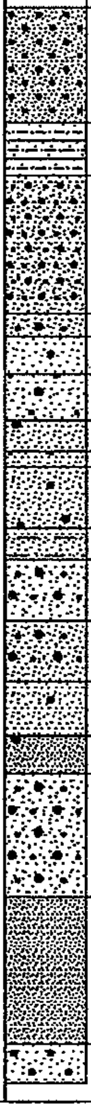
WELL LOG: S-112

Permit #: *N/A*	Drill Date: *July 24, 1998*	Use: *Monitoring*

Location: *3144 Passyunk Avenue, Philadelphia, PA*
Owner Loc #: *Philadelphia Refinery*
Owner: *Sun Company, Inc.*
Handex Loc #: *110535*
Owner Address: *Philadephia, PA*
BORING - Depth: *40 ft.* Diameter: *7 in.*
Drilling Method: *Hollow-Stem Auger*
CASING - Length: *1.75 ft.* Diameter: *2 in.*
Sampling Method: *Split Spoon*
SCREEN - Length: *35.0 ft.* Diameter: *2 in.*
Static Water Level: *10.78 ft.* *(July 24, 1998)*
WELL - Depth: *37.0 ft.*

Depth (ft.)	Sample ID	Blows/6 in.
	112-3	2-50/1
	112-4	7-5-5-7
20	112-5	7-13-17-10
	112-6	2-2-3-7
	112-7	7-12-15-10
25		
	112-8	8-8-7-7
	112-9	7-7-5-5
30	112-10	3-3-5-10

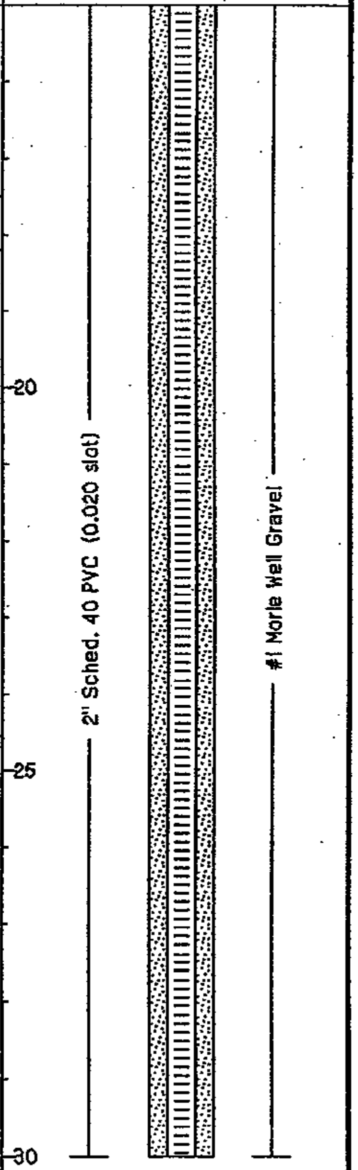
Graphic Log



Geologic Description

- Gray fine to medium GRAVEL and medium to coarse (+) SAND, trace Clay (matrix)
- Gray Clayey SILT, little fine to coarse Sand, trace fine Gravel, dry, low plasticity
- Dark gray to brown fine to coarse (+) SAND and fine to coarse GRAVEL, trace Clay (nodules)
- Brown f (-) to c SAND,some Gravel,trace Clay
- Green gray f,m (+),c SAND, trace m Gravel
- Tan brown f (-) to c SAND,little f to m Gravel
- Tan brown f to c (-) SAND,little f to m Gravel
- Tan to brown f (-) to c SAND, little f to m Gravel, trace Clay, (dry, nodules)
- Tan brown m to c (+) SAND,trace f to m Gravel
- Dark red to orange fine SAND, some Silt
- Brown m to c SAND, some f to m Gravel
- Brown m to c (+) SAND and f (+) to m GRAVEL, trace Clay
- Brown f,m (+),c SAND, trace fine Gravel
- Brown f (-) to c SAND, little f to m Gravel
- Brown m to c (+) SAND, some f to m Gravel
- Dark brown f (+) to m SAND
- F to m (+) GRAVEL, some m to c (+) Sand

Well Diagram



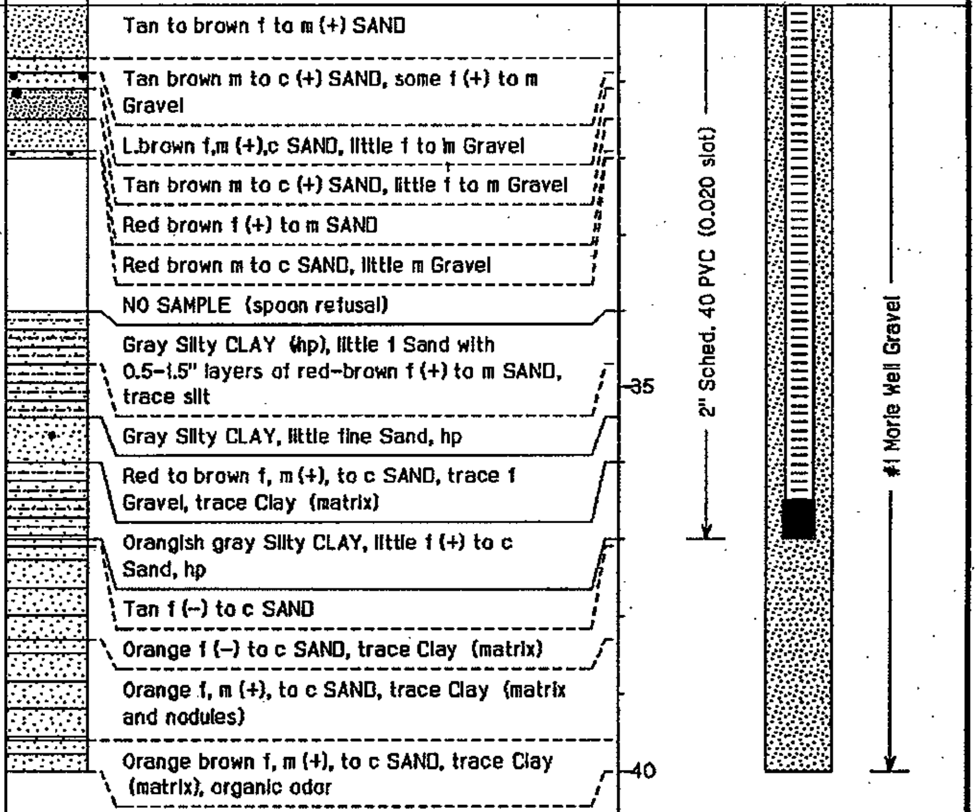
Geologist: Arsin Sahba
Driller: Dan Fincham - NFE

Handex Of Maryland

WELL LOG: S-112

Permit #: *N/A*
Drill Date: *July 24, 1998*
Use: *Monitoring*
Location: *3144 Passyunk Avenue, Philadelphia, PA*
Owner Loc #: *Philadelphia Refinery*
Owner: *Sun Company, Inc.*
Handex Loc #: *110535*
Owner Address: *Philadephia, PA*
BORING - Depth: *40 ft.* Diameter: *7 in.*
Drilling Method: *Hollow-Stem Auger*
CASING - Length: *1.75 ft.* Diameter: *2 in.*
Sampling Method: *Split Spoon*
SCREEN - Length: *35.0 ft.* Diameter: *2 in.*
Static Water Level: *10.78 ft.* *(July 24, 1998)*
WELL - Depth: *37.0 ft.*

Depth (ft.)	Sample ID	Sample Depth	Blows/6 in.	
	112-11		5-8-8-57	
	112-12		50/1	
35				
	112-13		1-1-2-8	
	112-14		3-7-9-8	
40	112-15		5-8-11-12	
45				



Geologic Description

- Tan to brown f to m (+) SAND
- Tan brown m to c (+) SAND, some f (+) to m Gravel
- L.brown f,m (+),c SAND, little f to m Gravel
- Tan brown m to c (+) SAND, little f to m Gravel
- Red brown f (+) to m SAND
- Red brown m to c SAND, little m Gravel
- NO SAMPLE (spoon refusal)
- Gray Silty CLAY (hp), little f Sand with 0.5-1.5" layers of red-brown f (+) to m SAND, trace silt
- Gray Silty CLAY, little fine Sand, hp
- Red to brown f, m (+), to c SAND, trace f Gravel, trace Clay (matrix)
- Orangish gray Silty CLAY, little f (+) to c Sand, hp
- Tan f (-) to c SAND
- Orange f (-) to c SAND, trace Clay (matrix)
- Orange f, m (+), to c SAND, trace Clay (matrix and nodules)
- Orange brown f, m (+), to c SAND, trace Clay (matrix), organic odor

NOTES: 1) Gravels are subrounded quartz and felspar, 2) Residual hydrocarbons 18-20.8 ft, 3) Strong hydrocarbon odor 20.8-22 ft, 4) Moderate hydrocarbon odor 22-22.8 ft, 5) Slight hydrocarbon odor 22.8-27.8 ft, 6) Wet at 14 ft, 7) lp = low plasticity, 8) mp = medium plasticity, 9) hp = high plasticity, 10) f = fine, 11) m = medium, 12) c = coarse.

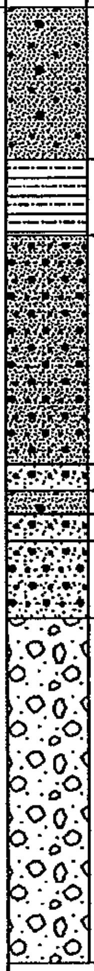
Geologist: Arsin Sahba
Driller: Dan Fincham - NFE

Handex
Handex Of Maryland

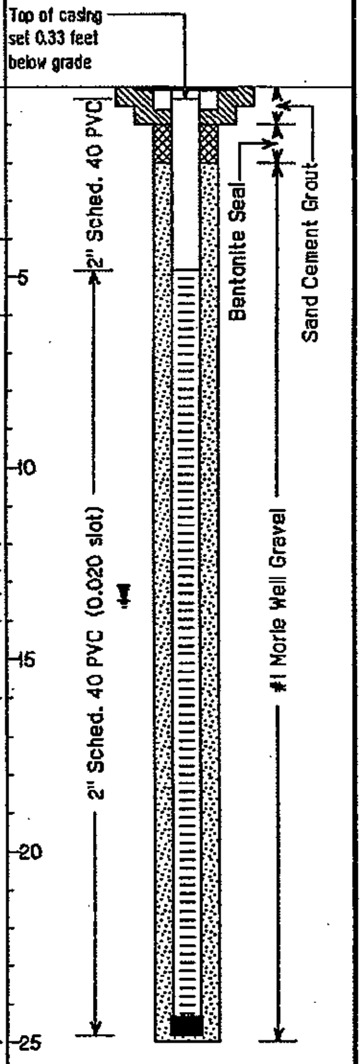
WELL LOG: S-113

Permit #: *N/A*
Drill Date: *July 25, 1998*
Use: *Monitoring*
Location: *3144 Passyunk Avenue, Philadelphia, PA*
Owner Loc #: *Philadelphia Refinery*
Owner: *Sun Company, Inc.*
Handex Loc #: *110535*
Owner Address: *Philadephia, PA*
BORING – Depth: *25 ft.* Diameter: *7 in.*
Drilling Method: *Hollow-Stem Auger*
CASING – Length: *4.5 ft.* Diameter: *2 in.*
Sampling Method: *Split Spoon*
SCREEN – Length: *20 ft.* Diameter: *2 in.*
Static Water Level: *13.17 ft.* *(July 28, 1998)*
WELL – Depth: *24.83 ft.*

Depth (ft.)	Sample ID	Sample Depth	Blows/6 in.		Graphic Log	Geologic Description
0						Dark brown fine SAND, little fine Gravel, little Clay, moist, Fill Material (?)
5						Gray brown Silty CLAY (moist)
						Gray brown fine (–) to coarse SAND, fine to medium GRAVEL, and CLAY (medium plasticity)
10						
	113-1	☒	6-9-10-10			Gray to brown f to m GRAVEL and m to c (+) SAND, trace Clay (nodular), moist
	113-2	☒	6-7-8-8			Brown f (–) to c SAND, little f Gravel, wet
15						Gray to brown f to m GRAVEL, and m to c (+) SAND, trace Clay (nodular), wet
						Tan, yellow, brown, gray, to red f to m GRAVEL, and m to c (+) SAND, trace Clay (nodular, dry, low plasticity)
20						NO SAMPLES – Coarse Sediments (sand & gravel)
25						
30						



Well Diagram



NOTES: 1) Strong hydrocarbon odor 12–14 ft, 2) Residual hydrocarbons 14–16 ft, 3) Gravels were subrounded quartz/feldspar, 4) c = coarse, 5) m = medium, 6) f = fine.

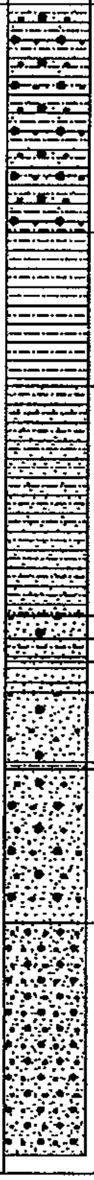
Geologist: Arsin Sahba
Driller: Dan Fincham – NFE

Handex

Handex Of Maryland

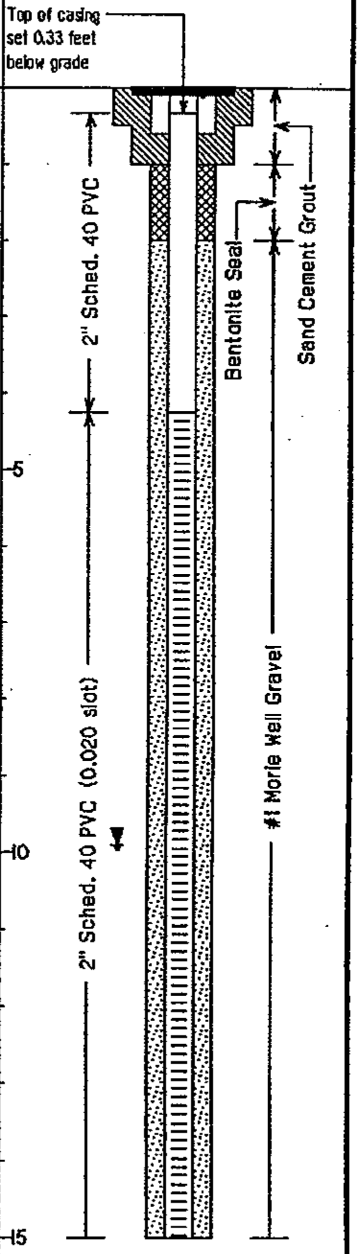
WELL LOG: S-114

Permit #: *N/A*
Drill Date: *July 25, 1996*
Use: *Monitoring*
Location: *3144 Passyunk Avenue, Philadelphia, PA*
Owner Loc #: *Philadelphia Refinery*
Owner: *Sun Company, Inc.*
Handex Loc #: *110535*
Owner Address: *Philadephia, PA*
BORING – Depth: *20.5 ft.* Diameter: *7 in.*
Drilling Method: *Hollow-Stem Auger*
CASING – Length: *3.92 ft.* Diameter: *2 in.*
Sampling Method: *Split Spoon*
SCREEN – Length: *16 ft.* Diameter: *2 in.*
Static Water Level: *9.57 ft.* *(July 26, 1996)*
WELL – Depth: *20.25 ft.*



Depth (ft.)	Sample ID	Sample Depth	Blows/6 in.		Graphic Log	Geologic Description
						Light brown Clayey SILT and medium to coarse (+) GRAVEL, dry
						Gray Clayey SILT, moist, low plasticity
5						Gray Silty CLAY, little fine to medium Sand, medium plasticity, moist to wet
	114-1	☒	5-4-7-11			Brown f (–) to c SAND,little f Gravel,little Clay
						Brown Silty CLAY,some f (–) to c Sand,little Grav
						Brown f (–) to c SAND, some Clay, little Gravel
10	114-2	☒	8-12-14-14			Brown f (–) to c SAND,little f Gravel,little Clay
						Dark red SILT and weathered GRAVEL
						Brown to tan f to c (+) SAND, some f to c Gravel, little Clay
						Brown m to c (+) SAND and GRAVEL,little Clay
15						

Well Diagram



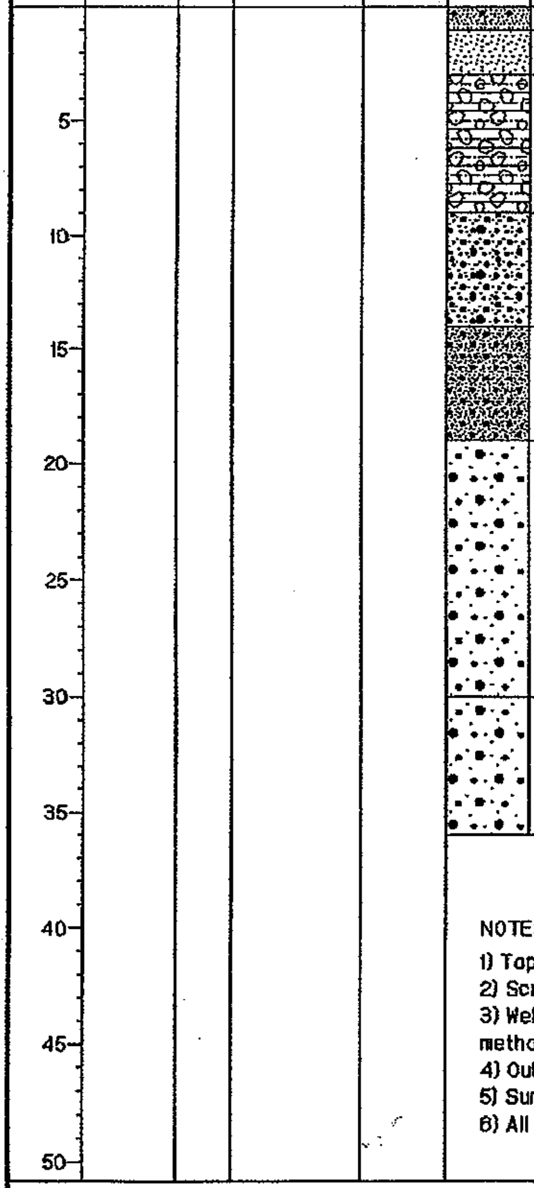
Geologist: Arsin Sahba
Driller: Dan Fincham – NFE

Handex Of Maryland

WELL LOG: RW–2

Permit #: *N/A*
Drill Date: *March 19–26, 1997*
Use: *Recovery*
Location: *3144 Passyunk Avenue, Philadelphia, PA*
Owner Loc #: *Philadelphia Refinery*
Owner: *Sun Company, Inc.*
Handex Loc #: *110535*
Owner Address: *Philadelphia, PA*
BORING – Depth: *36 ft.* Diameter: *20 In.*
Drilling Method: *Cable Tool*
CASING – Length: *12 ft./3 ft.* Diameter: *14 In.*
Sampling Method: *Bailed Cuttings*
SCREEN – Length: *20 ft.* Diameter: *14 In.*
Static Water Level: *12.91 ft.* *(March 26, 1997)*
WELL – Depth: *33 ft.*

Depth (ft.)	Sample ID	Sample Depth	Blows/6 In.		Graphic Log	Geologic Description



Tan to dark gray fine SAND, some fine to medium Gravel (angular), trace Silt, dry, loose

Medium brown to dray gray fine (+) medium to coarse SAND, some fine to medium Gravel, trace Silt, dry, loose

Brown to black SILT, little Gravel, trace fine, medium to coarse Sand, cobbles detected by driller but not recovered by bailer

Fine, medium to coarse (–) GRAVEL, some fine (–) medium to coarse Sand, little Clay (brown matrix), Gravel and sand variable color and subangular to subrounded, cobbles detected by driller but not recovered by bailer

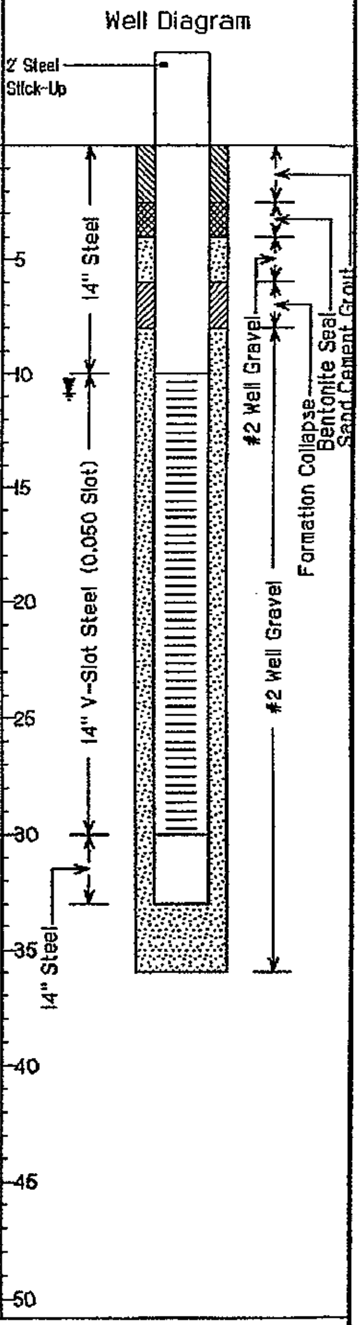
Fine (+)to medium GRAVEL, some fine, medium to coarse (+) Sand, trace Clay (brown matrix), Gravel and sand variable color and subangular to subrounded, cobbles?

Fine (–) medium to coarse SAND, some fine (+) to medium Gravel, trace Clay (brown matrix), Gravel and sand mostly white to tan but also variable colors, subangular to subrounded

Fine (–) medium to coarse SAND, little fine (+) to medium Gravel, trace Clay (brown as matrix and gray to light brown coherent medium plasticity at 34' to 34.5'), Gravel and sand mostly white to tan but also variable colors, subangular – subrounded

NOTES:

1) Top 4" and bottom 2" of screen are solid.
2) Screen and casing are low carbon steel.
3) Well developed on 3.26 and 3.27 by surge & bail method for about 10 hours.
4) Outer casing driven to 36.5' depth
5) Sump is 3' long.
6) All pipe connections are butt welded.



Geologist: Arsin Sahba
Driller: Chris Brenneman (Eichelbergers, Inc.)

Aoi 3

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. -BF88

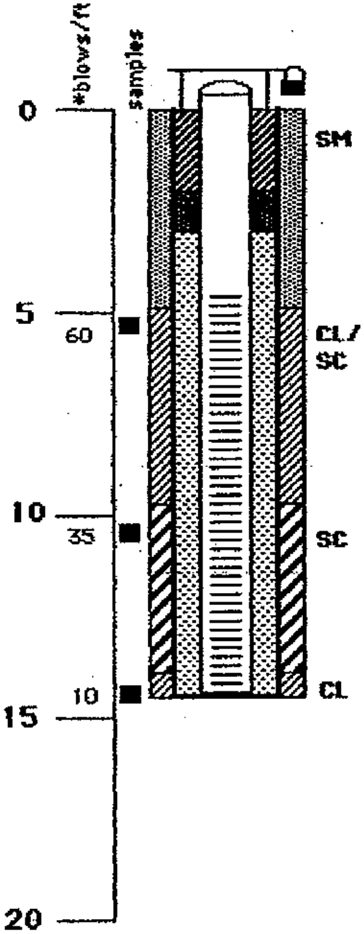
Project No. 113-909-032

Date M.W. completed 2/26/86

Supervising D & M Engineer/Geologist Dave Wagner

Depth (ft)

Description



SM Silty sand with trace gravel, brown-black, moist, hard

CL/SC Clayey silt with trace sand, brown, moist

SC Gravelly medium sand with some silt and clay

CL Silty clay, gray-brown, moist

Location - Chevron Refinery

Driller - Drill Consult

Drilling Completed - 2/26/86

Type of Rig - Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. - 7"

Borehole Depth - 14' 6"

Casing/Screen Type - PVC

Casing Diam. - 4"

Casing Depth - 14' 6"

Screen Setting - 4'6" - 14' 6"

Slot Width - 0.02"

Type of Seal - Bentonite

Type of Filterpack - #2 Sand

Type of Grout - Cement/Bentonite

MEASUREMENTS (NGVD)

Top of Casing Elevation - 12.93'

Static Water Level Elevation - 2.46'

Date Measured - 1/9/87

Surface Elevation - 9.78'

TEST DATA

Pump Type -

Depth to Intake (ft) -

Satic Water Level (ft) -

Pumping Water Level (ft) -

Drawdown (ft) -

Length of Test (Hrs) -

Notes:
* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack	░
Bentonite Seal	■
Cement Grout	▨

DAMES

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - BF89

Project No. 113-909-032

Date M.W. completed 2/19/86

Supervising D & M Engineer/Geologist T. Helgason

Location - Chevron Refinery

Driller - Drill Consult

Drilling Completed - 2/19/86

Type of Rig - Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. - 7"

Borehole Depth - 13.5'

Casing/Screen Type - PVC

Casing Diam. - 4"

Casing Depth - 13.5'

Screen Setting - 3.5' - 13.5'

Slot Width - 0.02"

Type of Seal - Bentonite

Type of Filterpack - #2 Sand

Type of Grout - Cement/Bentonite

MEASUREMENTS (NGVD)

Top of Casing Elevation - 11.81'

Static Water Level Elevation - 2.61'

Date Measured - 1/9/87

Surface Elevation - 11.57'

TEST DATA

Pump Type -

Depth to Intake (ft) -

Satic Water Level (ft) -

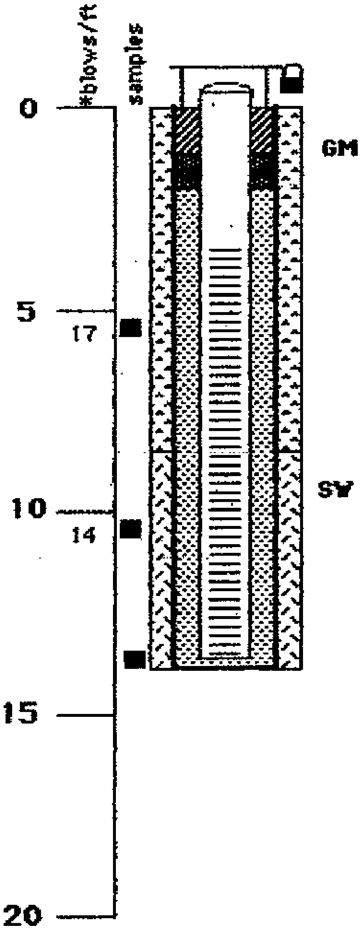
Pumping Water Level (ft) -

Drawdown (ft) -

Length of Test (Hrs) -

Depth (ft)

Description



Gravel to crushed stone, light brown

Silty gravel with some course sand, dark brown

Gravel with some white gravel with greenish deposits, reddish brown

Fine to coarse sand with some cobbles, dark brown

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack ░

Bentonite Seal ■

Cement Grout ▨

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - BF90

Project No. 113-909-032

Date M.W. completed 2/19/86

Supervising D & M Engineer/Geologist E. J. Fillo

Location - Chevron Refinery

Driller - Drill Consult

Drilling Completed - 2/19/86

Type of Rig - Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. - 7"

Borehole Depth - 15'

Casing/Screen Type - PVC

Casing Diam. - 4"

Casing Depth - 13'

Screen Setting - 3' - 13'

Slot Width - 0.02"

Type of Seal - Bentonite

Type of Filterpack - #2 Sand

Type of Grout - Cement/Bentonite

MEASUREMENTS (NGVD)

Top of Casing Elevation - 9.68'

Static Water Level Elevation - 8.33'

Date Measured - 1/9/87

Surface Elevation - 9.44'

TEST DATA

Pump Type -

Depth to Intake (ft) -

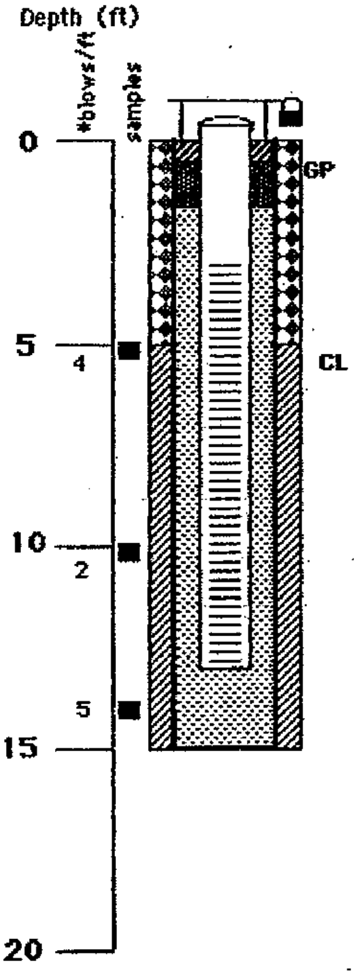
Satic Water Level (ft) -

Pumping Water Level (ft) -

Drawdown (ft) -

Length of Test (Hrs) -

Description



Black oily fill (crushed stone)

Black oily fill

Silty clay with trace fine sand, light brown, wet, soft

Silty clay with plant fragments, brownish gray, wet, very soft

Silty clay with plant fragments, gray, wet, medium stiff

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack ░

Bentonite Seal ■

Cement Grout ▨

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - BF99

Project No. 113-950-032

Date M.W. completed 10/21/86

Supervising D & M Geologist David Wagner

Location - Chevron Refinery

Driller - Lambert, Inc.

Drilling Completed - 10/21/86

Type of Rig - Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. - 10"

Borehole Depth - 35'

Casing/Screen Type - PVC

Casing Diam. - 4"

Casing Depth - 19.5'

Screen Setting - 9.5' - 19.5'

Slot Width - 0.02"

Type of Seal - Bentonite

Type of Filterpack - #2 Sand

Type of Grout -

MEASUREMENTS(NGVD)

Top of Casing Elevation - 13.37'

Static Water Level Elevation - 2.28'

Date Measured - 1/14/87

Surface Elevation - 12.62'

TEST DATA

Pump Type -

Depth to Intake (ft) -

Satic Water Level (ft) -

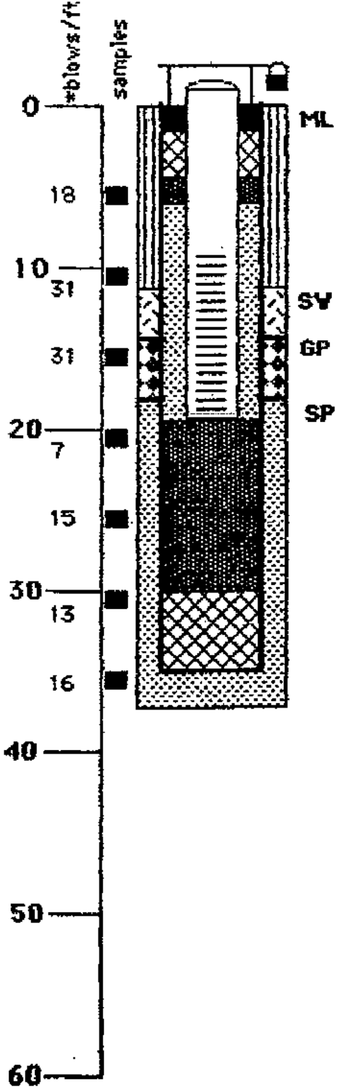
Pumping Water Level (ft) -

Drawdown (ft) -

Length of Test (Hrs) -

Depth(ft.)

Description



Silt with little to some fine sand, trace clay, medium brown, medium dense, moist; organics

Fine to coarse sand with little fine gravel, medium brown, dense, moist; strong petroleum odor

Fine gravel with little fine to coarse sand, trace silt, medium brown, dense, saturated; strong petroleum odor

Fine to medium sand with trace silt, light brown, loose, saturated

Grading to orange-brown

Trace to little clay and gravel; weak petroleum odor

Fine to coarse sand with trace fine gravel, trace silt, orange-brown, medium dense, saturated

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

WELL CONSTRUCTION KEY

FILTER PACK	░
BENTONITE SEAL	■
BENTONITE GROUT	▨
CAVE IN MATERIAL	☒
CONCRETE	■

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - BF100

Project No. 113-950-032

Date M.W. completed 10/17/86

Supervising D & M Geologist David Wagner

Location - Chevron Refinery

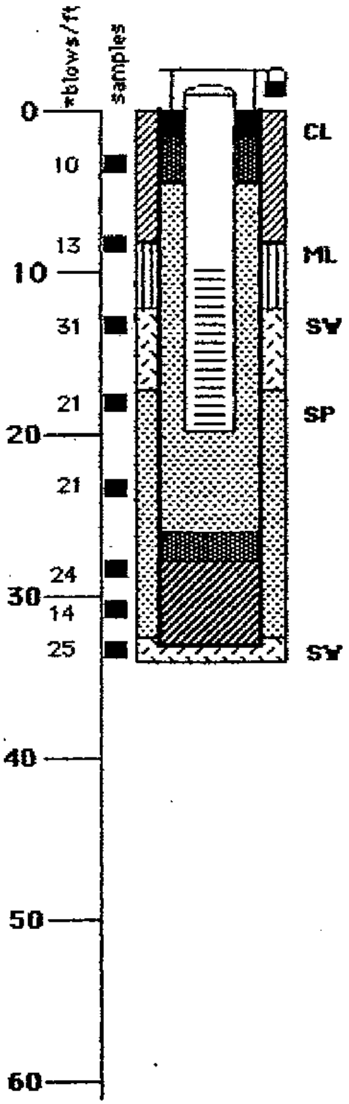
Driller - Lambert, Inc.

Drilling Completed - 10/17/86

Type of Rig - Hollow Stem Auger

Depth (ft)

Description



Clay with some silt, trace fine sand, light brown, stiff, moist

Silt and clay, trace gravel, medium brown, stiff, moist

Increasing silt; silt with little to some clay

Fine to coarse sand with some fine gravel, yellowish-brown, dense, saturated

Fine sand with little clay, little silt, light yellowish-brown, medium dense, saturated

Fine to medum sand with trace to little silt, trace clay, grayish-brown, medium dense, saturated

1' clay lense from 29' to 30'; clay with some silt, gray, moist

Decreasing clay; trace clay

Fine to coarse sand with trace to little fine gravel, trace silt, orangish-brown, medium dense, saturated

CONSTRUCTION DATA

Borehole Diam. - 10"

Borehole Depth - 33'

Casing/Screen Type - PVC

Casing Diam. - 4"

Casing Depth - 19.5'

Screen Setting - 9.5' - 19.5'

Slot Width - 0.02"

Type of Seal - Bentonite

Type of Filterpack - #2 Sand

Type of Grout - Bentonite

MEASUREMENTS(NGVD)

Top of Casing Elevation - 14.62'

Static Water Level Elevation - 1.79'

Date Measured - 1/14/87

Surface Elevation - 11.46'

TEST DATA

Pump Type -

Depth to Intake (ft) -

Satic Water Level (ft) -

Pumping Water Level (ft) -

Drawdown (ft) -

Length of Test (Hrs) -

WELL CONSTRUCTION KEY

FILTER PACK	░
BENTONITE SEAL	■
BENTONITE GROUT	▨
CAVE IN MATERIAL	☒
CONCRETE	■

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - BF101

Project No. 113-950-032

Date M.W. completed 10/15/86

Supervising D & M Geologist David Wagner

Location - Chevron Refinery

Driller - Lambert, Inc.

Drilling Completed - 10/15/86

Type of Rig - Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. - 10"

Borehole Depth - 59'

Casing/Screen Type - PVC

Casing Diam. - 4"

Casing Depth - 13'

Screen Setting - 3' - 13'

Slot Width - 0.02"

Type of Seal - Bentonite

Type of Filterpack - #2 Sand

Type of Grout -

MEASUREMENTS(NGVD)

Top of Casing Elevation - 9.03'

Static Water Level Elevation - 2.19'

Date Measured - 1/14/87

Surface Elevation - 6.12'

TEST DATA

Pump Type -

Depth to Intake (ft) -

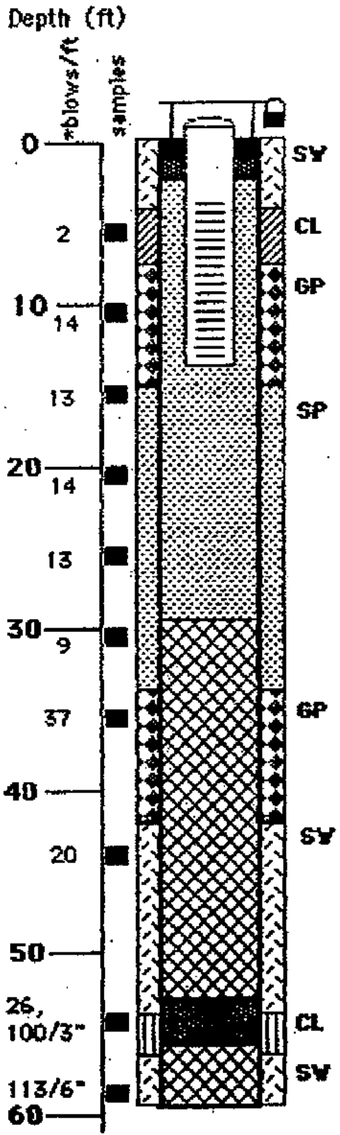
Satic Water Level (ft) -

Pumping Water Level (ft) -

Drawdown (ft) -

Length of Test (Hrs) -

Description



Fine to coarse sand, little to some silt, trace fine gravel, blackish-brown, loose, very moist

Clay with little to some silt, grayish-brown, soft, moist; abundant organics

Fine gravel with little to some fine to coarse sand, trace silt, very dense, saturated

Fine to medium sand with trace silt, light brown, medium dense, saturated

Grading to fine sand with little to some silt, trace clay

Grading to fine to coarse sand with little to some silt

Fine gravel with little to some fine to coarse sand, trace silt, brown, dense, saturated

Fine to coarse sand with little to some fine gravel, trace silt, light brown, medium dense, saturated

Increasing gravel; some fine gravel

Clay with little to some silt, light reddish-brown, very stiff, moist

Fine to coarse sand with little fine gravel, brown, very dense, saturated

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

FILTER PACK	▒
BENTONITE SEAL	■
BENTONITE GROUT	▨
CAVE IN MATERIAL	▩
CONCRETE	■

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - BF102

Project No. 113-950-032

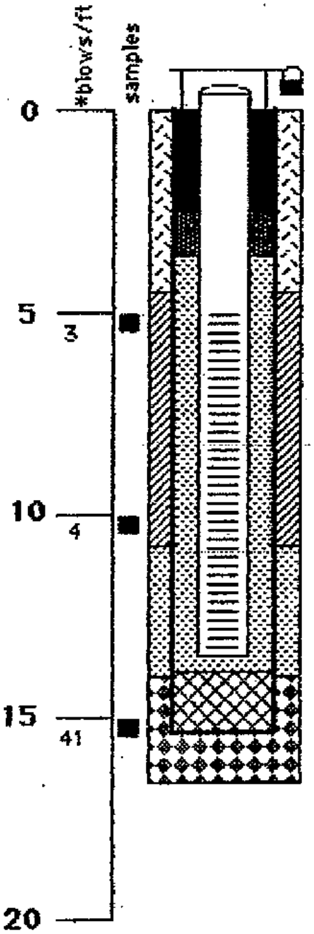
Date M.W. completed 10/10/86

Supervising D & M Geologist David Wagner

Location -	Chevron Refinery
Driller -	Lambert, Inc.
Drilling Completed -	10/10/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	10"
Borehole Depth -	15 '
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	*2 Sand
Type of Grout -	
MEASUREMENTS(NGVD)	
Top of Casing Elevation -	8.40'
Static Water Level Elevation -	4.95'
Date Measured -	1/14/87
Surface Elevation -	5.40'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft)

Description



SV Fine to coarse sand with little silt, blackish - brown, loose, saturated

CL Clay with little to trace silt, gray, soft, very moist

Clay with some silt, trace fine sand, very dark brown, soft, very moist to saturated

Increased fine sand and silt

SP Fine sand with little silt and little clay, brown and gray, loose, saturated

GP Fine gravel with little fine to coarse sand, trace silt, brown and gray, dense, saturated

WELL CONSTRUCTION KEY

FILTER PACK	▒
BENTONITE SEAL	▓
CONCRETE	■
CAVE IN MATERIAL	▨

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery **Boring/Well No. - BF103**

Project No. 113-950-032

Date M.W. completed 10/8/86

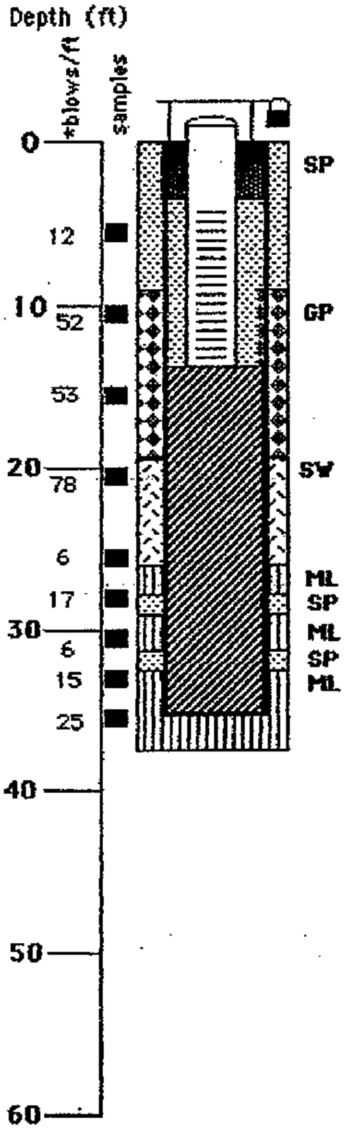
Supervising D & M Geologist David Wagner

Location - Chevron Refinery

Driller - Lambert, Inc.

Drilling Completed - 10/8/86

Type of Rig - Hollow Stem Auger



Description

Fine to medium sand, some silt, little fine gravel, brownish-black, medium dense, saturated; brick fragments

Fine gravel with little to some fine to coarse sand, trace silt, light brown, very dense, moist

Fine to coarse sand with trace to little silt, little fine gravel, light brown, very dense, saturated

26'-28' Silt with little fine to medium sand, little clay, gray, grading to reddish-brown toward bottom of spoon, medium stiff, saturated; wood fragments

28'-29' Fine to medium sand with trace to little silt, little clay, trace coarse sand, light brown, medium dense, saturated

29'-31' Silt with little fine to medium sand, trace clay, brownish-gray, medium stiff, saturated

31'-32' Fine to medium sand with trace to little silt, little clay, trace coarse sand, light brown, loose, saturated

32'-37' Silt with little clay, trace to little fine sand, gray, soft, saturated

CONSTRUCTION DATA

Borehole Diam. - 10"

Borehole Depth - 35'

Casing/Screen Type - PVC

Casing Diam. - 4"

Casing Depth - 14'

Screen Setting - 4' - 14'

Slot Width - 0.02"

Type of Seal - Bentonite

Type of Filterpack - #2 Sand

Type of Grout - Bentonite

MEASUREMENTS(NGVD)

Top of Casing Elevation - 16.73'

Static Water Level Elevation - 2.09'

Date Measured - 1/14/87

Surface Elevation - 13.88'

TEST DATA

Pump Type -

Depth to Intake (ft) -

Satic Water Level (ft) -

Pumping Water Level (ft) -

Drawdown (ft) -

Length of Test (Hrs) -

WELL CONSTRUCTION KEY

FILTER PACK	░
BENTONITE SEAL	■
BENTONITE GROUT	▨
CAVE IN MATERIAL	☒
CONCRETE	■

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

PROJECT: **Philly AOI-3 Logs 2015**
LOCATION: **Philly AOI-3**
PROJECT NUMBER:

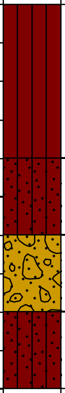
WELL / PROBEHOLE / BOREHOLE NO:
AOI4_BH-15-1
PAGE 1 OF 1

Aquaterra Technologies, Inc.

DRILLING / INSTALLATION:
STARTED **10/9/15** COMPLETED: **10/26/15**
DRILLING COMPANY: **Sweeney**
DRILLING EQUIPMENT: **Backhoe**
DRILLING METHOD: **Backhoe**
SAMPLING EQUIPMENT: **Hand Auger**

NORTHING (ft):
LAT:
GROUND ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
STATIC DTW (ft): **Not Encountered**
WELL CASING DIA. (in): **---**
LOGGED BY: **NS**

EASTING (ft):
LONG:
TOC ELEV (ft):
WELL DEPTH (ft): **---**
BOREHOLE DEPTH (ft): **10.0**
BOREHOLE DIA. (in): **12**
CHECKED BY: **TD**



Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)
			SILT LITTLE CLAY LITTLE GRAVEL ; orangeish brown; fine-grained; moist; subrounded		0845 BH-15-1 _0-2			2	
					OI4_BH-15-1@ 2-4'			0.0	
5			**SANDY SILT LITTLE GRAVEL** ; orangeish brown; fine to medium-grained; moist; subrounded		OI4_BH-15-1@ 4-6'			0.0	5
			SAND AND GRAVEL ; reddish brown; fine to medium-grained; moist; subangular		OI4_BH-15-1@ 6-8'			0.0	
			SANDY SILT LITTLE GRAVEL ; reddish brown; fine to medium-grained; moist; subrounded		OI4_BH-15-1@ 8-10'			0.0	
10			Refusal at 10 feet. Borehole terminated at 10 feet.						10
15									15
20									20
25									25
30									30
35									35

PROJECT: **Philly AOI-3 Logs 2015**
LOCATION: **Philly AOI-3**
PROJECT NUMBER:

WELL / PROBEHOLE / BOREHOLE NO:
BH-15-1 PAGE 1 OF 1

DRILLING / INSTALLATION:
STARTED **10/6/15** COMPLETED: **10/6/15**
DRILLING COMPANY: **Sweeney**
DRILLING EQUIPMENT: **Backhoe**
DRILLING METHOD: **Backhoe**
SAMPLING EQUIPMENT: **Hand Auger**

NORTHING (ft):
LAT:
GROUND ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
STATIC DTW (ft): **Not Encountered**
WELL CASING DIA. (in): **---**
LOGGED BY: **NS**

EASTING (ft):
LONG:
TOC ELEV (ft):
WELL DEPTH (ft): **---**
BOREHOLE DEPTH (ft): **11.4**
BOREHOLE DIA. (in): **12**
CHECKED BY: **TD**

Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)
	▩		**SANDY GRAVEL LITTLE SILT** ; brown; medium to coarse-grained; dry; subangular; Fill (bricks)	■	1115 BH-15-1 _0-2			38	
	▩		**SANDY SILT LITTLE GRAVEL** ; brown; fine to medium-grained; moist; subangular; Fill (wood, debris)	■	BH-15-1@ 2-4'			21	
5	▨		**SILTY CLAY LITTLE SAND AND GRAVEL** ; grayish brown; fine to medium-grained; moist; subangular	■	BH-15-1@ 4-6'			40	5
	▨		**SILTY CLAY TRACE GRAVEL** ; gray and brown; fine to medium-grained; moist; subangular; mottled	■	BH-15-1@ 6-8'			176	
	▧		**SILTY SAND TRACE CLAY** ; grayish brown; fine-grained; moist	■	BH-15-1@ 8-10'			225	
10	▧			■	1200 BH-15-1 _10-11			227	10
			Refusal at 11.4 feet. Borehole terminated at 11.4 feet.						
15									15
20									20
25									25
30									30
35									35

PROJECT: **Philly AOI-3 Logs 2015**
LOCATION: **Philly AOI-3**
PROJECT NUMBER:

WELL / PROBEHOLE / BOREHOLE NO:
BH-15-10
PAGE 1 OF 1

Aquaterra
Technologies, Inc.

DRILLING / INSTALLATION:
STARTED **10/9/15** COMPLETED: **10/9/15**
DRILLING COMPANY: **Sweeney**
DRILLING EQUIPMENT: **Backhoe**
DRILLING METHOD: **Backhoe**
SAMPLING EQUIPMENT: **Hand Auger**

NORTHING (ft):
LAT:
GROUND ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
STATIC DTW (ft): **Not Encountered**
WELL CASING DIA. (in): **---**
LOGGED BY: **NS**

EASTING (ft):
LONG:
TOC ELEV (ft):
WELL DEPTH (ft): **---**
BOREHOLE DEPTH (ft): **2.0**
BOREHOLE DIA. (in): **12**
CHECKED BY: **TD**

Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)
	▨		**GRAVEL** ; gray; fine to medium-grained; moist; subangular; Fill	■	BH-15-10@ 0-1' 1430			0.0	
	▨		**GRAVEL SOME SILT AND CLAY** ; reddish brown; fine to medium-grained; moist; subangular; Fill	■	BH-15-10 _0-2			0.0	
			Borehole terminated at 2 feet.						
5									5
10									10
15									15
20									20
25									25
30									30
35									35

PROJECT: **Philly AOI-3 Logs 2015**
LOCATION: **Philly AOI-3**
PROJECT NUMBER:

WELL / PROBEHOLE / BOREHOLE NO:
BH-15-2 PAGE 1 OF 1

Aquaterra Technologies, Inc.

DRILLING / INSTALLATION:
STARTED **10/6/15** COMPLETED: **10/6/15**
DRILLING COMPANY: **Sweeney**
DRILLING EQUIPMENT: **Backhoe**
DRILLING METHOD: **Backhoe**
SAMPLING EQUIPMENT: **Hand Auger**

NORTHING (ft):
LAT:
GROUND ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
STATIC DTW (ft): **Not Encountered**
WELL CASING DIA. (in): **---**
LOGGED BY: **NS**

EASTING (ft):
LONG:
TOC ELEV (ft):
WELL DEPTH (ft): **---**
BOREHOLE DEPTH (ft): **14.0**
BOREHOLE DIA. (in): **12**
CHECKED BY: **TD**

Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)
	▩		**SILTY SAND** ; brown; fine to medium-grained; dry; Fill (bricks, concrete, wood)	■	1325 BH-15-2 _0-2 BH-15-2@ 2-4'			4 3	
5	🟩		**SILTY CLAY LITTLE GRAVEL** ; grayish brown; fine to medium-grained; moist; subrounded	■	BH-15-2@ 4-6'			1	5
	🟩		**SILTY CLAY** ; grayish brown; loose; moist	■	BH-15-2@ 6-8'			1	
	🟩		**SILTY CLAY** ; gray and brown; loose; moist; mottled	■	BH-15-2@ 8-10'			1	
10	🟨		**SILTY SAND** ; grayish brown; fine to medium-grained; moist	■	BH-15-2@ 10-12'			2	10
	🟩		**SANDY CLAY** ; orangeish brown and gray; fine to medium-grained; moist	■	1430 BH-15-2 _12-14			1	
			Borehole terminated at 14 feet.						
15									15
20									20
25									25
30									30
35									35

PROJECT: **Philly AOI-3 Logs 2015**
LOCATION: **Philly AOI-3**
PROJECT NUMBER:

WELL / PROBEHOLE / BOREHOLE NO:
BH-15-3 PAGE 1 OF 1

DRILLING / INSTALLATION:
STARTED **10/6/15** COMPLETED: **10/6/54**
DRILLING COMPANY: **Sweeney**
DRILLING EQUIPMENT: **Backhoe**
DRILLING METHOD: **Backhoe**
SAMPLING EQUIPMENT: **Hand Auger**

NORTHING (ft):
LAT:
GROUND ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
STATIC DTW (ft): **Not Encountered**
WELL CASING DIA. (in): **---**
LOGGED BY: **NS**

EASTING (ft):
LONG:
TOC ELEV (ft):
WELL DEPTH (ft): **---**
BOREHOLE DEPTH (ft): **13.0**
BOREHOLE DIA. (in): **12**
CHECKED BY: **TD**

Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)
	▩		**SANDY GRAVEL LITTLE SILT** ; brown; medium to coarse-grained; dry; subangular; Fill (bricks)	■	0830 BH-15-3 _0-2			0.0	
	▩			■	BH-15-3@ 2-4'			2	
5	▨		**GRAVELLY SAND LITTLE SILT** ; grayish brown; fine to medium-grained; moist; subangular	■	BH-15-3@ 4-6'			18	5
	▨			■	BH-15-3@ 6-8'			27	
	▦		**SANDY GRAVEL** ; grayish brown; fine to coarse-grained; moist; rounded; large sub-rounded rocks (quartzite)	■	BH-15-3@ 8-10'			238	
10	▦			■	BH-15-3@ 10-12'			378	10
	▦			■	0915 BH-15-3 _12-13			431	
			Borehole terminated at 13 feet.						
15									15
20									20
25									25
30									30
35									35

PROJECT: **Philly AOI-3 Logs 2015**
LOCATION: **Philly AOI-3**
PROJECT NUMBER:

WELL / PROBEHOLE / BOREHOLE NO:
BH-15-4 PAGE 1 OF 1

DRILLING / INSTALLATION:
STARTED **10/5/15** COMPLETED: **10/5/15**
DRILLING COMPANY: **Sweeney**
DRILLING EQUIPMENT: **Backhoe**
DRILLING METHOD: **Backhoe**
SAMPLING EQUIPMENT: **Hand Auger**

NORTHING (ft):
LAT:
GROUND ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
STATIC DTW (ft): **Not Encountered**
WELL CASING DIA. (in): **---**
LOGGED BY: **NS**

EASTING (ft):
LONG:
TOC ELEV (ft):
WELL DEPTH (ft): **---**
BOREHOLE DEPTH (ft): **13.0**
BOREHOLE DIA. (in): **12**
CHECKED BY: **TD**

Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)
	▨		**SANDY GRAVEL LITTLE SILT** ; brown; medium to coarse-grained; dry; subangular; Fill (bricks, debris)	■	1400 BH-15-4 _0-2			74	
	▨			■	BH-15-4@ 2-4'			16	
5	🟩		**SILTY CLAY LITTLE SAND** ; brown; fine to medium-grained; moist	■	BH-15-4@ 4-6'			2	5
	🟩			■	BH-15-4@ 6-8'			1	
	🟩		**SILTY CLAY** ; light gray and orangeish brown; moist; mottled	■	BH-15-4@ 8-10'			7	
10	🟩			■					10
	🟩			■	BH-15-4@ 10-12'			1	
	🟩			■	1430 BH-15-4 _12-13			22	
			Borehole terminated at 13 feet.						
15									15
20									20
25									25
30									30
35									35

PROJECT: **Philly AOI-3 Logs 2015**
LOCATION: **Philly AOI-3**
PROJECT NUMBER:

WELL / PROBEHOLE / BOREHOLE NO:
BH-15-5 PAGE 1 OF 1

Aquaterra Technologies, Inc.

DRILLING / INSTALLATION:
STARTED **10/5/15** COMPLETED: **10/27/15**
DRILLING COMPANY: **Total Quality Drillling**
DRILLING EQUIPMENT: **HSA**
DRILLING METHOD: **HSA**
SAMPLING EQUIPMENT: **Split Spoon**

NORTHING (ft):
LAT:
GROUND ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
STATIC DTW (ft): **Not Encountered**
WELL CASING DIA. (in): **---**
LOGGED BY: **NS**

EASTING (ft):
LONG:
TOC ELEV (ft):
WELL DEPTH (ft): **---**
BOREHOLE DEPTH (ft): **16.0**
BOREHOLE DIA. (in): **12**
CHECKED BY: **TD**

Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)
	▨		**SANDY GRAVEL LITTLE SILT** ; brown; medium to coarse-grained; dry; subangular; Fill		1130 BH-15-5 _0-2			2	
	▨				BH-15-5@ 2-4'			9	
5	🟩		**SILTY CLAY** ; yellowish brown; moist; Utility clearing completed to a depth of 8' bgs via backhoe.		BH-15-5@ 4-6'			1	5
	🟩				BH-15-5@ 6-8'			4	
	🟩		**SANDY CLAY LITTLE GRAVEL** ; grayish brown; fine to medium-grained; moist; subrounded	☒	BH-15-5@ 8-10'	1.1		0.2	
10	🟩			☒	BH-15-5@ 10-12'	0.7		0.7	10
	🟧		**GRAVEL SOME SAND** ; brown; fine to medium-grained; wet; subrounded; (Trenton)	☒	1400 BH-15-5 _12-14	0.5		222.4	
15	🟧			☒	BH-15-5@ 14-16'	0.2		236.7	15
			Borehole terminated at 16 feet.						
20									20
25									25
30									30
35									35

PROJECT: **Philly AOI-3 Logs 2015**
LOCATION: **Philly AOI-3**
PROJECT NUMBER:

WELL / PROBEHOLE / BOREHOLE NO:
BH-15-6 PAGE 1 OF 1

Aquaterra
Technologies, Inc.

DRILLING / INSTALLATION:
STARTED **10/5/15** COMPLETED: **10/27/15**
DRILLING COMPANY: **Total Quality Drillling**
DRILLING EQUIPMENT: **HSA**
DRILLING METHOD: **HSA**
SAMPLING EQUIPMENT: **Split Spoon**

NORTHING (ft):
LAT:
GROUND ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
STATIC DTW (ft): **Not Encountered**
WELL CASING DIA. (in): **---**
LOGGED BY: **NS**

EASTING (ft):
LONG:
TOC ELEV (ft):
WELL DEPTH (ft): **---**
BOREHOLE DEPTH (ft): **16.0**
BOREHOLE DIA. (in): **12**
CHECKED BY: **TD**

Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)
	▩		**SANDY GRAVEL LITTLE SILT** ; brown; medium to coarse-grained; dry; subangular; Fill (bricks, rubber pieces)		1030 BH-15-6 _0-2			0.0	
	▩				BH-15-6@ 2-4'			14	
5	▨		**SILTY CLAY** ; yellowish brown; moist; Utility clearing completed to a depth of 8' bgs via backhoe.		BH-15-6@ 4-6'			6	5
	▨				BH-15-6@ 6-8'			6	
	▤		**SILTY SAND LITTLE GRAVEL** ; brown; fine to medium-grained; moist; subrounded	☒	BH-15-6@ 8-10'	0.7		8.2	
10	▤			☒	BH-15-6@ 10-12'	1		26.3	10
	▨		**SILTY CLAY TRACE SAND** ; light tan and gray; fine to medium sand-grained; stiff; moist	☒	BH-15-6@ 12-14'	0.8		27.8	
15	▦		**SAND AND GRAVEL** ; dark gray; fine to medium-grained; wet; subrounded; (Trenton)	☒	1130 BH-15-6 _14-16	0.6		4229	15
			Borehole terminated at 16 feet.						
20									20
25									25
30									30
35									35

PROJECT: **Philly AOI-3 Logs 2015**
LOCATION: **Philly AOI-3**
PROJECT NUMBER:

WELL / PROBEHOLE / BOREHOLE NO:
BH-15-7 PAGE 1 OF 1

Aquaterra
Technologies, Inc.

DRILLING / INSTALLATION:	NORTHING (ft):
STARTED **10/5/15** COMPLETED: **10/27/15**	EASTING (ft):
DRILLING COMPANY: **Total Quality Drillling**	LAT:
DRILLING EQUIPMENT: **HSA**	LONG:
DRILLING METHOD: **HSA**	GROUND ELEV (ft):
SAMPLING EQUIPMENT: **Split Spoon**	TOC ELEV (ft):
	INITIAL DTW (ft): **Not Encountered**
	WELL DEPTH (ft): **---**
	STATIC DTW (ft): **Not Encountered**
	BOREHOLE DEPTH (ft): **16.0**
	WELL CASING DIA. (in): **---**
	BOREHOLE DIA. (in): **12**
	LOGGED BY: **NS**
	CHECKED BY: **TD**

Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)
	▨		**SANDY GRAVEL LITTLE SILT** ; brown; fine to medium-grained; dry to moist; subangular; Fill		0920 BH-15-7 _0-2			3	
	▨				BH-15-7@ 2-4'			3	
5	🟥		**SANDY SILT TRACE CLAY** ; brown; fine to medium-grained; moist		BH-15-7@ 4-6'			2	5
	🟩		**SILTY CLAY LITTLE SAND** ; yellowish brown; fine to medium-grained; moist; Utility clearing completed to a depth of 8' bgs via backhoe.		BH-15-7@ 6-8'			1	
	🟩		**SANDY CLAY LITTLE SILT** ; grayish brown; moist	☒	BH-15-7@ 8-10'	0.7		0.7	
10	🟨		**CLAYEY SAND LITTLE GRAVEL TRACE SILT** ; grayish brown; fine to medium-grained; moist to wet; subrounded	☒	BH-15-7@ 10-12'	1.1		0.5	10
	🟨			☒	BH-15-7@ 12-14'	1.3		0.9	
15	🟨			☒	1445 BH-15-7 _14-16	2		5	15
			Borehole terminated at 16 feet.						
20									20
25									25
30									30
35									35

PROJECT: **Philly AOI-3 Logs 2015**
LOCATION: **Philly AOI-3**
PROJECT NUMBER:

WELL / PROBEHOLE / BOREHOLE NO:
BH-15-8 PAGE 1 OF 1

Aquaterra
Technologies, Inc.

DRILLING / INSTALLATION:
STARTED **10/9/15** COMPLETED: **10/9/15**
DRILLING COMPANY: **Sweeney**
DRILLING EQUIPMENT: **Backhoe**
DRILLING METHOD: **Backhoe**
SAMPLING EQUIPMENT: **Hand Auger**

NORTHING (ft):
LAT:
GROUND ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
STATIC DTW (ft): **Not Encountered**
WELL CASING DIA. (in): **---**
LOGGED BY: **NS**

EASTING (ft):
LONG:
TOC ELEV (ft):
WELL DEPTH (ft): **---**
BOREHOLE DEPTH (ft): **2.0**
BOREHOLE DIA. (in): **12**
CHECKED BY: **TD**

Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)
	▨		**SILT LITTLE CLAY** ; orangeish brown; moist	■	BH-15-8@ 0-1' 1145 BH-15-8 _1-2			0.0 0.0	
			Borehole terminated at 2 feet.						
5									5
10									10
15									15
20									20
25									25
30									30
35									35

PROJECT: **Philly AOI-3 Logs 2015**
LOCATION: **Philly AOI-3**
PROJECT NUMBER:

WELL / PROBEHOLE / BOREHOLE NO:
BH-15-9 PAGE 1 OF 1

DRILLING / INSTALLATION:
STARTED **10/9/15** COMPLETED: **10/9/15**
DRILLING COMPANY: **Sweeney**
DRILLING EQUIPMENT: **Backhoe**
DRILLING METHOD: **Backhoe**
SAMPLING EQUIPMENT: **Hand Auger**

NORTHING (ft):
LAT:
GROUND ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
STATIC DTW (ft): **Not Encountered**
WELL CASING DIA. (in): **---**
LOGGED BY: **NS**

EASTING (ft):
LONG:
TOC ELEV (ft):
WELL DEPTH (ft): **---**
BOREHOLE DEPTH (ft): **2.0**
BOREHOLE DIA. (in): **12**
CHECKED BY: **TD**

Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)
	■		Asphalt						
	▨		**GRAVEL SOME SILT AND CLAY** ; black and gray; fine to medium-grained; moist; subangular; Fill	■	1315 BH-15-9 _1-2			0.0	
			Borehole terminated at 2 feet.						
5									5
10									10
15									15
20									20
25									25
30									30
35									35

PROJECT: **Philly AOI-3 Logs 2015**
LOCATION: **Philly AOI-3**
PROJECT NUMBER:

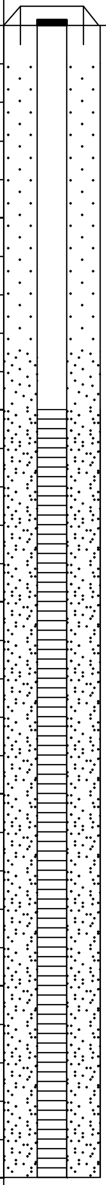
WELL / PROBEHOLE / BOREHOLE NO:
S-407 PAGE 1 OF 1

DRILLING / INSTALLATION:
STARTED **10/7/15** COMPLETED: **10/14/15**
DRILLING COMPANY: **Total Quality Drillling**
DRILLING EQUIPMENT: **HSA**
DRILLING METHOD: **HSA**
SAMPLING EQUIPMENT: **Split Spoon**

NORTHING (ft):
LAT:
GROUND ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
STATIC DTW (ft): **Not Encountered**
WELL CASING DIA. (in): **4**
LOGGED BY: **NS**

EASTING (ft):
LONG:
TOC ELEV (ft):
WELL DEPTH (ft): **30.0**
BOREHOLE DEPTH (ft): **30.0**
BOREHOLE DIA. (in): **12**
CHECKED BY: **TD**

Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)	Borehole Backfill
			SANDY CLAY LITTLE SILT ; yellowish brown; fine to medium-grained; moist		0815 S-407 _0-2			15		
			SILTY CLAY LITTLE SAND AND GRAVEL ; grayish brown; fine to medium-grained; moist to wet		S-407@ 2-4'			18		
5					S-407@ 4-6'			19	5	1-8.5' bgs: Bentonite
			CLAYEY SAND ; grayish brown; fine to medium-grained; moist; Utility clearing completed to a depth of 8' bgs via backhoe.		S-407@ 6-8'			24		
			SAND LITTLE SILT ; grayish brown; fine to coarse-grained; moist	☒	S-407@ 8-10'	0.5		8		
10			**SILTY CLAY LITTLE GRAVEL** ; yellowish brown; fine-grained; moist; subangular	☒	S-407@ 10-12'	0.3		0.0	10	
				☒	S-407@ 12-14'	0.5		5		
15			**SAND LITTLE GRAVEL LITTLE CLAY** ; dark brown; fine to medium-grained; moist to wet; subrounded; (trenton) visible LNAPL	☒	1130 S-407 _14-16	0.5		>999	15	
				☒	S-407@ 16-18'	1.2		>999		
			GRAVEL SOME SAND LITTLE CLAY ; dark gray and black; fine to medium-grained; wet; subangular	☒	S-407@ 18-20'	2		515		
20				☒	S-407@ 20-22'	0.5		178	20	8.5-30' bgs: Sand 10-30' bgs: 30-slot PVC Screen
			SAND SOME GRAVEL ; grayish brown; fine to medium-grained; wet; subangular	☒	S-407@ 22-24'	1		721		
25				☒	S-407@ 24-26'	0.3		563	25	
				☒	S-407@ 26-28'	0.8		367		
				☒	S-407@ 28-30'	0.4		58.7		
30			Borehole terminated at 30 feet.						30	
35									35	



PROJECT: **Philly AOI-3 Logs 2015**
LOCATION: **Philly AOI-3**
PROJECT NUMBER:

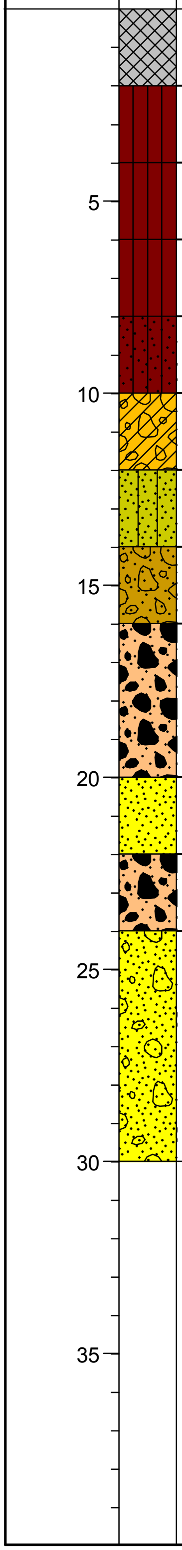
WELL / PROBEHOLE / BOREHOLE NO:
S-408 PAGE 1 OF 1

Aquaterra Technologies, Inc.

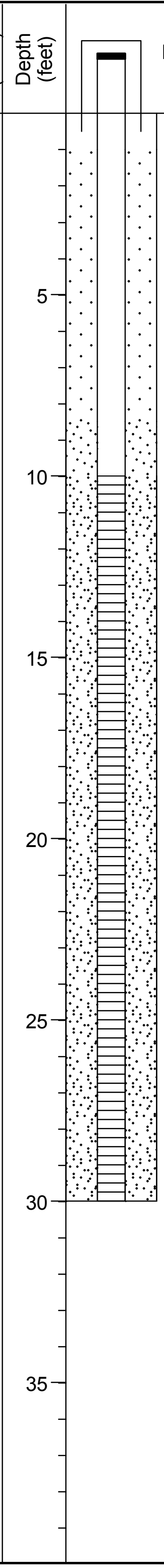
DRILLING / INSTALLATION:
STARTED **10/9/15** COMPLETED: **10/23/15**
DRILLING COMPANY: **Total Quality Drillling**
DRILLING EQUIPMENT: **HSA**
DRILLING METHOD: **HSA**
SAMPLING EQUIPMENT: **Split Spoon**

NORTHING (ft):
LAT:
GROUND ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
STATIC DTW (ft): **Not Encountered**
WELL CASING DIA. (in): **4**
LOGGED BY: **NS**

EASTING (ft):
LONG:
TOC ELEV (ft):
WELL DEPTH (ft): **30.0**
BOREHOLE DEPTH (ft): **30.0**
BOREHOLE DIA. (in): **12**
CHECKED BY: **TD**



USCS	Description	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)
	SAND AND GRAVEL ; dark brown and black; fine to medium-grained; moist; subangular; Fill	1015 S-408 _0-2			2
	SILT SOME CLAY LITTLE SAND ; grayish brown; fine to medium-grained; moist	S-408@ 2-4'			0.0
	SILT LITTLE CLAY TRACE SAND ; orangeish brown; fine to medium-grained; moist	S-408@ 4-6'			0.0
	SILT LITTLE CLAY TRACE GRAVEL ; orangeish brown and gray; fine-grained; moist; subrounded; Utility clearing completed to a depth of 8' bgs via backhoe.	S-408@ 6-8'			0.0
	SILT SOME SAND LITTLE GRAVEL ; dark brown; fine to medium-grained; moist; subangular	S-408@ 8-10'	0.6		0.4
	GRAVEL LITTLE CLAY LITTLE SAND ; grayish brown; medium to coarse-grained; moist; subangular	S-408@ 10-12'	0.5		4
	SILTY SAND LITTLE GRAVEL ; reddish brown to orangeish brown; fine to medium-grained; moist to wet; subangular	S-408@ 12-14'	0.9		5
	SAND AND GRAVEL ; grayish brown; fine to medium-grained; wet; subrounded	1130 S-408 _14-16	0.9		24
	GRAVEL LITTLE SAND ; grayish brown; fine to coarse-grained; wet; subrounded; (Trenton)	S-408@ 16-18'	0.6		7
		S-408@ 18-20'	0.2		0.0
	SAND ; grayish brown; fine to medium-grained; wet	S-408@ 20-22'	0.1		0.0
	GRAVEL LITTLE SAND ; grayish brown; fine to medium-grained; wet; subangular	S-408@ 22-24'	1.1		0.0
	SAND LITTLE GRAVEL ; grayish brown; fine to medium-grained; wet; subangular	S-408@ 24-26'	0.3		0.0
		S-408@ 26-28'	0.5		0.0
		S-408@ 28-30'	0.6		0.0
	Borehole terminated at 30 feet.				



Borehole Backfill

1-8.5' bgs: Bentonite

8.5-30' bgs: Sand
10-30' bgs: 30-slot PVC Screen

PROJECT: **Philly AOI-3 Logs 2015**
LOCATION: **Philly AOI-3**
PROJECT NUMBER:

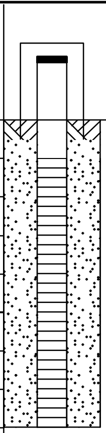
WELL / PROBEHOLE / BOREHOLE NO:
S-409 PAGE 1 OF 1

DRILLING / INSTALLATION:
STARTED **10/22/15** COMPLETED: **10/22/15**
DRILLING COMPANY: **Total Quality Drillling**
DRILLING EQUIPMENT: **HSA**
DRILLING METHOD: **HSA**
SAMPLING EQUIPMENT: **Split Spoon**

NORTHING (ft):
LAT:
GROUND ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
STATIC DTW (ft): **Not Encountered**
WELL CASING DIA. (in): **4**
LOGGED BY: **NS**

EASTING (ft):
LONG:
TOC ELEV (ft):
WELL DEPTH (ft): **8.0**
BOREHOLE DEPTH (ft): **8.0**
BOREHOLE DIA. (in): **12**
CHECKED BY: **TD**

Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)	Borehole Backfill
	▨		**SANDY SILT** ; dark brown; fine to medium-grained; moist; Fill (bricks) LNAPL present	■	S-409@ 0-2'			1		0-0.5' bgs: Concrete
	▨		**SILTY CLAY SOME GRAVEL** ; black; medium to coarse-grained; wet; Utility clearing completed to a depth of 8' bgs via backhoe.	■	S-409@ 2-4'			214		
5	▨			■	S-409@ 4-6'			302	5	0.5-8' bgs: Sand 1-8' bgs: 30-slot PVC Screen
	▨			■	S-409@ 6-8'			367		
			Borehole terminated at 8 feet.							
10									10	
15									15	
20									20	
25									25	
30									30	
35									35	



PROJECT: **Philly AOI-3 Logs 2015**
LOCATION: **Philly AOI-3**
PROJECT NUMBER:

WELL / PROBEHOLE / BOREHOLE NO:
S-410 PAGE 1 OF 1

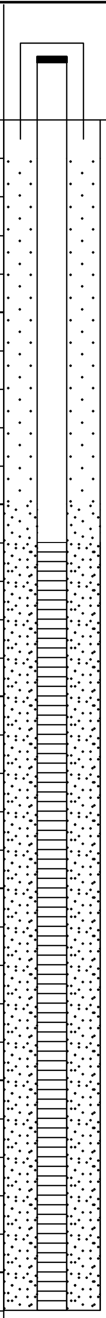
Aquaterra Technologies, Inc.

DRILLING / INSTALLATION:
STARTED **10/8/15** COMPLETED: **10/22/15**
DRILLING COMPANY: **Total Quality Drillling**
DRILLING EQUIPMENT: **HSA**
DRILLING METHOD: **HSA**
SAMPLING EQUIPMENT: **Split Spoon**

NORTHING (ft):
LAT:
GROUND ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
STATIC DTW (ft): **Not Encountered**
WELL CASING DIA. (in): **2**
LOGGED BY: **NS**

EASTING (ft):
LONG:
TOC ELEV (ft):
WELL DEPTH (ft): **31.0**
BOREHOLE DEPTH (ft): **30.0**
BOREHOLE DIA. (in): **12**
CHECKED BY: **TD**

Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)	Borehole Backfill
	▨		**SANDY SILT** ; dark brown; fine to medium-grained; moist; Fill (bricks) LNAPL present		1000 S-410 _0-2			1		
	▨		**SILTY CLAY SOME GRAVEL** ; black; medium to coarse-grained; wet; Utility clearing completed to a depth of 8' bgs via backhoe.		S-410@ 2-4'			214		
5	▨				S-410@ 4-6'			302	5	1-10' bgs: Bentonite
	▨				S-410@ 6-8'			367		
	▨		**SILTY CLAY LITTLE ORGANICS** ; black; moist to wet; (roots)	☒	S-410@ 8-10'	1.3		1770		
10	▨			☒	S-410@ 10-12'	0.9		1468	10	
	▨			☒	S-410@ 12-14'	1.1		568		
15	▨		**CLAY LITTLE SILT** ; black; moist to wet	☒	S-410@ 14-16'	0.8		343.6	15	
	▨			☒	S-410@ 16-18'	0.9		1248		
	▨		**SAND AND GRAVEL** ; black; fine to medium-grained; saturated; subrounded	☒	S-410@ 18-20'	0.8		721		
20	▨		**CLAY LITTLE SILT TRACE GRAVEL** ; black; fine to medium-grained; moist to wet; subrounded	☒	S-410@ 20-22'	1.7		798.2	20	10-31' bgs: Sand 11-30' bgs: 30-slot PVC Screen
	▨		**SAND AND GRAVEL** ; black; fine to medium-grained; wet; subangular	☒	S-410@ 22-24'	0.5		177.6		
25	▨			☒	S-410@ 24-26'	0.6		106.7	25	
	▨			☒	S-410@ 26-28'	0.5		193		
	▨			☒	S-410@ 28-30'	0.7		157.6		
30			Borehole terminated at 30 feet.						30	
35									35	



PROJECT: **Philly AOI-3 Logs 2015**
LOCATION: **Philly AOI-3**
PROJECT NUMBER:

WELL / PROBEHOLE / BOREHOLE NO:
S-411 PAGE 1 OF 1

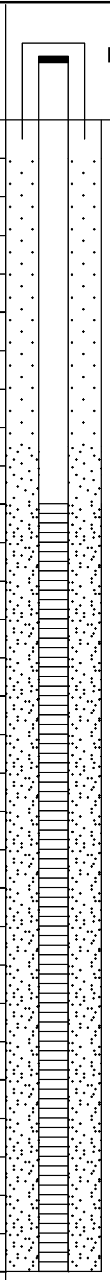
DRILLING / INSTALLATION:
STARTED **10/7/15** COMPLETED: **10/21/15**
DRILLING COMPANY: **Total Quality Drillling**
DRILLING EQUIPMENT: **HSA**
DRILLING METHOD: **HSA**
SAMPLING EQUIPMENT: **Split Spoon**

NORTHING (ft):
LAT:
GROUND ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
STATIC DTW (ft): **Not Encountered**
WELL CASING DIA. (in): **4**
LOGGED BY: **NS**

EASTING (ft):
LONG:
TOC ELEV (ft):
WELL DEPTH (ft): **30.0**
BOREHOLE DEPTH (ft): **30.0**
BOREHOLE DIA. (in): **12**
CHECKED BY: **TD**

Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID Method	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)
	▨		**SANDY CLAY** ; dark brown; fine to medium-grained; moist; Fill (bricks, concrete pieces)		S-411 _0-2 1415			0.0	
					S-411@ 2-4'			0.0	
5	🟩		**SILTY CLAY** ; gray and orangeish brown; moist; mottled; Utility clearing completed to a depth of 8' bgs via backhoe.		S-411@ 4-6'			0.0	5
					S-411@ 6-8'			0.0	
	🟩		**SANDY CLAY LITTLE SAND** ; grayish brown; fine to medium-grained; moist	☒	S-411@ 8-10'	2		0.0	
10				■	Geotech Sample 1030	2			10
	🟨		**SAND SOME GRAVEL** ; brown; fine to medium-grained; moist; subrounded; (Trenton)	☒	S-411@ 12-14'	0.5		5.9	
15				■	Geotech Sample 1200	2			15
	🟨		**SAND SOME GRAVEL** ; brown; fine to medium-grained; moist	☒	S-411@ 16-18'	0.7		52.7	
			No Recovery	☒		0			
20	🟫		**SAND AND GRAVEL** ; reddish brown; fine to medium-grained; moist to wet; subrounded	☒	S-411@ 20-22'	0.6		0.0	20
				☒	S-411@ 22-24'	0.5		0.0	
25				☒	S-411@ 24-26'	2		0.0	25
				☒	S-411@ 26-28'	0.4		0.0	
	🟨		**SAND LITTLE GRAVEL** ; orangeish brown; fine to medium-grained; saturated; subrounded	☒	S-411@ 28-30'	1.1		0.0	
30			Borehole terminated at 30 feet.						30
35									35

Borehole Backfill



1-8.5' bgs: Bentonite

8.5-30' bgs: Sand
10-30' bgs: 30-slot PVC Screen

PROJECT: **Philly AOI-3 Logs 2015**
LOCATION: **Philly AOI-3**
PROJECT NUMBER:

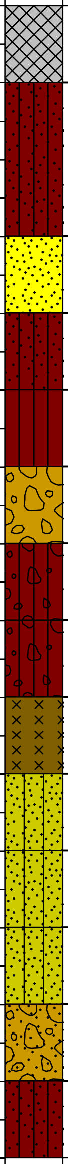
WELL / PROBEHOLE / BOREHOLE NO:
S-412 PAGE 1 OF 1

Aquaterra Technologies, Inc.

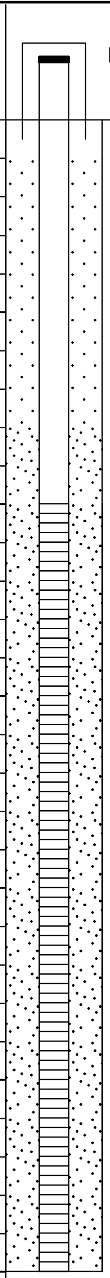
DRILLING / INSTALLATION:
STARTED **10/13/15** COMPLETED: **10/19/15**
DRILLING COMPANY: **Total Quality Drillling**
DRILLING EQUIPMENT: **HSA**
DRILLING METHOD: **HSA**
SAMPLING EQUIPMENT: **Split Spoon**

NORTHING (ft):
LAT:
GROUND ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
STATIC DTW (ft): **Not Encountered**
WELL CASING DIA. (in): **4**
LOGGED BY: **NS/LM**

EASTING (ft):
LONG:
TOC ELEV (ft):
WELL DEPTH (ft): **30.0**
BOREHOLE DEPTH (ft): **30.0**
BOREHOLE DIA. (in): **12**
CHECKED BY: **TD**



Time & Depth (feet)	USCS	Description	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Borehole Backfill
0-2		**SANDY GRAVEL LITTLE SILT** ; brown; medium to coarse-grained; dry; subangular; Fill (bricks, debris)	0915 S-412 _0-2			1	1-8' bgs: Bentonite
2-4		**SANDY SILT LITTLE GRAVEL** ; yellowish brown; fine to medium-grained; loose; dry; subangular	S-412@ 2-4'			0.0	
4-6			S-412@ 4-6'			0.0	
6-8		**SAND LITTLE GRAVEL AND SILT** ; yellowish brown; fine to medium-grained; moist; subrounded; Utility clearing completed to a depth of 8' bgs via backhoe.	S-412@ 6-8'			1	
8-10		**SANDY SILT** ; brown to gray	S-412@ 8-10'			0.0	8-30' bgs: Sand 10-30' bgs: 30-slot PVC Screen
10-12		**SAND** ; gray; Alluvial shelby tube collected	Geotech Sample			8.2	
12-14		**GRAVEL** ; gray; Trenton shelby tube collected	Geotech Sample			11.7	
14-16		**SILT AND GRAVEL** ; brownish gray; wet	S-412 _14-16			641.7	
16-18		**GRAVEL AND SILT** ; reddish brown	S-412@ 16-18'			503	
18-20		**GRAVELLY SILT AND SAND** ; reddish brown	S-412@ 18-20'			330.1	
20-22		**SILTY SAND** ; reddish brown	S-412@ 20-22'			150.7	
22-24		**SILTY SAND WITH GRAVEL** ; reddish brown	S-412@ 22-24'			136	
24-26		**SILTY SAND** ; reddish brown	S-412@ 24-26'			207	
26-28		**SAND AND GRAVEL** ; reddish orange and tannish brown	S-412@ 26-28'			40	
28-30		**SANDY SILT** ; grayish orange	S-412@ 28-30'			56	
30		Borehole terminated at 30 feet.					



PROJECT: **Philly AOI-3 Logs 2015**
LOCATION: **Philly AOI-3**
PROJECT NUMBER:

WELL / PROBEHOLE / BOREHOLE NO:
S-413 PAGE 1 OF 1

Aquaterra Technologies, Inc.

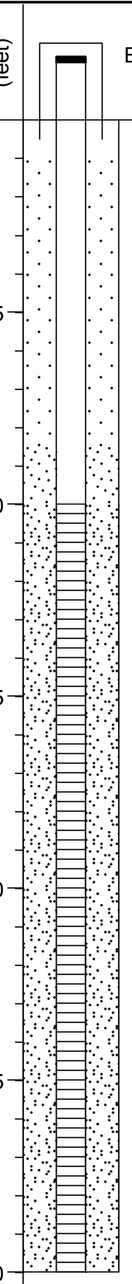
DRILLING / INSTALLATION:
STARTED **10/7/15** COMPLETED: **10/15/15**
DRILLING COMPANY: **Total Quality Drillling**
DRILLING EQUIPMENT: **HSA**
DRILLING METHOD: **HSA**
SAMPLING EQUIPMENT: **Split Spoon**

NORTHING (ft):
LAT:
GROUND ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
STATIC DTW (ft): **Not Encountered**
WELL CASING DIA. (in): **4**
LOGGED BY: **NS**

EASTING (ft):
LONG:
TOC ELEV (ft):
WELL DEPTH (ft): **30.0**
BOREHOLE DEPTH (ft): **30.0**
BOREHOLE DIA. (in): **12**
CHECKED BY: **TD**

Time & Depth (feet)	Description	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)
	SANDY GRAVEL LITTLE SILT ; brown; medium to coarse-grained; moist; subangular; Fill	0930 S-413 _0-2			3
	CLAYEY SILT TRACE SAND ; brown; fine to medium-grained; moist	S-413@ 2-4'			1
5		S-413@ 4-6'			1
	SILT LITTLE CLAY ; gray and orangeish brown; moist; mottled; Utility clearing completed to a depth of 8' bgs via backhoe.	S-413@ 6-8'			1
	SILTY CLAY TRACE GRAVEL ; light grayish brown; fine to medium-grained; dry to moist; subangular	S-413@ 8-10'	2		0.2
10	**SILTY CLAY** ; gray and reddish brown; moist; mottled	S-413@ 10-11'	2		3.1
	CLAYEY SAND ; reddish brown; fine to medium-grained; moist	S-413@ 11-12'			0.6
		S-413@ 12-14'	0.5		9.1
15	**SAND LITTLE GRAVEL** ; gray and black; fine to medium-grained; wet; subrounded; (trenton)	1300 S-413 _14-16	1		3594
		S-413@ 16-18'	1.2		1619
	GRAVEL SOME SAND ; brown; medium to coarse-grained; wet; subangular; (trenton)	S-413@ 18-20'	0.5		822
20	**SANDY CLAY LITTLE GRAVEL** ; brown; fine-grained; wet; subangular	S-413@ 20-22'	0.8		417
	SILTY CLAY LITTLE SAND ; brown; fine to medium-grained; moist to wet	S-413@ 22-24'	0.4		14
25	**SAND AND GRAVEL** ; brown to grayish brown; fine to medium-grained; wet; subrounded	S-413@ 24-26'	2		60.6
		S-413@ 26-28'	1.3		11.8
		S-413@ 28-30'	1.7		6.2
30	Borehole terminated at 30 feet.				
35					

Borehole Backfill



1-8.5' bgs: Bentonite

8.5-30' bgs: Sand
10-30' bgs: 30-slot PVC Screen

PROJECT: **Philly AOI-3 Logs 2015**
LOCATION: **Philly AOI-3**
PROJECT NUMBER:

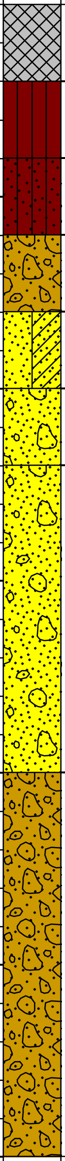
WELL / PROBEHOLE / BOREHOLE NO:
S-414 PAGE 1 OF 1

Aquaterra Technologies, Inc.

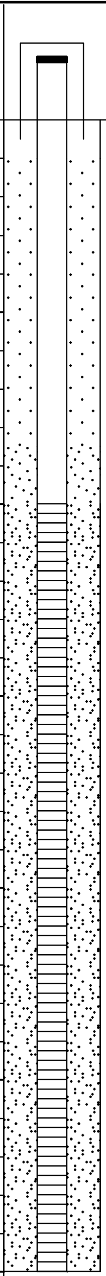
DRILLING / INSTALLATION:
STARTED **10/7/15** COMPLETED: **10/16/15**
DRILLING COMPANY: **Total Quality Drillling**
DRILLING EQUIPMENT: **HSA**
DRILLING METHOD: **HSA**
SAMPLING EQUIPMENT: **Split Spoon**

NORTHING (ft):
LAT:
GROUND ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
STATIC DTW (ft): **Not Encountered**
WELL CASING DIA. (in): **4**
LOGGED BY: **NS**

EASTING (ft):
LONG:
TOC ELEV (ft):
WELL DEPTH (ft): **30.0**
BOREHOLE DEPTH (ft): **30.0**
BOREHOLE DIA. (in): **12**
CHECKED BY: **TD**



Time & Depth (feet)	Description	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)	Borehole Backfill
	SANDY GRAVEL LITTLE SILT ; brown; medium to coarse-grained; dry; subangular; Fill	1200 S-414 _0-2			19		
	SILT LITTLE CLAY LITTLE SAND ; dark brown; fine to medium-grained; moist	S-414@ 2-4'			1		
5	**SANDY SILT LITTLE CLAY** ; gray; fine to medium-grained; moist	S-414@ 4-6'			9	5	1-8.5' bgs: Bentonite
	SAND AND GRAVEL ; reddish brown; fine to coarse-grained; moist; subrounded; Utility clearing completed to a depth of 8' bgs via backhoe.	S-414@ 6-8'			9		
	CLAYEY SAND ; brown; fine to medium-grained; moist	S-414@ 8-10'	0.2		6.4		
10	**SAND LITTLE GRAVEL** ; light tan; fine to medium-grained; moist; subrounded	S-414@ 10-12'	0.5		1303.7	10	
	SAND LITTLE GRAVEL ; dark reddish brown; fine to medium-grained; moist	S-414@ 12-14'	0.2		298.4		
15		S-414@ 14-16'	0.2		259.3	15	
		S-414@ 16-18'	0.9		2834		
		S-414@ 18-20'	0.5		705		
20	**SAND AND GRAVEL** ; grayish brown; fine to medium-grained; moist to wet; subrounded; (Trenton)	1315 S-414 _20-22	1.3		2853	20	8.5-30' bgs: Sand 10-30' bgs: 30-slot PVC Screen
		S-414@ 22-24'	0.3		258.6		
25		S-414@ 24-26'	0.4		67.9	25	
		S-414@ 26-28'	0.5		48.7		
		S-414@ 28-30'	1		16.2		
30	Borehole terminated at 30 feet.					30	
35						35	



PROJECT: **Philly AOI-3 Logs 2015**
LOCATION: **Philly AOI-3**
PROJECT NUMBER:

WELL / PROBEHOLE / BOREHOLE NO:
S-415 PAGE 1 OF 1

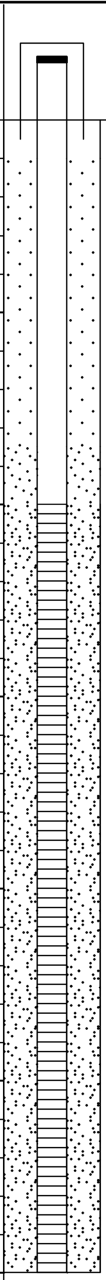
Aquaterra Technologies, Inc.

DRILLING / INSTALLATION:
STARTED **10/12/15** COMPLETED: **10/13/15**
DRILLING COMPANY: **Total Quality Drillling**
DRILLING EQUIPMENT: **HSA**
DRILLING METHOD: **HSA**
SAMPLING EQUIPMENT: **Split Spoon**

NORTHING (ft):
LAT:
GROUND ELEV (ft):
INITIAL DTW (ft): **Not Encountered**
STATIC DTW (ft): **Not Encountered**
WELL CASING DIA. (in): **4**
LOGGED BY: **NS**

EASTING (ft):
LONG:
TOC ELEV (ft):
WELL DEPTH (ft): **30.0**
BOREHOLE DEPTH (ft): **30.0**
BOREHOLE DIA. (in): **12**
CHECKED BY: **TD**

Time & Depth (feet)	USCS	Description	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)	Borehole Backfill
		GRAVEL SOME SILT AND SAND ; brown; fine to coarse-grained; dry; subangular; Fill (bricks)	0845 S-415 _0-2			0.0		
			S-415@ 2-4'			6		
5		**SILTY CLAY LITTLE GRAVEL** ; dark brown; fine to medium-grained; hard to dense; dry; subangular	S-415@ 4-6'			0.0	5	1-8.5' bgs: Bentonite
		SILTY CLAY LITTLE GRAVEL ; yellowish brown; fine to medium-grained; dry to moist; subangular; Utility clearing completed to a depth of 8' bgs via backhoe.	S-415@ 6-8'			0.4		
		No recovery		0				
10		**SANDY CLAY LITTLE SILT** ; brown and gray; fine to medium-grained; moist; gray (quartzite) subangular medium size gravel bottom of spoon	S-415@ 10-12'	1.1		1.6	10	
			S-415@ 12-14'	0.5		0.1		
15		**GRAVEL LITTLE SILT AND CLAY** ; gray; fine to medium-grained; moist; subangular	S-415@ 14-16'	0.8		310	15	
		SAND AND GRAVEL ; gray; fine to medium-grained; moist to wet; subrounded; (trenton gravel)	1300 S-415 _16-18	1.2		1328		
			S-415@ 18-20'	0.8		516		8.5-30' bgs: Sand 10-30' bgs: 30-slot PVC Screen
20		**SAND SOME GRAVEL** ; dark gray; fine to medium-grained; wet; subrounded	S-415@ 20-22'	2		598	20	
			S-415@ 22-24'	1.2		1202		
25		**SAND AND GRAVEL** ; dark gray; fine to medium-grained; wet; subrounded	S-415@ 24-26'	0.5		164.8	25	
			S-415@ 26-28'	2		44.1		
			S-415@ 28-30'			10.8		
30		Borehole terminated at 30 feet.					30	
35							35	



APPENDIX D

EVERGREEN QA/QC PLAN AND FIELD PROCEDURES MANUAL

LANGAN

Quality Assurance/ Quality Control Plan and Field Procedures Manual

Sunoco Partners Marcus Hook Industrial Complex and Philadelphia
Energy Solutions (PES) Philadelphia Refinery Complex

Evergreen Resources Management Operations
May 20, 2016

Table of Contents Page

Appendix

1.0 INTRODUCTION

This Quality Assurance/Quality Control Plan and Field Procedures Manual (QA/QC Plan) outlines the procedures developed to ensure the collection and analysis of quality data for investigations completed under the United States Environmental Protection Agency (USEPA) Resource Conservation and Recovery Act (RCRA), Pennsylvania Department of Environmental Protection (PADEP) Act 2, and Pennsylvania and Delaware's Tank programs at the Sunoco Partners Marketing and Terminals, LP (Sunoco Partners) Marcus Hook Industrial Complex (MHIC) and the Philadelphia Energy Solutions Refining and Marketing, LLC (PES) Philadelphia Refinery Complex (PRC) on behalf of Evergreen Resources Management Operations (Evergreen). This document shall be used in conjunction with the site-specific work plans developed for each site and Standard Operating Procedures (SOPs) for field work as incorporated as Appendix A of this QA/QC Plan.

The QA/QC Plan is a planning document that provides a "blueprint" for obtaining the type and quality of data needed to support environmental decision making. The QA/QC Plan integrates relevant technical and quality aspects of a project and documents quality assurance and quality control.

The selection criteria and evaluation specified in this document will be used for validating the data in accordance with the USEPA Guidance on Environmental Data Verification and Data Validation (USEPA 240-R-02-004), dated November 2002 (EPA QA/G-8), USEPA Contract Laboratory Program National Functional Guidelines (NFGs) for Superfund Organic Methods Data Review (USEPA 540-R-08-01), dated June 2008 (SOM02.2) and USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review (USEPA 540-R-10-011), dated January 2010 (ISM02.2). Qualifiers assigned to the data will be consistent with the data qualifiers specified in the NFGs and the USEPA Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use (USEPA 540-R-08-01), collectively referred to herein as validation guidance.

2.0 QUALITY CONTROL REQUIREMENTS

The field and laboratory QC requirements for the characterization and remediation activities are discussed in the following subsections. Specific QC checks and acceptance criteria are provided in the referenced analytical methods.

2.1 Field Sampling Quality Control

The field QC requirements include analyzing reference standards for field instrument calibration and for routine calibration verifications. All initial and continuing calibration procedures will be implemented by trained personnel following the manufacturer's instructions to ensure the equipment is functioning within the specified tolerances. The calibration and maintenance history of the project-specific field instrumentation will be maintained in an active field logbook.

Field QC samples for this project include field duplicate samples to assess the overall precision of the sampling and analysis event, equipment rinse blanks to ensure proper cleaning of non-dedicated equipment is conducted between samples to avoid potential cross contamination (also generally referred to as field blanks), and trip blank samples to monitor cross contamination of water samples by volatile organic compounds (VOCs) during sample transport.

The frequency of collection of equipment rinse blanks will be one per sampling event. Field duplicate samples will only be prepared for groundwater samples, not for soil sampling events, at a collection frequency of 1 in 20 samples. One trip blank will be included for every shipment of samples to an analytical laboratory, at a minimum frequency of one trip blank per sample shipment which contains samples for VOCs analyses.

2.2 Analytical Quality Control

The laboratory QC requirements for the analyses may include evaluating chemical/thermal preservation, holding times, handling requirements, method blanks, instrument performance checks, initial calibration standards, calibration verification standards, internal standards, surrogate compound spikes, interference check samples, serial dilution samples, matrix spike/matrix spike duplicate (MS/MSD) samples, and laboratory control samples (LCS). The acceptance criteria for the above identified requirements will be generated by the laboratory and included in the laboratory reports, along with the other laboratory QC requirements.

3.0 DATA VERIFICATION, VALIDATION, AND USABILITY

All field and laboratory data will be reviewed, verified, and/or validated. These terms are defined as follows:

- Data review is the in-house examination to ensure that the data have been recorded, transmitted, and processed correctly.
- Data verification is the process for evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, and/or contractual requirements.
- Data validation is an analyte-specific and sample-specific process that extends the evaluation of data beyond method, procedure, or contractual compliance (i.e., data verification) to determine the quality of a specific data set relative to the end use.

Field data and logbooks will be reviewed to ensure that the requirements of the sampling program, including the number of samples and locations, sampling, and sample handling procedures, were fulfilled.

Data verification, validation, and usability assessments performed on a percentage of lab packages to ensure that the data are scientifically defensible, properly documented, of known quality, and meet the project objectives, are described in the following sections. Data determined to be unusable may require corrective action be taken. Data use limitations will be identified in the data validation and usability assessment (VUA) report, which will be generated as required for characterization or final reporting to the agencies.

3.1 Data Review, Verification, and Validation Requirements

Data review, verification, and validation of the analytical data will be performed by each consultant completing the field activities. The exception to this scenario will be Aquaterra Technologies, Inc. (Aquaterra), in which case Aquaterra will review/verify the data and the consultant company working with Aquaterra will subsequently validate the samples.

Field information will be reviewed to ensure that all field measurements were conducted in accordance with the requirements of the site-specific work plan and this QA/QC Plan including applicable SOPs. Field measurements obtained using procedures inconsistent with the requirements of these documents will be evaluated and may require that additional samples are collected or the use of the data be restricted.

Stage 1 Verification and Validation Checks

One hundred percent of the sample results will go through a Stage 1 verification and validation. As part of the data management process, each consultant will complete verification and validation based on the validation guidance. Data verification and validation will consist of the following items based on the guidance stated.

Stage 1 verification and validation of the laboratory analytical data package consists of checks for the compliance of sample receipt conditions, sample characteristics (e.g., percent moisture), and analytical results (with associated information). It is recommended that the following minimum baseline checks (as relevant) be performed on the laboratory analytical data package received for a Stage 1 validation label:

1. Documentation identifies the laboratory receiving and conducting analyses, and includes documentation for all samples submitted by the project or requester for analyses.
2. Requested analytical methods were performed and the analysis dates are present.
3. Requested target analyte results are reported along with the original laboratory data qualifiers and data qualifier definitions for each reported result.
4. Requested target analyte result units are reported.
5. Requested reporting limits for all samples are present and results at and below the requested (required) reporting limits are clearly identified (including sample detection limits if required).
6. Sampling dates (including times if needed), date and time of laboratory receipt of samples, and sample conditions upon receipt at the laboratory (including preservation, pH and temperature) are documented.
7. Sample results are evaluated by comparing sample conditions upon receipt at the laboratory (e.g., preservation checks) and sample characteristics (e.g., percent moisture) to the validation guidance.

Stage 2 Verification and Validation Checks

A minimum of 10 percent of the samples will be flagged for VUA. When a laboratory work order is selected, the entire work order will undergo Stage 2 validation. Laboratory work orders or sample delivery groups (SDGs) that are selected for VUA will undergo validation based on the NFGs.

The selection of samples that will undergo VUA process is designed to meet the needs of the site investigation, characterization, remediation, and closure programs, such as tank closures. Sampling that falls outside these programs will not undergo the VUA process. This includes samples that are collected for permit compliance, such as RCRA and effluent wastewater, as well as product samples, onsite soil reuse samples, and waste characterization samples.

Ten percent of samples will be selected based on the following additional conditions:

1. Sample package selected will contain a field duplicate sample.
2. Sample package selected will contain an equipment rinse blank.
3. Sample package selected will be representative of the contracted analytical laboratories, sample media, parameters, time, and project goals.

QC samples that are collected in the field will provide the best information for completing the VUA reports. The conditions for selection of samples are designed to provide the most useful information regarding sample analysis. Therefore, field duplicate samples have been identified as a priority condition. However, field duplicate samples will only be prepared for groundwater samples, not for soil sampling events. This is due to the known, inherent heterogeneity of soil at the sites. For program efficiency, entire SDGs will be selected for submission in the VUA process. Individual samples should not be selected and processed unless there is an overriding reason to do so, such as a point of compliance sample result that when compared to the historic data set appears to be anomalous.

Stage 2 data validation includes a review of the following QC data deliverables:

1. Technical holding times
2. Method blanks
3. Surrogate spikes
4. MS/MSD results
5. LCS results
6. Field duplicates

7. Trip and equipment rinse blank samples

Stage 2B Verification and Validation Checks

Stage 2B verification and validation will be completed on inorganic analytical data and will contain the following (in addition to Stage 1 verification):

1. Requested methods (handling, preparation, cleanup, and analytical) are performed.
2. Method dates (including dates, times and duration of analysis for radiation counting measurements and other methods, if needed) for handling (e.g., Toxicity Characteristic Leaching Procedure), preparation, cleanup and analysis are present, as appropriate.
3. Sample-related QC data and QC acceptance criteria (e.g., method blanks, surrogate recoveries, deuterated monitoring compounds (DMC) recoveries, laboratory control sample (LCS) recoveries, duplicate analyses, matrix spike and matrix spike duplicate recoveries, serial dilutions, post digestion spikes, standard reference materials) are provided and linked to the reported field samples (including the field quality control samples such as trip and equipment blanks).
4. Requested spike analytes or compounds (e.g., surrogate, DMCs, LCS spikes, post digestion spikes) have been added, as appropriate.
5. Sample holding times (from sampling date to preparation and preparation to analysis) are evaluated.
6. Frequency of QC samples is checked for appropriateness (e.g., one LCS per twenty samples in a preparation batch).
7. Sample results are evaluated by comparing holding times and sample-related QC data to the requirements in the data validation guidance.
8. Initial calibration data (e.g., initial calibration standards, initial calibration verification [ICV] standards, initial calibration blanks [ICBs]) are provided for all requested analytes and linked to field samples reported. For each initial calibration, the calibration type used is present along with the initial calibration equation used including any weighting factor(s) applied and the associated correlation coefficients, as appropriate. Recalculations of the standard concentrations using the initial calibration curve are present, along with their associated percent recoveries, as appropriate (e.g., if required by the project, method, or contract). For the ICV standard, the associated percent recovery (or percent difference, as appropriate) is present.
9. Appropriate number and concentration of initial calibration standards are present.

10. Continuing calibration data (e.g., continuing calibration verification [CCV] standards and continuing calibration blanks [CCBs]) are provided for all requested analytes and linked to field samples reported, as appropriate. For the CCV standard(s), the associated percent recoveries (or percent differences, as appropriate) are present.
11. Reported samples are bracketed by CCV standards and CCBs standards as appropriate.
12. Method specific instrument performance checks are present as appropriate (e.g., tunes for mass spectrometry methods, DDT/Endrin breakdown checks for pesticides and aroclors, instrument blanks and interference checks for ICP methods).
13. Frequency of instrument QC samples is checked for appropriateness (e.g., gas chromatography-mass spectroscopy [GC-MS] tunes have been run every 12 hours).
14. Sample results are evaluated by comparing instrument-related QC data to the requirements in the data validation guidance.

Stage 3 Verification and Validation Checks

Stage 3 verification and validation will be completed on organic analytical data and will contain the following (in addition to Stage 2B):

1. Instrument response data (e.g., GC peak areas, ICP corrected intensities) are reported for requested analytes, surrogates, internal standards, and DMCs for all requested field samples, matrix spikes, matrix spike duplicates, LCS, and method blanks as well as calibration data and instrument QC checks (e.g., tunes, DDT/Endrin breakdowns, interelement correction factors, and Florisil cartridge checks).
2. Reported target analyte instrument responses are associated with appropriate internal standard analyte(s) for each (or selected) analyte(s) (for methods using internal standard for calibration).
3. Fit and appropriateness of the initial calibration curve used or required (e.g., mean calibration factor, regression analysis [linear or non-linear, with or without weighting factors, with or without forcing]) is checked with recalculation of the initial calibration curve for each (or selected) analyte(s) from the instrument response.
4. Comparison of instrument response to the minimum response requirements for each (or selected) analyte(s).
5. Recalculation of each (or selected) opening and closing CCV (and CCB) response from the peak data reported for each (or selected) analyte(s) from the instrument response, as appropriate.

6. Compliance check of recalculated opening and/or closing CCV (and CCB) response to recalculated initial calibration response for each (or selected) analyte(s).
7. Recalculation of percent ratios for each (or selected) tune from the instrument response, as appropriate.
8. Compliance check of recalculated percent ratio for each (or selected) tune from the instrument response.
9. Recalculation of each (or selected) instrument performance check (e.g., DDT/Endrin breakdown for pesticide analysis, instrument blanks, interference checks) from the instrument response.
10. Recalculation and compliance check of retention time windows (for chromatographic methods) for each (or selected) analyte(s) from the laboratory reported retention times.
11. Recalculation of reported results for each reported (or selected) target analyte(s) from the instrument response.
12. Recalculation of each (or selected) reported spike recovery (surrogate recoveries, DMC recoveries, LCS recoveries, duplicate analyses, matrix spike and matrix spike duplicate recoveries, serial dilutions, post digestion spikes, standard reference materials etc.) from the instrument response.
13. Each (or selected) sample result(s) and spike recovery(ies) are evaluated by comparing the recalculated numbers to the laboratory reported numbers according to the requirements in the data validation guidance.

Stage 4 Verification and Validation Checks

Additional data validation may be completed for selected sites and/or sampling events, up to EPA Level 4 data review, which will require a laboratory data package inclusive of raw data. Stage 4 verification and validation includes all of the elements of the previous stages of validation and the following:

1. Evaluation of instrument performance checks (GC/MS)
2. Initial and continuing calibration checks (organic and inorganic analyses)
3. Review of internal standards (GC/MS)
4. Instrument blanks (inorganics)
5. Interference check samples (metals)
6. Recalculations of sample results and reporting limits

3.2 Validation Codes

Consultant specific validation codes will be added to the database. This will allow quick identification of the consultant that has performed the verification and/or VUA. Stantec may append additional codes for data management purposes to the codes provided in dt_result table approval_code field. Valid codes are as follows:

Langan:

- LAN1 – Historical data collected by Langan Level 1 Validation (Verification)
- LAN-VER – Langan performed verification
- LAN-USB – Langan performed usability

GHD:

- GHD-VER – GHD performed verification
- GHD-USB – GHD performed usability

Stantec:

- STN-VER – Stantec performed verification
- STN-USB – Stantec performed usability

This methodology creates a means for consultants to perform verification and usability on data collected by another consultant.

3.3 Data Updates in the Electronic Data Deliverables

All consultants will request EQuIS 4 file format Electronic Data Deliverables (EDDs) for data management from the analytical laboratories. In order to facilitate the data updates in the database, the following methodology will be used.

1. The consultant chemist / chemist team will open the .RES file for the EDD that has been selected to be validated for usability. The file can be opened using Excel, Access, Notepad, or similar tool. Although, it is a best practice to open the file in a way to preserve the textual nature of the EDD, it is not necessary.
2. The chemist will use the result_comment field in the .RES file to enter the qualifiers associated with the record and add a semicolon as a delimiter (;) followed by the reason code for the qualification.

3. The .RES file is to be saved with a .USB extension at the end of the file. This file is to be separate from the original .RES file provided and should not be used to over write the original .RES file that was sent with the EDD. This will result in the laboratory work order undergoing VUA having five files instead of four for the EDD. For example:
    - 1234.SMP
    - 1234.TST
    - 1234.BCH
    - 1234.RES
    - 1234.RES.USB
4. Stantec will use the fifth file to update the database with the appropriate qualifiers and codes in validator_qualifiers and approval_a through approval_d fields in dt_result table in the database.
5. Stantec will also change the validated y/n field in dt_result table in the database for the particular EDD.

3.4 Validation Qualifiers

The following qualifiers should be used during the validation/usability process. These are based on the NFGs, validation guidance, and commonly used qualifiers.

Data Qualifiers and Definitions

U	The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
J	The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
J+	The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample, potentially biased high.
J-	The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample, potentially biased low.
UJ	The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.
NJ	The analyte has been "tentatively identified" or "presumptively identified" as present and the associated numerical value is the estimated concentration in the sample.

R	The data are unusable. The sample results are rejected due to serious deficiencies in meeting QC criteria. The analyte may or may not be present in the sample.
B	The analyte was detected in the method, field, and/or trip blank. This qualifier is not pursuant to the NFGs.

If additional qualifiers are required, please forward the suggestions to the Stantec Data Management Team and they will be added to the list of approved codes.

Submitting Data and Validation Codes for Inclusion in the Database

EDDs will be submitted to the database using the SharePoint portal intake forms. The appropriate qualifiers and codes that have been added to the result_comment field in the .RES.USB file will be included in the submission.

Reason Codes

Following is a list of reason codes available for validation. If additional codes are required, please forward the suggestions to the Stantec Data Management Team and they will be added to the list of approved codes.

Reason Code	Reason Description
General Use	
EC	Result exceeds the calibration range.
HT	Holding time requirement was not met
MB	Method blank or preparation blank contamination
LCS	Laboratory control sample evaluation criteria not met
FB	Field blank contamination
RB	Rinsate blank contamination
SQL	The analysis meets all qualitative identification criteria, but the measured concentration is less than the reporting limit.
FD	Field duplicate evaluation criteria not met
TvP	Total to Partial criteria not met
RL	Reporting limit exceeds decision criteria (for non-detects)
Inorganic Methods	
ICV	Initial calibration verification evaluation criteria not met
CCV	Continuing calibration verification evaluation criteria not met
CCB	Continuing calibration blank contamination
PB	Preparation Blank
ICS	Interference check sample evaluation criteria not met
D	Laboratory duplicate or spike duplicate precision evaluation criteria not met
MS	Matrix spike recovery outside acceptance range
PDS	Post-digestion spike recovery outside acceptance range
MSA	Method of standard additions correction coefficient _0.995
DL	Serial dilution results did not meet evaluation criteria
Organic Methods	
TUNE	Instrument performance (tuning) criteria not met
ICAL	Initial calibration evaluation criteria not met
CCAL	Continuing calibration evaluation criteria not met
SUR	Surrogate recovery outside acceptance range
MS/SD	Matrix spike/matrix spike duplicate precision criteria not met
MS	Matrix spike recovery outside acceptance range
IS	Internal standard evaluation criteria not met
LM	The PFK lock mass SICPs indicate that ion suppression evident
ID	Target compound identification criteria not met
Results Reported for Analytes Analyzed Multiple Times	
NSR	Not selected for reporting because the result was qualified as unusable
NSDL	Not selected for reporting because diluted resulted was selected for reporting
NSQ	Not selected for reporting because result was lesser quality based on data validation
NSO	Not selected for reporting because of other reason
Bias Codes	
H	Bias in sample result likely to be high
L	Bias in sample result likely to be low
I	Bias in sample result is indeterminate

3.4 Verification and Validation Summary

Verification of sample collection procedures will consist of reviewing sample collection documentation for compliance with the requirements of the site-specific work plan and this QA/QC Plan. If alternate sampling procedures were used, the acceptability of the procedure will be evaluated to determine the effect on the usability of the data. Data usability will not be affected if the procedure used is determined to be an acceptable alternative that fulfills the measurement performance criteria in this QA/QC Plan.

The results of the data verification and validation procedure will identify data that do not meet the measurement performance criteria of this QA/QC Plan. Data verification and validation will determine whether the data are acceptable, of limited usability (qualified as estimated), or rejected. Data qualified as estimated will be reviewed and a discussion of the usability of estimated data will be included in the VUA report.

Data determined to be unusable may require corrective action to be taken. Potential types of corrective action may include resampling by the field team or reanalysis of samples by the laboratory. The corrective actions taken are dependent upon the ability to mobilize the field team and whether or not the data are critical for project data quality objectives to be achieved. Data use limitations will be identified in VUA report, which will be generated as required for characterization or final reporting to the agencies. Each consultant will be responsible for their own VUA reports.

Revision History

Revision	Description	Prepared By	Date
1.0	Initial creation of document as SOP for VUA	Stantec (Gus Sukkurwala/Jennifer Menges/Andrew Bradley)	5/31/2015
2.0	Incorporation into QA/QC Plan	GHD (Colleen Costello)	3/21/2016
3.0	Inclusion of Field Procedures. Edits from Langan (Emily Strake & Kevin McKeever)	Stantec (Jennifer Menges)	5/13/2016

APPENDIX A
EVERGREEN FIELD PROCEDURES MANUAL

Evergreen
Field Procedures Manual

Sunoco Partners Marcus Hook Industrial Complex and Philadelphia Energy Solutions (PES) Philadelphia Refinery Complex

Evergreen Resources Management Operations

May 20, 2016

Table of Contents

1.0 INTRODUCTION

This Field Procedures Manual outlines the standard operating procedures developed to ensure the collection and analysis of quality data for investigations completed under the United States Environmental Protection Agency (USEPA) Resource Conservation and Recovery Act (RCRA) program, Pennsylvania Department of Environmental Protection (PADEP) Act 2 program and Pennsylvania and Delaware's Tank programs at the Sunoco Partners Marketing and Terminals, LP (Sunoco Partners) Marcus Hook Industrial Complex (MHIC) and the Philadelphia Energy Solutions Refining and Marketing, LLC (PES) Philadelphia Refinery Complex (PRC) on behalf of Evergreen Resources Management Operations (Evergreen). The MHIC and PRC are herein referred to as facility or site.

Evergreen's consultants collect data in pursuit of site characterization and remediation that will meet the expectations of the appropriate regulatory agencies. This document shall be used in conjunction with the site-specific work plans developed for each site and the QA/QC Plan of which this manual was incorporated as Appendix A.

1.1 Training Qualifications

All field personnel involved in field work at MHIC and the PRC shall have completed and where applicable, be current with OSHA 40-hour HAZWOPER training, annual OSHA 8-hour HAZWOPER refresher, Process Safety Management (PSM) training, site-specific safety module training for current facility badges (including fire watch and hole watch, if required), TWIC Card, annual drug screening, and annual respirator fit testing. All field personnel new to the facility should be provided with onsite health and safety (H&S) orientation by an experienced member of the project team. The onsite orientation should include review of the facility's emergency action plan and training on Evergreen and site-specific H&S requirements. Appropriately qualified personnel should perform field work, based on the work scope and experience level required by the task to be executed.

1.2 Health and Safety Requirements

All consultants performing work at the referenced sites on behalf of Evergreen shall comply with the *Evergreen Resources Management Operations Health and Safety Requirements* dated June 1, 2014. This includes contractors, sub-contractors, and third party companies performing work for Evergreen at MHIC and the PES PRC. Each consultant must also have their own site-specific health and safety plan (HASP) submitted to and approved by Evergreen prior to performing any work. A site-specific HASP must be reviewed and signed by all field personnel prior to commencement of field activities.

1.3 PPE Requirements

The minimum standard PPE at the facilities includes fire resistant clothing (FRC; coveralls may be Nomex or other FRC, 6 ounce minimum, orange in color) with the name of the company displayed on the back of the garment, hard hat, sturdy safety-toe boots, safety glasses, long-gauntlet leather gloves, and personal H_2S monitors. Nitrile gloves for chemical protection and hearing protection may also be required depending on the location and type of work. Workers are to be trained on these PPE requirements before being permitted onsite. An appropriate respirator may be required if site-specific air monitoring action levels are met, in accordance with the site-specific HASP. If a worker has a particular sensitivity or concern, a respirator may be worn regardless of OSHA action levels. During winter weather conditions, slip prevention footwear such as crampons or overshoes should be worn for traction. Task-specific PPE will be further identified in following sections.

1.4 Site Controls

Safety cones and/or caution tape should be used in high traffic areas. The "Buddy System" may also be employed in high traffic areas, in areas where other contractors are working, and in remote areas. Additional task-specific site controls will be detailed in following sections.

1.5 Equipment and Decontamination

Numerous practices are employed throughout the processes of site investigation and sampling to assure the integrity of the resulting data. The risk in use of non-dedicated equipment at multiple sampling locations lies in the potential for cross-contamination. While the threat of cross-contamination is always present, it can be minimized through the implementation of a consistent decontamination program during sensitive site measurement and data collection activities.

All site equipment to be used in multiple locations (non-dedicated) for sampling of soil, sediment, and/or groundwater will be decontaminated immediately prior to initial use and between uses at each location according to the following steps:

- Remove particulates with a sorbent pad or towel and/or initial rinse with clean potable tap water;
- Wash equipment with clean sponge, soft cloth, or scrub brush as necessary in a solution of tap water/laboratory grade detergent (Alconox®, Liquinox®, or equivalent);
- Rinse with tap water;
- Rinse with deionized or distilled water; and
- Air dry for as long as possible.

Rinse water generated during decontamination procedures will be treated onsite by passing the water through a bucket or tube filled with activated carbon prior to discharge to the ground surface. Additional decontamination procedures may be appropriate depending on the task, and will be identified in the following sections, as applicable.

1.6 Documentation

All site activities and conditions for characterization activities should be recorded by field personnel in a field computer (e.g., YUMA) using the EQuIS Data Gathering Engine (EDGE) application, or if necessary, a field book may be used. The entry shall include at a minimum, the date, time, weather conditions, location, personnel present onsite, field readings, sampling methodology, as well as additional comments or observations. Task specific observations which should also be recorded will be identified in the following applicable sections.

2.0 LIQUID LEVEL ACQUISITION (WELL GAUGING) PROCEDURES

2.1 Potential Hazards

Traffic, pinch points, chemical (airborne and physical contact), and biological are all likely hazards to be encountered as well as slip/trip/fall potential during onsite well gauging activities. Additional hazards may be mentioned in the site-specific HASP and/or the daily job safety analysis (JSA).

2.2 Materials and Equipment Necessary for Task Completion

Optical oil/water interface probe with a graduated measuring tape to 0.01 foot accuracy, decontamination supplies (laboratory-grade detergent, deionized or distilled water, appropriate containers, scrub brush, and sorbent pads or paper towels), socket set, flathead screwdriver (or pry bar or manhole cover lifter), clear bailers with string for confirmation of light non-aqueous phase liquids (LNAPL), if necessary, and air monitoring instruments (optional, based on previous site visits).

2.3 Methodology

This task involves the deployment of an optical oil/water interface probe with a graduated measuring tape to 0.01 foot accuracy into a well (in most cases), recording the measurement, and decontaminating the probe. The recorded field measurements may then be utilized for one of several applications including: well sampling, water table gradient mapping, LNAPL occurrence, LNAPL thickness, and/or gradient mapping, and various testing procedures. Wells should be gauged in order of least to most contaminated, based on existing sampling data or LNAPL occurrence, to minimize the potential for cross-contamination between wells. If LNAPL is detected in a well that does not typically have LNAPL, it should be confirmed with a clear bailer.

The proper procedure for liquid level acquisition is as follows:

1) Decontaminate the optical oil/water interface probe with a graduated measuring tape to 0.01 foot accuracy prior to initial deployment, and again after each well measurement to prevent cross-contamination between wells.

2) If warranted, mark off a work area surrounding the well(s) to be gauged with safety cones and/or caution tape in order to protect personnel from auto traffic; the "Buddy System" may also be employed.

3) Where applicable, lift the manhole cover off of the well head (a screwdriver, pry bar, or manhole cover lifter may be used to lift the cover depending on the size of the manhole) or open protective well casing (stickup) and remove the well plug, if present.

4) Most wells should contain a mark or notch in the top edge of the casing from which normalized readings are to be measured (reference point elevation). Slowly lower the optical oil/water interface probe with a graduated measuring tape to 0.01 foot accuracy into the well until the instrument signals contact with liquid. Note whether or not the instrument’s tone is indicative of the presence of free-phase LNAPL (commonly a solid tone), or water (commonly an oscillating or beeping tone). If LNAPL is present, record the depth at which LNAPL was first indicated to the nearest hundredth of a foot, as measured from the top of well casing mark/notch. Slowly lower the probe through the LNAPL until the instrument’s tone changes to indicate the presence of water. Record the depth at which water was first indicated to the nearest hundredth of a foot. A clear bailer may be used to verify the existence or approximate amount and appearance of LNAPL. If no LNAPL is apparent, record the depth to water.

5) Retract the probe from the well and secure the well appropriately.

6) Note the date and time of measurement for gauging and record all measurements and observations in the field computer or, if necessary, in a field book for subsequent electronic data entry.

7) Decontaminate the probe in accordance with the decontamination procedure outlined in Section 1.5.

8) Clean up the work area, remove gauging equipment, and remove any traffic control devices.

3.0 GROUNDWATER MONITORING PROCEDURES

3.1 Potential Hazards

Traffic, pinch points, chemical (airborne and physical contact), and biological are all likely hazards to be encountered as well as slip/trip/fall potential during onsite well gauging activities. Additional hazards may be mentioned in the site-specific HASP and/or the daily JSA.

3.2 Materials and Equipment Necessary for Task Completion

A list of equipment required to access, gauge, purge, and sample site monitoring wells is presented below. Also listed are materials necessary to store, label, preserve, and transport groundwater samples.

- Current site map detailing well locations;
- Field book and/or field computer for recording site data;
- Graduated, optical oil/water interface probe;
- Keys and tools to provide well access;
- Appropriate, laboratory prepared sample containers and labels;
- Appropriate well purging apparatus as determined by volume of groundwater to be purged and compounds to be analyzed;
- Water quality meter for monitoring indicator field parameters (DO, pH, specific conductance, redox potential, and turbidity if available);
- Dedicated polyethylene bottom-loading bailer or well pump and disposable tubing for groundwater sample collection;
- Clean nylon or polypropylene bailer cord;
- Disposable nitrile sampling gloves;
- Decontamination supplies;
- Calibrated five-gallon bucket and watch or stopwatch to determine discharge rate during purging;
- Blank chain-of-custody forms; and

- Cooler(s) and ice for sample preservation.

3.3 Methodology for Three Well Volume Sampling

Prior to site visitation for the groundwater sampling event, the following data will be reviewed to ensure proper preparation for field activities:

- Most recent liquid level data from all wells;
- Most recent analytical data from all wells to determine gauging and sampling sequence; and
- Well construction characteristics.

Each monitoring well to be sampled will be gauged to obtain liquid level data immediately prior to initiation of the sampling process (refer to well gauging procedures above). Liquid level data should be recorded in a field computer or if necessary, a field book. Should free-phase LNAPL be detected by the gauging process, routine groundwater sampling will not be conducted at that location. If groundwater sampling under LNAPL is warranted, refer to the sub-LNAPL sampling section and methodology in Section 3.6.

Groundwater sampling will be initiated by purging from the well a minimum of three well volumes, except in cases where the well is pumped dry, as referenced below. Well purging is performed to remove stagnant water and to draw representative water from the aquifer into the well for subsequent sampling and analysis. In extreme cases where a well is pumped dry and/or shows little recharge capacity, the well should be evacuated once prior to sampling. Wellbore storage volume should be estimated using as-built information stored in the field computer or as indicated on the well log, and the depth to water measurement obtained immediately prior to sampling.

Water quality should be monitored and readings recorded in the field computer or field book while purging, typically through use of a multi-parameter water quality meter with a flow through cell or cord for down-well measurements. Water quality readings should be recorded a minimum of three times (pre-purge, during purge, and post-purge/sample collection) or four times (pre-purge and following each well volume). The parameters to be monitored and recorded are dissolved oxygen, pH, specific conductance, redox potential, temperature, and turbidity if available.

Well purging can be performed with various equipment including: a dedicated bailer for hand bailing low volumes of water; a surface mounted electric centrifugal pump with dedicated polyethylene tubing; and/or submersible pump (particularly when the depth to water is greater than 20 feet) with dedicated polyethylene tubing. During pumping, the intake will be placed directly below the static water surface and slowly lowered during the purging process. This procedure may not be necessary in low-yielding wells but is important in high-yielding, permeable strata where an intake initially placed deep in a well may draw laterally and have little influence in exchanging water from shallower depths within the well bore.

Flow rate during well purging will be approximated by the bucket and stop watch method. The duration of pumping required to remove three well volumes will be calculated directly from this flow rate. All fluids removed during purging will be treated onsite with activated carbon or in accordance with an approved work plan.

The sequence of obtaining groundwater samples will be based upon available historical site data for existing wells and photoionization detector (PID) readings for newly installed wells. Monitoring wells will be sampled in order of those having the lowest to highest concentration of constituents of concern (or PID readings for new wells), based upon the most recent available set of laboratory analyses, to reduce the potential for cross-contamination. For general monitoring events, groundwater samples will not be obtained for analysis from any well containing measurable free product. If groundwater sampling under LNAPL is warranted, refer to the sub-LNAPL sampling section and methodology in Section 3.6.

The following sequence of procedures will be implemented for the collection of groundwater samples from monitoring wells.

1) Establish a clean work area where sampling equipment will not come in contact with the ground or any potentially contaminated surfaces.
2) Use a dedicated polyethylene sampling bailer for each well.
3) Use a clean pair of nitrile gloves.

4) Attach an appropriate length of unused, clean nylon or polypropylene cord to the designated sampling bailer.

5) Select appropriate laboratory-provided sample containers.

6) Slowly lower sampling bailer into well until water surface is encountered; continue to lower the sampling bailer into the standing water column to one foot below the water surface.

7) Retrieve bailer at a steady rate to avoid excess agitation.

8) Visually inspect bailed sample to ensure that no free product or organic detritus has been collected.

9) Uncap first designated sample vial and fill from bailer as rapidly as possible but minimizing agitation; secure septum and lid.

10) Inspect sealed sample for entrapped air; if air is present, remove the lid and gently top off sample in vial, seal and inspect. Repeat until no air is apparent.

11) Repeat Steps 9 and 10 for the remaining sample vials based on the laboratory and/or regulatory protocol.

12) Complete and attach labels to sample containers noting sample collector, date, time, and location of sample; record same data in field computer or field book.

13) Place samples in ice-filled cooler in such a manner as to avoid breakage. Samples will be maintained at a temperature of approximately 4°C.

14) Dispose of gloves, bailer, and bailer cord as solid waste and move to next sample location.

3.4 Methodology for Low-Flow Purging and Sampling

For wells that will be purged and sampled via low-flow methodology, the USEPA Region III Bulletin QAD023: *Procedure for Low-Flow Purging and Sampling of Groundwater Monitoring Wells* will be followed. The following data will be reviewed for each well in order to set the pump intake for the low-flow sampling:

- Soil boring lithologic log;
- Well construction log showing the screened interval;
- Identification of the most permeable zone screened by the well;
- Approximate depth to static water;

- Proposed pump intake setting; and
- Technical rationale for the pump intake setting, preferably across from the most impacted/contaminated subsurface interval.

Adjustable rate, submersible, bladder pumps in conjunction with polyethylene tubing for purging and sampling will be used. An alternate set up could include a stainless steel submersible pump, such as a Hurricane® pump or a Monsoon® pump with dedicated polyethylene tubing. The tubing diameter will be between 3/16-inch and ½-inch inner diameter and the length of the tubing extended outside of the well should be minimized. Flow-through cells will be used to monitor groundwater quality parameters during sampling. Monitoring well information, equipment specifications, water level measurements, parameter readings, and other pertinent information will be recorded during well purging and sampling.

The following sequence of procedures will be implemented for the collection of groundwater samples from monitoring wells by the low-flow methodology.

1) PID Screening of Well: A PID measurement may be collected at the rim of the well immediately after the well cap is removed and recorded in the field computer or field book, if historic data is not available.
2) Depth to Water Measurement: A depth to water measurement will be collected and recorded. To avoid disturbing accumulated sediment and to prevent the inadvertent mixing of stagnant water, measuring the total depth of the well should be done at the completion of sampling.
3) Low Stress Purging Startup: Water pumping will commence at a rate of 100 to 400 milliliters per minute (mL/min). This pumping should cause very little drawdown in the well (less than 0.2-0.3 feet) and the water level should stabilize. Water level measurements are made frequently, and flow rate will be recorded in mL/min on the sampling form or field computer.
4) Low Stress Purging and Sampling: The water level and pumping rate will be monitored and recorded every five minutes during purging, and any pumping rate adjustments will be recorded. During the early phase of purging, emphasis will be placed on minimizing and stabilizing pumping stress, and recording any necessary adjustments. Adjustments, when necessary, will be made in the first 15 minutes of purging. If necessary, pumping rates will

be reduced to the minimum capabilities of the pump to avoid well dewatering. If the minimal drawdown exceeds 0.3 feet, but the water level stabilizes above the pump intake setting, purging will continue until indicator field parameters stabilize, as detailed in Step 5 below. If the water level drops below the pump intake setting at the absolute minimum purge rate, the pump will remain in place and the water level will be allowed to recover repeatedly until there will be sufficient water volume in the well to permit the collection of samples.

5) Indicator Field Parameter Monitoring: During well purging, indicator field parameters (DO, pH, specific conductance, redox potential, and turbidity if available) will be monitored every five minutes (or less frequently, if appropriate). Purging will be considered complete and sampling can commence when all the indicator field parameters have stabilized. Stabilization will be achieved when three consecutive readings, taken at five minute intervals (or less frequently, if appropriate), are within the following limits:
    - DO (±10 percent);
    - turbidity (±10 percent);
    - specific conductance (±3 percent);
    - pH (± 0.1 unit); and
    - redox potential ([Eh] ±10 mv).

    Temperature and depth to water will be also monitored during purging. Should any of the parameter-specific components of the water quality meter fail during monitoring, the sampling team will attempt to locate a replacement multi-meter or individual criteria meter. If none are available, the sampling team will continue recording the parameters that are operational, and proceed with the sampling. Any other field observations relating to sample quality, such as odor, foaming, effervescence, and sheens, will also be recorded in the field computer or on the sampling form.

6) Collection of Ground Water Samples: Water samples for laboratory analyses will be collected prior to the flow-through cell by either using a bypass assembly or by temporarily disconnecting the flow-through cell. All sample containers will be filled by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence. During purging and sampling, the tubing should remain filled with water in order to minimize possible changes in water chemistry upon contact with the atmosphere. Methods employed to ensure that the outlet tubing will be filled include adjusting the tubing angle upward to

completely fill the tubing and restricting the diameter of the tubing near the outlet of the tubing.

The order in which samples will be collected is as follows:

- Volatile organics;
- Gas sensitive (e.g., Fe^{+2}, CH_4, H_2S/HS);
- Base neutrals or PAHs;
- Total petroleum hydrocarbons;
- Total metals;
- Dissolved metals;
- Cyanide;
- Sulfate and chloride;
- Nitrate and ammonia;
- Preserved inorganic;
- Non-preserved inorganic; and
- Bacteria.

After the appropriate laboratory-provided glassware is filled and labeled, the samples shall be placed in an ice-filled cooler and maintained at approximate 4°C for submittal to the laboratory. Upon completion of sampling at the well, decontaminate non-dedicated equipment in accordance with the decontamination procedure outlined in Section 1.5, and dispose of all dedicated equipment (gloves, tubing, etc.) as solid waste before moving to the next location.

3.5 Methodology for Passive (No-Purge) Sampling for Groundwater Collection

There are many passive groundwater sampling devices that allow for accurate sample collection without purging. Each device has specific uses and conditions for which they are more applicable. This methodology presents details for the use of HydraSleeve samplers.

The HydraSleeve is a disposable, single use device for the collection of representative groundwater samples for laboratory analysis of physical and chemical parameters.

HydraSleeves are placed within the screened interval (or other defined interval) of the well and activated after an equilibrium period. When used according to the manufacturer's instruction, the HydraSleeve will collect a groundwater sample without purging, thus causing no drawdown, agitation, or water column mixing. The HydraSleeve collects a sample from the screened interval only, and excludes water (or other fluids) from other parts of the well by use of check valve that seals when the sampler is full. The HydraSleeve takes advantage of the continuous natural movement of groundwater, which produces an equilibrium condition between the water in a well screen and the adjacent formation. HydraSleeves produce reliable data from low yield wells where other sample methods cannot due to well screen dewatering and associated alteration in water chemistry.

The HydraSleeve consists of the following components:

1) A long (usually 3 to 5 feet), flexible, lay-flat polyethylene sample sleeve, which is sealed at the bottom, and is equipped with a reed valve at the top allowing water to enter the HydraSleeve only during active sample retrieval.
2) A reusable, stainless steel weight attached with a clip to the bottom of the sleeve. The weight is used to carry the sample sleeve down the well to the specified depth (usually the bottom of the well screen). An optional top weight is also available to compress the sleeve in wells with short well screens.
3) A tether line attached to a spring clip at the top of the sample sleeve to deploy the device within the well and later retrieve it for sample collection.
4) A discharge tube is supplied with the device, which is used to puncture the wall of the sleeve after it is recovered to allow direct filling of sample bottles.

Deployment

Upon retrieval, the HydraSleeve is designed to effectively collect a "core" of water from within the well screen, which is equivalent in length and diameter to the sample sleeve. The upward motion opens the valve at the top, which then allows the device to fill with water. The Hydrasleeve should be installed with the top of the sample sleeve as close to the desired sample interval as possible. This will allow the sampler to fill and the check valve to close before the top of the device is pulled past the top of the sample interval.

To assemble and deploy the HydraSleeve:

1) Remove the Hydrasleeve from its package and hold it by the top, pinching the top at the holes.
2) Attach the spring clip and tether in the holes.
3) Slide the clip and bottom weight assembly into the holes at the bottom of the sleeve.
4) Lower the Hydrasleeve by the tether to the bottom or to the specified depth and secure the tether at the wellhead (Note: do not pull the HydraSleeve upward at any time during deployment, as this could cause the check valve to open and water to fill the sleeve inadvertently).

Sample Collection

Although the HydraSleeve only displaces approximately 100 milliliters (ml) of water during deployment, the well should be allowed to stabilize prior to sample collection so that natural flow conditions and contaminant distribution can return to equilibrium conditions. In certain jurisdictions, regulatory directives may prescribe a minimum equilibration period. When used for periodic monitoring programs, such as quarterly or semi-annual sampling, the HydraSleeve can be installed and remain in the well until the next sampling event, thus providing ample time for the well to equilibrate.

To collect a sample:

1) Be sure the tether is secured to the top of the well.
2) In one smooth motion, pull the tether upward at a rate of approximately 1 foot per second. The weight of the sampler will be felt when the valve closes. Continue pulling upward until the HydraSleeve is clear of the well.
3) Discard the water trapped at the top of the HydraSleeve above the reed valve.
4) Hold the HydraSleeve at the reed valve, and puncture the sleeve with the discharge tube just below the reed valve.
5) Decant the water into sample containers.
6) Discard the HydraSleeve as solid waste and process the excess water through activated carbon prior to discharge to the ground surface.

The weight and clips should be decontaminated prior to deploying a replacement HydraSleeve in the well. Tethers can be dedicated to individual wells or decontaminated and reused.

3.6 Methodology for Sub-LNAPL Sampling

The following section describes the methodology used for obtaining groundwater samples from the water column beneath LNAPL. Wells for sub-LNAPL sampling are not purged of three well volumes prior to sampling. This will prevent the potential of drawing LNAPL into the sample and to be representative of steady-state groundwater conditions beneath the LNAPL.

The following data will be reviewed for each well in order determine the appropriate equipment necessary:

- Well construction log showing diameter and total depth of the well;
- Approximate depth to LNAPL; and
- Approximate depth to static water.

A list of equipment for sub-LNAPL sampling is presented below:

- Field book or field computer for recording site data;
- Optical oil/water interface probe with a graduated measuring tape to 0.01 foot accuracy;
- Keys and tools to provide well access;
- Peristaltic pump;
- Polyethylene tubing specifications of 0.25-inch outer diameter x 0.17-inch inner diameter is preferable as this small diameter assists in achieving lower flow rates;
- Silicone tubing of appropriate diameter to operate peristaltic pump;
- Polyvinyl chloride (PVC) drop tube (1.5-inch or other appropriate diameter);
- PVC rod (0.5-inch or other appropriate diameter);
- PVC end cap for drop tube;
- Tether for end cap;
- Clamps for securing drop tube to well casing;
- Appropriate sample containers and labels;

- Decontamination supplies;
- Blank chain-of-custody forms; and
- Cooler and ice for sample preservation.

The following sequence of procedures will be implemented for the collection of sub-LNAPL groundwater samples.

1) Determine LNAPL Thickness: Use an optical oil/water interface probe with a graduated measuring tape to 0.01 foot accuracy to collect depth to LNAPL and depth to water measurements.
2) Installing Sampling Equipment: Deploy a 1.5-inch (or other appropriate diameter) PVC pipe (drop tube), with an attached end cap, through the LNAPL layer in the well. The end cap should be tethered to the drop tube so it is not lost in the well when removed and in a way that allows the drop tube to be sealed during installation. Lower the drop tube until the bottom of the tube is approximately two feet into the water column below the bottom of the LNAPL. Secure the drop tube to the well, and allow the system to equilibrate, approximately one half hour. The end cap is then removed by inserting a 0.5-inch (or other appropriate diameter) PVC rod into the drop tube and pushing on the cap until the lid is removed. The cap will be removed along with the tube upon completion of sampling.
3) Collection of Groundwater Samples: Lower polyethylene tubing through the 1.5-inch drop tube into the water column. Connect the polyethylene tubing to silicon tubing and engage the peristaltic pump for groundwater retrieval. Set the flow rate to the lowest pumping rate that can be sustained so that the LNAPL is not drawn into the tubing. Begin collecting groundwater in the sample container and continue until enough volume is obtained for all bottleware required by the laboratory for the requested analyses.

3.7 Decontamination Requirements

Of particular significance to the procedures of groundwater measurement and sampling is the limitation, whenever possible, of materials inserted into a well bore and, even more importantly, of materials transferred from well to well.

Many items can be discarded between well sampling and/or gauging locations without significantly impacting project costs. Dedicated sampling equipment which can be discarded between well sampling locations, will be used whenever possible to preclude decontamination requirements. Sampling equipment included in this category are polyethylene bailers, bailer cord, nitrile gloves, and sampling tubing. However, other monitoring and sampling equipment, such as oil/water interface probes and submersible sampling pumps, must be reused from well to well.

All site equipment to be used in multiple locations (non-dedicated) for gauging and/or sampling of groundwater will be decontaminated immediately prior to initial use and between uses at each location according to the following steps:

- Remove particulates with a sorbent pad or towel and/or initial rinse with clean potable tap water;
- Wash equipment with clean sponge, soft cloth, or scrub brush as necessary in a solution of tap water/laboratory grade detergent (Alconox®, Liquinox®, or equivalent);
- Rinse with tap water;
- Rinse with deionized or distilled water; and
- Air dry for as long as possible.

Rinse water generated during decontamination procedures will be treated onsite by passing the water through a bucket filled with activated carbon prior to disposal.

3.8 Documentation

All site activities and conditions at the time of purging and groundwater sampling should be recorded by field personnel in a field computer via the EDGE application or, if necessary, a field book may be used. The entry shall include the date, time, weather conditions, location (well name), personnel present onsite, PID readings, sampling methodology, purge rate, purge volume, and the aforementioned groundwater indicator parameters. A field qualifier “SL” shall be applied to each sub-LNAPL sample entry to denote sample collection as sub-LNAPL. Additional comments or observations (e.g., well damage, nearby pumping, LNAPL sheen) should also be recorded.

4.0 SOIL SAMPLING & WELL INSTALLATION PROCEDURES

4.1 Site Controls

Prior to hand augering, hydroexcavation, utilizing a backhoe, or deploying any drilling apparatus to the site, an underground utility line protection request must be made (i.e., Pennsylvania One Call) for mark-out of known subsurface utilities and associated laterals proximal to the drilling location. Site plans, if available, should be reviewed to document and avoid the location of onsite utilities.

After review of all known mapped and marked utilities, a site reconnaissance will be performed to document the location of utility meters and storm sewer drains. In addition, the location of overhead utilities must be documented. After completing the subsurface and overhead utility review, the area to drill may be considered clear of utilities, or the location may be adjusted to a nearby location, which must also be cleared.

Lastly, any drilling activities must be preceeded by clearing of the borehole, prior to advancement of augers or split spoons. To ensure the safety of workers, the borehole will be cleared by hand, hydroexcavator, or backhoe to a depth of approximately 8 feet below ground surface.

4.2 Potential Hazards

Traffic, pinch points, chemical (airborne and physical contact), and biological are all likely hazards to be encountered during soil sampling and well installation, as well as slip/trip/fall potential. Drilling is considered a high risk activity which requires facility approval prior to implementation. Additional hazards are identified in the site-specific HASP and/or the daily JSA.

4.3 Materials and Equipment Necessary for Task Completion

A list of equipment required to oversee test boring advancement and, where applicable, sample soil is presented below. Also listed are materials necessary to store, label, preserve, and transport soil samples.

- Current site map detailing well locations;
- Field computer and/or field book for recording site data;

- Appropriate, laboratory prepared sample containers and labels;
- PID;
- Single-use, disposable plastic scoops or stainless steel scoop for collecting soil samples;
- Single-use, disposable, laboratory-supplied syringes for soil sample collection (if applicable);
- Scale for weighing samples (e.g., methanol kits, if necessary);
- Disposable nitrile sampling gloves;
- Measuring tape (for measuring core recovery);
- Munsell soil color chart/book (recommended);
- Decontamination equipment (if applicable);
- Blank chain-of-custody forms; and
- Cooler(s) and ice for sample preservation.

4.4 Decontamination Requirements

All down-hole drilling equipment must be steam cleaned prior to drilling at each soil boring or well location. All soil sampling equipment must be cleaned with detergent and rinsed with deionized or distilled water prior to deployment into the borehole. All well construction materials (i.e. PVC well casing, PVC well screen, sand pack, bentonite) should be clean and dedicated to each borehole.

4.5 Methodology for Soil Boring Installation

4.5.1. Borehole Advancement

During test drilling activities, a borehole is advanced into the subsurface via a rotary or direct-push drilling technique. Various types of drilling methods could be deployed at these facilities to advance the borehole and gain access to the subsurface for characterization and sampling. A description of the most commonly utilized drilling methods is included below:

4.5.1.1 Hollow Stem Auger

A hollow, steel pipe (available diameters vary) with welded, exterior steel “flights” is used to convey subsurface material to the surface when rotated clockwise. A bit at the bottom of the lead auger cuts into the subsurface material, and the rotation conveys the loosened material (cuttings) up the flights, allowing the hole to be advanced (cuttings may not always return to the surface, such as when drilling in soft, saturated materials). The hollow center of the auger allows the driller to access the subsurface for soil sample collection and, where applicable, well installation during borehole advancement. During borehole advancement, a center stem of steel rods connected to an auger plug prevent soil cuttings from entering the drill column. Once a desired drilling depth is reached, the center plug and rods can be pulled out, leaving the auger stem in place to prevent borehole collapse. A split-spoon sampler can be threaded onto the rods in place of the plug and driven via a hammer to obtain a sample (Standard Penetration Test), or if terminal depth has been reached a monitoring well could be installed through the augers.

4.5.1.2 Air and Mud Rotary

Rotary drilling methods are similar to hollow stem auger drilling, however specialized drilling bits at the bottom of rods are used to cut into the subsurface material using compressed air, vibration, and/or pressurized drilling mud. Compressed air or mud is forced through the drilling rods via an air compressor or pump, and escapes through small holes in the drill bit. The circulation of drilling mud, or air combined with introduced water or formation water, conveys the soil cuttings to the surface (while also cooling the drilling bit and preventing borehole collapse).

4.5.1.3 Geoprobe®

A direct-push drilling method, Geoprobe® sampling utilizes a hydraulic hammer to drive steel rods into the subsurface for soil sampling. This method advances a core barrel lined with a plastic Macro-Core® sleeve into the soil column for continuous soil core collection.

4.5.1.4 Hand Auger

A stainless steel or aluminum hand auger is physically advanced to a desired soil sampling depth through rotation of the auger and head.

4.5.2 Soil Sampling

Soil samples will be obtained for lithologic logging and where appropriate, for laboratory analysis with one of three different sampling devices: Split barrel spoon sampler, hand auger, or Geoprobe® soil sampler. For either method, the sampling devices are lowered through the hollow-stem augers or open borehole to allow sampling of undisturbed sediments below the bit or drive shoe. Soil samples will be collected at regular intervals for subsurface characterization and selection of appropriate well screen interval(s). Soils which appear to be visually impacted or from intervals which exhibit the highest deflections on the screening device (PID or similar) will be sampled for laboratory analysis in accordance with an approved sampling plan.

4.5.2.1. Split barrel spoon sampler (split spoon)

The split spoon sampler will be driven into the soil column in accordance with ASTM Standard Method D1586 (Reference A6, Appendix E). Soil sampling by split spoon is characterized by drilling a borehole with a hollow-stem auger to the desired sampling depth (the standard calls for one sample per five foot depth interval). The split spoon sampler is attached to the drilling rods after removal of the auger plug. The drill operator will drive the sampler into the undisturbed soil by repeatedly striking the drilling rods with a 140 pound safety hammer over a 30 inch drop. Field personnel will record the number of blows required to drive the split spoon sampler for each successive six-inch interval. After the sampler has been filled, the driller will remove the rods and sampler from the borehole and should provide the intact sampler to field personnel for opening (the drive shoe and head can be loosened). Field personnel should split the spoon, scan with PID, measure sample recovery, thoroughly describe the soil lithology, note visual observations and odors, note degree of saturation, and where applicable collect soil sample(s) utilizing a stainless steel or disposable scoop. An approved, retractable knife may be used to trim the top and edges of the sample, and once prepared the sample should be containerized in appropriate sample containers.

4.5.2.2. Geoprobe®

The Geoprobe® operator will advance the drilling rods into the subsurface using a truck or track-mounted drill with a hydraulic hammer. A dedicated Geoprobe® Macro-Core® liner is inserted into the core barrel to collect continuous core samples, usually one per 4 foot interval. The Geoprobe® operator will remove the soil filled liner from the core barrel, cut the liner, and provide field personnel with the intact cores. After retrieval of the sample, the liner may be removed by field personnel and the soil core should be scanned with a PID and logged, including documentation of core recovery, soil lithology, visual observations and odors, and degree of saturation. Where applicable, field staff should remove the soil sample utilizing a stainless steel or disposable scoop and containerize in an appropriate sample container.

4.5.2.3. Hand Auger

The self-powered hand auger allows for soil from the desired interval to be collected directly through removal of the soil sample that is collected in the auger head for every six inches of advancement.

4.6 Methodology for Leaded Tank Bottoms Soil Sampling

Leaded tank bottom material is described as containing materials distinguished by distinctive rust/red to black, metallic, mostly oxidized scale materials, sometimes in a matrix of petroleum wax sludge. The approach for identifying leaded tank bottom materials is summarized below:

- If materials are encountered within the previously designated leaded tank bottom areas, matching the physical description given above for leaded tank bottoms, then samples should be collected for lead analysis.
- If total lead results are above the site-specific standard (SSS) for lead of 2,240 milligrams per kilogram (mg/kg) then samples should be analyzed for lead via Toxicity Characteristic Leaching Procedure (TCLP), EPA Test Method 1311.
- Delineated areas that exhibit soils that physically resemble leaded tank bottoms, exhibit lead concentrations greater than 2,240 mg/kg, and exceed 5 milligrams per liter (mg/l) for lead in the TCLP leachate (which is characteristically hazardous for lead) will retain the leaded tank bottom designation. If no soils are encountered that meet all three of these criteria, then the area will no longer be classified as a leaded tank bottom area.

4.7 Methodology for Monitoring Well or Recovery Well Installation

4.7.1 Well Construction

After drilling to a desired terminal depth via any of the drilling methods referenced above, permanent monitoring wells can be installed to allow access to groundwater for future monitoring and groundwater sampling. In general, monitoring wells are constructed of pipe with a slotted interval(s) (screen) through which groundwater can flow into the well from a desired water-bearing stratum. In most cases, PVC materials are utilized for monitoring well construction.

- For applications where LNAPL thickness measurement is necessary, the screened interval should extend above the presumed highest groundwater level.
- For applications where the shallowest groundwater interval is to be monitored (e.g., water-table aquifer), a single well casing is installed.
- For applications where multiple water bearing strata will be penetrated and where deep groundwater conditions are selected for monitoring, a double-cased well may be installed to prevent the vertical migration of contaminants to the deeper water bearing zone from shallower zone(s).

Each well construction type and considerations for field staff regarding how many casings are needed have been provided below.

4.7.1.1 Single Casing Construction

The most commonly installed monitoring well at the facilities have single casings and are constructed of PVC. To determine the length of screen used, seasonal groundwater table or tidal fluctuations should be considered to allow the water table to intercept the well screen throughout the year. Field personnel should advise the driller on the required well diameter, total well depth, screen interval, screen length, and slot size based on available subsurface information prior to drilling. Once the borehole is completed and the drilling crew has been advised on the desired construction, the drilling crew will thread the well screen onto an end cap at the wellhead and will lower the well into the borehole, adding lengths of casing until the terminal depth is reached.

While the well is held near the center of the borehole, the annular space between the well screen and formation is carefully backfilled with a sand filter pack, which consists of clean, sorted quartz sand sized to the formation grain size (typically #1 or #2 sand). The sand pack establishes continuity with the formation and acts as a filter to prevent soil from entering the well (the well screen slot size should be sized according to the formation median grain size to mitigate sediment intrusion, however is most commonly available from suppliers as 0.01 or 0.02-inch diameter slot size).

The sand pack should extend one to two feet above the top of well screen, and care must be taken by the driller to not bridge the sand or overshoot the top of sand target depth (particularly when installing wells through the auger stem). Above the sand pack, a seal (grout) is installed in the annular space between the well casing and the soil. The seal is comprised of hydrated bentonite, sometimes amended with pellets or a grout consisting of hydrated Portland cement, bentonite powder, or a blend of the two. A conventional grout blend is 95% Portland cement and 5% bentonite powder. The purpose of the seal is to prevent surface water from infiltrating the well screen. It is installed from the top of the sand to one to two feet below ground surface.

In circumstances where the top of well sand terminates below the water table (e.g., deeper groundwater or submerged screen), grout should be mixed into a slurry at the ground surface and pumped via tremmie pipe or hose to prevent bridging. Above the well seal, the annular space can be backfilled with granular bentonite or concrete. A cement cap or well pad is placed at the surface to further mitigate potential infiltration of surface water. A locking, steel protective casing (stand pipe) or a locking, flush-mounted curb box should be installed to protect the well.

4.7.1.2 Double Casing Construction

Construction of a double cased well is similar to that of a single case well; however, to prevent groundwater infiltration from shallower water bearing zones, a second casing is installed through a surface casing. This type of construction requires drilling two different diameter boreholes.

During drilling through the shallower groundwater bearing zone(s), a larger diameter borehole is drilled and should be sized according to the desired well and/or outer casing diameter. This may require reaming of the borehole depending on the conditions and drilling equipment. An outer (surface) casing is installed and the annulus is grouted. After the outer casing is installed and the grout has set, the borehole is advanced through the surface casing with a smaller diameter drill stem and bit. When the desired terminal depth is reached, a monitoring well is installed through the inner casing using the above-referenced single casing construction procedure (the annular space between the outer and inner casings above the well filter sand should be pressure grouted).

4.7.2 Handling of Soil Cuttings

Soil cuttings generated during drilling will be containerized or stockpiled on plastic until sampling and analytical data can be obtained. Soil cutting final placement (onsite soil reuse or offsite disposal) will be performed in accordance with Pennsylvania Department of Environmental Protection (PADEP) approved onsite soil reuse plans for each facility.

4.7.3 Well Development

After installation, monitoring wells will be developed to remove residual soil from within the well and filter media and to establish communication between the well and formation. Pump and surge methodology, either through use of a ditch pump or air compressor connected to black polyethylene pipe and surge block, should be utilized to successively agitate relatively clear groundwater from the well. Surging should begin from the bottom of the screened interval and continue iteratively to the top of the well screen in approximately 2 to 4-foot intervals (i.e., pump and surge each 2 to 4 foot interval of well screen several times until relatively clear discharge water is maintained, then move up to the next screen interval until all of the screen has been developed).

Alternately, a submersible pump may be used to pump water from the screened interval of shallow wells, with the screen of the well surged to evacuate silt that remains in the sand pack. The well should be alternately surged and purged until groundwater flowing from the well appears relatively free of sediments. A vacuum truck may be used for development for wells that contains product. Well development water should be managed/treated in accordance with the site-specific work plan.

4.8 Documentation

All site activities and conditions at the time of soil sampling, well installation, and well development should be recorded by field personnel in a field computer via the EDGE application or, if necessary, a field book may be used. The entry shall include the date, time, weather conditions, location (well or boring name), personnel present onsite, and the aforementioned lithologic data and well construction information. The entry shall include detailed data required to create representative soil boring lithologic logs and well as-built logs (if a well is constructed). This data should include but not be limited to soil type, soil texture (e.g., USCS), soil color, relative moisture content, depth of apparent water table, PID readings, blow counts (if split spoon samples are collected), sample recovery, total depth of borehole, length of well screen, length of well casing, sand pack interval, filter sand size, grout materials used, well seal interval, and all well construction materials. Notes should also include well development pumping rate, duration, and observations. Additional comments or observations should also be recorded, as appropriate.

5.0 LIGHT NON-AQUEOUS PHASE LIQUID (LNAPL) SAMPLING PROCEDURES

5.1 Potential Hazards

Traffic, pinch points, chemical (airborne and physical contact), and biological are all likely hazards to be encountered during LNAPL sampling, as well as slip/trip/fall potential. Additional hazards may be mentioned in the site-specific HASP and/or the daily JSA. If significant amounts of LNAPL are being handled, a Tyvek suit should also be worn.

5.2 Materials and Equipment Necessary for Task Completion

A list of equipment required to sample LNAPL from a monitoring well is presented below:

- Current site map detailing well locations;
- Field book or field computer for recording site data;
- Optical oil/water interface probe with a graduated measuring tape to 0.01 foot accuracy;
- Keys and tools to provide well access;
- Appropriate sample containers and labels. LNAPL samples will be collected in laboratory provided glassware with appropriate preservative, if applicable. A minimum of 10 ml is required for most laboratory analyses. In the case that sufficient volume is not obtained, a swabbing technique (described below) could be used;
- Sorbent pads (required for swabbing technique);
- Stainless steel or clear bottom-loading or top-loading bailer, depending on product thickness;
- Clean nylon or polypropylene bailer cord;
- Decontamination supplies;
- Blank chain-of-custody forms; and
- Cooler and ice for sample preservation.

5.3 Decontamination Requirements

During LNAPL sampling activities, dedicated sampling equipment (i.e., clear bailers, nitrile gloves, and bailer cord) may be utilized; thereby, minimizing decontamination requirements. However, a stainless steel bailer may be used and decontaminated between LNAPL sampling locations. The optical oil/water interface probe with a graduated measuring tape to 0.01 foot accuracy used to record the presence or absence and approximate thickness of LNAPL prior to sampling also requires decontamination between sampling locations. Decontamination procedures are detailed in Section 1.5.

5.4 Sampling Procedure

Immediately prior to sampling, each monitoring well should be gauged to obtain liquid levels (i.e., depth to LNAPL and depth to water) for estimation of current LNAPL thickness. Refer to Section 3.0 for appropriate well gauging procedures. Liquid level data should be recorded in a field book or field computer through the EDGE application or, if necessary, a field book.

LNAPL sampling may be performed via two different methods, based upon the LNAPL thickness/availability at the time of sampling: direct sample or swabbing. As indicated above, a minimum LNAPL volume of 10 mL is typically required by the analytical laboratory for most LNAPL characterization.

The following sequence of procedures will be implemented for the collection of LNAPL samples from monitoring wells:

1) A clean work area will be established so that sampling equipment will not come in contact with the ground surface or any other potentially contaminated surfaces near the wellhead.
2) A pre-cleaned stainless steel bailer or dedicated disposable bailer will be used for each well.
3) A new pair of nitrile gloves will be worn during sampling and replaced for each well.
4) Based on the gauged depth to LNAPL, an appropriate length of dedicated nylon or polypropylene cord will be tied to the sampling bailer.
5) An appropriately sized (i.e., 40 ml glass vial with plastic cap fitted with Teflon® lined septum) laboratory-provided sample container will be used to containerize the LNAPL sample.

6) The sampling bailer will be slowly lowered into the well until the liquid level is encountered. Once encountered, the sampling bailer should be lowered into the standing liquid column to a depth of approximately 1 foot, or other appropriate depth based on product thickness.
7) The bailer should be retrieved at a steady rate to avoid excess agitation.
8) The bailed sample should be visually evaluated for the presence or absence of LNAPL. If sufficient LNAPL volume is present (>10 ml), a direct sample of the LNAPL will be collected into the laboratory vial. If less than 10 ml of LNAPL is apparent, a sorbent pad may be used to absorb the LNAPL from the surface of the groundwater sample and the swab placed in the laboratory vial. The site-specific work plan should dictate whether a swab sample should be analyzed, or if the well should be monitored at a later date for re-sampling.
9) Labels will be completed and attached to the sample vials, indicating the sample collector's name, date, time, and location of sample; record same data in field computer or field notebook.
10) Store samples in a secure location until possession is transferred to the laboratory.
11) Nitrile gloves, bailer, bailer cord, and any other trash will be disposed of as solid waste.

5.5 Documentation

All site activities and conditions at the time of sampling should be recorded by field personnel in a field computer via the EDGE application or, if necessary, a field book may be used. The entry shall include the date, time, weather conditions, location (well name), personnel present onsite, and the aforementioned well gauging parameters. Additional comments or observations (e.g., color or apparent viscosity of LNAPL) should be recorded.

6.0 INDOOR AND AMBIENT AIR SAMPLING PROCEDURES

In preparation for indoor and/or ambient air sampling, appropriate facility personnel should be notified of intended sampling prior to mobilization. The purpose of this would be to confirm that there are not any non-routine activities occurring in the building, such as painting of indoor walls, which would cause incidental contamination of the samples.

6.1 Materials and Equipment Necessary for Task Completion

A list of equipment required to collect indoor and/or ambient air samples is presented below:

- Field data book or field computer for recording site data;
- Laboratory certified Summa canisters (standard size is 6 liters);
- Flow controllers (standard duration is 8-hours) with integrated vacuum gauge;
- Equipment for elevating sample intake height (examples: extended sampling inlets, zip ties to attach units to fencing, tables, etc);
- Camera; and
- Blank chain-of-custody forms.

6.2 Precautions to Avoid Incidental Contamination

EPA Method TO-15 is the most common method used for analysis of air samples at these sites. This method is highly sensitive to trace concentrations of volatile organic compounds (VOCs). To avoid incidental contamination:

- Do not wear cologne or fragrance on day of sampling;
- Do not use hand sanitizers or lotions;
- Do not store canisters near containers of gasoline, or any fuel; and
- Make sure there are no sources of VOCs in the vehicle used to transport the canisters.

6.3 Sampling Procedure

1) Set Up Summa Canister. Inlets of the flow controllers are to be placed in the breathing zone, approximately 4 to 6 feet above the ground surface. Elevate Summa canisters using appropriate materials available onsite or use laboratory-provided extended inlets (approximately 3 ft long sampling canes). Indoor air samples should be representative of air

in the buildings and should be placed away from obvious ventilation to outdoor air or sources of VOCs. Securely attach flow controller and extended sampling inlet if applicable.

2) Start Air Sample Collection. Open the valve. Document the initial vacuum (should be between approximately -30 inHg and -26 inHg) and the start time of the test. If the vacuum is significantly outside of the range or has a high rate of change, consider using an alternate canister or flow controller as there may be leakage.
3) Monitoring Summa Condition During Sampling Period. Several times during the sampling period, verify that the Summa is in good condition and that the vacuum is decreasing at an appropriate rate several times during the sampling period. An example of a reasonable frequency would be every two hours during an 8-hour event. During these checks, record the time, remaining vacuum, and canister condition. If necessary, obtain a permit to operate a camera, and take a least one photo of each sampling location.
4) Completing Air Sample Collection. Near the end of the sampling period, monitor the gauge more frequently. The sample collection should be stopped when the gauge reads approximately -5 inHg. At this point, close the canister valve. Record the sample end time and sample end vacuum. Ensure that the canister is labeled with the sample ID. Remove all of the attached equipment from the canister. Pack the canisters, flow controller wrapped in bubble wrap, chain of custody (additional information in the following section), and any other laboratory provided equipment back into the original packaging.

6.4 Documentation

All site activities and conditions at the time of air sampling should be recorded by field personnel. The entry shall include the date, time, weather conditions (including wind direction and start/end barometric pressure), sample locations and IDs, and personnel present onsite. Any observation that could influence the level of VOCs in the samples should be noted.

7.0 SURFACE WATER SAMPLING PROCEDURES

7.1 Field Procedures for Surface Water Sampling

7.1.1 General

Surface water sampling is performed to obtain samples for surface water bodies that are representative of existing surface water conditions. Surface water sampling (or gauging) within 3 feet of a bulkhead at certain facilities will require field personnel to wear a life vest.

Surface water sampling locations for surface water quality and groundwater interaction studies are selected based on the following:

1) Study objectives
2) Location of point surface discharges
3) Non-point source discharges and tributaries
4) Presence of structures (e.g., bridge, dam)
5) Accessibility

During surface water sampling it is important to obtain samples that are not impacted by the re-suspension of sediment produced because of improper or poor surface water sampling techniques.

7.1.2 Surface Water Sample Location Selection

Prior to conducting surface water sampling activities, the first requirement is the consideration and development of surface water sampling locations. It is important that all surface water sampling locations be selected in accordance with the work plan.

Wading for surface water samples increases the chances of disturbance of sediments from the floor of the surface water body. When wading for surface water samples be aware of potential safety and health risks. A life vest and safety line must be worn at all times where footing is unstable or when sampling in fast moving or more than 3 feet (0.9 m) deep. A two-person team is required for most surface water sampling activities. If the site conditions require the use of the life vest and safety line, the two people involved in the sampling must be competent swimmers.

Surface water samples must be collected with no suspended sediments. Surface water samples are collected commencing with the furthest downstream location to avoid sediment interference with upstream locations.

7.1.2.1 Rivers, Streams, and Creeks

Surface water samples are generally collected in areas of surface water bodies that are representative of the surface water body conditions. Representative surface water samples will usually be collected in sections of surface water bodies that have a uniform cross section and flow rate. Mixing is influenced by turbulence and water velocity, therefore the selection of surface water sampling locations immediately downstream of a riffle area (i.e., fast flow zone) will ensure good vertical mixing. These locations are also likely areas for deposition of sediment since this occurs in areas of decreased flow velocity.

Surface water sampling locations should not be established in areas near point source discharges. Surface water sampling of these source discharge points can be performed to assess the impact of these source areas on overall surface water quality. Sample tributaries as close to the mouth as possible. It is important to select surface water sample locations considering the impact downstream, including tributary flow and sediment.

In all instances, properly document all surface water sampling locations. Documentation may include photographs and tie-ins to known structures.

7.1.2.2. Sampling Equipment and Techniques

When collecting surface water samples, direct dipping of the sample container into the stream or water is acceptable unless the sample container contains preservatives. If preserved, a pre-cleaned unpreserved sample container should be used to collect the surface water sample. The surface water sample is then transferred to the appropriate preserved sample container. When collecting surface water samples, submerse the inverted bottle to the desired sample depth and tilt the opening of the sample container upstream to fill. During surface water sample collection, wading or movement may cause sediment deposits to be re-suspended and can result in biased samples. Wading is acceptable if the stream has a noticeable current and the samples are collected directly in the sample container when faced upstream. If the stream is too deep to wade in or if addition samples must be collected at various depths, additional sampling equipment will be required. Surface water samples should be collected about 6 inches (15 cm) below the surface, with the sample bottles being completely submerged. Taking the surface water sample at this depth eliminates the collection of floating debris in the sample container.

Surface water sample collection where the flow depth is less than 1 inch (<2.5 cm) requires the use of special equipment to eliminate sediment disturbance. Surface water sampling may be conducted with a container then transferred to the appropriate sample container, or collection may be performed using a peristaltic pump. A small excavation in the stream bed to create a sump for sample collection can also be considered but should be prepared in advance to allow all the sediment to settle prior to surface water sampling activities.

Teflon™ bailers can be used for surface water sampling if it is not necessary to collect surface water samples at specific depths. A bottom loading bailer with a check ball is sufficient. When the bailer is lowered through the water, the water is continually displaced through the bailer until the desired depth is reached. The bailer is retrieved and the check ball prohibits the release of the collected surface water sample. Bailers are not suitable in surface water bodies with strong currents, or where depth-specific sampling is required. For discrete and specified depth surface water sampling, and the parameters to be monitored do not require a Teflon™ coated sampling device, a standard Kemmerer or Van Dorn sampler can be used. The Kemmerer sampler is a brass cylinder with rubber stoppers that leave the sampler ends open while the sampler is being lowered. The sampler is lowered in a vertical position to allow water to pass through. The Van Dorn sampler is plastic and is lowered in a horizontal position. For both samplers, a messenger is sent down a rope when the sampler has reached the required depth. The messenger causes the stopper on the sampler to close. The sampler is then retrieved and the surface water sample can be collected through a valve. DO sample bottles can be filled by allowing overflow using a rubber tube attached to the valve. During depth-specific surface water sampling, take care not to disturb bottom sediments.

Glass beakers or stainless steel cups may also be used to collect surface water samples if parameter interference does not occur. The beaker or cup must be rinsed at least three times with the surface water sample prior to sample collection.

All equipment must be thoroughly decontaminated.

7.1.2.3 Field Notes for Surface Water Sampling

Record daily surface sampling activities, describe surface water sampling locations, sampling techniques, and, if applicable, provide a description of photographs taken. Visual observations are important and provide valuable information when interpreting surface water quality results. Observations include:

1) Weather conditions
2) Stream flow directions
3) Stream physical conditions (width, depth, etc.)
4) Tributaries
5) Effluent discharges
6) Impoundments
7) Bridges
8) Railway trestles
9) Oil sheens
10) Odors
11) Buried debris
12) Vegetation
13) Algae
14) Fish and other aquatic life
15) Surrounding industrial areas

The following factors should be considered for surface water sampling:

1) Predominant Surrounding Land Use: Observe the prevalent land use type in the vicinity and note any other land uses in the area which, although not dominant, may potentially affect surface water quality.

2) Local Watershed Erosion: Note the existing or potential erosion of soil in the local watershed and its movement into the stream. Erosion can be rated through visual observation of watershed stream characteristics including increases or decreases in turbidity.

3) Local Watershed Non-Point Source Pollution: This refers to problems or potential problems other than erosion and sedimentation. Nonpoint source pollution can be diffuse agricultural and urban runoff. Other factors may include feed lots, wetlands, septic systems, dams, impoundments, and mine seepage.

4) Estimated Stream Width: The estimated distance from shore at a transect representative of the stream width in the area.

5) Estimated Stream Depth: Riffle (rocky area), run (steady flow area), and pool (still area). Estimate the vertical distance from the water surface to the bottom of the surface water body at a representative depth at three locations.

6) High Water Mark: Estimate the vertical distance from the bank of the surface water body to the peak overflow level, as indicated by debris hanging in bank or flood plain vegetation, and deposition of silt. In instances where bank flow is rare, high water marks may not be evident.

7) Velocity: Record or measure the stream velocity in a representative run area.

8) Dam Present: Indicate the presence or absence of a dam upstream or downstream of the surface water sampling location. If a dam is present, include specific information detailing the alteration of the surface water flow.

9) Channelized: Indicate if the area surrounding the surface water sampling location is channelized.

10) Canopy Cover: Note the general proportion of open to shaded areas which best describes the amount of cover at the surface water sampling location.

7.2 References

For additional information pertaining to surface water sampling, the user of this manual may reference the following:

ASTM D5358 Practice for Sampling with a Dipper or Pond Sampler

ASTM D4489 Practices for Sampling of Waterborne Oils

ASTM D3325 Practice for the Preservation of Waterborne Oil Samples

ASTM D4841 Practice for Estimation of Holding Time for Water Samples Containing Organic and Inorganic Constituents

ASTM D4411 Guide for Sampling Fluvial Sediment in Motion

ASTM D4823 Guide for Core-Sampling Submerged, Unconsolidated Sediments

ASTM D3213 Practice for Handling, Storing, and Preparing Soft Undisturbed Marine Soil

ASTM D3976 Practice for Preparation of Sediment Samples for Chemical Analysis

ASTM E1391 Guide for Collection, Storage, Characterization, and Manipulation of Sediments for Toxicological Testing

ASTM D4581 Guide for Measurement of Morphologic Characteristics of Surface Water Bodies

ASTM D5906 Guide for Measuring Horizontal Positioning During Measurements of Surface Water Depths

ASTM D5073 Practice for Depth Measurement of surface water

8.0 SEDIMENT SAMPLING PROCEDURES

8.1. Introduction

Sediment sampling is conducted to obtain samples that are representative of existing chemical and/or physical conditions of sediment.

8.2 Equipment Decontamination

On environmental sites, sediment sampling equipment (e.g., split spoons, trowel, spoons, shovels, bowls, dredges, corers, scoops) are typically cleaned as follows:

1) Wash with clean potable water and laboratory detergent, using a brush as necessary to remove particulates.
2) Rinse with tap water.
3) Rinse with deionized water.
4) Air dry for as long as possible.

Additional or different decontamination procedures may be necessary if sampling for some parameters, including VOCs and metals.

8.3 Sample Site Selection

Before any sampling is conducted, the first requirement is to consider suitable sampling locations. Sampling locations should be selected in accordance with the work plan. Wading for sediment samples in lagoons, lakes, ponds, and slow-moving rivers and streams must be done with caution since bottom deposits are easily disturbed. Sampling must only be attempted where safe conditions exist and samples must be collected from undisturbed sediments. All sediment samples are to be collected commencing with the most downstream sample to avoid sediment interference with other downstream samples. A life vest and safety line should be worn in all cases where footing is unstable or where water is fast moving or over 3 feet (0.85 m) in depth. A second person may also be required for most of the sampling scenarios.

8.3.1. Rivers, Streams, and Creeks

Sediment samples may be collected along a cross-section of a river or stream in order to adequately characterize the bed material, or from specific sediment deposits as described in the work plan. A common procedure is to sample at quarter points along the cross-section of the sampling site selected. Samples may be composited as described in the work plan. Samples of dissimilar composition (e.g., grain size, organic content) should not be combined. Representative samples can usually be collected in portions of the surface water body that have a uniform cross-section and flow rate. Since mixing is influenced by turbulence and water velocity, the selection of a site immediately downstream of a riffle area (e.g., fast flow zone) are likely areas for deposition of sediment since the greatest deposition occurs where stream velocity slows.

A site that is clear of immediate point sources (e.g., tributaries and industrial and municipal effluents) is preferred for the collection of sediment samples unless the sampling is being performed to assess these sources.

8.4 Sampling Equipment and Techniques

8.4.1. General

Any equipment or sampling technique(s) [e.g., stainless steel, polyvinyl chloride (PVC)] used to collect a sample is acceptable so long as it provides a sample which is representative of the area being sampled and is consistent with the work plan.

8.4.2. Sediment Sampling Equipment and Techniques

A variety of methods may be used to collect sediment samples from a stream, river, or lake bed. Dredging (Peterson, Ponar, Van Veen), coring and scooping are acceptable sediment sample collection techniques. Precautions shall be taken to ensure that a representative sample of the targeted sediment is collected. Caution should be exercised when wading in shallow water so as not to disturb the area to be sampled. Samplers should be selected based on the interval to be sampled, type of sediment/sludge (silt, sand, gravel), and required sample volume. More than one sampler is often required to implement a sampling program at a site. The following describes some of these methods. Manufacturer’s information should be consulted to determine the limitations of each type of sampling equipment.

8.4.3 Dredging

The Peterson dredge is best used for rocky bottoms, in very deep water, or when the stream velocity is rapid. The dredge should be lowered slowly as it approaches the bottom, so as to not disturb the lighter sediments.

The Ponar dredge is similar to the Peterson dredge in size and weight. The Ponar dredge is a "clam-shell" type unit that closes on contact with the river/lake bottom. Depending on the size of the unit, a winch is required for larger units, whereas smaller units are available for lowering by a hand line. Once retrieved, the unit is opened and the sample extracted using a sample scoop or spoon. The unit has been modified by the addition of side plates and a screen on top of the sample compartment. This permits water to pass through the sampler as it descends.

The Ponar grab sampler functions by the use of a spring-latch-messenger arrangement. The sampler is lowered to the bottom of the water body by means of a rope, then the messenger is sent down to trip the latch causing the sampler to close on the sediments. The sampler is then raised slowly to minimize the disturbance of the lighter sediments. Sediment is then placed into a stainless steel bowl, homogenized, and placed into the appropriate sample container (if collecting for VOC parameters, fill the VOC jars before homogenization).

8.4.4. Corers

Core samplers are used to obtain vertical columns of sediment. Many types of coring devices are available, depending on the depth of water from which the sample is to be collected, the type of bottom material, and the length of core to be obtained. They vary from hand-push tubes to weight or gravity-driven devices to vibrating penetration devices.

Coring devices are useful in contaminant monitoring due to the minimal disturbance created during descent. The sample is withdrawn intact, allowing the removal of only those layers of interest. Core liners consisting of plastic or Teflon may also be added, thereby reducing the potential for sample contamination and maintaining a stratified sample. The samples may be shipped to the lab in the tubes in which they were collected. The disadvantage of coring devices is that only a small sampling surface area and sample size is obtained, often necessitating repetitive sampling in order to collect the required amount of sediment for analysis. It is also often difficult to extract the sediment sample back out through the water column without losing the sample.

The core tube is pushed/driven into the sediment until only 4 inches (10 cm) or less of tube is above the sediment-water interface. When sampling hard or coarse sediments, a slight rotation of the tube while it is pushed will create greater penetration and reduce compaction. Cap the tube with a Teflon plug or a sheet of Teflon. The tube is then slowly withdrawn, keeping the sample in the tube. Before pulling the bottom part of the core above the water surface, it must be capped.

8.4.5 Scooping

The easiest way to collect a sediment sample is to scoop the sediment using a stainless steel spoon or scoop. This may be done by wading into the stream or pond and, while facing upstream (into the current), scooping the sample from along the bottom in an upstream direction. This method is only practical in very shallow water.

8.4.6 Mixing

Sediment samples collected for chemical analysis should be thoroughly mixed (except for VOCs) in a stainless steel bowl prior to placement in the appropriate sample container. Standard procedures exist for preparation of sediment samples (ASTM D3976). These should be followed or the laboratory informed of applicable procedures.

8.4.7 Air Monitoring

Prior to sediment/sludge sampling, measure the breathing space above the sample location with a PID, should the potential for volatiles be present, and use a hydrogen sulfide meter should hydrogen sulfide be present. Repeat these measurements during sampling. If either of these measurements exceed any of the air quality criteria established in the HASP, air purifying respirators (APRs) or supplied air systems will be required.

8.4.8 Sample Location Tie-In/Surveying

The recording of the sample locations and depth on the site plan is extremely important. This may be accomplished by manual measurement (i.e., swing ties), global positioning system (GPS) survey, or stadia methods. Manual measurements for each sample location should be tied into three permanent features (e.g., buildings, utility poles, hydrants). Diagrams with measurements should be included in the field book.

8.5 Field Notes

A bound field book is used to record daily activities, describe sampling locations and techniques, and describe photographs (if taken). Visual observations are important, as they may prove invaluable in interpreting water or sediment quality results. Observations shall include (as applicable) weather, stream flow conditions, stream physical conditions (width, depth, etc.), tributaries, effluent discharges, impoundments, bridges, railroad trestles, oil sheens, odors, buried debris, vegetation, algae, fish or other aquatic life, and surrounding industrial areas. The following observations should be considered:

- Predominant Surrounding Land Use: Observe the prevalent land use type in the vicinity (noting any other land uses in the area which, although not predominant, may potentially affect water quality).
- Local Watershed Erosion: The existing or potential erosion of soil within the local watershed (the portion of the watershed that drains directly into the stream) and its movement into a stream is noted. Erosion can be rated through visual observation of watershed and stream characteristics. (Note any turbidity observed during water quality assessment.)
- Local Watershed Non-point Source Pollution: This item refers to problems and potential problems other than siltation. Non-point source pollution is defined as diffuse agricultural and urban runoff (e.g., stormwater runoff). Other compromising factors in a watershed that may affect water quality are feedlots, wetlands, septic systems, dams and impoundments, and/or mine seepage.
- Estimated Stream Width: Estimate the distance from shore at a transect representative of the stream width in the area.

- Estimated Stream Depth: Riffle (rocky area), run (steady flow area), and pool (still area). Estimate the vertical distance from water surface to stream bottom at a representative depth at each of the three locations.
- High Water Mark: Estimate the vertical distance from the stream bank to the peak overflow level, as indicated by debris hanging in bank or floodplain vegetation, and deposition of silt or soil. In instances where bank overflow is rare, a high water mark may not be evident.
- Velocity: Record an estimate of stream velocity in a representative run area (see Section 12.0).
- Dam Present: Indicate the presence or absence of a dam upstream or downstream of the sampling station. If a dam is present, include specific information relating to alteration of flow.
- Channelized: Indicate whether the area around the sampling station is channelized.
- Canopy Cover: Note the general proportion of open to shaded area which best describes the amount of cover at the sampling station.
- Sediment Odors: Disturb sediment and note any odors described (or include any other odors not listed) which are associated with sediment in the area of the sampling station.
- Sediment Oils: Note the term which best describes the relative amount of any sediment oils observed in the sampling area.
- Sediment Characteristics: Note the grain size, color, consistency, layering, presence of biological organisms, man-made debris, etc. in accordance with standard ASTM soil description protocols.
- Sediment Deposits: Note those deposits described (or include any other deposits not listed) which are present in the sampling area. Also indicate whether the undersides of rocks not deeply embedded are black (which generally indicates low dissolved oxygen or anaerobic conditions).

8.6 References

For additional information pertaining to this topic, the user of this manual may reference the following:

ASTM D5358 Practice for Sampling with a Dipper or Pond Sampler
ASTM D4489 Practices for Sampling of Waterborne Oils
ASTM D3325 Practice for the Preservation of Waterborne Oil Samples

ASTM D4841 Practice for Estimation of Holding Time for Water Samples Containing Organic and Inorganic Constituents

ASTM D4416 Guide for Sampling Fluvial Sediment in Motion

ASTM D4823 Guide for Core-Sampling Submerged, Unconsolidated Sediments

ASTM D3213 Practice for Handling, Storing, and Preparing Soft Undisturbed Marine Soil

ASTM D3976 Practice for Preparation of Sediment Samples for Chemical Analysis

ASTM E1391 Guide for Collection, Storage, Characterization, and Manipulation of Sediments for Toxicological Testing

ASTM D4581 Guide for Measurement of Morphologic Characteristics of Surface Water Bodies

ASTM D5906 Guide for Measuring Horizontal Positioning During Measurements of Surface Water Depths

ASTM D5073 Practice for Depth Measurement of Surface Water

ASTM D5413 Test Methods for Measurement of Water Levels in Open-Water Bodies

9.0 SLUG TEST PROCEDURES

9.1 Materials and Equipment Necessary for Task Completion

Water level (data) logger capable of recording pressure and/or depth at sub-second time intervals (preferably a vented logger capable of advanced logging modes); vented, direct-read cable of sufficient length (with dessicant); interface tape/probe or water level meter; solid (mechanical) slug, pneumatic slug, or packer system [the introduction or removal of water is not recommended (e.g., bailer or bucket)]; 5 gallon bucket, traffic cones and/or barricades, deionized or distilled water and Alconox®; decontamination bucket and brush; and laptop computer or rugged reader.

9.2 Decontamination Requirements

Equipment utilized during slug testing must be thoroughly decontaminated with Alconox® and deionized/distilled water prior to and between uses at each test well to prevent cross contamination between wells. Any groundwater removed from the well during testing must be containerized and either treated and discharged to ground surface, or disposed of in an approved manner, preferably in a properly installed, onsite holding tank. If LNAPL is encountered/recovered, it should be containerized and properly disposed onsite. However, the preferred test initiation methods (solid and/or pneumatic slug) do not generate any groundwater.

9.3 Methodology for Slug Testing

Slug tests are utilized to provide in-situ estimations of hydraulic conductivity (k) in saturated media, most often in geologic formations that exhibit aquifer properties (low k media can also be tested with special consideration). Slug tests involve rapidly displacing the static water level in a well, and analyzing the well's rate and pattern of recovery back to near-static conditions. Falling head or slug-in tests involve analysis of displacement due to the addition of volume, and rising head or slug-out tests involve the analysis of displacement due to the removal of volume. Displacement is initiated using either a solid or pneumatic slug. Water level response is monitored immediately following the initial displacement and for the ensuing time period until the water level has returned to near-static level (generally within 5% of static). Water level response should be recorded using a water level (data) logger capable of recording pressure and/or depth at sub-second time intervals (preferably a vented logger). Logarithmic logging modes are preferred to shorten the data file while still providing high resolution data just after test initiation.

9.4 Field Procedures

1) Test Well Construction and Configuration - Well construction details are needed to perform slug test calculations and are important considerations when selecting appropriate wells for testing. Important as-built details include: total well depth, well screened interval(s), depth to (static) water, casing diameter, screen diameter, filter pack diameter, filter pack size, and filter pack interval. While these details should be documented on the well log, static water level and total well depth should be field-confirmed before the test. Of particular importance to the testing procedure is the relationship between static water level and well screened interval, and the degree of well development. Test results for poorly or insufficiently-developed wells may be strongly affected by drilling debris/disturbance in the formation that can create skin effects, lowering the apparent formation k. Analysis of testing data for wells screened across the water-table should consider drainage of the filter pack media. In addition, a pneumatic slug assembly should not be utilized unless the test well is screened below the water table and the water level remains above the screen throughout the test.

2) Test Setup and Initiation - Upon arrival, the test well should be gauged for static depth to water and total well depth so that the total water column length can be estimated. Well gauging data should be recorded in a rugged reader using an EDGE file, if available, or field form or book.

    a. Solid Slug
    The displacement volume of the slug is needed. It is suggested that the slug be prefabricated and calibrated for displacement volume prior to site use. Calculate the expected initial well displacement, using the slug volume and well casing radius, and deploy the data logger/cable to a depth just below that level while considering the slug length (to avoid conflict and tangling of the slug and transducer). Also consider the submergence depth limit of the data logger (usually indicated on the logger body). Generally, placing the data logger a foot or two below the bottom of the slug is good practice. Once submerged, allow the

data logger temperature to equilibrate with groundwater prior to initiating the test (up to 30 minutes).

While the data logger temperature equilibrates, secure the slug to an adequate length of disposable string or rope and hang in the well to a depth just above the water surface. Mark the string/rope to accommodate the slug length and tie off. Using the rugged reader or field computer, set up a new test (logarithmic mode or sub-second recording interval) in the data logger supplied software and start the test. Indicate in the file name the type of test and test number (e.g., rising or falling head; test 1 or 2). Once logging is initiated, quickly and smoothly lower the slug (slug-in or falling head test) to the submerged depth and tie off the string/rope (displacement should be instantaneous). Monitor the data logger data until the water level has returned to near-static level. Stop the falling head test.

Without moving the slug or data logger, set up a new test in the data logger supplied software with the same settings and indicate in the file name the type of test being performed (rising head or slug out). Start the test and once the data logger is running, instantaneously lift the slug and tie off the string/rope to its pre-test position (just above static). Monitor the data being recorded by the data logger and stop the test when the water level has returned to near-static.

b. Pneumatic Slug

If a high formation k is anticipated, solid slug removal is found to be too slow to capture well recovery, or to minimize equipment decontamination for wells with submerged screens, a pneumatic slug assembly should be utilized.

Open air release valve, secure pneumatic slug assembly to well casing and tighten coupling to provide an air tight seal. Insert the data logger/cable and deploy to the target submergence depth [it is generally best to keep the data logger shallow (~1-2 feet below static water level) and use small initial displacements to avoid dynamic recovery effects in high k formations]. Close the air release valve and attach the air pump or compressor. Pressurize the well and use the pressure gauge to set initial displacement. Check for air leaks using a soapy water mixture and sprayer (assembly must be air tight). Allow the water level to return to static and remove the air pump. Using the rugged reader or field computer, set up a new test (logarithmic mode or sub-second recording interval) in the data logger supplied software and start the test. Indicate in the file name the type of test and test number (e.g., rising head; test number). Once logging is initiated, open the air release valve and monitor the test data. Stop the test when the water level has returned to near-static.

3) Test Monitoring and Guidelines - The following are general guidelines for slug testing performance as published by Midwest Geosciences Group in "Field Guide for Slug Testing and Data Analysis:"

- Conduct at least three or more tests per well and if possible conduct both rising and falling head test data.
- Use two or more initial displacement values (2 slug sizes or air pressures applied) that vary by an order of magnitude or more.
- Final slug test initial displacement should be nearly equivalent to the first test's displacement.
- Allow tests to run until near-static conditions are achieved (+/- 5% of static)
- Digital slug test data files collected with the data loggers and/or EDGE files should be backed up to either a thumb drive, corporate email server, and/or corporate file server immediately after collection.

4) Test Data Reduction and Processing - Prior to slug test analyses, digital data logger files should be normalized so that multiple tests conducted on the same test well can be compared for the assessment of test validity and well conditions. Reducing the data as follows:

- From each raw data file, estimate the time of test initiation and the head (depth or pressure) under static conditions.

- In each slug test data file, subtract the time of test initiation from the elapsed time and save to a new field (normalized time or test time; start of test should be time zero).
- In each slug test data file, subtract the static pressure head from the test period pressure head values and save to a new field (deviation from static).
- To normalize the deviation from static values, divide that field by the displacement expected based upon the slug volume or air pressure head applied.
- Create a graphical plot of the normalized head data versus test time for each test performed on the test well. Review the data plots and confirm that the testing data for each repeat test roughly concur. Also confirm that the actual and expected initial displacements are nearly equal.
- If repeat testing data and/or expected versus actual initial displacements vary widely, review well completion details and testing methods prior to performing further analysis (step 5 below) as the results may not be valid (e.g., the well screen interval may be poorly developed or fouled, the data logger may have moved or placed too deep in the well, slug was removed too slowly). The well may need to be retested.

5) Test Data Analysis - For the purposes of this standard operating procedural document, it is assumed that slug test analysis software will be used to apply standard solution methods to the testing data. Various computer programs are available, such as AQTESOLV Professional. Choose an appropriate test solution method by considering the following well configurations (in AQTESOLV, use the Solution Expert):

   a. Submerged Screen and/or Confined Aquifer Well - If the well screen fully penetrates the intersecting aquifer, utilize the Cooper et al. Model or Hvorslev Model and analyze the curve match and/or best fit. If well is partially penetrating a confined formation, utilize the KGS Model or Hvorslev Model. If well screen is submerged in an unconfined formation, utilize the KGS Model or Bouwer and Rice Model.

b. Water-Table Intersects Well Screen - If the well screen is intersected by the water table, utilize the Bouwer and Rice Model (double straight line effect) or KGS Model.

c. Rapid Well Recovery in High k Formations - If well response to displacement is extremely rapid and normalized head plots display an oscillatory or concave-downward form, utilize the Butler and Zhan Model (most comprehensive solution available) or High-k Hvorslev Model for confined wells, or the High-k Bouwer and Rice Model.

9.5 Limitations

In general, results of slug test data analyses provide an initial estimate of formation k and have a small scale of relevance (particularly in high k settings). Slug tests can be strongly affected by the degree of well development and can be used diagnostically to assess the degree of well development. In most cases, slug testing should be performed on several wells in an area of interest to develop an understanding of the formation characteristics (e.g., heterogeneous or homogeneous formations).

10.0 PUMP TEST PROCEDURES

10.1 Materials and Equipment Necessary for Task Completion

Water-level (data) loggers (transducers) capable of recording pressure and/or depth at sub-second time intervals (preferably a vented logger capable of advanced logging modes for at least the pumping well); vented, direct-read cables of sufficient length (with dessicant packs); interface tape/probe or water-level meter; well pump (preferably a submersible pump), drop pipe and layflat or comparable discharge line of sufficient length, totalizing flow meter (recommended) and 5 gallon bucket, stop watch, rain gauge or nearby weather station; materials needed to monitor surface water bodies near the test site (e.g., staff gauge, weir, stakes, data logger, camera with permission from refinery personnel); traffic cones and/or barricades, deionized or distilled water and Alconox®; decontamination bucket and brush; laptop computer or rugged reader; portable generator or other power supply appropriate for the submersible pump; and containment (e.g., frac tank) or activated carbon filtration for the temporary staging or filtering of discharge water.

10.2 Decontamination Requirements

Equipment utilized during pumping tests must be thoroughly decontaminated with Alconox® and deionized/distilled water prior to and between uses at each test well to prevent cross contamination between wells. Any groundwater removed from the tested well must be containerized and either treated (filtered as appropriate) and discharged to ground surface, or disposed of in an approved manner, preferably in a properly installed, onsite holding tank. If LNAPL is encountered/recovered, it should be containerized and properly disposed of on or off-site.

10.3 Methodology for Pump Testing

10.3.1 Pre-test Considerations

In general, pumping tests are performed to estimate large-scale in-situ hydraulic properties of water-bearing strata in the subsurface (i.e., transmissivity and storativity) and average out local-scale heterogeneity that can limit the applicability of smaller-scale testing methods, such as slug tests. The geographical area influenced by a pumping test will be determined by the hydraulic properties of the strata being tested (including hydraulic properties of other strata supplying recharge to the pumped formation), boundary conditions, and on the duration of the test.

Pumping tests are also commonly performed to generate drawdown data from which hydraulic boundary conditions, hydraulic flow regime (e.g., anisotropy), and aquifer type (i.e., unconfined or confined, leaky confined) may be estimated. Smaller-scale pumping tests may also be utilized to address pumping efficiency and/or signal to noise ratio (pumping rate) at the pumping well, or to assist in remedial system design. However at this scale, the assumptions of some data analysis methods may not be applicable and should be considered prior to testing.

Appropriate design of a pumping test should include review of site-specific information regarding the geology and hydrogeology of the test area. Pumping test design should also consider the goal(s) of the test (i.e., scale of application of derived aquifer properties, identification of boundary influences, sources of recharge, well efficiency). This should include review of available lithologic well logs or test boring logs, geologic maps, cross sections, structure contour maps, isopach maps, and any other available information so that a conceptual model relating geologic units to hydrostratigraphic units or water-bearing strata can be developed. Additional pre-test considerations should include identification of any potential positive or negative hydraulic barriers, tidal effects, and/or influence from other wells that may be pumping in the test area. Without sufficient knowledge of factors influencing water-levels and hydrology of the test area, test results could be misinterpreted.

Often times, budget considerations and/or time limitations will necessitate the use of an existing monitoring well as the pumping well and/or existing wells as observation points. While this is generally acceptable, the wells must be screened appropriately with respect to the goals of the test and knowledge of well construction is critical to applying test solutions. Wells should also be redeveloped prior to testing if they are relatively old or if records of sufficient well development at the time of installation are not readily available.

Pumping tests can be divided into two general classifications: step-drawdown tests and constant rate tests. Step tests typically involve pumping a well at progressively higher rates or “steps” at intervals of one or two hours per step (typically up to 3 steps). They are often used to estimate the yield a well will sustain during a constant rate pumping test and to evaluate well efficiency (frictional head losses between the screen/gravel pack and the formation). Constant rate pumping tests are used primarily to evaluate hydraulic properties of water-bearing strata for design of groundwater treatment systems and/or water supply purposes (e.g., groundwater allocation). Where budgets permit, the best pumping test approach is to first perform a step-drawdown test on the pumping well to evaluate well efficiency and sustainable yield (and to gauge whether or not the pumping well needs additional development), allow recovery to near-static conditions, and then initiate a constant rate test.

The test duration is subject to goals of the test and to budget considerations. Optimally, a constant rate test should be run until all drawdowns have stabilized or boundary conditions are identified, and gravity drainage effects are curtailed; however, this is seldom practical due to time limitations. In most instances, an 8 hour constant rate test will be adequate, and a 24 hour test will be sufficient for higher sensitivity sites. Occasionally a 72 hour pumping test is warranted, though this is usually reserved for large scale water supply work. If there are any unexplained water level anomalies observed toward the scheduled end of a test, the test should be continued if at all possible.

The approximate test flow rate needs to be determined in advance for proper pump and discharge design selection, and sizing of discharge containment. If it is not appropriate to perform a step test, sustainable yield can be estimated from slug test data or a brief (<30 minutes) pumping episode the day before the actual test. Generally, it is best to pump the test well at a rate that maximizes the signal to noise ratio (a higher pumping rate does not influence test scale and should not be used as a means to shorten the test duration).

If testing must be performed in an area where contamination is known to be present, careful consideration of the impacts of the test scale should be considered prior to testing so that the spread of subsurface contamination is not increased. If floating product (LNAPL) is present at or near the pumping well, drawdown should be limited so as to not impact uncontaminated soils below the static water table (i.e., create a “smear” zone or allow for the significant migration of free-phase product). Discharge water must be either 1) treated prior to discharge or 2) containerized for on or off-site disposal. If it is to be discharged directly on-site and allowed to infiltrate, it must be routed sufficiently far enough from the test area as to avoid any artificial recharge effects. All appropriate withdrawal and discharge permits must be obtained and complied with. If discharge water is to be treated on-site, proper contaminant loading calculations for the test flow rate, approximate contaminant loading and test duration must be performed in advance to insure treatment is sufficient. Any on-site treatment should also include at least one discharge effluent sample analysis by an approved laboratory to document treatment effectiveness.

10.3.2 Pre-Test Water Level Monitoring

Water-level conditions in the test area should be monitored for at least one week prior to initiation of testing to identify background trends and factors influencing groundwater levels in the test area. Data loggers should be deployed in all wells to be utilized in the pumping test and set to record depth or pressure at a resolution that is high enough to identify any potential trends (generally a 15 minute recording interval is sufficient for background monitoring). A manual water level should be measured with a water-level meter or interface probe and referenced to the top of casing mark to calibrate the data logger data at the time of deployment and at sufficient intervals throughout the recording period to validate the data and provide backup data in the event that a data logger was to fail.

Ideally, groundwater levels should be static prior to starting a pumping test so that pumping influences alone can be readily evaluated. Any significant precipitation events within the previous several days (documented through use of a site rain gauge or nearby weather station) will usually result in noticeable water level changes. If there are any major water level changes observed that cannot be explained prior to testing, additional investigation into possible area influences (e.g., local well pumping or construction de-watering) should be conducted.

10.3.3 Pumping Test Set Up

Prior to starting the test, all well measuring points (i.e. top of casing) should be clearly marked and preferably surveyed to the nearest 0.01 feet in elevation. The horizontal distance between all wells utilized should be measured and illustrated on a base map. If there are any surface water bodies in the vicinity, a staff gauge (or similar measuring device) should be set up and surveyed to evaluate possible test influences on water levels or stream flow.

The preferred pump to be used for a pumping test is a submersible centrifugal pump powered by either existing site power or a portable generator. These pumps are not explosion proof, so a conductivity probe must be tied into the pump controls to alleviate any possibility of product coming into contact with the pump (if product is anticipated). If the test pump is designed to pump total fluids (e.g. air operated double diaphragm pump, jack pump, etc.) discharge must either be containerized, or treatment must include an oil/water separator to handle any floating product. The submersible pump should be set deep enough to maintain flow during the test period or at a maximum of just above the screened interval, using a handling line to support the pump's weight [**NOTE:** extreme care must be taken that the power cord is neither bearing any of the pumps weight, nor damaged during installation due to the potential for severe electric shock]. A check valve (or two check valves) should be installed above the pump in the discharge line to prevent backflow into the well after testing.

Discharge piping from the pump should include a flow meter (preferably with totalizer), followed by a flow adjustment valve. The flow meter should be installed in a straight section of hard piping of sufficient length to avoid meter distortion caused by turbulence (typically about 10 pipe diameters on either side of the meter). In low-flow pumping tests, flow rate can be calculated by measuring the exact time required to fill a known-sized container (bucket and stop watch) several times throughout the testing period. The bucket and stop watch method of estimating flow should also be used to back up and check the flow meter data.

Precise and frequent water-level measurements (to the nearest 0.01 feet) and time denotations before, during, and after pumping tests are critical to achieving accurate test results. In terms of prioritization, data loggers should be utilized in at least the pumping well and observation wells closest to the pumping well. Wells further from the pumping well may be manually monitored, due to the reduced likelihood that early-time drawdown will be critical at distal locations. Back-up manual measurements should be collected at least hourly during the first 8 hours of the test, and then at least every 3 hours, to verify data logger measurements. Readings from the transducers are not completely reliable until they have been submerged for at least 30 minutes (sensor equilibration period). All field personnel should have watches with a second hand, and they should all be calibrated to the same time. Liquid level measurements should be obtained using an optical oil/water interface probe with a graduated measuring tape to 0.01 foot accuracy for those wells with floating product. For wells without product, a water-level meter may be sufficient. All non-dedicated probes must be properly decontaminated after each level reading to prevent any possibility of cross- contamination between wells.

Data loggers should be deployed in each selected well to a depth that will maintain submergence through the test period. Data loggers selected should be capable of being submerged to that anticipated depth (typically noted on the instrument body). The transducer cable should be secured at the wellhead (manufacturer supplied hangers, well caps, or electrical tape/cable ties) to minimize any movement of the sensor. Care must be taken that the transducer cable is not damaged from rough edges at the well head, and that no vehicles run over the cable. The data logger installed in the pumping well will need to be installed at a depth that will maintain submergence through the test, but also remain clear of the submersible pump (and pump noise if possible). In addition, wells with floating product may require an inner PVC stilling well surrounding the data logger cable to prevent damage from contact with the product. A stilling well may also eliminate the need for any water-level corrections for product thickness.

10.3.4 Running the Test

Once the data loggers have been deployed and secured, tests should be set up in each device and each device either started or “future” started to begin logging when the pump is turned on. The data logger in the pumping well should be set to logarithmic logging mode to capture sub-second data during the early portion of the test. If possible, the pump discharge control valve should be have been pre-set (based on the step test or mini pump test) to the desired flow rate prior to turning on the pump. However, depending on the test pumps performance curves, minor flow rate adjustments are generally needed during the first hour or two of the test to correct for the additional lift required by the pump due to increasing drawdown. In addition, movement of the discharge hose after the test has been started should be avoided, since any change in the elevation of the discharge will affect the pumping rate. All changes in flow rate should be recorded and time stamped.

A minimum of two field personnel are needed to run a pumping test, with additional personnel required for tests with multiple observations wells or additional complexity. One person should be designated to turn on the pump, monitor and adjust flow rate, maintain discharge and treatment, maintain the generator, etc. The second person should be responsible for data logger management and manual water-level measurements. As a rule of thumb regarding the frequency of manual well gauging, one measurement every half minute during the first 5 to 10 minutes, followed by one measurement every 3 to 5 minutes during the first hour, one measurement every 10 to 20 minutes for the second hour, and one hourly measurement thereafter is acceptable.

Throughout the test, data loggers should be downloaded in real time through use of direct-read, vented cables (or non-vented with a barometric logger for compensation) to monitor water-level conditions. It is essential that some data reduction be accomplished in the field, so that major water level trends are recognized during the test. At a minimum, drawdown trends from the pumping well and two of the nearest monitoring wells need to be semi-log plotted against time so that deviations indicative of boundary conditions can be discerned before pumping is ceased. This will allow decisions to be made about whether the test should run longer than planned.

Generally, water quality samples are collected during a pumping test for laboratory analysis of constituents of concern. These are generally collected after the first hour of pumping and just prior to pump shutdown. If the test is of more than 24 hours duration, it is advisable to collect additional samples during the testing period. All groundwater samples should be collected following Evergreen Field Procedures.

10.3.5 Post-test Recovery

At the conclusion of the test, water level recovery data should be collected until near-static conditions are re-established. This requires the installation of a check valve in the discharge line above the submersible pump to prevent backflow. The recovery data has the advantage in that there are no variations in the curve produced due to variations in pumping rate and is independent of test length. In water-table aquifers, however, the effects of formation de-watering can cause the recovery trends to be substantially different from drawdown trends. Consequently, recovery (residual drawdown) data should be used in conjunction with drawdown data where possible.

10.3.6 Data Analysis

The data collected during pumping tests are analyzed to estimate aquifer hydraulic properties, such as transmissivity, conductivity, and storage. Data collected by transducers must be downloaded and transformed (dimensionless drawdown or displacement from static) prior to analysis. Analysis typically involves curve matching of site data to type curves established in literature for particular flow regimes. Curve matching is commonly performed utilizing computer software, such as HydroSOLV's AQTESOLV program, along with diagnostic methods and derivative analysis to best estimate aquifer properties through identification of flow regimes and conditions.

It is noted that the mathematical solutions used in pumping test analysis include many assumptions that must be considered in the context of each test area (e.g., the formation is of uniform thickness and of infinite areal extent). In addition, some of the values incorporated into typical pumping test solutions are not actually measured, but are educated estimates (e.g., porosity based on lithology, etc.). Many problems associated with pumping test data evaluation are due to not recognizing, and/or correcting for, deviations from the theoretical solution employed. Some of the more common analytical errors occur due to: partial well penetration effects, formation de-watering effects, casing storage effects, poor pumping well efficiency and/or the application of incorrect equations or units. Consequently, a thorough understanding of the underlying assumptions inherent to the solution employed is required before the validity of the results can be trusted.

APPENDIX E

SOIL, GROUNDWATER, AND AIR ANALYTICAL REPORTS (ON CD)

APPENDIX F

STANTEC INDOOR AIR ASSESSMENT REPORT AND GHD AIR DATA EVALUATION LETTER

Evaluation of Specific Volatile Organic Compounds in Occupied Buildings at the former Sunoco Philadelphia Refinery

Sunoco, Inc. (R&M) Philadelphia Refinery Remediation Program

Philadelphia, Pennsylvania

Prepared for:

Sunoco, Inc. (R&M)
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Lester, Pennsylvania 19029

March 22, 2013

Project Number: 213402094

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March 20, 2013

EVALUATION OF SPECIFIC VOLATILE ORGANIC COMPOUNDS IN OCCUPIED BUILDINGS AT THE FORMER SUNOCO PHILADELPHIA REFINERY

SUNOCO, INC. (R&M) PHILIDELPHIA REFINERY REMEDIATION PROGRAM

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Executive Summary

On Wednesday, October 24 and Thursday, October 25, 2012, Stantec Consulting Services Inc. (Stantec) conducted a comprehensive study of airborne volatile organic compounds (VOCs) in occupied buildings at the former Sunoco, Inc. (R&M) Philadelphia Refinery, now Philadelphia Energy Solutions (PES) Refining and Marketing (R&M) LLC, located at 3144 Passyunk Avenue, Philadelphia, Pennsylvania (the refinery). The study was conducted as part of Sunoco's participation in a real estate and refinery operation transaction. The study was performed to document the concentration of a number of specific chemicals which may be present inside occupied buildings from refinery activities or related refinery conditions.

Methodology

An initial site visit was conducted on September 18 and 19, 2012 by Stantec and Sunoco to select the occupied buildings to be evaluated and to determine the tentative number and locations of samples to be collected during the study. Based on the initial site visit, a sampling plan was subsequently developed which specified collection of air samples inside occupied buildings on the refinery property for analysis of petroleum-related VOCs in air utilizing United States Environmental Protection Agency (US EPA) Method TO-15 for analysis. This method calls for the collection of air samples into specially prepared vacuum SUMMA canisters (or cans). The sampling plan also specified collection of these air samples over a four (4) hour period to accommodate the possible variability in ambient VOC concentrations.

Samples were collected inside occupied areas of the selected buildings and outdoor air samples were collected for comparison. Thirty-four (34) samples were collected inside buildings and seven (7) samples outdoors. Three (3) trip blanks were also submitted for analysis. Compounds of interest for this study were consistent with the Pennsylvania Department of Environmental Protection's (PADEP) Short List of Petroleum Products, specifically: methyl tert-butyl ether (MTBE), 1,2-dichloroethane, benzene, toluene, 1,2-dibromoethane (ethylene dibromide), ethylbenzene, xylenes, isopropylbenzene (cumene), 1,2,4-trimethylbenzene (1,2,4-TMB), and 1,3,5-trimethylbenzene (1,3,5-TMB). The concentrations of VOCs detected in each sample of indoor and outdoor air were compared to occupational exposure limits (OELs) and risk-based screening levels published by US EPA and PADEP. Summary statistics were calculated to compare the ranges of concentrations of VOCs found in indoor air to concentrations in outdoor air.

Results

The concentrations of all compounds detected in indoor and outdoor air were many orders of magnitude less than the Occupational Safety and Health Administration (OSHA) Permissible

Exposure Limit (PEL) time-weighted averages (TWAs) and the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs®) TWA.

The maximum concentrations of all compounds detected in all samples were equal to (benzene only) or less than the corresponding risk-based US EPA Regional Screening Levels (RSLs) and the PADEP Indoor Air Quality (IAQ) criteria for exposure in industrial environments. Note that the US EPA RSL concentrations for chemicals with cancer health effects (MTBE, benzene, and ethylbenzene) were multiplied by a factor of ten (10) to reflect a target cancer risk of 1 in 100,000 or 1E-05 which is consistent with the Pennsylvania risk-based standards.

There were notable differences in the concentrations of most of the compounds detected inside the individual buildings that are not evident from the arithmetic means of the analytical results for all indoor air samples. Specifically, the highest concentrations of benzene were found in the Point Breeze Lab samples (11 and 8.4 µg/m^3) and the 440 Building samples (9 and 7.2 µg/m^3). The highest concentrations of toluene (88 and 330 µg/m^3), ethylbenzene (11 and 6 µg/m^3), total xylenes (51.1 and 31.6 µg/m^3) were found in the PB Lab samples (west lab and 2nd floor office, respectively). The highest concentrations of 1,3,5-TMB (3.9 µg/m^3) and 1,2,4-TMB (11 µg/m^3) were found in the PB Lab, 2nd floor office sample although the PB Lab, west lab sample was not significantly different than other indoor air sample locations.

The concentrations of benzene, toluene, ethylbenzene, xylenes, and trimethylbenzenes in buildings other than the 440 Building and the PB Lab were comparable to the concentrations in outdoor air.

Conclusions

The findings of this evaluation indicate that the indoor and outdoor concentrations of VOCs associated with refinery operations were orders of magnitude lower than occupational exposure limits, and lower than or equal to (benzene only) conservative risk-based screening levels published by US EPA and PADEP for long-term exposures in industrial settings. Note that the US EPA RSL concentrations for chemicals with cancer health effects were adjusted to be consistent with the Pennsylvania risk-based standards. Assuming that the concentrations of petroleum-related VOCs found inside the occupied buildings in late October 2012 are representative of long-term conditions, there do not appear to be health concerns for people who work inside the buildings from exposure to these chemicals.

Table of Contents

1.0 Introduction

Stantec Consulting Services Inc. (Stantec) conducted a comprehensive study of airborne volatile organic compounds (VOCs) in occupied buildings at the former Sunoco, Inc. (R&M) Philadelphia Refinery, now Philadelphia Energy Solutions (PES) Refining and Marketing (R&M) LLC, located at 3144 Passyunk Avenue, Philadelphia, Pennsylvania (the refinery). The study was conducted as part of Sunoco's participation in a real estate and refinery operation transaction. The study was performed to document the concentration of a number of specific chemicals that may be present inside occupied buildings from refinery activities or related refinery conditions.

During a real estate and operational transition involving a facility such as this refinery, the potential for residual chemical exposure in occupied buildings exists and it is reasonable to assess the potential adverse health risk.

This facility refines, processes, and blends transportation fuels. The chemicals of interest for this study were consistent with the Pennsylvania Department of Environmental Protection (PADEP) Table IV-9 Short List of Petroleum Products (PADEP 2004), specifically: methyl tertiary-butyl ether (MTBE), 1,2-dichloroethane, benzene, toluene, 1,2-dibromoethane (ethylene dibromide), ethylbenzene, xylenes, isopropylbenzene (cumene), 1,2,4-trimethylbenzene (1,2,4-TMB), and 1,3,5-trimethylbenzene (1,3,5-TMB). Although the PADEP Table IV-9 Short List is for analysis of soil and water samples, all of the compounds listed for water except naphthalene, are volatile compounds of interest in air.

An initial site visit was conducted on Tuesday, September 18, and Wednesday, September 19, 2012 by Jim Oppenheim (Sunoco), Jennifer Menges (Stantec), and John Reiter (Stantec) to select the occupied buildings where sampling would be conducted and to determine the tentative number and locations of samples to be collected during the study. The sampling plan developed based on this initial site visit, and subsequently implemented by Stantec field staff in cooperation with refinery personnel in October 2012, specified collection of air samples inside occupied buildings on the refinery property for analysis of concentrations of VOCs in air by United States Environmental Protection Agency (US EPA) Method TO-15 (US EPA 1999).

US EPA Method TO-15 calls for the collection of air samples into specially prepared vacuum SUMMA canisters (or cans). The sampling plan specified collection of these air samples over a four (4) hour period of time to accommodate the possible variability in ambient VOC concentrations. Samples were collected inside occupied areas of the buildings and outside samples were collected for comparison. Thirty-four (34) samples were collected inside of buildings and seven (7) samples were collected outdoors. Three (3) trip blanks were also submitted for laboratory analysis.

Analytical results were compared to occupational exposure limits (OELs), specifically the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs) and the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values

(TLVs®). Results were also compared to current (November 2012) US EPA risk-based Regional Screening Levels (RSL) for industrial occupancies and PADEP Indoor Air Quality (IAQ) criteria for industrial occupancies. Additionally, PADEP-referenced odor thresholds were cited.

2.0 Chemical Constituents and Applicable Exposure Limits

The facility is a refinery that processes and blends large quantities of petroleum-based transportation fuels. The refining and blending processes generate the volatile petroleum-based organic compounds of interest for this investigation. In addition to being flammable, these volatile compounds may cause adverse health effects ranging from upper respiratory tract irritation at lower concentrations of exposure to more severe effects such as central nervous system depression or intoxication at high concentrations of exposure. Benzene is also considered to be a human carcinogen based on epidemiologic studies demonstrating an increased risk for acute myelogenous leukemia in occupational cohorts exposed to high concentrations (e.g. exceeding approximately 10 parts per million (ppm)) over many years (ATSDR 2007). The potential for adverse health effects correlates with increasing concentrations and duration of exposure.

All of the compounds monitored in this study have relevant occupational standards and risk-based screening levels. The OELs were developed based on the precept that nearly all persons may be exposed to a concentration of the chemical at or below the exposure limit, day after day, week after week, for a working lifetime, without experiencing any adverse health effects due to the chemical exposure.

Risk-based screening levels are concentrations of chemicals in environmental media (soil, ambient air, and drinking water) that correspond to pre-determined levels of cancer risk and/or non-cancer hazard, under the assumption that an individual will be exposed daily over thirty (30) years (residential) or twenty-five (25) years working life-time. Two sources of risk-based screening concentrations are presented in this report: US EPA RSLs and PADEP IAQ criteria. All screening concentrations used to evaluate sampling results were developed for exposures in industrial settings.

The US EPA RSLs have been harmonized across US EPA Regions and are generally accepted as a quick and conservative method for initial evaluation of constituents found in environmental media. RSLs are presented by the US EPA as being protective for members of the general population (including sensitive groups) over a lifetime. Thus concentrations of chemicals in environmental media that are less than the RSLs are believed to be of no concern for public health. Concentrations of chemicals above conservative RSLs do not necessarily mean that health effects will occur as a result of exposure, but that further evaluation of the situation should be considered. There are carcinogenic target risk (TR) screening concentrations and non-carcinogenic hazard index (HI) screening concentrations. All chemicals produce non-cancer health effects at some level of exposure and some may also be carcinogenic. Screening concentrations generally (although not always) reflect the more sensitive outcome and lowest associated concentration.

Although the non-residential PADEP IAQ criteria were developed under the Pennsylvania Land Recycling Program to assist in the evaluation of vapor intrusion into non-residential buildings, these risk-based concentrations are analogous to US EPA RSLs and provide additional references for evaluating the results of the samples collected during this study.

3.0 Sampling Methodology

3.1 COLLECTION OF AMBIENT AIR SAMPLES

Ambient air samples were prepared by first checking the laboratory-provided SUMMA canister vacuum using a digital gauge and documenting the pre-sample pressure. Flow regulators with integral pressure gauges were attached to the canisters and tightened by hand. Sampling was initiated by opening the SUMMA canister valve to its fully open position.

Samples were collected at breathing zone height by placing the SUMMA canisters on elevated surfaces so that the sample collection intake ports were approximately three (3) to six (6) feet above the ground or floor surface. Samples were collected for approximately four (4) hours. While grab samples may have been sufficient, sample durations were intentionally longer to provide some assurance that if the concentration of the compound(s) were variable, the sample would be representative.

Samples were collected at indoor and outdoor locations previously selected and discussed during the initial site visit and sampling plan development. However, since sample conditions are dynamic and may have been different at the time of sample collection, the field technicians used their best judgment in sample location selection and, as a result, some locations may be different than originally planned. Three (3) trip blanks were provided to the lab for analysis.

3.2 QUALITY ASSURANCE PROCEDURES FOR SAMPLE COLLECTION

Sample quality assurance encompasses procedures used for pre-sample preparation; handling of samples before, during, and after collection; elimination of potential cross contamination; and elimination of collection of interfering compounds or materials. The need for some of these is unnecessary when using SUMMA canisters due the inherent relatively failsafe technology.

Flow rate and volume are not critical since the sample methodology is for whole air (i.e., a prescribed total volume) regardless of the rate of sampling or total volume of air collected. The flow regulators provide an approximate canister fill time. Following sample completion the final pressure is recorded for assurance that air was indeed collected into the canister.

Contemporary sampling media provides little opportunity for cross-contamination or external contamination. SUMMA canisters were cleaned and prepared by the analytical laboratory in a manner consistent and appropriate for re-use and the methodology and compounds selected for analysis.

Onsite recordkeeping included SUMMA can serial number, flow controller serial number, start time, stop time, total sample time, location of sample, pre-sample pressure, post-sample pressure, and notes pertaining to the location of the sample. This information is provided in Table 1.

The laboratory received the samples according to their strict receipt requirements and documentation. A *Sample Acceptance Check Form* is provided with the laboratory analytical reports provided in Appendix A.

4.0 Sampling Locations

Figure 1 illustrates the locations of buildings in which samples were collected and outside sample locations. The indoor sample locations were selected during the initial site visit by Jim Oppenheim (Sunoco), Jennifer Menges (Stantec), and John Reiter (Stantec). The indoor sample locations were selected based on the current and anticipated occupancy and use of the buildings, populations in the buildings, and locations of occupants within the buildings. The number and locations of indoor air samples per building were selected to be representative of conditions and potential exposure to the building occupants. Outdoor sample locations were selected based on the proximity to buildings in which samples were collected, and in some instances, proximity to pumping and product handling equipment. The number and locations of outdoor air samples were selected to be representative of petroleum-related compounds in ambient air that may contribute to the presence of the same compounds in indoor air.

Samples were collected in building locations identified in Table 1 and shown on Figure 1. Indoor air samples were collected in the following locations:

- Blending & Shipping (B&S) Office
- 24 Gate Building
- Girard Point (GP) Training Building
- GP Main Office Building
- 440 Building
- 15 Pump House
- North Yard Scale House
- Schuylkill River Tank Farm (SRTF) Propane Loading
- SRTF Main Pump House
- Point Breeze (PB) Main Office Building
- PB Lab
- PB Refinery Hall
- PB Maintenance Shop

Duplicate samples were collected in the 24 Gate Building (1st floor), the GP Main Office Building (2nd floor east), and the PB Refinery Hall (2nd floor east wing).

Outdoor samples were collected in the following locations:

- near the B&S Office
- outside the GP Main Office Building
- outside 15 Pump House, under the equipment roof at grade
- outside 15 Pump House, under the equipment roof approximately eight (8) to ten (10) feet below grade
- outside the North Yard Scale House
- outside the SRTF Main Pump House
- outside in the PB gate area, near the PB buildings

5.0 Analytical Results

Table 1 lists the sample location, date of sampling, start time, stop time, total sample duration, canister ID, regulator ID, pre-sample pressure, and post-sample pressure. Table 2 presents the analytical results for each indoor and outdoor sample location. Summary statistics for indoor and outdoor air samples are presented in Table 3 along with occupational exposure standards and risk-based screening concentrations. Laboratory analytical reports are provided in Appendix A.

The table below presents the arithmetic mean for all compounds detected in two (2) or more samples, or the only concentration detected. The maximum detected concentrations are shown below the means in bold, italic font. Two (2) of the compounds of interest, 1,2-dichloroethane and 1,2-dibromoethane were not detected in any of the samples and are not included on this summary table. The three (3) duplicate samples corresponding to sample numbers 3, 15, and 40 on Table 2 yielded analytical results that were virtually identical to the results of the corresponding “sample” and are not factored into the summary statistics.

Summary of Air Sampling Results 1)

Compound	**OSHA PEL 2)**	**ACGIH TLV 3)**	**RSL Ind. 4)**	**PADEP Ind. 5)**	**Indoor**		**Outdoor**	
					Freq. Detect	**Concentration** (mean / ***max***)	**Freq. Detect**	**Concentration** (mean / ***max***)
MTBE 6)	—	1.8E+05	4.7E+02	3.1E+02	2/34	1.28E+00 ***1.6E+00***	0/7	—
Benzene	3.19E+03	1.6E+03	1.6E+01	1.1E+01	34/34	2.9E+00 ***1.1E+01***	6/7	2.62E+00 ***4.9E+00***
Ethylbenzene	4.34E+05	8.68E+04	4.90E+01	7.30E+01	30/34	1.77E+00 ***1.1E+01***	2/7	1.97E+00 ***3.1E+00***
Toluene	7.54E+05	7.54E+05	2.20E+04	1.20E+03	34/34	1.88E+01 ***3.3E+02***	7/7	7.61E+00 ***1.9E+01***
Xylenes	4.34E+05	4.34E+05	4.40E+02	3.00E+02	34/34	7.50E+00 ***5.11E+01***	5/7	6.55E+00 ***1.71E+01***
Cumene	2.46E+05	2.46E+05	1.80E+03	1.10E+03	17/34	1.42E+00 ***2.6E+00***	1/7	2.0E+00 ***2.0E+00***
1,3,5-TMB 7)	—	1.23E+05	3.10E+01	1.70E+01	7/34	1.53E+00 ***3.9E+00***	1/7	1.6E+00 ***1.6E+00***
1,2,4-TMB 8)	—	1.23E+05	3.10E+01	1.70E+01	31/34	1.96E+00 ***1.1E+01***	4/7	1.69E+00 ***3.6E+00***

Footnotes:

1) All concentrations, including those for occupational standards are given in µg/m^3
2) OSHA Permissible Exposure Limit (PEL)
3) ACGIH Threshold Limit Value (TLV)
4) EPA Regional Screening Level (RSL) for industrial exposure
5) Pennsylvania Department of Environmental Protection IAQ criteria for industrial exposure
6) methyl tert-butyl ether
7) 1,3,5-trimethylbenzene (RSL for 1,2,4-trimethylbenzene)
8) 1,2,4-trimethylbenzene

The analytical results are discussed in the following sections with concentrations provided in micrograms per cubic meter (µg/m^3).

5.1 COMPARISON OF INDOOR AIR SAMPLES

5.1.1 Indoor Air Samples

Of the ten (10) compounds analyzed (m,p-xylenes and o-xylene were combined into total xylenes), 1,2-dichloroethane and 1,2-dibromoethane were not detected in any sample and MTBE was detected only in two (2) samples, both on the second floor of the PB Refinery Hall. Benzene, toluene, and xylene were detected in the majority of the indoor and outdoor samples. No compounds were detected in the trip blanks.

There were notable differences in the concentrations of most of the compounds detected inside the individual buildings that are not evident from the arithmetic means of the analytical results for all indoor air samples. Specifically, the highest concentrations of benzene were found in the PB Lab samples (11 and 8.4 µg/m^3) and the 440 Building samples (9 and 7.2 µg/m^3). The highest concentrations of toluene (88 and 330 µg/m^3), ethylbenzene (11 and 6 µg/m^3), total xylenes (51.1 and 31.6 µg/m^3) were found in the PB Lab samples (west lab and 2nd floor office, respectively). The highest concentrations of 1,3,5-TMB (3.9 µg/m^3) and 1,2,4-TMB (11 µg/m^3) were found in the PB Lab, 2nd floor office sample although the PB Lab, west lab sample was not significantly different than other indoor air sample locations.

MTBE was detected only in samples collected in the PB Refinery Hall building (2nd floor, both conference room and east wing) and was undetected in any other inside or outside sample.

The concentrations of benzene, toluene, ethylbenzene, xylenes, and trimethylbenzenes in buildings other than the 440 Building and the PB Lab were similar to the concentrations in outdoor air. As shown in the table below, the range of concentrations detected in air samples from the 440 Building and the PB Lab are compared to the range of concentrations found in all of the other buildings (as a group; not including non-detects) from which samples were collected.

Range of Concentrations Detected in Indoor Air by Building 1)

Compound	440 Building		PB Lab		All Other Buildings		Outdoor	
	low	high	low	high	low	high	low	high
MTBE 2)	—	—	—	—	0.96	1.6	—	—
Benzene	7.2	9.0	8.4	11	0.94	4.3	1.2	4.9
Ethylbenzene	0.97	1.8	6.0	11	0.74	2.9	0.83	3.1
Toluene	8.2	8.3	88	330	3.6	14	2.0	19
Xylenes	4.4	5.8	31.6	51.1	2.5	14.7	2.0	17.1
Cumene	1.9	2.5	1.3	2.6	0.77	2.1	2.0	2.0
1,3,5-TMB 3)	—	—	1.4	3.9	0.87	1.3	1.6	1.6
1,2,4-TMB 4)	1.2	1.3	3.9	11	0.78	4.0	0.92	3.6

Footnotes:

1) All concentrations are given in µg/m^3
2) methyl tert-butyl ether
3) 1,3,5-trimethylbenzene
4) 1,2,4-trimethylbenzene

It is apparent that the concentrations of VOCs found indoors on the second floor of the PB Lab were higher than in the other buildings and higher than outdoor air. In particular, the lowest concentrations of ethylbenzene, toluene, and total xylenes detected in the PB Lab were higher than the highest concentrations of those same compounds found in all other buildings combined. These results indicate that sources in the PB Lab were likely contributing to the concentrations of VOCs in this space.

5.1.2 Outdoor Ambient Air Samples

From the discussion above, it can be seen that the range of VOC concentrations detected in samples of outdoor air overlap the range of the same compounds detected in air from all of the buildings except for the PB Lab. While benzene, toluene, xylenes, and 1,2,4-TMB were found in more than 50% of the outdoor air samples as shown in Table 3, MTBE, cumene, and 1,3,5-TMB were less prevalent in outdoor air than in indoor air.

With the exceptions of the 440 Building and the PB Lab noted previously, the range of concentrations of VOCs were similar in indoor and outdoor air.

6.0 Comparison of Inside Samples to Applicable Exposure Limits

6.1 OCCUPATIONAL EXPOSURE LIMITS

OELs published as OSHA PELs and ACGIH TLVs® are presented in Table 3 for all constituents for which these were available. ACGIH TLVs are health-based values and refer to concentrations of chemicals to which it is believed nearly all workers may be repeatedly exposed, day after day, over a working lifetime, without adverse health effects. The majority of OSHA PELs are based on 1969 TLVs with the exception that some have been updated as chemical-specific standards to reflect more current toxicological data and research (e.g., benzene).

As shown by Table 3, the concentrations of all detected compounds inside the buildings and in outdoor air samples are more than 100 times lower than the lowest OEL (benzene).

6.2 RISK-BASED SCREENING LEVELS

US EPA RSLs and PADEP IAQ criteria concentrations for exposure to constituents in air in industrial settings are presented on Table 3 and discussed briefly below.

6.2.1 US EPA RSLs

US EPA RSLs for carcinogenic chemicals are derived to correspond to an excess lifetime cancer risk of 1 in 1,000,000 (1 in 1 million or 1E-06) for a person (receptor) who is assumed to be exposed to that concentration over an extended period of time (twenty-five (25) years for industrial). The RSL concentrations for cancer health effects (MTBE, benzene, and ethylbenzene) were multiplied by a factor of 10 to correspond to the Pennsylvania target risk of 1 in 100,000 (1 in one hundred thousand or 1E-05). To put the conservatism of the risk-based screening levels for cancer health effects into perspective, between 1 in 4 and 1 in 3 people in the United States develop some type of cancer during their lifetime.

RSLs for chemicals that produce adverse non-cancer effects are concentrations that are very unlikely to produce health effects in people who are exposed over many years. Concentrations of constituents below applicable RSL concentrations are generally not considered to be of concern for public health. Concentrations above RSLs do not necessarily mean that adverse health effects will occur, but do indicate that additional evaluation may be appropriate. All RSL concentrations for non-cancer health effects (toluene, all xylene isomers, cumene and both trimethylbenzene isomers) correspond to a Hazard Quotient (HQ) of 1.0. The HQ is the ratio of the potential exposure to the chemical on a daily basis to the level of exposure at which no non-cancer adverse health effects would be expected to occur. Like the risk-based screening levels for cancer as a health outcome, screening levels for non-cancer health effects are also extremely conservative (protective). No adjustments to non-cancer screening level concentrations were required because both the EPA RSLs and PADEP IAQ criteria were derived to correspond to HQ of 1.0.

6.2.2 PADEP Indoor Air Quality Criteria

Similar to the US EPA RSLs, the PADEP IAQ criteria for evaluating vapor intrusion into non-residential buildings are derived using risk-based algorithms. The concentrations correspond to a target cancer risk of 1E-05 and HQ of 1.0. These values were developed as guidelines for remediation and were published in the Land Recycling Program Technical Guidance Manual (January 24, 2004). For the majority of the compounds found in this investigation, the US EPA RSLs and PADEP IAQ criteria values are similar. The most notable exception is toluene, where the EPA RSL is approximately ten (10) times higher than the PADEP IAQ criteria. It should also be noted that the PADEP criteria were published in 2004 and the EPA RSLs are current as of November 2012.

The PADEP odor thresholds are also shown on Table 3. None of the petroleum-related compounds selected for analysis in indoor or outdoor samples were detected in concentrations approaching or exceeding these published odor thresholds.

6.2.3 Comparison of Results to Risk-Based Screening Levels

As can be seen from Table 3, none of the concentrations of VOCs detected in either samples of indoor air or outdoor air were higher than the corresponding risk-based screening levels for long-term exposure in an industrial setting. The highest concentration of benzene found in the second floor of the PB Lab (11 µg/m^3) was equal to the PADEP industrial (non-residential) IAQ criteria, but slightly less than the current (November 2012) EPA RSL (16 µg/m^3) adjusted to a cancer risk of 1E-05.

7.0 Summary and Conclusions

With the exception of the concentrations of all chemicals found in the air of the PB Lab, and for benzene in the 440 Building, the average indoor concentrations of VOCs were similar to the average outdoor concentrations.

The concentrations of all chemicals detected in indoor and outdoor air were several orders of magnitude less than the OSHA PEL TWAs and the ACGIH TLV® TWAs. No concentration of any chemical remotely approached the corresponding odor threshold listed by PADEP.

The maximum concentrations of all chemicals detected in all samples were equal to (benzene in the PB Lab) or less than the corresponding conservative risk-based US EPA RSL and the PADEP IAQ criteria for exposure in industrial environments. Note that the US EPA RSL concentrations for chemicals with cancer health effects (MTBE, benzene, and ethylbenzene) were multiplied by a factor of ten (10) to reflect a target cancer risk of 1 in 100,000 or 1E-05 which is consistent with the Pennsylvania risk-based standards. US EPA RSLs are derived to correspond to a target cancer risk of 1 in 1,000,000 or 1E-06. Non-cancer screening criteria (toluene, xylenes, 1,3,5-TMB and 1,2,4-TMB) correspond to a HQ of 1.0.

In general, the concentrations of petroleum-related VOCs found in the air inside and outside of the buildings were low, considering that the facility is a petroleum refinery. The concentrations of individual VOCs found during this investigation can be put into perspective by comparing the results to regional ambient air concentrations reported by PADEP.

Regional ambient air quality in the Philadelphia area where the refinery is located is best represented by data from the Marcus Hook monitoring station (latitude 39.8178, longitude -75.4142). The table below shows the arithmetic mean indoor and outdoor concentrations of benzene, toluene, ethylbenzene, xylenes (m-, p- isomers), 1,3,5-trimethylbenzene, and 1,2,4-trimethylbenzene documented at the facility alongside regional outdoor air concentrations from the Marcus Hook monitoring station (PADEP 2003).

Comparison of Concentrations Detected to Regional Air 1)

Compound	***Facility Results*** *2)*		***Marcus Hook*** *3)*
	Indoors	***Outdoors***	
Benzene	2.9 (±2.45)	2.62 (±1.48)	2.84
Ethylbenzene	1.77 (±1.99)	1.97 (±1.61)	0.91
Toluene	18.77 (±56.76)	7.61 (±5.65)	5.46
Xylenes (m,p)	5.67 (±7.44)	4.86 (±4.59)	2.91
1,3,5-TMB 4)	1.53 (±1.06)	1.6	0.34
1,2,4-TMB 5)	1.96 (±1.91)	1.69 (±1.29)	0.88

Footnotes:
1) All concentrations are given in µg/m^3
2) *Mean (Standard Deviation)* values from Table 3
3) From PADEP 2003
4) 1,3,5-trimethylbenzene
5) 1,2,4-trimethylbenzene

As would be expected, the concentrations of petroleum-related compounds in the outdoor air at the facility were somewhat higher than regional background. However, the average concentrations of benzene in both indoor and outdoor air at the facility were similar to the annual average concentration reported for the Marcus Hook monitoring station in 2000 (PADEP 2003). As discussed previously, the arithmetic mean of the toluene concentrations from all of the indoor air samples is highly influenced by the concentrations detected in the PB Lab.

In conclusion, the findings of this study show that the concentrations of volatile organic compounds associated with refinery operations found in indoor and outdoor air were orders of magnitude lower than occupational exposure standards, and lower than or equal to (benzene only) conservative risk-based screening levels published by US EPA and PADEP for long-term exposures in industrial (non-residential) settings. The concentrations of petroleum-related compounds detected in the air inside occupied buildings on the former Sunoco Philadelphia Refinery are not anticipated to pose an adverse health risk for persons working in those buildings.

8.0 References

Agency for Toxic Substances and Disease Registry (ATSDR), Toxicological Profile for Benzene, August, 2007.

American Conference of Governmental Industrial Hygienists, Threshold Limit Values for Chemical Substances, ACGIH Publication No. 0113, 2013.

Pennsylvania Department of Environmental Protection (PADEP), Bureau of Land Recycling and Land Management, Technical Guidance Manual-Section IV.A.4 Vapor Intrusion into Buildings from Groundwater and Soil under the Act 2 Statewide Health Standard. Table 3-Indoor Air Criteria, January 24, 2004.

Pennsylvania Department of Environmental Protection, Southern Delaware County Air Monitoring Project, Third Interim Report. Table 2.3, July 31, 2003. (http://www.dep.state.pa.us/dep/deputate/airwaste/aq/toxics/projects/sdel/sdelrpt3.pdf)

Code of Federal Regulations Chapter 29 Part 1910, Occupational Safety and Health Standards, Subpart Z – Toxic and Hazardous Substances, Table Z-1 Limits for Air Contaminants. (http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9992)

US EPA Regional Screening Levels Table, November 2012.

US EPA, Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition. Compendium Method TO-15. Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially-Prepared Canisters and Analyzed by Gas Chromatography/ Mass Spectrometry (GC/MS). January 1999.

FIGURE

SOURCE: BASEMAP PROVIDED BY LANGAN ENGINEERING AND ENVIRONMENTAL SERVICES

LEGEND

● OUTDOOR AIR SAMPLING LOCATION

□ AREA OF INTEREST

□ BUILDING LOCATION FOR INDOOR AIR SAMPLING

FIGURE 1

SITE PLAN

FOR:

Sunoco, Inc. (R&M)
Philadelphia Refinery
3144 Passyunk Avenue
Philadelphia, PA. 19145

0 250 500 FEET

SCALE: AS SHOWN
DATE: 8/28/2013
DRN: TFB
CHD: JLM

TABLES

Table 1: Sample Locations and Parameters - Sunoco Philadelphia Refinery

Sample No.	Location/Description	Date	Start Time	Stop Time	Sample Duration (hr:min)	Canister ID	Regulator ID	Pre-Sample Pressure, (PSI)[1]	Post-Sample Pressure, (PSI)[1]
1	B&S Office	10/24/2012	10:35	14:35	4:00	AC01003	FCA00317	29.5	8.0
2	B&S Office (outside)	10/24/2012	10:37	14:39	4:02	AC00760	FCA00595	29.5	13.0
3	24 Gate Building (1st floor)	10/24/2012	10:50	14:50	4:00	AC01853	FCA00134	29.5	7.0
4	24 Gate Building (2nd floor)	10/24/2012	10:52	14:52	4:00	AC01010	FCA00188	29.6	7.3
5	GP Training Building (1st floor vending area)	10/24/2012	11:07	15:07	4:00	AC01928	FCA00161	29.5	9.0
6	GP Training Building (1st floor west)	10/24/2012	11:10	15:10	4:00	AC01669	FCA00564	29.5	9.0
7	GP Training Building (3rd floor gym)	10/24/2012	11:12	15:13	4:01	AC00641	FCA00023	29.5	6.5
8	GP Training Building (basement)	10/24/2012	11:10	15:16	4:06	AC00747	FCA00604	29.5	7.5
9	GP Main Office Building (basement west)	10/24/2012	12:26	16:26	4:00	AC01113	FCA00575	29.5	7.0
10	GP Main Office Building (basement center)	10/24/2012	12:31	16:31	4:00	AC01436	FCA00521	29.4	10.0
11	GP Main Office Building (basement east)	10/24/2012	12:33	16:33	4:00	AC01376	FCA00349	29.4	8.0
12	GP Main Office Building (1st floor entrance)	10/24/2012	12:36	16:37	4:01	AC00672	FCA00198	29.4	4.8
13	GP Main Office Building (1st floor west)	10/24/2012	12:48	16:48	4:00	AC00475	FCA00402	29.5	3.5
14	GP Main Office Building (2nd floor west)	10/24/2012	12:54	16:54	4:00	AC01263	FCA00516	29.4	9.5
15	GP Main Office Building (2nd floor east)	10/24/2012	12:40	16:40	4:00	AC01145	FCA00374	29.4	6.5
16	GP Main Office Building (outside west)	10/24/2012	12:44	16:44	4:00	AC00782	FCA00298	29.6	0.0
17	440 Building (2nd floor Room 221, inspection)	10/24/2012	13:10	17:10	4:00	AC01215	FCA00365	29.5	8.0
18	440 Building (2nd floor meeting room)	10/24/2012	13:13	17:13	4:00	AC01670	FCA00319	29.6	5.5
19	15 Pump House (inside)	10/24/2012	13:27	17:27	4:00	AC01930	FCA00016	29.5	7.0
20	15 Pump House (under roof w/ pump equipment, approximately 8-10' below grade)	10/24/2012	13:30	17:30	4:00	AC01420	FCA00397	29.5	6.3
21	15 Pump House (outside, at grade)	10/24/2012	13:35	17:35	4:00	AC01464	FCA00034	29.5	3.0
22	North Yard Scale House (inside)	10/24/2012	13:51	17:51	4:00	AC00590	FCA00168	29.5	7.8
23	North Yard Scale House (outside)	10/25/2012	8:17	12:18	4:01	AC01664	FCA00422	29.0	11.0
24	“Trip blank,” regulator attached, unopened	10/25/2012	---	---	---	AC01830	FCA00480	29.4	29.4

Table 1: Sample Locations and Parameters - Sunoco Philadelphia Refinery

Sample No.	Location/Description	Date	Start Time	Stop Time	Sample Duration (hr:min)	Canister ID	Regulator ID	Pre-Sample Pressure, (PSI) [1]	Post-Sample Pressure, (PSI) [1]
25	"Trip blank," regulator attached, unopened	10/25/2012	---	---	---	AC01093	FCA00058	29.5	29.5
26	SRTF Propane Loading (inside)	10/25/2012	8:59	12:59	4:00	AC00540	FCA00482	29.3	8.5
27	SRTF Main Pump House (inside)	10/25/2012	9:07	13:08	4:01	AC01810	FCA00609	29.4	8.0
28	SRTF Main Pump House (outside)	10/25/2012	9:10	13:10	4:00	AC01350	FCA00454	29.5	5.0
29	PB Main Office Building, (safety office)	10/25/2012	8:23	12:23	4:00	AC00716	FCA00239	29.5	0.0
30	PB Main Office Building, (medical area)	10/25/2012	8:29	12:29	4:00	AC00501	FCA00015	29.5	6.0
31	PB Main Office Building, (1st floor lobby)	10/25/2012	8:34	12:34	4:00	AC00765	FCA00303	29.5	5.8
32	PB Main Office Building,(1st floor east wing)	10/25/2012	8:37	12:37	4:00	AC01403	FCA00432	29.5	10.0
33	PB Main Office Building, (1st floor west wing)	10/25/2012	8:41	12:41	4:00	AC01573	FCA00449	29.5	3.0
34	PB Main Office Building, (2nd floor west wing)	10/25/2012	8:44	12:44	4:00	AC00947	FCA00632	29.5	5.0
35	PB Main Office Building, (2nd floor center file room)	10/25/2012	8:48	12:48	4:00	AC00033	FCA00473	29.5	4.0
36	PB Main Office Building, (2nd floor east conference room)	10/25/2012	8:51	12:51	4:00	AC01790	FCA00538	29.5	3.5
37	PB Lab (west lab)	10/25/2012	9:00	13:00	4:00	AC01886	FCA00274	29.5	5.0
38	PB Lab (2nd floor office)	10/25/2012	9:08	13:08	4:00	AC01487	FCA00418	29.5	4.5
39	PB Refinery Hall (2nd floor conference room)	10/25/2012	9:40	13:40	4:00	AC01115	FCA00563	29.6	6.5
40	PB Refinery Hall (2nd floor east wing)	10/25/2012	9:43	13:43	4:00	AC01243	FCA00603	29.4	2.0
41	PB Maintenance Shop (break room)	10/25/2012	9:51	13:51	4:00	AC01218	FCA00405	29.6	9.0
42	PB Maintenance Shop (office)	10/25/2012	9:55	13:55	4:00	AC01179	FCA00040	29.6	4.8
43	PB buildings (adjacent gate area)	10/25/2012	10:00	14:00	4:00	AC00870	FCA00215	29.5	6.0
44	"Trip blank," regulator attached, unopened	10/25/2012	---	---	---	AC00993	FCA00619	29.5	29.5

1. PSI = pounds per square inch

Table 2: Laboratory Analytical Results – Select Volatile Organic Compounds (VOCs) - Sunoco Philadelphia Refinery [1,2,3]

Sample	Type[4]	Location/Description	Methyl Tertiary Butyl Ether (MTBE)	1,2-dichloroethane	Benzene	Toluene	1,2 Dibromoethane	Ethylbenzene	m,p-Xylene	o-Xylene	total Xylene	Cumene	1,3,5-Trimethyl benzene	1,2,4-Trimethyl benzene
1	I	B&S Office	ND[5]	ND	4.3	7.4	ND	1.3	4.5	1.6	6.1	2.1	ND	1.5
3	I	24 Gate Building (1st floor)	ND	ND	2.1	7.0	ND	1.5	4.0	1.5	5.5	1.0	ND	1.7
4	I	24 Gate Building (2nd floor)	ND	ND	1.8	6.8	ND	1.2	3.8	1.4	5.2	ND	ND	1.5
5	I	GP Training Building (1st floor vending area)	ND	ND	3.5	7.2	ND	1.3	3.7	1.4	5.1	1.0	ND	1.6
6	I	GP Training Building (1st floor west)	ND	ND	4.2	7.5	ND	2.2	4.6	1.7	6.3	1.3	ND	1.8
7	I	GP Training Building (3rd floor gym)	ND	ND	4.2	12	ND	1.8	6.3	2.2	8.5	2.0	1.2	4.0
8	I	GP Training Building (basement)	ND	ND	3.1	7.8	ND	1.5	4.9	1.8	6.7	1.5	0.97	3.2
9	I	GP Main Office Building (basement west)	ND	ND	2.3	6.9	ND	1.3	4.2	1.5	5.7	1.4	ND	1.6
10	I	GP Main Office Building (basement center)	ND	ND	2.2	6.9	ND	1.2	3.6	1.3	4.9	1.0	ND	1.3
11	I	GP Main Office Building (basement east)	ND	ND	1.6	6.1	ND	0.86	2.7	1.0	3.7	ND	ND	0.93
12	I	GP Main Office Building (1st floor entrance)	ND	ND	1.7	6.2	ND	0.99	2.9	1.1	4.0	ND	ND	1.0
13	I	GP Main Office Building (1st floor west)	ND	ND	1.5	5.6	ND	0.86	2.6	0.96	3.56	ND	ND	ND
14	I	GP Main Office Building (2nd floor west)	ND	ND	1.6	6	ND	1.1	3.0	1.1	4.1	0.79	ND	1.0
15	I	GP Main Office Building (2nd floor east)	ND	ND	1.9	6.4	ND	1.2	3.4	1.2	4.6	1.0	ND	1.2
17	I	440 Building (2nd floor Room 221, inspection)	ND	ND	9.0	8.3	ND	1.8	4.3	1.5	5.8	2.5	ND	1.3
18	I	440 Building (2nd floor meeting room)	ND	ND	7.2	8.2	ND	0.97	3.2	1.2	4.4	1.9	ND	1.2
19	I	15 Pump House (inside)	ND	ND	3.6	14	ND	2.9	11	3.7	14.7	0.77	1.3	3.3
22	I	North Yard Scale House (inside)	ND	ND	1.7	9.2	ND	1.7	4.6	1.5	6.1	0.85	ND	1.2
26	I	SRTF Propane Loading (inside)	ND	ND	2.1	4.0	ND	0.99	3.8	1.3	5.1	1.1	ND	1.4
27	I	SRTF Main Pump House (inside)	ND	ND	2.3	3.6	ND	ND	3	1.1	4.1	ND	ND	ND
29	I	PB Main Office Building, (safety office)	ND	ND	1.6	6.5	ND	0.95	3.3	1.1	4.4	ND	ND	0.99
30	I	PB Main Office Building, (medical area)	ND	ND	1.2	4.4	ND	ND	2.3	0.87	3.17	ND	ND	1.1
31	I	PB Main Office Building, (1st floor lobby)	ND	ND	1.3	4.8	ND	ND	2.5	0.91	3.41	ND	ND	0.94
32	I	PB Main Office Building,(1st floor east wing)	ND	ND	1.3	5.2	ND	ND	2.5	ND	2.5	ND	ND	ND
33	I	PB Main Office Building, (1st floor west wing)	ND	ND	1.4	5	ND	0.93	3.5	1.1	4.6	ND	ND	0.97
34	I	PB Main Office Building, (2nd floor west wing)	ND	ND	1.3	4.9	ND	0.89	3.3	1.3	4.6	ND	ND	1.1

Table 2: Laboratory Analytical Results – Select Volatile Organic Compounds (VOCs) - Sunoco Philadelphia Refinery [1,2,3]

Sample	Type[4]	Location/Description	Methyl Tertiary Butyl Ether (MTBE)	1,2-dichloroethane	Benzene	Toluene	1,2 Dibromoethane	Ethylbenzene	m,p-Xylene	o-Xylene	total Xylene	Cumene	1,3,5-Trimethyl benzene	1,2,4-Trimethyl benzene
35	I	PB Main Office Building, (2nd floor center file room)	ND	ND	1.2	5.9	ND	1.0	3.7	1.4	5.1	ND	ND	0.95
36	I	PB Main Office Building, (2nd floor east conf. room)	ND	ND	0.94	4.0	ND	0.74	2.5	0.97	3.47	ND	ND	0.78
37	I	PB Lab (west lab)	ND	ND	11	88	ND	11	42	9.1	51.1	1.3	1.4	3.9
38	I	PB Lab (2nd floor office)	ND	ND	8.4	330	ND	6.0	24	7.6	31.6	2.6	3.9	11
39	I	PB Refinery Hall (2nd floor conference room)	0.96	ND	1.4	6.4	ND	1.1	3.9	1.4	5.3	ND	ND	1.1
40	I	PB Refinery Hall (2nd floor east wing)	1.6	ND	2.0	8.8	ND	1.4	5.4	1.8	7.2	ND	ND	1.5
41	I	PB Maintenance Shop (break room)	ND	ND	1.8	9.0	ND	1.3	5.2	1.9	7.1	ND	1.1	3.1
42	I	PB Maintenance Shop (office)	ND	ND	1.7	8.2	ND	1.1	4.6	1.7	6.3	ND	0.87	2.5
2	O	B&S Office (outside)	ND	ND	3.9	6.5	ND	ND	3.7	1.4	5.1	2.0	ND	1.3
16	O	GP Main Office Building (outside west)	ND	ND	1.3	4.6	ND	ND	2.0	ND	2.0	ND	ND	ND
20	O	15 Pump House (under roof w/ pump equipment, approximately 8-10' below grade)	ND	ND	2.1	7.4	ND	0.83	2.8	1.1	3.9	ND	ND	0.92
21	O	15 Pump House (outside, at grade)	ND	ND	4.9	19	ND	3.1	13	4.1	17.1	ND	1.6	3.6
23	O	North Yard Scale House (outside)	ND	ND	ND	3.8	ND	ND	ND	ND	ND	ND	ND	ND
28	O	SRTF Main Pump House (outside)	ND	ND	2.3	2	ND	ND	ND	ND	ND	ND	ND	ND
43	O	PB buildings (adjacent gate area)	ND	ND	1.2	10	ND	ND	2.8	0.99	3.79	ND	ND	0.93
24	TB	"Trip blank" - not opened	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
25	TB	"Trip blank" - not opened	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
44	TB	"Trip blank" - not opened	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

1. All units are in micrograms per cubic meter of air (ug/m^3) by volume
2. All samples were analyzed utilizing EPA Method TO-15.
3. Copies of Laboratory Analytical Results are provided as Appendix A.
4. "I"=Indoor air sample; "O"=Outdoor air sample; "TB"= Trip Blank, SUMMA canisters which were not opened, used for QA/QC.
5. "ND"=Non-Detect

Table 3: Summary Statistics – Select Volatile Organic Compounds (VOCs) - Sunoco Philadelphia Refinery [1,2,3]

Analytes		Methyl Tertiary Butyl Ether (MTBE)	1,2-dichloroethane	Benzene	Toluene	1,2 Dibromoethane	Ethyl benzene	mp-Xylene	o-Xylene	total Xylene	Cumene	1,3,5-Trimethyl benzene	1,2,4-Trimethyl benzene
Health Effects [4,5]		c	c	c	nc	c	c	nc	nc	nc	nc	nc	nc
Occupational and Risk-Based Screening Criteria													
OSHA PELs [6]		--	2.02E+05	3.19E+03	7.54E+05	1.54E+05	4.34E+05	4.34E+05	4.34E+05	4.34E+05	2.46E+05	--	--
ACGIH TLVs® [6]		1.80E+05	4.05E+04	1.60E+03	7.54E+04	--	8.68E+04	4.34E+05	4.34E+05	4.34E+05	2.46E+05	1.23E+05	1.23E+05
EPA RSLs Industrial[7]		4.70E+02	7.70E+01	1.60E+01	2.20E+04	2.00E-01	4.90E+01	4.40E+02	4.40E+02	4.40E+02	1.80E+03	3.10E+01	3.10E+01
PADEP IAQ Industrial [8]		3.10E+02	3.10E+00	1.10E+01	1.20E+03	3.70E-01	7.30E+01	3.00E+02	3.00E+02	3.00E+02	1.10E+03	1.70E+01	1.70E+01
PADEP Odor		1.90E+02	2.40E+04	2.70E+03	6.40E+02	1.92E+05	6.08E+05	2.00E+03	2.00E+03	2.00E+03	6.00E+01	--	--
Summary Statistics for Indoor Samples													
Indoor	Number - total	34	34	34	34	34	34	34	34	34	34	34	34
	Non-Detects	32	34	0	0	34	4	0	1	0	17	27	3
	Detects	2	0	34	34	0	30	34	33	34	17	7	31
	Minimum	0.96	--	0.94	3.6	--	0.74	2.3	0.87	3.17	0.77	0.87	0.78
	Maximum	1.6	--	11	330	--	11	42	9.1	51.1	2.6	3.9	11
	Median	1.28	--	1.85	6.85	--	1.2	3.75	1.4	5.1	1.3	1.2	1.3
	Mean	1.28	--	2.90	18.77	--	1.77	5.67	1.85	7.50	1.42	1.53	1.96
	Std. Deviation	0.45	--	2.45	56.76	--	1.99	7.44	1.76	9.15	0.59	1.06	1.91
Summary Statistics for Outdoor Samples													
Outdoor	Number - total	7	7	7	7	7	7	7	7	7	7	7	7
	Non-Detects	7	7	1	0	7	5	2	3	2	6	6	3
	Detects	0	0	6	7	0	2	5	4	5	1	1	4
	Minimum	.	.	1.2	2	.	0.83	2	0.99	2.85	2	1.6	0.92
	Maximum	.	.	4.9	19	.	3.1	13	4.1	17.1	2	1.6	3.6
	Median	.	.	2.2	6.5	.	1.965	2.8	1.25	3.9	2	1.6	1.115
	Mean	.	.	2.62	7.61	.	1.97	4.86	1.90	6.55	2.00	1.60	1.69
	Std. Deviation	.	.	1.48	5.65	.	1.61	4.59	1.48	5.95	.	.	1.29

1. All units are in micrograms per cubic meter of air (ug/m^3)
2. All samples were analyzed utilizing EPA Method TO-15.
3. VOCs were not detected in any of the three “Trip Blank” SUMMA canisters.
4. “c” – EPA classifies as Carcinogen
5. “nc” – EPA classifies as Non-Carcinogen.
6. Occupational Safety and Health Permissible Exposure Limits (OSHA PELs) and American Conference of Industrial Hygienists Threshold Limit Values (TLVs®) were converted from parts per billion (ppb) to ug/m^3 using the following formula: ug/m^3=(ppb*MW)/24.45.
7. US EPA Regional Screening Levels, November 2012, adjusted to 1E-05 for carcinogens; HI of 1.0 for non-carcinogens.
8. Pennsylvania Department of Environmental Protection (PADEP), Bureau of Land Recycling and Land Management, Technical Guidance Manual-Section IV.A.4 Vapor Intrusion into buildings from Groundwater and Soil under the Act 2 Statewide Health Standard. January 24, 2004 (Table 3-Indoor Air Criteria).

APPENDIX A

Columbia Analytical Services INC
Now part of the ALS Group
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LABORATORY REPORT

November 8, 2012

John Reiter
Stantec Consulting Services, Inc.
12075 Corporate Pkwy, Ste. 200
Mequon, WI 53092

RE: Sunoco IH Air Testing / 213402094

Dear John:

Enclosed are the results of the samples submitted to our laboratory on October 31, 2012. For your reference, these analyses have been assigned our service request number P1204493.

All analyses were performed according to our laboratory's NELAP and DoD-ELAP-approved quality assurance program. The test results meet requirements of the current NELAP and DoD-ELAP standards, where applicable, and except as noted in the laboratory case narrative provided. For a specific list of NELAP and DoD-ELAP-accredited analytes, refer to the certifications section at www.caslab.com. Results are intended to be considered in their entirety and apply only to the samples analyzed and reported herein.

Columbia Analytical Services, Inc. dba ALS Environmental (ALS) is certified by the California Department of Health Services, NELAP Laboratory Certificate No. 02115CA; Arizona Department of Health Services, Certificate No. AZ0694; Florida Department of Health, NELAP Certification E871020; New Jersey Department of Environmental Protection, NELAP Laboratory Certification ID #CA009; New York State Department of Health, NELAP NY Lab ID No: 11221; Oregon Environmental Laboratory Accreditation Program, NELAP ID: CA200007; The American Industrial Hygiene Association, Laboratory #101661; United States Department of Defense Environmental Laboratory Accreditation Program (DoD-ELAP), Certificate No. L11-203; Pennsylvania Registration No. 68-03307; TX Commission of Environmental Quality, NELAP ID T104704413-12-3; Minnesota Department of Health, NELAP Certificate No. 362188; Washington State Department of Ecology, ELAP Lab ID: C946, State of Utah Department of Health, NELAP Certificate No. CA01527Z012-Z; Los Angeles Department of Building and Safety, Approval No: TA00001. Each of the certifications listed above have an explicit Scope of Accreditation that applies to specific matrices/methods/analytes; therefore, please contact me for information corresponding to a particular certification.

If you have any questions, please call me at (805) 526-7161.

Respectfully submitted,

ALS | Environmental

Samantha Henningsen
Project Manager

Client: Stantec Consulting Services, Inc. Service Request No: P1204493
Project: Sunoco IH Air Testing / 213402094

CASE NARRATIVE

The samples were received intact under chain of custody on October 31, 2012 and were stored in accordance with the analytical method requirements. Please refer to the sample acceptance check form for additional information. The results reported herein are applicable only to the condition of the samples at the time of sample receipt.

Volatile Organic Compound Analysis

The samples were analyzed for selected volatile organic compounds in accordance with EPA Method TO-15 from the Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition (EPA/625/R-96/010b), January, 1999. The analytical system was comprised of a gas chromatograph / mass spectrometer (GC/MS) interfaced to a whole-air preconcentrator.

The results of analyses are given in the attached laboratory report. All results are intended to be considered in their entirety, and Columbia Analytical Services, Inc. dba ALS Environmental (ALS) is not responsible for utilization of less than the complete report.

Use of Columbia Analytical Services, Inc. dba ALS Environmental (ALS)'s Name. Client shall not use ALS's name or trademark in any marketing or reporting materials, press releases or in any other manner ("Materials") whatsoever and shall not attribute to ALS any test result, tolerance or specification derived from ALS's data ("Attribution") without ALS's prior written consent, which may be withheld by ALS for any reason in its sole discretion. To request ALS's consent, Client shall provide copies of the proposed Materials or Attribution and describe in writing Client's proposed use of such Materials or Attribution. If ALS has not provided written approval of the Materials or Attribution within ten (10) days of receipt from Client, Client's request to use ALS's name or trademark in any Materials or Attribution shall be deemed denied. ALS may, in its discretion, reasonably charge Client for its time in reviewing Materials or Attribution requests. Client acknowledges and agrees that the unauthorized use of ALS's name or trademark may cause ALS to incur irreparable harm for which the recovery of money damages will be inadequate. Accordingly, Client acknowledges and agrees that a violation shall justify preliminary injunctive relief. For questions contact the laboratory.

DETAIL SUMMARY REPORT

Client: Stantec Consulting Services, Inc.
Service Request: P1204493
Project ID: Sunoco IH Air Testing / 213402094

Date Received: 10/31/2012
Time Received: 09:10

Client Sample ID	Lab Code	Matrix	Date Collected	Time Collected	Container ID	Pi1 (psig)	Pf1 (psig)	TO-15 - VOC Cans
Sample 1	P1204493-001	Air	10/24/2012	14:35	AC01003	-3.85	3.67	X
Sample 2	P1204493-002	Air	10/24/2012	14:39	AC00760	-6.54	3.79	X
Sample 3	P1204493-003	Air	10/24/2012	14:50	AC01853	-3.60	3.61	X
Sample 4	P1204493-004	Air	10/24/2012	14:52	AC01010	-3.29	3.63	X
Sample 5	P1204493-005	Air	10/24/2012	15:07	AC01928	-3.21	3.60	X
Sample 6	P1204493-006	Air	10/24/2012	15:10	AC01669	-4.20	3.70	X
Sample 7	P1204493-007	Air	10/24/2012	15:13	AC00641	-3.08	3.75	X
Sample 8	P1204493-008	Air	10/24/2012	15:16	AC00747	-3.67	3.78	X
Sample 9	P1204493-009	Air	10/24/2012	16:26	AC01113	-3.10	3.67	X
Sample 10	P1204493-010	Air	10/24/2012	16:31	AC01436	-5.08	3.56	X
Sample 11	P1204493-011	Air	10/24/2012	16:33	AC01376	-3.84	3.74	X
Sample 12	P1204493-012	Air	10/24/2012	16:37	AC00672	-2.29	3.58	X
Sample 13	P1204493-013	Air	10/24/2012	16:40	AC01145	-4.00	3.75	X
Sample 14	P1204493-014	Air	10/24/2012	16:44	AC00782	0.31	3.62	X
Sample 15	P1204493-015	Air	10/24/2012	16:48	AC00475	-1.47	3.55	X
Sample 16	P1204493-016	Air	10/24/2012	16:54	AC01263	-3.77	3.76	X
Sample 17	P1204493-017	Air	10/24/2012	17:10	AC01215	-2.97	3.72	X
Sample 18	P1204493-018	Air	10/24/2012	17:13	AC01670	-2.52	3.64	X
Sample 19	P1204493-019	Air	10/24/2012	17:27	AC01930	-2.75	3.57	X
Sample 20	P1204493-020	Air	10/24/2012	17:30	AC01420	-3.07	3.72	X
Sample 21	P1204493-021	Air	10/24/2012	17:35	AC01464	-1.69	3.65	X
Sample 22	P1204493-022	Air	10/24/2012	17:51	AC00590	-2.29	3.77	X
Sample 24 TB	P1204493-023	Air	10/24/2012	00:00	AC01830	-14.50	3.68	X

Columbia Analytical Services

2655 Park Center Drive, Suite A
Simi Valley, California 93065
Phone (805) 526-7161
Fax (805) 526-7270

Air - Chain of Custody Record & Analytical Service Request

Page 1 of 2

Requested Turnaround Time in Business Days (Surcharges) please circle
1 Day (100%) 2 Day (75%) 3 Day (50%) 4 Day (35%) 5 Day (25%) 10 Day-Standard

CAS Project No. P1204493

CAS Contact:

Company Name & Address (Reporting Information)
Stantec
12075 Corporate Pkwy
mequon, WI 53092

Project Name: Sunoco IH AirTesting

Project Number: 213402094

Project Manager: John Reiter

P.O. # / Billing Information: John Reiter

Phone: 262-643-9154

Fax: 262-241-4901

Email Address for Result Reporting: John.Reiter@Stantec.com

Sampler (Print & Sign):

Client Sample ID	Laboratory ID Number	Date Collected	Time Collected	Canister ID (Bar code # - AC, SC, etc.)	Flow Controller ID (Bar code #- FC #)	Canister Start Pressure "Hg	Canister End Pressure "Hg/psig	Sample Volume	Analysis Method		Comments e.g. Actual Preservative or specific instructions
Sample 1	①-3.54	10/24/12	10:35 14:35	AC01003	FCA00317	29.5	8				
Sample 2	②-6.55	10/24/12	10:37 14:39	AC00760	FCA00595	29.5	13.0				
Sample 3	③-3.67	10/24/12	10:50 14:50	AC01853	FCA00134	29.5	7.0				
Sample 4	④-3.33	10/24/12	10:53 14:53	AC01010	FCA00188	29.6	7.25				
Sample 5	⑤-3.19	10/24/12	11:07 15:07	AC01928	FCA00161	29.5	9.0				
Sample 6	⑥-4.21	10/24/12	11:10 15:10	AC01689	FCA00564	29.5	9.0				
Sample 7	⑦-3.57	10/24/12	11:13 15:13	AC00641	FCA00023	29.5	6.5				
Sample 8	⑧-3.67	10/24/12	11:16 15:16	AC00747	FCA00604	29.5	7.5				
Sample 9	⑨-3.14	10/24/12	12:26 16:26	AC01113	FCA00575	29.5	7.0				
Sample 10	⑩-5.11	10/24/12	12:31 16:31	AC01436	FCA00521	29.4	10.0				
Sample 11	⑪-3.87	10/24/12	12:33 16:33	AC01376	FCA00344	29.4	8.0				
Sample 12	⑫-2.33	10/24/12	12:36 16:37	AC00672	FCA00198	29.4	4.75				
Sample 13	⑬-4.03	10/24/12	12:40 16:40	AC00[illegible]1145	FCA00374	29.4	6.5				
Sample 14	⑭+0.25	10/24/12	12:44 16:44	AC00782	FCA00298	29.6	0.0				

Report Tier Levels - please select
Tier I - Results (Default if not specified) ____
Tier II (Results + QC Summaries) ____
Tier III (Results + QC & Calibration Summaries) ____
Tier IV (Data Validation Package) 10% Surcharge ____

EDD required Yes / No
Type: ____________

Project Requirements (MRLs, QAPP)

Relinquished by: (Signature)	Date: 10/24/12	Time: 18:30	Received by: (Signature)	Date: 10/26/12	Time: 0910
Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Date:	Time:

Cooler / Blank Temperature ___ °C

COC AIR REV 3/11

Columbia Analytical Services℠

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Simi Valley, California 93065
Phone (805) 526-7161
Fax (805) 526-7270

Air - Chain of Custody Record & Analytical Service Request

Page 2 of 2

Requested Turnaround Time in Business Days (Surcharges) please circle
1 Day (100%) 2 Day (75%) 3 Day (50%) 4 Day (35%) 5 Day (25%) 10 Day-Standard

CAS Project No. P1204443

CAS Contact:

Company Name & Address (Reporting Information)
Stantec
12075 Corporate Pkwy
Mequon, WI 53092

Project Name: Sunoco IH Air Testing

Project Number: 213402094

Project Manager: John Reiter

P.O. # / Billing Information: John Reiter

Phone: 262-643-9154

Fax: 262-241-4901

Email Address for Result Reporting: John.reiter@stantec.com

Sampler (Print & Sign): Richard Page

Client Sample ID	Laboratory ID Number	Date Collected	Time Collected	Canister ID (Bar code # - AC, SC, etc.)	Flow Controller ID (Bar code # - FC #)	Canister Start Pressure "Hg	Canister End Pressure "Hg/psig	Sample Volume	Analysis Method		Comments e.g. Actual Preservative or specific instructions
Sample 15	⑮-1.53	10/24/12	12:48 16:49	AC00475	FCA00402	29.5	3.5				
Sample 16	⑯-3.82	10/24/12	12:54 16:54	AC01263	FCA00516	29.4	9.5				
Sample 17	⑰-3.04	10/24/12	13:10 17:10	AC01215	FCA00365	29.5	8.0				
Sample 18	⑱-2.63	10/24/12	13:13 17:13	AC01670	FCA00319	29.6	5.5				
Sample 19	⑲-2.77	10/24/12	13:27 17:27	AC01930	FCA00016	29.5	7.0				
Sample 20	⑳-3.14	10/24/12	13:38 17:38	AC01420	FCA00397	29.5	6.25				
Sample 21	㉑-1.78	10/24/12	13:35 17:35	AC01464	FCA00034	29.5	3.0				
Sample 22	㉒-2.39	10/24/12	13:51 17:51	AC00590	FCA00168	29.8	7.75				
~~Sample 23~~		~~10/24/12~~	~~13:54~~	~~AC01664~~	~~FCA00422~~	~~29.5~~					Not Collected
Sample 24TB	㉓-14.47	10/24/12	—	AC01830	—	29.4	29.4				

Report Tier Levels - please select
Tier I - Results (Default if not specified) ____
Tier II (Results + QC Summaries) ____
Tier III (Results + QC & Calibration Summaries) ____
Tier IV (Data Validation Package) 10% Surcharge ____

EDD required Yes / No
Type: ____________

Project Requirements (MRLs, QAPP)

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Date:	Time:
	10/24/12	18:30		10/31/12	0910
Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Date:	Time:

Cooler / Blank Temperature ____ °C

COC AIR REV 3-11

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Sample Acceptance Check Form

Client: Stantec Consulting Services, Inc. Work order: P1204493

Project: Sunoco IH Air Testing / 213402094

Sample(s) received on: 10/31/12 Date opened: 10/31/12 by: MZAMORA

Note: This form is used for all samples received by CAS. The use of this form for custody seals is strictly meant to indicate presence/absence and not as an indication of compliance or nonconformity. Thermal preservation and pH will only be evaluated either at the request of the client and/or as required by the method/SOP.

		Yes	**No**	**N/A**
1	Were **sample containers** properly marked with client sample ID?	☒	☐	☐
2	Container(s) **supplied by CAS**?	☒	☐	☐
3	Did **sample containers** arrive in good condition?	☒	☐	☐
4	Were **chain-of-custody** papers used and filled out?	☒	☐	☐
5	Did **sample container labels** and/or tags agree with custody papers?	☒	☐	☐
6	Was **sample volume** received adequate for analysis?	☒	☐	☐
7	Are samples within specified holding times?	☒	☐	☐
8	Was proper **temperature** (thermal preservation) of cooler at receipt adhered to?	☐	☐	☒
9	Was a **trip blank** received?	☐	☒	☐
10	Were **custody seals** on outside of cooler/Box?	☐	☒	☐
	Location of seal(s)? ____________ Sealing Lid?	☐	☐	☒
	Were signature and date included?	☐	☐	☒
	Were seals intact?	☐	☐	☒
	Were custody seals on outside of sample container?	☐	☒	☐
	Location of seal(s)? ____________ Sealing Lid?	☐	☐	☒
	Were signature and date included?	☐	☐	☒
	Were seals intact?	☐	☐	☒
11	Do containers have appropriate **preservation**, according to method/SOP or Client specified information?	☐	☐	☒
	Is there a client indication that the submitted samples are **pH** preserved?	☐	☐	☒
	Were **VOA vials** checked for presence/absence of air bubbles?	☐	☐	☒
	Does the client/method/SOP require that the analyst check the sample pH and if necessary alter it?	☐	☐	☒
12	**Tubes:** Are the tubes capped and intact?	☐	☐	☒
	Do they contain moisture?	☐	☐	☒
13	**Badges:** Are the badges properly capped and intact?	☐	☐	☒
	Are dual bed badges separated and individually capped and intact?	☐	☐	☒

Lab Sample ID	**Container Description**	**Required pH ***	**Received pH**	**Adjusted pH**	**VOA Headspace** (Presence/Absence)	**Receipt / Preservation Comments**
P1204493-001.01	6.0 L Ambient Can					
P1204493-002.01	6.0 L Ambient Can					
P1204493-003.01	6.0 L Ambient Can					
P1204493-004.01	6.0 L Ambient Can					
P1204493-005.01	6.0 L Ambient Can					
P1204493-006.01	6.0 L Ambient Can					
P1204493-007.01	6.0 L Ambient Can					
P1204493-008.01	6.0 L Ambient Can					

Explain any discrepancies: (include lab sample ID numbers): ____________

RSK - MEEPP, HCL (pH<2); RSK - CO2, (pH 5-8); Sulfur (pH>4)

Sample Acceptance Check Form

Client: Stantec Consulting Services, Inc. Work order: P1204493

Project: Sunoco IH Air Testing / 213402094

Sample(s) received on: 10/31/12 Date opened: 10/31/12 by: MZAMORA

Lab Sample ID	Container Description	Required pH *	Received pH	Adjusted pH	VOA Headspace (Presence/Absence)	Receipt / Preservation Comments
P1204493-009.01	6.0 L Ambient Can					
P1204493-010.01	6.0 L Ambient Can					
P1204493-011.01	6.0 L Ambient Can					
P1204493-012.01	6.0 L Ambient Can					
P1204493-013.01	6.0 L Ambient Can					
P1204493-014.01	6.0 L Ambient Can					
P1204493-015.01	6.0 L Ambient Can					
P1204493-016.01	6.0 L Ambient Can					
P1204493-017.01	6.0 L Ambient Can					
P1204493-018.01	6.0 L Ambient Can					
P1204493-019.01	6.0 L Ambient Can					
P1204493-020.01	6.0 L Ambient Can					
P1204493-021.01	6.0 L Ambient Can					
P1204493-022.01	6.0 L Ambient Can					
P1204493-023.01	6.0 L Ambient Can					

Explain any discrepancies: (include lab sample ID numbers):

RSK - MEEPP, HCL (pH<2); RSK - CO2, (pH 5-8); Sulfur (pH>4)

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Sample 1**
Client Project ID: **Sunoco IH Air Testing / 213402094**

CAS Project ID: P1204493
CAS Sample ID: P1204493-001

Test Code: EPA TO-15
Instrument ID: Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9
Analyst: Wida Ang
Sample Type: 6.0 L Summa Canister
Test Notes:
Container ID: AC01003

Date Collected: 10/24/12
Date Received: 10/31/12
Date Analyzed: 11/3/12
Volume(s) Analyzed: 1.00 Liter(s)

Initial Pressure (psig): -3.85 Final Pressure (psig): 3.67

Canister Dilution Factor: 1.69

CAS #	**Compound**	**Result** $\mu g/m^3$	MRL $\mu g/m^3$	**Result** ppbV	MRL ppbV	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.85	ND	0.23	
107-06-2	1,2-Dichloroethane	ND	0.85	ND	0.21	
71-43-2	Benzene	**4.3**	0.85	**1.3**	0.26	
108-88-3	Toluene	**7.4**	0.85	**2.0**	0.22	
106-93-4	1,2-Dibromoethane	ND	0.85	ND	0.11	
100-41-4	Ethylbenzene	**1.3**	0.85	**0.31**	0.19	
179601-23-1	m,p-Xylenes	**4.5**	1.7	**1.0**	0.39	
95-47-6	o-Xylene	**1.6**	0.85	**0.37**	0.19	
98-82-8	Cumene	**2.1**	0.85	**0.43**	0.17	
108-67-8	1,3,5-Trimethylbenzene	ND	0.85	ND	0.17	
95-63-6	1,2,4-Trimethylbenzene	**1.5**	0.85	**0.30**	0.17	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client:	**Stantec Consulting Services, Inc.**		
Client Sample ID:	**Sample 2**	CAS Project ID:	P1204493
Client Project ID:	**Sunoco IH Air Testing / 213402094**	CAS Sample ID:	P1204493-002
Test Code:	EPA TO-15	Date Collected:	10/24/12
Instrument ID:	Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9	Date Received:	10/31/12
Analyst:	Wida Ang	Date Analyzed:	11/3/12
Sample Type:	6.0 L Summa Canister	Volume(s) Analyzed:	1.00 Liter(s)
Test Notes:			
Container ID:	AC00760		

Initial Pressure (psig): -6.54 Final Pressure (psig): 3.79

Canister Dilution Factor: 2.27

CAS #	**Compound**	**Result µg/m³**	MRL µg/m³	**Result ppbV**	MRL ppbV	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	1.1	ND	0.31	
107-06-2	1,2-Dichloroethane	ND	1.1	ND	0.28	
71-43-2	Benzene	**3.9**	1.1	**1.2**	0.36	
108-88-3	Toluene	**6.5**	1.1	**1.7**	0.30	
106-93-4	1,2-Dibromoethane	ND	1.1	ND	0.15	
100-41-4	Ethylbenzene	ND	1.1	ND	0.26	
179601-23-1	m,p-Xylenes	**3.7**	2.3	**0.86**	0.52	
95-47-6	o-Xylene	**1.4**	1.1	**0.32**	0.26	
98-82-8	Cumene	**2.0**	1.1	**0.40**	0.23	
108-67-8	1,3,5-Trimethylbenzene	ND	1.1	ND	0.23	
95-63-6	1,2,4-Trimethylbenzene	**1.3**	1.1	**0.26**	0.23	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
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RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Sample 3**
Client Project ID: **Sunoco IH Air Testing / 213402094**

CAS Project ID: P1204493
CAS Sample ID: P1204493-003

Test Code: EPA TO-15
Instrument ID: Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9
Analyst: Wida Ang
Sample Type: 6.0 L Summa Canister
Test Notes:
Container ID: AC01853

Date Collected: 10/24/12
Date Received: 10/31/12
Date Analyzed: 11/3/12
Volume(s) Analyzed: 1.00 Liter(s)

Initial Pressure (psig): -3.60 Final Pressure (psig): 3.61

Canister Dilution Factor: 1.65

CAS #	Compound	**Result** **µg/m³**	MRL µg/m³	**Result** **ppbV**	MRL ppbV	**Data** **Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.83	ND	0.23	
107-06-2	1,2-Dichloroethane	ND	0.83	ND	0.20	
71-43-2	Benzene	**2.1**	0.83	**0.66**	0.26	
108-88-3	Toluene	**7.0**	0.83	**1.9**	0.22	
106-93-4	1,2-Dibromoethane	ND	0.83	ND	0.11	
100-41-4	Ethylbenzene	**1.5**	0.83	**0.35**	0.19	
179601-23-1	m,p-Xylenes	**4.0**	1.7	**0.93**	0.38	
95-47-6	o-Xylene	**1.5**	0.83	**0.35**	0.19	
98-82-8	Cumene	**1.0**	0.83	**0.21**	0.17	
108-67-8	1,3,5-Trimethylbenzene	ND	0.83	ND	0.17	
95-63-6	1,2,4-Trimethylbenzene	**1.7**	0.83	**0.35**	0.17	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client:	**Stantec Consulting Services, Inc.**		
Client Sample ID:	**Sample 4**	CAS Project ID:	P1204493
Client Project ID:	**Sunoco IH Air Testing / 213402094**	CAS Sample ID:	P1204493-004

Test Code:	EPA TO-15	Date Collected:	10/24/12
Instrument ID:	Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9	Date Received:	10/31/12
Analyst:	Wida Ang	Date Analyzed:	11/3/12
Sample Type:	6.0 L Summa Canister	Volume(s) Analyzed:	1.00 Liter(s)
Test Notes:			
Container ID:	AC01010		

Initial Pressure (psig): -3.29 Final Pressure (psig): 3.63

Canister Dilution Factor: 1.61

CAS #	**Compound**	**Result µg/m³**	MRL µg/m³	**Result ppbV**	MRL ppbV	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.81	ND	0.22	
107-06-2	1,2-Dichloroethane	ND	0.81	ND	0.20	
71-43-2	Benzene	**1.8**	0.81	**0.56**	0.25	
108-88-3	Toluene	**6.8**	0.81	**1.8**	0.21	
106-93-4	1,2-Dibromoethane	ND	0.81	ND	0.10	
100-41-4	Ethylbenzene	**1.2**	0.81	**0.28**	0.19	
179601-23-1	m,p-Xylenes	**3.8**	1.6	**0.88**	0.37	
95-47-6	o-Xylene	**1.4**	0.81	**0.33**	0.19	
98-82-8	Cumene	ND	0.81	ND	0.16	
108-67-8	1,3,5-Trimethylbenzene	ND	0.81	ND	0.16	
95-63-6	1,2,4-Trimethylbenzene	**1.5**	0.81	**0.31**	0.16	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Sample 5**
Client Project ID: **Sunoco IH Air Testing / 213402094**

CAS Project ID: P1204493
CAS Sample ID: P1204493-005

Test Code: EPA TO-15
Instrument ID: Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9
Analyst: Wida Ang
Sample Type: 6.0 L Summa Canister
Test Notes:
Container ID: AC01928

Date Collected: 10/24/12
Date Received: 10/31/12
Date Analyzed: 11/3/12
Volume(s) Analyzed: 1.00 Liter(s)

Initial Pressure (psig): -3.21 Final Pressure (psig): 3.60

Canister Dilution Factor: 1.59

CAS #	**Compound**	**Result** µg/m³	MRL µg/m³	**Result** ppbV	MRL ppbV	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.80	ND	0.22	
107-06-2	1,2-Dichloroethane	ND	0.80	ND	0.20	
71-43-2	Benzene	**3.5**	0.80	**1.1**	0.25	
108-88-3	Toluene	**7.2**	0.80	**1.9**	0.21	
106-93-4	1,2-Dibromoethane	ND	0.80	ND	0.10	
100-41-4	Ethylbenzene	**1.3**	0.80	**0.31**	0.18	
179601-23-1	m,p-Xylenes	**3.7**	1.6	**0.86**	0.37	
95-47-6	o-Xylene	**1.4**	0.80	**0.32**	0.18	
98-82-8	Cumene	**1.0**	0.80	**0.21**	0.16	
108-67-8	1,3,5-Trimethylbenzene	ND	0.80	ND	0.16	
95-63-6	1,2,4-Trimethylbenzene	**1.6**	0.80	**0.33**	0.16	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Sample 6** CAS Project ID: P1204493
Client Project ID: **Sunoco IH Air Testing / 213402094** CAS Sample ID: P1204493-006

Test Code: EPA TO-15 Date Collected: 10/24/12
Instrument ID: Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9 Date Received: 10/31/12
Analyst: Wida Ang Date Analyzed: 11/3/12
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 1.00 Liter(s)
Test Notes:
Container ID: AC01669

Initial Pressure (psig): -4.20 Final Pressure (psig): 3.70

Canister Dilution Factor: 1.75

CAS #	Compound	Result µg/m³	MRL µg/m³	Result ppbV	MRL ppbV	Data Qualifier
1634-04-4	Methyl tert-Butyl Ether	ND	0.88	ND	0.24	
107-06-2	1,2-Dichloroethane	ND	0.88	ND	0.22	
71-43-2	Benzene	**4.2**	0.88	**1.3**	0.27	
108-88-3	Toluene	**7.5**	0.88	**2.0**	0.23	
106-93-4	1,2-Dibromoethane	ND	0.88	ND	0.11	
100-41-4	Ethylbenzene	**2.2**	0.88	**0.50**	0.20	
179601-23-1	m,p-Xylenes	**4.6**	1.8	**1.1**	0.40	
95-47-6	o-Xylene	**1.7**	0.88	**0.38**	0.20	
98-82-8	Cumene	**1.3**	0.88	**0.26**	0.18	
108-67-8	1,3,5-Trimethylbenzene	ND	0.88	ND	0.18	
95-63-6	1,2,4-Trimethylbenzene	**1.8**	0.88	**0.37**	0.18	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client:	**Stantec Consulting Services, Inc.**		
Client Sample ID:	**Sample 7**	CAS Project ID:	P1204493
Client Project ID:	**Sunoco IH Air Testing / 213402094**	CAS Sample ID:	P1204493-007

Test Code:	EPA TO-15	Date Collected:	10/24/12
Instrument ID:	Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9	Date Received:	10/31/12
Analyst:	Wida Ang	Date Analyzed:	11/3/12
Sample Type:	6.0 L Summa Canister	Volume(s) Analyzed:	1.00 Liter(s)
Test Notes:			
Container ID:	AC00641		

Initial Pressure (psig): -3.08 Final Pressure (psig): 3.75

Canister Dilution Factor: 1.59

CAS #	**Compound**	**Result** **µg/m³**	MRL µg/m³	**Result** **ppbV**	MRL ppbV	**Data** **Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.80	ND	0.22	
107-06-2	1,2-Dichloroethane	ND	0.80	ND	0.20	
71-43-2	Benzene	**4.2**	0.80	**1.3**	0.25	
108-88-3	Toluene	**12**	0.80	**3.1**	0.21	
106-93-4	1,2-Dibromoethane	ND	0.80	ND	0.10	
100-41-4	Ethylbenzene	**1.8**	0.80	**0.41**	0.18	
179601-23-1	m,p-Xylenes	**6.3**	1.6	**1.4**	0.37	
95-47-6	o-Xylene	**2.2**	0.80	**0.51**	0.18	
98-82-8	Cumene	**2.0**	0.80	**0.41**	0.16	
108-67-8	1,3,5-Trimethylbenzene	**1.2**	0.80	**0.25**	0.16	
95-63-6	1,2,4-Trimethylbenzene	**4.0**	0.80	**0.82**	0.16	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Sample 8**
Client Project ID: **Sunoco IH Air Testing / 213402094**

CAS Project ID: P1204493
CAS Sample ID: P1204493-008

Test Code: EPA TO-15
Instrument ID: Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9
Analyst: Wida Ang
Sample Type: 6.0 L Summa Canister
Test Notes:
Container ID: AC00747

Date Collected: 10/24/12
Date Received: 10/31/12
Date Analyzed: 11/3/12
Volume(s) Analyzed: 1.00 Liter(s)

Initial Pressure (psig): -3.67 Final Pressure (psig): 3.78

Canister Dilution Factor: 1.68

CAS #	**Compound**	**Result** **µg/m³**	MRL µg/m³	**Result** **ppbV**	MRL ppbV	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.84	ND	0.23	
107-06-2	1,2-Dichloroethane	ND	0.84	ND	0.21	
71-43-2	Benzene	**3.1**	0.84	**0.97**	0.26	
108-88-3	Toluene	**7.8**	0.84	**2.1**	0.22	
106-93-4	1,2-Dibromoethane	ND	0.84	ND	0.11	
100-41-4	Ethylbenzene	**1.5**	0.84	**0.34**	0.19	
179601-23-1	m,p-Xylenes	**4.9**	1.7	**1.1**	0.39	
95-47-6	o-Xylene	**1.8**	0.84	**0.42**	0.19	
98-82-8	Cumene	**1.5**	0.84	**0.30**	0.17	
108-67-8	1,3,5-Trimethylbenzene	**0.97**	0.84	**0.20**	0.17	
95-63-6	1,2,4-Trimethylbenzene	**3.2**	0.84	**0.65**	0.17	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Sample 9** CAS Project ID: P1204493
Client Project ID: **Sunoco IH Air Testing / 213402094** CAS Sample ID: P1204493-009

Test Code: EPA TO-15 Date Collected: 10/24/12
Instrument ID: Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9 Date Received: 10/31/12
Analyst: Wida Ang Date Analyzed: 11/3/12
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 1.00 Liter(s)
Test Notes:
Container ID: AC01113

Initial Pressure (psig): -3.10 Final Pressure (psig): 3.67

Canister Dilution Factor: 1.58

CAS #	**Compound**	**Result** µg/m³	MRL µg/m³	**Result** ppbV	MRL ppbV	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.79	ND	0.22	
107-06-2	1,2-Dichloroethane	ND	0.79	ND	0.20	
71-43-2	Benzene	**2.3**	0.79	**0.72**	0.25	
108-88-3	Toluene	**6.9**	0.79	**1.8**	0.21	
106-93-4	1,2-Dibromoethane	ND	0.79	ND	0.10	
100-41-4	Ethylbenzene	**1.3**	0.79	**0.29**	0.18	
179601-23-1	m,p-Xylenes	**4.2**	1.6	**0.97**	0.36	
95-47-6	o-Xylene	**1.5**	0.79	**0.36**	0.18	
98-82-8	Cumene	**1.4**	0.79	**0.28**	0.16	
108-67-8	1,3,5-Trimethylbenzene	ND	0.79	ND	0.16	
95-63-6	1,2,4-Trimethylbenzene	**1.6**	0.79	**0.32**	0.16	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Sample 10**
Client Project ID: **Sunoco IH Air Testing / 213402094**
CAS Project ID: P1204493
CAS Sample ID: P1204493-010

Test Code: EPA TO-15
Instrument ID: Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9
Analyst: Wida Ang
Sample Type: 6.0 L Summa Canister
Test Notes:
Container ID: AC01436
Date Collected: 10/24/12
Date Received: 10/31/12
Date Analyzed: 11/3/12
Volume(s) Analyzed: 1.00 Liter(s)

Initial Pressure (psig): -5.08 Final Pressure (psig): 3.56

Canister Dilution Factor: 1.90

CAS #	**Compound**	**Result** µg/m³	MRL µg/m³	**Result** ppbV	MRL ppbV	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.95	ND	0.26	
107-06-2	1,2-Dichloroethane	ND	0.95	ND	0.23	
71-43-2	Benzene	**2.2**	0.95	**0.69**	0.30	
108-88-3	Toluene	**6.9**	0.95	**1.8**	0.25	
106-93-4	1,2-Dibromoethane	ND	0.95	ND	0.12	
100-41-4	Ethylbenzene	**1.2**	0.95	**0.27**	0.22	
179601-23-1	m,p-Xylenes	**3.6**	1.9	**0.83**	0.44	
95-47-6	o-Xylene	**1.3**	0.95	**0.31**	0.22	
98-82-8	Cumene	**1.0**	0.95	**0.20**	0.19	
108-67-8	1,3,5-Trimethylbenzene	ND	0.95	ND	0.19	
95-63-6	1,2,4-Trimethylbenzene	**1.3**	0.95	**0.26**	0.19	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client:	**Stantec Consulting Services, Inc.**		
Client Sample ID:	**Sample 11**	CAS Project ID:	P1204493
Client Project ID:	**Sunoco IH Air Testing / 213402094**	CAS Sample ID:	P1204493-011
Test Code:	EPA TO-15	Date Collected:	10/24/12
Instrument ID:	Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9	Date Received:	10/31/12
Analyst:	Wida Ang	Date Analyzed:	11/5/12
Sample Type:	6.0 L Summa Canister	Volume(s) Analyzed:	1.00 Liter(s)
Test Notes:			
Container ID:	AC01376		

Initial Pressure (psig): -3.84   Final Pressure (psig): 3.74

Canister Dilution Factor: 1.70

CAS #	**Compound**	**Result** **µg/m^3**	MRL µg/m^3	**Result** **ppbV**	MRL ppbV	**Data** **Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.85	ND	0.24	
107-06-2	1,2-Dichloroethane	ND	0.85	ND	0.21	
71-43-2	Benzene	**1.6**	0.85	**0.50**	0.27	
108-88-3	Toluene	**6.1**	0.85	**1.6**	0.23	
106-93-4	1,2-Dibromoethane	ND	0.85	ND	0.11	
100-41-4	Ethylbenzene	**0.86**	0.85	**0.20**	0.20	
179601-23-1	m,p-Xylenes	**2.7**	1.7	**0.63**	0.39	
95-47-6	o-Xylene	**1.0**	0.85	**0.24**	0.20	
98-82-8	Cumene	ND	0.85	ND	0.17	
108-67-8	1,3,5-Trimethylbenzene	ND	0.85	ND	0.17	
95-63-6	1,2,4-Trimethylbenzene	**0.93**	0.85	**0.19**	0.17	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Sample 12** CAS Project ID: P1204493
Client Project ID: **Sunoco IH Air Testing / 213402094** CAS Sample ID: P1204493-012

Test Code: EPA TO-15
Instrument ID: Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9
Analyst: Wida Ang
Sample Type: 6.0 L Summa Canister
Test Notes:
Container ID: AC00672

Date Collected: 10/24/12
Date Received: 10/31/12
Date Analyzed: 11/5/12
Volume(s) Analyzed: 1.00 Liter(s)

Initial Pressure (psig): -2.29 Final Pressure (psig): 3.58

Canister Dilution Factor: 1.47

CAS #	**Compound**	**Result** **µg/m³**	MRL µg/m³	**Result** **ppbV**	MRL ppbV	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.74	ND	0.20	
107-06-2	1,2-Dichloroethane	ND	0.74	ND	0.18	
71-43-2	Benzene	**1.7**	0.74	**0.54**	0.23	
108-88-3	Toluene	**6.2**	0.74	**1.6**	0.20	
106-93-4	1,2-Dibromoethane	ND	0.74	ND	0.096	
100-41-4	Ethylbenzene	**0.99**	0.74	**0.23**	0.17	
179601-23-1	m,p-Xylenes	**2.9**	1.5	**0.67**	0.34	
95-47-6	o-Xylene	**1.1**	0.74	**0.25**	0.17	
98-82-8	Cumene	ND	0.74	ND	0.15	
108-67-8	1,3,5-Trimethylbenzene	ND	0.74	ND	0.15	
95-63-6	1,2,4-Trimethylbenzene	**1.0**	0.74	**0.21**	0.15	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Sample 13**
Client Project ID: **Sunoco IH Air Testing / 213402094**
CAS Project ID: P1204493
CAS Sample ID: P1204493-013

Test Code: EPA TO-15
Instrument ID: Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9
Analyst: Wida Ang
Sample Type: 6.0 L Summa Canister
Test Notes:
Container ID: AC01145

Date Collected: 10/24/12
Date Received: 10/31/12
Date Analyzed: 11/6/12
Volume(s) Analyzed: 1.00 Liter(s)

Initial Pressure (psig): -4.00 Final Pressure (psig): 3.75

Canister Dilution Factor: 1.72

CAS #	**Compound**	**Result** **µg/m³**	MRL µg/m³	**Result** **ppbV**	MRL ppbV	**Data** **Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.86	ND	0.24	
107-06-2	1,2-Dichloroethane	ND	0.86	ND	0.21	
71-43-2	Benzene	**1.5**	0.86	**0.47**	0.27	
108-88-3	Toluene	**5.6**	0.86	**1.5**	0.23	
106-93-4	1,2-Dibromoethane	ND	0.86	ND	0.11	
100-41-4	Ethylbenzene	**0.86**	0.86	**0.20**	0.20	
179601-23-1	m,p-Xylenes	**2.6**	1.7	**0.60**	0.40	
95-47-6	o-Xylene	**0.96**	0.86	**0.22**	0.20	
98-82-8	Cumene	ND	0.86	ND	0.18	
108-67-8	1,3,5-Trimethylbenzene	ND	0.86	ND	0.18	
95-63-6	1,2,4-Trimethylbenzene	ND	0.86	ND	0.18	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client:	**Stantec Consulting Services, Inc.**		
Client Sample ID:	**Sample 14**	CAS Project ID:	P1204493
Client Project ID:	**Sunoco IH Air Testing / 213402094**	CAS Sample ID:	P1204493-014
Test Code:	EPA TO-15	Date Collected:	10/24/12
Instrument ID:	Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9	Date Received:	10/31/12
Analyst:	Wida Ang	Date Analyzed:	11/5/12
Sample Type:	6.0 L Summa Canister	Volume(s) Analyzed:	1.00 Liter(s)
Test Notes:			
Container ID:	AC00782		

Initial Pressure (psig): 0.31 Final Pressure (psig): 3.62

Canister Dilution Factor: 1.22

CAS #	**Compound**	**Result µg/m³**	MRL µg/m³	**Result ppbV**	MRL ppbV	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.61	ND	0.17	
107-06-2	1,2-Dichloroethane	ND	0.61	ND	0.15	
71-43-2	Benzene	**1.6**	0.61	**0.51**	0.19	
108-88-3	Toluene	**6.0**	0.61	**1.6**	0.16	
106-93-4	1,2-Dibromoethane	ND	0.61	ND	0.079	
100-41-4	Ethylbenzene	**1.1**	0.61	**0.26**	0.14	
179601-23-1	m,p-Xylenes	**3.0**	1.2	**0.70**	0.28	
95-47-6	o-Xylene	**1.1**	0.61	**0.26**	0.14	
98-82-8	Cumene	**0.79**	0.61	**0.16**	0.12	
108-67-8	1,3,5-Trimethylbenzene	ND	0.61	ND	0.12	
95-63-6	1,2,4-Trimethylbenzene	**1.0**	0.61	**0.20**	0.12	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Sample 15**
Client Project ID: **Sunoco IH Air Testing / 213402094**

CAS Project ID: P1204493
CAS Sample ID: P1204493-015

Test Code: EPA TO-15
Instrument ID: Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9
Analyst: Wida Ang
Sample Type: 6.0 L Summa Canister
Test Notes:
Container ID: AC00475

Date Collected: 10/24/12
Date Received: 10/31/12
Date Analyzed: 11/5/12
Volume(s) Analyzed: 1.00 Liter(s)

Initial Pressure (psig): -1.47 Final Pressure (psig): 3.55

Canister Dilution Factor: 1.38

CAS #	**Compound**	**Result** **µg/m³**	MRL µg/m³	**Result** **ppbV**	MRL ppbV	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.69	ND	0.19	
107-06-2	1,2-Dichloroethane	ND	0.69	ND	0.17	
71-43-2	Benzene	**1.9**	0.69	**0.61**	0.22	
108-88-3	Toluene	**6.4**	0.69	**1.7**	0.18	
106-93-4	1,2-Dibromoethane	ND	0.69	ND	0.090	
100-41-4	Ethylbenzene	**1.2**	0.69	**0.28**	0.16	
179601-23-1	m,p-Xylenes	**3.4**	1.4	**0.78**	0.32	
95-47-6	o-Xylene	**1.2**	0.69	**0.29**	0.16	
98-82-8	Cumene	**1.0**	0.69	**0.21**	0.14	
108-67-8	1,3,5-Trimethylbenzene	ND	0.69	ND	0.14	
95-63-6	1,2,4-Trimethylbenzene	**1.2**	0.69	**0.25**	0.14	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Sample 16**
Client Project ID: **Sunoco IH Air Testing / 213402094**

CAS Project ID: P1204493
CAS Sample ID: P1204493-016

Test Code: EPA TO-15
Instrument ID: Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9
Analyst: Wida Ang
Sample Type: 6.0 L Summa Canister
Test Notes:
Container ID: AC01263

Date Collected: 10/24/12
Date Received: 10/31/12
Date Analyzed: 11/5/12
Volume(s) Analyzed: 1.00 Liter(s)

Initial Pressure (psig): -3.77 Final Pressure (psig): 3.76

Canister Dilution Factor: 1.69

CAS #	**Compound**	**Result** **µg/m³**	MRL µg/m³	**Result** **ppbV**	MRL ppbV	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.85	ND	0.23	
107-06-2	1,2-Dichloroethane	ND	0.85	ND	0.21	
71-43-2	Benzene	**1.3**	0.85	**0.42**	0.26	
108-88-3	Toluene	**4.6**	0.85	**1.2**	0.22	
106-93-4	1,2-Dibromoethane	ND	0.85	ND	0.11	
100-41-4	Ethylbenzene	ND	0.85	ND	0.19	
179601-23-1	m,p-Xylenes	**2.0**	1.7	**0.46**	0.39	
95-47-6	o-Xylene	ND	0.85	ND	0.19	
98-82-8	Cumene	ND	0.85	ND	0.17	
108-67-8	1,3,5-Trimethylbenzene	ND	0.85	ND	0.17	
95-63-6	1,2,4-Trimethylbenzene	ND	0.85	ND	0.17	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Sample 17** CAS Project ID: P1204493
Client Project ID: **Sunoco IH Air Testing / 213402094** CAS Sample ID: P1204493-017

Test Code: EPA TO-15 Date Collected: 10/24/12
Instrument ID: Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9 Date Received: 10/31/12
Analyst: Wida Ang Date Analyzed: 11/5/12
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 1.00 Liter(s)
Test Notes:
Container ID: AC01215

Initial Pressure (psig): -2.97 Final Pressure (psig): 3.72

Canister Dilution Factor: 1.57

CAS #	**Compound**	**Result** µg/m³	MRL µg/m³	**Result** ppbV	MRL ppbV	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.79	ND	0.22	
107-06-2	1,2-Dichloroethane	ND	0.79	ND	0.19	
71-43-2	Benzene	**9.0**	0.79	**2.8**	0.25	
108-88-3	Toluene	**8.3**	0.79	**2.2**	0.21	
106-93-4	1,2-Dibromoethane	ND	0.79	ND	0.10	
100-41-4	Ethylbenzene	**1.8**	0.79	**0.41**	0.18	
179601-23-1	m,p-Xylenes	**4.3**	1.6	**0.98**	0.36	
95-47-6	o-Xylene	**1.5**	0.79	**0.34**	0.18	
98-82-8	Cumene	**2.5**	0.79	**0.50**	0.16	
108-67-8	1,3,5-Trimethylbenzene	ND	0.79	ND	0.16	
95-63-6	1,2,4-Trimethylbenzene	**1.3**	0.79	**0.25**	0.16	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Sample 18** CAS Project ID: P1204493
Client Project ID: **Sunoco IH Air Testing / 213402094** CAS Sample ID: P1204493-018

Test Code: EPA TO-15 Date Collected: 10/24/12
Instrument ID: Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9 Date Received: 10/31/12
Analyst: Wida Ang Date Analyzed: 11/5/12
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 1.00 Liter(s)
Test Notes:
Container ID: AC01670

Initial Pressure (psig): -2.52 Final Pressure (psig): 3.64

Canister Dilution Factor: 1.51

CAS #	Compound	Result µg/m³	MRL µg/m³	Result ppbV	MRL ppbV	Data Qualifier
1634-04-4	Methyl tert-Butyl Ether	ND	0.76	ND	0.21	
107-06-2	1,2-Dichloroethane	ND	0.76	ND	0.19	
71-43-2	Benzene	**7.2**	0.76	**2.2**	0.24	
108-88-3	Toluene	**8.2**	0.76	**2.2**	0.20	
106-93-4	1,2-Dibromoethane	ND	0.76	ND	0.098	
100-41-4	Ethylbenzene	**0.97**	0.76	**0.22**	0.17	
179601-23-1	m,p-Xylenes	**3.2**	1.5	**0.75**	0.35	
95-47-6	o-Xylene	**1.2**	0.76	**0.28**	0.17	
98-82-8	Cumene	**1.9**	0.76	**0.39**	0.15	
108-67-8	1,3,5-Trimethylbenzene	ND	0.76	ND	0.15	
95-63-6	1,2,4-Trimethylbenzene	**1.2**	0.76	**0.24**	0.15	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client:	**Stantec Consulting Services, Inc.**		
Client Sample ID:	**Sample 19**	CAS Project ID:	P1204493
Client Project ID:	**Sunoco IH Air Testing / 213402094**	CAS Sample ID:	P1204493-019
Test Code:	EPA TO-15	Date Collected:	10/24/12
Instrument ID:	Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9	Date Received:	10/31/12
Analyst:	Wida Ang	Date Analyzed:	11/5/12
Sample Type:	6.0 L Summa Canister	Volume(s) Analyzed:	1.00 Liter(s)
Test Notes:			
Container ID:	AC01930		

Initial Pressure (psig): -2.75 Final Pressure (psig): 3.57

Canister Dilution Factor: 1.53

CAS #	Compound	Result µg/m³	MRL µg/m³	Result ppbV	MRL ppbV	Data Qualifier
1634-04-4	Methyl tert-Butyl Ether	ND	0.77	ND	0.21	
107-06-2	1,2-Dichloroethane	ND	0.77	ND	0.19	
71-43-2	Benzene	**3.6**	0.77	**1.1**	0.24	
108-88-3	Toluene	**14**	0.77	**3.6**	0.20	
106-93-4	1,2-Dibromoethane	ND	0.77	ND	0.10	
100-41-4	Ethylbenzene	**2.9**	0.77	**0.66**	0.18	
179601-23-1	m,p-Xylenes	**11**	1.5	**2.6**	0.35	
95-47-6	o-Xylene	**3.7**	0.77	**0.85**	0.18	
98-82-8	Cumene	**0.77**	0.77	**0.16**	0.16	
108-67-8	1,3,5-Trimethylbenzene	**1.3**	0.77	**0.27**	0.16	
95-63-6	1,2,4-Trimethylbenzene	**3.3**	0.77	**0.68**	0.16	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client:	**Stantec Consulting Services, Inc.**		
Client Sample ID:	**Sample 20**	CAS Project ID:	P1204493
Client Project ID:	**Sunoco IH Air Testing / 213402094**	CAS Sample ID:	P1204493-020
Test Code:	EPA TO-15	Date Collected:	10/24/12
Instrument ID:	Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9	Date Received:	10/31/12
Analyst:	Wida Ang	Date Analyzed:	11/6/12
Sample Type:	6.0 L Summa Canister	Volume(s) Analyzed:	1.00 Liter(s)
Test Notes:			
Container ID:	AC01420		

Initial Pressure (psig): -3.07 Final Pressure (psig): 3.72

Canister Dilution Factor: 1.58

CAS #	**Compound**	**Result µg/m³**	MRL µg/m³	**Result ppbV**	MRL ppbV	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.79	ND	0.22	
107-06-2	1,2-Dichloroethane	ND	0.79	ND	0.20	
71-43-2	Benzene	**2.1**	0.79	**0.65**	0.25	
108-88-3	Toluene	**7.4**	0.79	**2.0**	0.21	
106-93-4	1,2-Dibromoethane	ND	0.79	ND	0.10	
100-41-4	Ethylbenzene	**0.83**	0.79	**0.19**	0.18	
179601-23-1	m,p-Xylenes	**2.8**	1.6	**0.65**	0.36	
95-47-6	o-Xylene	**1.1**	0.79	**0.24**	0.18	
98-82-8	Cumene	ND	0.79	ND	0.16	
108-67-8	1,3,5-Trimethylbenzene	ND	0.79	ND	0.16	
95-63-6	1,2,4-Trimethylbenzene	**0.92**	0.79	**0.19**	0.16	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Sample 21**
Client Project ID: **Sunoco IH Air Testing / 213402094**

CAS Project ID: P1204493
CAS Sample ID: P1204493-021

Test Code: EPA TO-15
Instrument ID: Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9
Analyst: Wida Ang
Sample Type: 6.0 L Summa Canister
Test Notes:
Container ID: AC01464

Date Collected: 10/24/12
Date Received: 10/31/12
Date Analyzed: 11/5/12
Volume(s) Analyzed: 1.00 Liter(s)

Initial Pressure (psig): -1.69 Final Pressure (psig): 3.65

Canister Dilution Factor: 1.41

CAS #	Compound	Result µg/m³	MRL µg/m³	Result ppbV	MRL ppbV	Data Qualifier
1634-04-4	Methyl tert-Butyl Ether	ND	0.71	ND	0.20	
107-06-2	1,2-Dichloroethane	ND	0.71	ND	0.17	
71-43-2	Benzene	**4.9**	0.71	**1.5**	0.22	
108-88-3	Toluene	**19**	0.71	**5.0**	0.19	
106-93-4	1,2-Dibromoethane	ND	0.71	ND	0.092	
100-41-4	Ethylbenzene	**3.1**	0.71	**0.70**	0.16	
179601-23-1	m,p-Xylenes	**13**	1.4	**3.0**	0.32	
95-47-6	o-Xylene	**4.1**	0.71	**0.94**	0.16	
98-82-8	Cumene	ND	0.71	ND	0.14	
108-67-8	1,3,5-Trimethylbenzene	**1.6**	0.71	**0.33**	0.14	
95-63-6	1,2,4-Trimethylbenzene	**3.6**	0.71	**0.74**	0.14	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client:	**Stantec Consulting Services, Inc.**		
Client Sample ID:	**Sample 22**	CAS Project ID:	P1204493
Client Project ID:	**Sunoco IH Air Testing / 213402094**	CAS Sample ID:	P1204493-022
Test Code:	EPA TO-15	Date Collected:	10/24/12
Instrument ID:	Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9	Date Received:	10/31/12
Analyst:	Wida Ang	Date Analyzed:	11/5/12
Sample Type:	6.0 L Summa Canister	Volume(s) Analyzed:	1.00 Liter(s)
Test Notes:			
Container ID:	AC00590		

Initial Pressure (psig): -2.29 Final Pressure (psig): 3.77

Canister Dilution Factor: 1.49

CAS #	Compound	**Result µg/m³**	MRL µg/m³	**Result ppbV**	MRL ppbV	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.75	ND	0.21	
107-06-2	1,2-Dichloroethane	ND	0.75	ND	0.18	
71-43-2	Benzene	**1.7**	0.75	**0.53**	0.23	
108-88-3	Toluene	**9.2**	0.75	**2.4**	0.20	
106-93-4	1,2-Dibromoethane	ND	0.75	ND	0.097	
100-41-4	Ethylbenzene	**1.7**	0.75	**0.39**	0.17	
179601-23-1	m,p-Xylenes	**4.6**	1.5	**1.1**	0.34	
95-47-6	o-Xylene	**1.5**	0.75	**0.34**	0.17	
98-82-8	Cumene	**0.85**	0.75	**0.17**	0.15	
108-67-8	1,3,5-Trimethylbenzene	ND	0.75	ND	0.15	
95-63-6	1,2,4-Trimethylbenzene	**1.2**	0.75	**0.24**	0.15	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Sample 24 TB**
Client Project ID: **Sunoco IH Air Testing / 213402094**

CAS Project ID: P1204493
CAS Sample ID: P1204493-023

Test Code: EPA TO-15
Instrument ID: Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9
Analyst: Wida Ang
Sample Type: 6.0 L Summa Canister
Test Notes:
Container ID: AC01830

Date Collected: 10/24/12
Date Received: 10/31/12
Date Analyzed: 11/5/12
Volume(s) Analyzed: 1.00 Liter(s)

Canister Dilution Factor: 1.00

CAS #	**Compound**	**Result** µg/m³	MRL µg/m³	**Result** ppbV	MRL ppbV	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.50	ND	0.14	
107-06-2	1,2-Dichloroethane	ND	0.50	ND	0.12	
71-43-2	Benzene	ND	0.50	ND	0.16	
108-88-3	Toluene	ND	0.50	ND	0.13	
106-93-4	1,2-Dibromoethane	ND	0.50	ND	0.065	
100-41-4	Ethylbenzene	ND	0.50	ND	0.12	
179601-23-1	m,p-Xylenes	ND	1.0	ND	0.23	
95-47-6	o-Xylene	ND	0.50	ND	0.12	
98-82-8	Cumene	ND	0.50	ND	0.10	
108-67-8	1,3,5-Trimethylbenzene	ND	0.50	ND	0.10	
95-63-6	1,2,4-Trimethylbenzene	ND	0.50	ND	0.10	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client:	**Stantec Consulting Services, Inc.**		
Client Sample ID:	**Method Blank**	CAS Project ID:	P1204493
Client Project ID:	**Sunoco IH Air Testing / 213402094**	CAS Sample ID:	P121103-MB
Test Code:	EPA TO-15	Date Collected:	NA
Instrument ID:	Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9	Date Received:	NA
Analyst:	Wida Ang	Date Analyzed:	11/3/12
Sample Type:	6.0 L Summa Canister	Volume(s) Analyzed:	1.00 Liter(s)
Test Notes:			

Canister Dilution Factor: 1.00

CAS #	**Compound**	**Result** **µg/m³**	MRL µg/m³	**Result** **ppbV**	MRL ppbV	**Data** **Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.50	ND	0.14	
107-06-2	1,2-Dichloroethane	ND	0.50	ND	0.12	
71-43-2	Benzene	ND	0.50	ND	0.16	
108-88-3	Toluene	ND	0.50	ND	0.13	
106-93-4	1,2-Dibromoethane	ND	0.50	ND	0.065	
100-41-4	Ethylbenzene	ND	0.50	ND	0.12	
179601-23-1	m,p-Xylenes	ND	1.0	ND	0.23	
95-47-6	o-Xylene	ND	0.50	ND	0.12	
98-82-8	Cumene	ND	0.50	ND	0.10	
108-67-8	1,3,5-Trimethylbenzene	ND	0.50	ND	0.10	
95-63-6	1,2,4-Trimethylbenzene	ND	0.50	ND	0.10	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Method Blank**
Client Project ID: **Sunoco IH Air Testing / 213402094**

CAS Project ID: P1204493
CAS Sample ID: P121105-MB

Test Code: EPA TO-15
Instrument ID: Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9
Analyst: Wida Ang
Sample Type: 6.0 L Summa Canister
Test Notes:

Date Collected: NA
Date Received: NA
Date Analyzed: 11/5/12
Volume(s) Analyzed: 1.00 Liter(s)

Canister Dilution Factor: 1.00

CAS #	**Compound**	**Result** µg/m³	MRL µg/m³	**Result** ppbV	MRL ppbV	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.50	ND	0.14	
107-06-2	1,2-Dichloroethane	ND	0.50	ND	0.12	
71-43-2	Benzene	ND	0.50	ND	0.16	
108-88-3	Toluene	ND	0.50	ND	0.13	
106-93-4	1,2-Dibromoethane	ND	0.50	ND	0.065	
100-41-4	Ethylbenzene	ND	0.50	ND	0.12	
179601-23-1	m,p-Xylenes	ND	1.0	ND	0.23	
95-47-6	o-Xylene	ND	0.50	ND	0.12	
98-82-8	Cumene	ND	0.50	ND	0.10	
108-67-8	1,3,5-Trimethylbenzene	ND	0.50	ND	0.10	
95-63-6	1,2,4-Trimethylbenzene	ND	0.50	ND	0.10	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client:	**Stantec Consulting Services, Inc.**		
Client Sample ID:	**Method Blank**	CAS Project ID:	P1204493
Client Project ID:	**Sunoco IH Air Testing / 213402094**	CAS Sample ID:	P121106-MB

Test Code:	EPA TO-15	Date Collected:	NA
Instrument ID:	Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9	Date Received:	NA
Analyst:	Wida Ang	Date Analyzed:	11/6/12
Sample Type:	6.0 L Summa Canister	Volume(s) Analyzed:	1.00 Liter(s)
Test Notes:			

Canister Dilution Factor: 1.00

CAS #	**Compound**	**Result µg/m³**	MRL µg/m³	**Result ppbV**	MRL ppbV	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.50	ND	0.14	
107-06-2	1,2-Dichloroethane	ND	0.50	ND	0.12	
71-43-2	Benzene	ND	0.50	ND	0.16	
108-88-3	Toluene	ND	0.50	ND	0.13	
106-93-4	1,2-Dibromoethane	ND	0.50	ND	0.065	
100-41-4	Ethylbenzene	ND	0.50	ND	0.12	
179601-23-1	m,p-Xylenes	ND	1.0	ND	0.23	
95-47-6	o-Xylene	ND	0.50	ND	0.12	
98-82-8	Cumene	ND	0.50	ND	0.10	
108-67-8	1,3,5-Trimethylbenzene	ND	0.50	ND	0.10	
95-63-6	1,2,4-Trimethylbenzene	ND	0.50	ND	0.10	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

SURROGATE SPIKE RECOVERY RESULTS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Project ID: **Sunoco IH Air Testing / 213402094**
CAS Project ID: P1204493

Test Code: EPA TO-15
Instrument ID: Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9
Analyst: Wida Ang
Sample Type: 6.0 L Summa Canister(s)
Test Notes:

Date(s) Collected: 10/24/12
Date(s) Received: 10/31/12
Date(s) Analyzed: 11/3 - 11/6/12

Client Sample ID	CAS Sample ID	1,2-Dichloroethane-d4 Percent Recovered	Toluene-d8 Percent Recovered	Bromofluorobenzene Percent Recovered	Acceptance Limits	Data Qualifier
Method Blank	P121103-MB	**97**	**98**	**102**	70-130	
Method Blank	P121105-MB	**96**	**102**	**104**	70-130	
Method Blank	P121106-MB	**94**	**100**	**106**	70-130	
Lab Control Sample	P121103-LCS	**99**	**101**	**104**	70-130	
Lab Control Sample	P121105-LCS	**97**	**98**	**106**	70-130	
Lab Control Sample	P121106-LCS	**97**	**100**	**108**	70-130	
Sample 1	P1204493-001	**97**	**99**	**104**	70-130	
Sample 2	P1204493-002	**101**	**98**	**102**	70-130	
Sample 3	P1204493-003	**100**	**98**	**104**	70-130	
Sample 3	P1204493-003DUP	**98**	**95**	**103**	70-130	
Sample 4	P1204493-004	**102**	**96**	**105**	70-130	
Sample 5	P1204493-005	**97**	**98**	**106**	70-130	
Sample 6	P1204493-006	**98**	**98**	**105**	70-130	
Sample 7	P1204493-007	**98**	**96**	**107**	70-130	
Sample 8	P1204493-008	**96**	**100**	**108**	70-130	
Sample 9	P1204493-009	**99**	**98**	**107**	70-130	
Sample 10	P1204493-010	**97**	**100**	**105**	70-130	
Sample 11	P1204493-011	**98**	**98**	**106**	70-130	
Sample 12	P1204493-012	**95**	**101**	**106**	70-130	
Sample 13	P1204493-013	**96**	**97**	**107**	70-130	
Sample 14	P1204493-014	**96**	**101**	**107**	70-130	
Sample 15	P1204493-015	**97**	**100**	**103**	70-130	
Sample 15	P1204493-015DUP	**94**	**104**	**110**	70-130	
Sample 16	P1204493-016	**97**	**97**	**105**	70-130	
Sample 17	P1204493-017	**99**	**98**	**109**	70-130	
Sample 18	P1204493-018	**96**	**100**	**106**	70-130	
Sample 19	P1204493-019	**96**	**101**	**107**	70-130	
Sample 20	P1204493-020	**95**	**101**	**108**	70-130	
Sample 21	P1204493-021	**98**	**98**	**102**	70-130	
Sample 22	P1204493-022	**97**	**99**	**100**	70-130	
Sample 24 TB	P1204493-023	**94**	**105**	**103**	70-130	

Surrogate percent recovery is verified and accepted based on the on-column result.
Reported results are shown in concentration units and as a result of the calculation, may vary slightly from the on-column percent recovery.

LABORATORY CONTROL SAMPLE SUMMARY

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Lab Control Sample**
Client Project ID: **Sunoco IH Air Testing / 213402094**

CAS Project ID: P1204493
CAS Sample ID: P121103-LCS

Test Code: EPA TO-15
Instrument ID: Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9
Analyst: Wida Ang
Sample Type: 6.0 L Summa Canister
Test Notes:

Date Collected: NA
Date Received: NA
Date Analyzed: 11/03/12
Volume(s) Analyzed: 0.125 Liter(s)

CAS #	**Compound**	Spike Amount µg/m³	**Result µg/m³**	**% Recovery**	CAS Acceptance Limits	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	204	**231**	**113**	67-116	
107-06-2	1,2-Dichloroethane	208	**220**	**106**	70-118	
71-43-2	Benzene	208	**214**	**103**	66-121	
108-88-3	Toluene	208	**211**	**101**	67-111	
106-93-4	1,2-Dibromoethane	208	**228**	**110**	73-122	
100-41-4	Ethylbenzene	206	**217**	**105**	71-117	
179601-23-1	m,p-Xylenes	412	**427**	**104**	70-116	
95-47-6	o-Xylene	200	**212**	**106**	70-116	
98-82-8	Cumene	196	**210**	**107**	70-116	
108-67-8	1,3,5-Trimethylbenzene	208	**230**	**111**	71-121	
95-63-6	1,2,4-Trimethylbenzene	200	**228**	**114**	73-127	

Laboratory Control Sample percent recovery is verified and accepted based on the on-column result.
Reported results are shown in concentration units and as a result of the calculation, may vary slightly.

LABORATORY CONTROL SAMPLE SUMMARY

Page 1 of 1

Client:	**Stantec Consulting Services, Inc.**		
Client Sample ID:	**Lab Control Sample**	CAS Project ID:	P1204493
Client Project ID:	**Sunoco IH Air Testing / 213402094**	CAS Sample ID:	P121105-LCS
Test Code:	EPA TO-15	Date Collected:	NA
Instrument ID:	Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9	Date Received:	NA
Analyst:	Wida Ang	Date Analyzed:	11/05/12
Sample Type:	6.0 L Summa Canister	Volume(s) Analyzed:	0.125 Liter(s)
Test Notes:			

CAS #	**Compound**	Spike Amount µg/m³	**Result µg/m³**	**% Recovery**	CAS Acceptance Limits	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	204	**210**	**103**	67-116	
107-06-2	1,2-Dichloroethane	208	**199**	**96**	70-118	
71-43-2	Benzene	208	**199**	**96**	66-121	
108-88-3	Toluene	208	**191**	**92**	67-111	
106-93-4	1,2-Dibromoethane	208	**211**	**101**	73-122	
100-41-4	Ethylbenzene	206	**205**	**100**	71-117	
179601-23-1	m,p-Xylenes	412	**407**	**99**	70-116	
95-47-6	o-Xylene	200	**202**	**101**	70-116	
98-82-8	Cumene	196	**198**	**101**	70-116	
108-67-8	1,3,5-Trimethylbenzene	208	**216**	**104**	71-121	
95-63-6	1,2,4-Trimethylbenzene	200	**213**	**107**	73-127	

Laboratory Control Sample percent recovery is verified and accepted based on the on-column result.
Reported results are shown in concentration units and as a result of the calculation, may vary slightly.

LABORATORY CONTROL SAMPLE SUMMARY

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Lab Control Sample**
Client Project ID: **Sunoco IH Air Testing / 213402094**

CAS Project ID: P1204493
CAS Sample ID: P121106-LCS

Test Code: EPA TO-15
Instrument ID: Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9
Analyst: Wida Ang
Sample Type: 6.0 L Summa Canister
Test Notes:

Date Collected: NA
Date Received: NA
Date Analyzed: 11/06/12
Volume(s) Analyzed: 0.125 Liter(s)

CAS #	**Compound**	Spike Amount µg/m³	**Result µg/m³**	**% Recovery**	CAS Acceptance Limits	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	204	**221**	**108**	67-116	
107-06-2	1,2-Dichloroethane	208	**209**	**100**	70-118	
71-43-2	Benzene	208	**203**	**98**	66-121	
108-88-3	Toluene	208	**202**	**97**	67-111	
106-93-4	1,2-Dibromoethane	208	**221**	**106**	73-122	
100-41-4	Ethylbenzene	206	**210**	**102**	71-117	
179601-23-1	m,p-Xylenes	412	**416**	**101**	70-116	
95-47-6	o-Xylene	200	**206**	**103**	70-116	
98-82-8	Cumene	196	**206**	**105**	70-116	
108-67-8	1,3,5-Trimethylbenzene	208	**226**	**109**	71-121	
95-63-6	1,2,4-Trimethylbenzene	200	**223**	**112**	73-127	

Laboratory Control Sample percent recovery is verified and accepted based on the on-column result.
Reported results are shown in concentration units and as a result of the calculation, may vary slightly.

LABORATORY DUPLICATE SUMMARY RESULTS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Sample 3**
Client Project ID: **Sunoco IH Air Testing / 213402094**

CAS Project ID: P1204493
CAS Sample ID: P1204493-003DUP

Test Code: EPA TO-15
Instrument ID: Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9
Analyst: Wida Ang
Sample Type: 6.0 L Summa Canister
Test Notes:
Container ID: AC01853

Date Collected: 10/24/12
Date Received: 10/31/12
Date Analyzed: 11/3/12
Volume(s) Analyzed: 1.00 Liter(s)

Initial Pressure (psig): -3.60
Final Pressure (psig): 3.61

Canister Dilution Factor: 1.65

Compound	Sample Result µg/m³	 ppbV	**Duplicate Sample Result** **µg/m³**	 ppbV	Average µg/m³	**% RPD**	RPD Limit	**Data Qualifier**
Methyl tert-Butyl Ether	ND	ND	ND	ND	-	-	25	
1,2-Dichloroethane	ND	ND	ND	ND	-	-	25	
Benzene	2.12	0.663	2.30	0.721	2.21	**8**	25	
Toluene	6.97	1.85	6.97	1.85	6.97	**0**	25	
1,2-Dibromoethane	ND	ND	ND	ND	-	-	25	
Ethylbenzene	1.53	0.352	1.58	0.364	1.555	**3**	25	
m,p-Xylenes	4.03	0.928	4.16	0.957	4.095	**3**	25	
o-Xylene	1.51	0.348	1.54	0.356	1.525	**2**	25	
Cumene	1.02	0.209	1.03	0.210	1.025	**1**	25	
1,3,5-Trimethylbenzene	ND	ND	ND	ND	-	-	25	
1,2,4-Trimethylbenzene	1.73	0.352	1.78	0.362	1.755	**3**	25	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

LABORATORY DUPLICATE SUMMARY RESULTS

Page 1 of 1

Client:	**Stantec Consulting Services, Inc.**		
Client Sample ID:	**Sample 15**	CAS Project ID:	P1204493
Client Project ID:	**Sunoco IH Air Testing / 213402094**	CAS Sample ID:	P1204493-015DUP
Test Code:	EPA TO-15	Date Collected:	10/24/12
Instrument ID:	Tekmar AUTOCAN/Agilent 5973inert/6890N/MS9	Date Received:	10/31/12
Analyst:	Wida Ang	Date Analyzed:	11/5/12
Sample Type:	6.0 L Summa Canister	Volume(s) Analyzed:	1.00 Liter(s)
Test Notes:			
Container ID:	AC00475		

Initial Pressure (psig): -1.47 Final Pressure (psig): 3.55

Canister Dilution Factor: 1.38

Compound	Sample Result µg/m³	Sample Result ppbV	**Duplicate Sample Result µg/m³**	Duplicate Sample Result ppbV	Average µg/m³	**% RPD**	RPD Limit	**Data Qualifier**
Methyl tert-Butyl Ether	ND	ND	ND	ND	-	-	25	
1,2-Dichloroethane	ND	ND	ND	ND	-	-	25	
Benzene	1.95	0.609	2.06	0.645	2.005	**5**	25	
Toluene	6.44	1.71	6.80	1.80	6.62	**5**	25	
1,2-Dibromoethane	ND	ND	ND	ND	-	-	25	
Ethylbenzene	1.21	0.279	1.21	0.279	1.21	**0**	25	
m,p-Xylenes	3.40	0.784	3.41	0.785	3.405	**0.3**	25	
o-Xylene	1.25	0.288	1.28	0.294	1.265	**2**	25	
Cumene	1.01	0.205	1.08	0.220	1.045	**7**	25	
1,3,5-Trimethylbenzene	ND	ND	ND	ND	-	-	25	
1,2,4-Trimethylbenzene	1.24	0.251	1.28	0.261	1.26	**3**	25	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

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LABORATORY REPORT

November 8, 2012

John Reiter
Stantec Consulting Services, Inc.
12075 Corporate Pkwy, Ste. 200
Mequon, WI 53092

RE: Sunoco IH Air Testing / 213402094

Dear John:

Enclosed are the results of the samples submitted to our laboratory on October 31, 2012. For your reference, these analyses have been assigned our service request number P1204494.

All analyses were performed according to our laboratory's NELAP and DoD-ELAP-approved quality assurance program. The test results meet requirements of the current NELAP and DoD-ELAP standards, where applicable, and except as noted in the laboratory case narrative provided. For a specific list of NELAP and DoD-ELAP-accredited analytes, refer to the certifications section at www.caslab.com. Results are intended to be considered in their entirety and apply only to the samples analyzed and reported herein.

Columbia Analytical Services, Inc. dba ALS Environmental (ALS) is certified by the California Department of Health Services, NELAP Laboratory Certificate No. 02115CA; Arizona Department of Health Services, Certificate No. AZ0694; Florida Department of Health, NELAP Certification E871020; New Jersey Department of Environmental Protection, NELAP Laboratory Certification ID #CA009; New York State Department of Health, NELAP NY Lab ID No: 11221; Oregon Environmental Laboratory Accreditation Program, NELAP ID: CA200007; The American Industrial Hygiene Association, Laboratory #101661; United States Department of Defense Environmental Laboratory Accreditation Program (DoD-ELAP), Certificate No. L11-203; Pennsylvania Registration No. 68-03307; TX Commission of Environmental Quality, NELAP ID T104704413-12-3; Minnesota Department of Health, NELAP Certificate No. 362188; Washington State Department of Ecology, ELAP Lab ID: C946, State of Utah Department of Health, NELAP Certificate No. CA01527Z012-Z; Los Angeles Department of Building and Safety, Approval No: TA00001. Each of the certifications listed above have an explicit Scope of Accreditation that applies to specific matrices/methods/analytes; therefore, please contact me for information corresponding to a particular certification.

If you have any questions, please call me at (805) 526-7161.

Respectfully submitted,

ALS | Environmental

Samantha Henningsen
Project Manager

Client: Stantec Consulting Services, Inc. Service Request No: P1204494
Project: Sunoco IH Air Testing / 213402094

CASE NARRATIVE

The samples were received intact under chain of custody on October 31, 2012 and were stored in accordance with the analytical method requirements. Please refer to the sample acceptance check form for additional information. The results reported herein are applicable only to the condition of the samples at the time of sample receipt.

Volatile Organic Compound Analysis

The samples were analyzed for selected volatile organic compounds in accordance with EPA Method TO-15 from the Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition (EPA/625/R-96/010b), January, 1999. The analytical system was comprised of a gas chromatograph / mass spectrometer (GC/MS) interfaced to a whole-air preconcentrator.

The results of analyses are given in the attached laboratory report. All results are intended to be considered in their entirety, and Columbia Analytical Services, Inc. dba ALS Environmental (ALS) is not responsible for utilization of less than the complete report.

Use of Columbia Analytical Services, Inc. dba ALS Environmental (ALS)'s Name. Client shall not use ALS's name or trademark in any marketing or reporting materials, press releases or in any other manner ("Materials") whatsoever and shall not attribute to ALS any test result, tolerance or specification derived from ALS's data ("Attribution") without ALS's prior written consent, which may be withheld by ALS for any reason in its sole discretion. To request ALS's consent, Client shall provide copies of the proposed Materials or Attribution and describe in writing Client's proposed use of such Materials or Attribution. If ALS has not provided written approval of the Materials or Attribution within ten (10) days of receipt from Client, Client's request to use ALS's name or trademark in any Materials or Attribution shall be deemed denied. ALS may, in its discretion, reasonably charge Client for its time in reviewing Materials or Attribution requests. Client acknowledges and agrees that the unauthorized use of ALS's name or trademark may cause ALS to incur irreparable harm for which the recovery of money damages will be inadequate. Accordingly, Client acknowledges and agrees that a violation shall justify preliminary injunctive relief. For questions contact the laboratory.

DETAIL SUMMARY REPORT

Client: Stantec Consulting Services, Inc.
Project ID: Sunoco IH Testing / 213402094

Service Request: P1204494

Date Received: 10/31/2012
Time Received: 09:10

Client Sample ID	Lab Code	Matrix	Date Collected	Time Collected	Container ID	Pi1 (psig)	Pf1 (psig)	TO-15 - VOC Cans
Sample 23	P1204494-001	Air	10/25/2012	12:17	AC01664	-6.14	3.79	X
Sample 25	P1204494-002	Air	10/25/2012	00:00	AC01093	-14.50	3.74	X
Sample 26	P1204494-003	Air	10/25/2012	12:59	AC00540	-3.15	3.59	X
Sample 27	P1204494-004	Air	10/25/2012	13:08	AC01810	-4.85	3.59	X
Sample 28	P1204494-005	Air	10/25/2012	13:10	AC01350	-2.60	3.71	X
Sample 29	P1204494-006	Air	10/25/2012	12:23	AC00716	-0.41	4.20	X
Sample 30	P1204494-007	Air	10/25/2012	12:29	AC00501	-2.50	3.61	X
Sample 31	P1204494-008	Air	10/25/2012	12:34	AC00765	-3.73	3.68	X
Sample 32	P1204494-009	Air	10/25/2012	12:37	AC01403	-5.30	3.76	X
Sample 33	P1204494-010	Air	10/25/2012	12:41	AC01573	-0.55	3.66	X
Sample 34	P1204494-011	Air	10/25/2012	12:44	AC00947	-2.79	3.49	X
Sample 35	P1204494-012	Air	10/25/2012	12:48	AC00033	-2.24	3.50	X
Sample 36	P1204494-013	Air	10/25/2012	12:51	AC01790	-2.23	3.48	X
Sample 37	P1204494-014	Air	10/25/2012	13:00	AC01886	-3.04	3.62	X
Sample 38	P1204494-015	Air	10/25/2012	13:08	AC01487	-2.38	3.62	X
Sample 39	P1204494-016	Air	10/25/2012	13:40	AC01115	-3.59	3.71	X
Sample 40	P1204494-017	Air	10/25/2012	13:43	AC01243	-0.40	3.96	X
Sample 41	P1204494-018	Air	10/25/2012	13:51	AC01218	-3.00	3.67	X
Sample 42	P1204494-019	Air	10/25/2012	13:55	AC01179	-1.52	3.71	X
Sample 43	P1204494-020	Air	10/25/2012	14:00	AC00870	-3.27	3.76	X
Sample 44	P1204494-021	Air	10/25/2012	10:05	AC00993	-14.47	3.72	X

Columbia Analytical Services

2655 Park Center Drive, Suite A
Simi Valley, California 93065
Phone (805) 526-7161
Fax (805) 526-7270

Air - Chain of Custody Record & Analytical Service Request

Page 1 of 2

Requested Turnaround Time in Business Days (Surcharges) please circle
1 Day (100%) 2 Day (75%) 3 Day (50%) 4 Day (35%) 5 Day (25%) 10 Day-Standard

CAS Project No. P1204494

CAS Contact:

Company Name & Address (Reporting Information)
Stantec
12075 Corporate Pky
Mequon, WI 53092

Project Name: Sunoco IH Testing

Project Number: 213402094

Project Manager: John Reiter

P.O. # / Billing Information: John Reiter

Phone: 262-

Fax: 262-241-4901

Email Address for Result Reporting: John.REITER@Stantec.com

Sampler (Print & Sign): Richard Pager Richard Pager

Client Sample ID	Laboratory ID Number	Date Collected	Time Collected	Canister ID (Bar code # - AC, SC, etc.)	Flow Controller ID (Bar code # - FC #)	Canister Start Pressure "Hg	Canister End Pressure "Hg/psig	Sample Volume	Analysis Method		Comments e.g. Actual Preservative or specific instructions
Sample 23	①-6.16	10/25/12	8:17 12:17	AC01664	FCA00422	29.0	11.0				
Sample 25	②-14.45	10/25/12		AC01093	FCA00058	29.5	—		Field		Blank
Sample 26	③-3.18	10/25/12	8:59 12:59	AC00540	FCA00482	29.3	8.5				
Sample 27	④-4.58	10/25/12	9:07 13:07	AC01830	FCA00609	29.4	8.0				
Sample 28	⑤-2.65	10/25/12	9:10 13:10	AC01350	FCA00454	29.5	5.0				
Sample 29	⑥-0.47	10/25/12	8:23 12:23	AC00716	FCA00239	29.5	0.0				
Sample 30	⑦-2.59	10/25/12	8:29 12:29	AC00501	FCA00015	29.5	6.0				
Sample 31	⑧-3.79	10/25/12	8:34 12:34	AC00765	FCA00303	29.5	5.75				
Sample 32	⑨-5.62	10/25/12	8:37 12:37	AC01403	FCA00432	29.5	10.0				
Sample 33	⑩-0.55	10/25/12	8:41 12:41	AC01573	FCA00449	29.5	3.0				
Sample 34	⑪-2.76	10/25/12	8:44 12:44	AC00947	FCA00632	29.5	5.0				
Sample 35	⑫-2.27	10/25/12	8:48 12:48	AC00933	FCA00473	29.5	4.0				
Sample 36	⑬-2.23	10/25/12	8:51 12:51	AC01790	FCA00538	29.5	3.5				
Sample 37	⑭-3.07	10/25/12	9:00 13:00	AC01886	FCA00225	29.5	5.0				

Report Tier Levels - please select

Tier I - Results (Default if not specified) ____
Tier II (Results + QC Summaries) ____
Tier III (Results + QC & Calibration Summaries) ____
Tier IV (Data Validation Package) 10% Surcharge ____

EDD required Yes / No
Type: ____________

Project Requirements (MRLs, QAPP)

Relinquished by: (Signature) Richard Pager Date: 10:25 Time: 15:09 Received by: (Signature) Date: Time: 0910

Relinquished by: (Signature) Date: Time: Received by: (Signature) Date: Time:

Cooler / Blank Temperature ____°C

Columbia Analytical Services

2655 Park Center Drive, Suite A
Simi Valley, California 93065
Phone (805) 526-7161
Fax (805) 526-7270

Air - Chain of Custody Record & Analytical Service Request

Page 2 of 2

Requested Turnaround Time in Business Days (Surcharges) please circle
1 Day (100%) 2 Day (75%) 3 Day (50%) 4 Day (35%) 5 Day (25%) 10 Day-Standard

CAS Project No. P1204494

CAS Contact:

Company Name & Address (Reporting Information)

Project Name

Project Number

Project Manager

P.O. # / Billing Information

Phone

Fax

Email Address for Result Reporting

Sampler (Print & Sign) Richard Pager Richard Pager

Client Sample ID	Laboratory ID Number	Date Collected	Time Collected	Canister ID (Bar code # - AC, SC, etc.)	Flow Controller ID (Bar code #- FC #)	Canister Start Pressure "Hg	Canister End Pressure "Hg/psig	Sample Volume	Analysis Method		Comments e.g. Actual Preservative or specific instructions
Sample 38	⑮-236	10/25/12	9:08 13:08	AC01487	FCA00418	29.5	4.5				
Sample 39	⑯-356	10/25/12	9:40 13:40	AC01115	FCA00503	29.6	6.5				
Sample 40	⑰-0.40	10/25/12	9:43 13:43	AC01243	FCA00603	29.4	2.0				
Sample 41	⑱-300	10/25/12	9:51 13:51	AC01218	FCA00405	29.6	9.0				
Sample 42	⑲-155	10/25/12	9:55 13:55	AC01179	FCA00040	29.6	4.75				
Sample 43	⑳-3.31	10/25/12	10:00 14:00	AC00870	FCA00215	29.5	6.0				
Sample 44	㉑-14.0	10/25/12	10:05	AC00993	FCA00619	29.5	~~FRTP~~		Blank		
	-19.41(3)						Field				

Report Tier Levels - please select
Tier I - Results (Default if not specified) ____
Tier II (Results + QC Summaries) ____
Tier III (Results + QC & Calibration Summaries) ____
Tier IV (Data Validation Package) 10% Surcharge ____

EDD required Yes / No
Type: ____

Project Requirements (MRLs, QAPP)

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Date:	Time:
Richard Pager	10/25	15:09		10/31/12	0910
Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Date:	Time:

Cooler / Blank Temperature ____ °C

Sample Acceptance Check Form

Client: Stantec Consulting Services, Inc. Work order: P1204494
Project: Sunoco IH Testing / 213402094
Sample(s) received on: 10/31/12 Date opened: 10/31/12 by: MZAMORA

Note: This form is used for all samples received by CAS. The use of this form for custody seals is strictly meant to indicate presence/absence and not as an indication of compliance or nonconformity. Thermal preservation and pH will only be evaluated either at the request of the client and/or as required by the method/SOP.

		Yes	No	N/A
1	Were **sample containers** properly marked with client sample ID?	☐	☒	☐
2	Container(s) **supplied by CAS**?	☒	☐	☐
3	Did **sample containers** arrive in good condition?	☒	☐	☐
4	Were **chain-of-custody** papers used and filled out?	☒	☐	☐
5	Did **sample container labels** and/or tags agree with custody papers?	☐	☒	☐
6	Was **sample volume** received adequate for analysis?	☒	☐	☐
7	Are samples within specified holding times?	☒	☐	☐
8	Was proper **temperature** (thermal preservation) of cooler at receipt adhered to?	☐	☐	☒
9	Was a **trip blank** received?	☐	☒	☐
10	Were **custody seals** on outside of cooler/Box?	☐	☒	☐
	Location of seal(s)? ____________ Sealing Lid?	☐	☐	☒
	Were signature and date included?	☐	☐	☒
	Were seals intact?	☐	☐	☒
	Were custody seals on outside of sample container?	☐	☒	☐
	Location of seal(s)? ____________ Sealing Lid?	☐	☐	☒
	Were signature and date included?	☐	☐	☒
	Were seals intact?	☐	☐	☒
11	Do containers have appropriate **preservation**, according to method/SOP or Client specified information?	☐	☐	☒
	Is there a client indication that the submitted samples are **pH** preserved?	☐	☐	☒
	Were **VOA vials** checked for presence/absence of air bubbles?	☐	☐	☒
	Does the client/method/SOP require that the analyst check the sample pH and if necessary alter it?	☐	☐	☒
12	**Tubes:** Are the tubes capped and intact?	☐	☐	☒
	Do they contain moisture?	☐	☐	☒
13	**Badges:** Are the badges properly capped and intact?	☐	☐	☒
	Are dual bed badges separated and individually capped and intact?	☐	☐	☒

Lab Sample ID	Container Description	Required pH *	Received pH	Adjusted pH	VOA Headspace (Presence/Absence)	Receipt / Preservation Comments
P1204494-001.01	6.0 L Ambient Can					
P1204494-002.01	6.0 L Ambient Can					
P1204494-003.01	6.0 L Ambient Can					
P1204494-004.01	6.0 L Ambient Can					
P1204494-005.01	6.0 L Ambient Can					
P1204494-006.01	6.0 L Ambient Can					
P1204494-007.01	6.0 L Ambient Can					
P1204494-008.01	6.0 L Ambient Can					

Explain any discrepancies: (include lab sample ID numbers):

Sample -002 has an ID of "Sample 25" on the COC, and "Sample 28" on the canister tag.

Sample -004 has canister SN AC01830, we received canister AC01810.

Sample -018 has an ID of "Sample 41" on the COC, and "Sample 40" on the canister tag.

RSK - MEEPP, HCL (pH<2); RSK - CO2, (pH 5-8); Sulfur (pH>4)

Sample Acceptance Check Form

Client: Stantec Consulting Services, Inc.
Work order: P1204494
Project: Sunoco IH Testing / 213402094
Sample(s) received on: 10/31/12
Date opened: 10/31/12
by: MZAMORA

Lab Sample ID	Container Description	Required pH *	Received pH	Adjusted pH	VOA Headspace (Presence/Absence)	Receipt / Preservation Comments
P1204494-009.01	6.0 L Ambient Can					
P1204494-010.01	6.0 L Ambient Can					
P1204494-011.01	6.0 L Ambient Can					
P1204494-012.01	6.0 L Ambient Can					
P1204494-013.01	6.0 L Ambient Can					
P1204494-014.01	6.0 L Ambient Can					
P1204494-015.01	6.0 L Ambient Can					
P1204494-016.01	6.0 L Ambient Can					
P1204494-017.01	6.0 L Ambient Can					
P1204494-018.01	6.0 L Ambient Can					
P1204494-019.01	6.0 L Ambient Can					
P1204494-020.01	6.0 L Ambient Can					
P1204494-021.01	6.0 L Ambient Can					

Explain any discrepancies: (include lab sample ID numbers):

RSK - MEEPP, HCL (pH<2); RSK - CO2, (pH 5-8); Sulfur (pH>4)

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Sample 23**
Client Project ID: **Sunoco IH Testing / 213402094**

CAS Project ID: P1204494
CAS Sample ID: P1204494-001

Test Code: EPA TO-15
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16
Analyst: Lusine Hakobyan
Sample Type: 6.0 L Summa Canister
Test Notes:
Container ID: AC01664

Date Collected: 10/25/12
Date Received: 10/31/12
Date Analyzed: 11/2/12
Volume(s) Analyzed: 1.00 Liter(s)

Initial Pressure (psig): -6.14 Final Pressure (psig): 3.79

Canister Dilution Factor: 2.16

CAS #	**Compound**	**Result** **μg/m³**	MRL μg/m³	**Result** **ppbV**	MRL ppbV	**Data** **Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	1.1	ND	0.30	
107-06-2	1,2-Dichloroethane	ND	1.1	ND	0.27	
71-43-2	Benzene	ND	1.1	ND	0.34	
108-88-3	Toluene	**3.8**	1.1	**1.0**	0.29	
106-93-4	1,2-Dibromoethane	ND	1.1	ND	0.14	
100-41-4	Ethylbenzene	ND	1.1	ND	0.25	
179601-23-1	m,p-Xylenes	ND	2.2	ND	0.50	
95-47-6	o-Xylene	ND	1.1	ND	0.25	
98-82-8	Cumene	ND	1.1	ND	0.22	
108-67-8	1,3,5-Trimethylbenzene	ND	1.1	ND	0.22	
95-63-6	1,2,4-Trimethylbenzene	ND	1.1	ND	0.22	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client:	**Stantec Consulting Services, Inc.**		
Client Sample ID:	**Sample 25**	CAS Project ID:	P1204494
Client Project ID:	**Sunoco IH Testing / 213402094**	CAS Sample ID:	P1204494-002
Test Code:	EPA TO-15	Date Collected:	10/25/12
Instrument ID:	Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16	Date Received:	10/31/12
Analyst:	Lusine Hakobyan	Date Analyzed:	11/2/12
Sample Type:	6.0 L Summa Canister	Volume(s) Analyzed:	1.00 Liter(s)
Test Notes:			
Container ID:	AC01093		

Canister Dilution Factor: 1.00

CAS #	Compound	Result µg/m³	MRL µg/m³	Result ppbV	MRL ppbV	Data Qualifier
1634-04-4	Methyl tert-Butyl Ether	ND	0.50	ND	0.14	
107-06-2	1,2-Dichloroethane	ND	0.50	ND	0.12	
71-43-2	Benzene	ND	0.50	ND	0.16	
108-88-3	Toluene	ND	0.50	ND	0.13	
106-93-4	1,2-Dibromoethane	ND	0.50	ND	0.065	
100-41-4	Ethylbenzene	ND	0.50	ND	0.12	
179601-23-1	m,p-Xylenes	ND	1.0	ND	0.23	
95-47-6	o-Xylene	ND	0.50	ND	0.12	
98-82-8	Cumene	ND	0.50	ND	0.10	
108-67-8	1,3,5-Trimethylbenzene	ND	0.50	ND	0.10	
95-63-6	1,2,4-Trimethylbenzene	ND	0.50	ND	0.10	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Sample 26** CAS Project ID: P1204494
Client Project ID: **Sunoco IH Testing / 213402094** CAS Sample ID: P1204494-003

Test Code: EPA TO-15 Date Collected: 10/25/12
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16 Date Received: 10/31/12
Analyst: Lusine Hakobyan Date Analyzed: 11/2/12
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 1.00 Liter(s)
Test Notes:
Container ID: AC00540

Initial Pressure (psig): -3.15 Final Pressure (psig): 3.59

Canister Dilution Factor: 1.58

CAS #	**Compound**	**Result** **µg/m³**	MRL µg/m³	**Result** **ppbV**	MRL ppbV	**Data** **Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.79	ND	0.22	
107-06-2	1,2-Dichloroethane	ND	0.79	ND	0.20	
71-43-2	Benzene	**2.1**	0.79	**0.67**	0.25	
108-88-3	Toluene	**4.0**	0.79	**1.1**	0.21	
106-93-4	1,2-Dibromoethane	ND	0.79	ND	0.10	
100-41-4	Ethylbenzene	**0.99**	0.79	**0.23**	0.18	
179601-23-1	m,p-Xylenes	**3.8**	1.6	**0.87**	0.36	
95-47-6	o-Xylene	**1.3**	0.79	**0.31**	0.18	
98-82-8	Cumene	**1.1**	0.79	**0.22**	0.16	
108-67-8	1,3,5-Trimethylbenzene	ND	0.79	ND	0.16	
95-63-6	1,2,4-Trimethylbenzene	**1.4**	0.79	**0.29**	0.16	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client:	**Stantec Consulting Services, Inc.**		
Client Sample ID:	**Sample 27**	CAS Project ID:	P1204494
Client Project ID:	**Sunoco IH Testing / 213402094**	CAS Sample ID:	P1204494-004
Test Code:	EPA TO-15	Date Collected:	10/25/12
Instrument ID:	Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16	Date Received:	10/31/12
Analyst:	Lusine Hakobyan	Date Analyzed:	11/2/12
Sample Type:	6.0 L Summa Canister	Volume(s) Analyzed:	1.00 Liter(s)
Test Notes:			
Container ID:	AC01810		

Initial Pressure (psig): -4.85 Final Pressure (psig): 3.59

Canister Dilution Factor: 1.86

CAS #	**Compound**	**Result** **µg/m³**	MRL µg/m³	**Result** **ppbV**	MRL ppbV	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.93	ND	0.26	
107-06-2	1,2-Dichloroethane	ND	0.93	ND	0.23	
71-43-2	Benzene	**2.3**	0.93	**0.71**	0.29	
108-88-3	Toluene	**3.6**	0.93	**0.96**	0.25	
106-93-4	1,2-Dibromoethane	ND	0.93	ND	0.12	
100-41-4	Ethylbenzene	ND	0.93	ND	0.21	
179601-23-1	m,p-Xylenes	**3.0**	1.9	**0.69**	0.43	
95-47-6	o-Xylene	**1.1**	0.93	**0.26**	0.21	
98-82-8	Cumene	ND	0.93	ND	0.19	
108-67-8	1,3,5-Trimethylbenzene	ND	0.93	ND	0.19	
95-63-6	1,2,4-Trimethylbenzene	ND	0.93	ND	0.19	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Sample 28**
Client Project ID: **Sunoco IH Testing / 213402094**

CAS Project ID: P1204494
CAS Sample ID: P1204494-005

Test Code: EPA TO-15
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16
Analyst: Lusine Hakobyan
Sample Type: 6.0 L Summa Canister
Test Notes:
Container ID: AC01350

Date Collected: 10/25/12
Date Received: 10/31/12
Date Analyzed: 11/2/12
Volume(s) Analyzed: 1.00 Liter(s)

Initial Pressure (psig): -2.60 Final Pressure (psig): 3.71

Canister Dilution Factor: 1.52

CAS #	**Compound**	**Result** **µg/m³**	MRL µg/m³	**Result** **ppbV**	MRL ppbV	**Data** **Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.76	ND	0.21	
107-06-2	1,2-Dichloroethane	ND	0.76	ND	0.19	
71-43-2	Benzene	**2.3**	0.76	**0.70**	0.24	
108-88-3	Toluene	**2.0**	0.76	**0.54**	0.20	
106-93-4	1,2-Dibromoethane	ND	0.76	ND	0.099	
100-41-4	Ethylbenzene	ND	0.76	ND	0.18	
179601-23-1	m,p-Xylenes	ND	1.5	ND	0.35	
95-47-6	o-Xylene	ND	0.76	ND	0.18	
98-82-8	Cumene	ND	0.76	ND	0.15	
108-67-8	1,3,5-Trimethylbenzene	ND	0.76	ND	0.15	
95-63-6	1,2,4-Trimethylbenzene	ND	0.76	ND	0.15	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client:	**Stantec Consulting Services, Inc.**		
Client Sample ID:	**Sample 29**	CAS Project ID:	P1204494
Client Project ID:	**Sunoco IH Testing / 213402094**	CAS Sample ID:	P1204494-006
Test Code:	EPA TO-15	Date Collected:	10/25/12
Instrument ID:	Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16	Date Received:	10/31/12
Analyst:	Lusine Hakobyan	Date Analyzed:	11/2/12
Sample Type:	6.0 L Summa Canister	Volume(s) Analyzed:	1.00 Liter(s)
Test Notes:			
Container ID:	AC00716		

Initial Pressure (psig): -0.41 Final Pressure (psig): 4.20

Canister Dilution Factor: 1.32

CAS #	Compound	Result µg/m³	MRL µg/m³	Result ppbV	MRL ppbV	Data Qualifier
1634-04-4	Methyl tert-Butyl Ether	ND	0.66	ND	0.18	
107-06-2	1,2-Dichloroethane	ND	0.66	ND	0.16	
71-43-2	Benzene	**1.6**	0.66	**0.50**	0.21	
108-88-3	Toluene	**6.5**	0.66	**1.7**	0.18	
106-93-4	1,2-Dibromoethane	ND	0.66	ND	0.086	
100-41-4	Ethylbenzene	**0.95**	0.66	**0.22**	0.15	
179601-23-1	m,p-Xylenes	**3.3**	1.3	**0.76**	0.30	
95-47-6	o-Xylene	**1.1**	0.66	**0.25**	0.15	
98-82-8	Cumene	ND	0.66	ND	0.13	
108-67-8	1,3,5-Trimethylbenzene	ND	0.66	ND	0.13	
95-63-6	1,2,4-Trimethylbenzene	**0.99**	0.66	**0.20**	0.13	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client:	**Stantec Consulting Services, Inc.**		
Client Sample ID:	**Sample 30**	CAS Project ID:	P1204494
Client Project ID:	**Sunoco IH Testing / 213402094**	CAS Sample ID:	P1204494-007

Test Code: EPA TO-15
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16
Analyst: Lusine Hakobyan
Sample Type: 6.0 L Summa Canister
Test Notes:
Container ID: AC00501

Date Collected: 10/25/12
Date Received: 10/31/12
Date Analyzed: 11/2/12
Volume(s) Analyzed: 1.00 Liter(s)

Initial Pressure (psig): -2.50 Final Pressure (psig): 3.61

Canister Dilution Factor: 1.50

CAS #	Compound	Result µg/m³	MRL µg/m³	Result ppbV	MRL ppbV	Data Qualifier
1634-04-4	Methyl tert-Butyl Ether	ND	0.75	ND	0.21	
107-06-2	1,2-Dichloroethane	ND	0.75	ND	0.19	
71-43-2	Benzene	**1.2**	0.75	**0.36**	0.23	
108-88-3	Toluene	**4.4**	0.75	**1.2**	0.20	
106-93-4	1,2-Dibromoethane	ND	0.75	ND	0.098	
100-41-4	Ethylbenzene	ND	0.75	ND	0.17	
179601-23-1	m,p-Xylenes	**2.3**	1.5	**0.53**	0.35	
95-47-6	o-Xylene	**0.87**	0.75	**0.20**	0.17	
98-82-8	Cumene	ND	0.75	ND	0.15	
108-67-8	1,3,5-Trimethylbenzene	ND	0.75	ND	0.15	
95-63-6	1,2,4-Trimethylbenzene	**1.1**	0.75	**0.23**	0.15	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Sample 31**
Client Project ID: **Sunoco IH Testing / 213402094**
CAS Project ID: P1204494
CAS Sample ID: P1204494-008

Test Code: EPA TO-15
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16
Analyst: Lusine Hakobyan
Sample Type: 6.0 L Summa Canister
Test Notes:
Container ID: AC00765

Date Collected: 10/25/12
Date Received: 10/31/12
Date Analyzed: 11/2/12
Volume(s) Analyzed: 1.00 Liter(s)

Initial Pressure (psig): -3.73 Final Pressure (psig): 3.68

Canister Dilution Factor: 1.68

CAS #	**Compound**	**Result** **µg/m³**	MRL µg/m³	**Result** **ppbV**	MRL ppbV	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.84	ND	0.23	
107-06-2	1,2-Dichloroethane	ND	0.84	ND	0.21	
71-43-2	Benzene	**1.3**	0.84	**0.41**	0.26	
108-88-3	Toluene	**4.8**	0.84	**1.3**	0.22	
106-93-4	1,2-Dibromoethane	ND	0.84	ND	0.11	
100-41-4	Ethylbenzene	ND	0.84	ND	0.19	
179601-23-1	m,p-Xylenes	**2.5**	1.7	**0.57**	0.39	
95-47-6	o-Xylene	**0.91**	0.84	**0.21**	0.19	
98-82-8	Cumene	ND	0.84	ND	0.17	
108-67-8	1,3,5-Trimethylbenzene	ND	0.84	ND	0.17	
95-63-6	1,2,4-Trimethylbenzene	**0.94**	0.84	**0.19**	0.17	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Sample 32**
Client Project ID: **Sunoco IH Testing / 213402094**

CAS Project ID: P1204494
CAS Sample ID: P1204494-009

Test Code: EPA TO-15
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16
Analyst: Lusine Hakobyan
Sample Type: 6.0 L Summa Canister
Test Notes:
Container ID: AC01403

Date Collected: 10/25/12
Date Received: 10/31/12
Date Analyzed: 11/2/12
Volume(s) Analyzed: 1.00 Liter(s)

Initial Pressure (psig): -5.30 Final Pressure (psig): 3.76

Canister Dilution Factor: 1.96

CAS #	**Compound**	**Result** µg/m³	MRL µg/m³	**Result** ppbV	MRL ppbV	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.98	ND	0.27	
107-06-2	1,2-Dichloroethane	ND	0.98	ND	0.24	
71-43-2	Benzene	**1.3**	0.98	**0.41**	0.31	
108-88-3	Toluene	**5.2**	0.98	**1.4**	0.26	
106-93-4	1,2-Dibromoethane	ND	0.98	ND	0.13	
100-41-4	Ethylbenzene	ND	0.98	ND	0.23	
179601-23-1	m,p-Xylenes	**2.5**	2.0	**0.58**	0.45	
95-47-6	o-Xylene	ND	0.98	ND	0.23	
98-82-8	Cumene	ND	0.98	ND	0.20	
108-67-8	1,3,5-Trimethylbenzene	ND	0.98	ND	0.20	
95-63-6	1,2,4-Trimethylbenzene	ND	0.98	ND	0.20	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client:	**Stantec Consulting Services, Inc.**		
Client Sample ID:	**Sample 33**	CAS Project ID:	P1204494
Client Project ID:	**Sunoco IH Testing / 213402094**	CAS Sample ID:	P1204494-010
Test Code:	EPA TO-15	Date Collected:	10/25/12
Instrument ID:	Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16	Date Received:	10/31/12
Analyst:	Lusine Hakobyan	Date Analyzed:	11/2/12
Sample Type:	6.0 L Summa Canister	Volume(s) Analyzed:	1.00 Liter(s)
Test Notes:			
Container ID:	AC01573		

Initial Pressure (psig): -0.55 Final Pressure (psig): 3.66

Canister Dilution Factor: 1.30

CAS #	**Compound**	**Result** **µg/m³**	MRL µg/m³	**Result** **ppbV**	MRL ppbV	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.65	ND	0.18	
107-06-2	1,2-Dichloroethane	ND	0.65	ND	0.16	
71-43-2	Benzene	**1.4**	0.65	**0.45**	0.20	
108-88-3	Toluene	**5.0**	0.65	**1.3**	0.17	
106-93-4	1,2-Dibromoethane	ND	0.65	ND	0.085	
100-41-4	Ethylbenzene	**0.93**	0.65	**0.21**	0.15	
179601-23-1	m,p-Xylenes	**3.5**	1.3	**0.81**	0.30	
95-47-6	o-Xylene	**1.1**	0.65	**0.26**	0.15	
98-82-8	Cumene	ND	0.65	ND	0.13	
108-67-8	1,3,5-Trimethylbenzene	ND	0.65	ND	0.13	
95-63-6	1,2,4-Trimethylbenzene	**0.97**	0.65	**0.20**	0.13	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Sample 34** CAS Project ID: P1204494
Client Project ID: **Sunoco IH Testing / 213402094** CAS Sample ID: P1204494-011

Test Code: EPA TO-15 Date Collected: 10/25/12
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16 Date Received: 10/31/12
Analyst: Lusine Hakobyan Date Analyzed: 11/3/12
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 1.00 Liter(s)
Test Notes:
Container ID: AC00947

Initial Pressure (psig): -2.79 Final Pressure (psig): 3.49

Canister Dilution Factor: 1.53

CAS #	**Compound**	**Result µg/m³**	MRL µg/m³	**Result ppbV**	MRL ppbV	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.77	ND	0.21	
107-06-2	1,2-Dichloroethane	ND	0.77	ND	0.19	
71-43-2	Benzene	**1.3**	0.77	**0.41**	0.24	
108-88-3	Toluene	**4.9**	0.77	**1.3**	0.20	
106-93-4	1,2-Dibromoethane	ND	0.77	ND	0.10	
100-41-4	Ethylbenzene	**0.89**	0.77	**0.21**	0.18	
179601-23-1	m,p-Xylenes	**3.3**	1.5	**0.75**	0.35	
95-47-6	o-Xylene	**1.3**	0.77	**0.30**	0.18	
98-82-8	Cumene	ND	0.77	ND	0.16	
108-67-8	1,3,5-Trimethylbenzene	ND	0.77	ND	0.16	
95-63-6	1,2,4-Trimethylbenzene	**1.1**	0.77	**0.23**	0.16	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Sample 35** CAS Project ID: P1204494
Client Project ID: **Sunoco IH Testing / 213402094** CAS Sample ID: P1204494-012

Test Code: EPA TO-15 Date Collected: 10/25/12
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16 Date Received: 10/31/12
Analyst: Lusine Hakobyan Date Analyzed: 11/3/12
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 1.00 Liter(s)
Test Notes:
Container ID: AC00033

Initial Pressure (psig): -2.24 Final Pressure (psig): 3.50

Canister Dilution Factor: 1.46

CAS #	**Compound**	**Result** **µg/m³**	MRL µg/m³	**Result** **ppbV**	MRL ppbV	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.73	ND	0.20	
107-06-2	1,2-Dichloroethane	ND	0.73	ND	0.18	
71-43-2	Benzene	**1.2**	0.73	**0.39**	0.23	
108-88-3	Toluene	**5.9**	0.73	**1.6**	0.19	
106-93-4	1,2-Dibromoethane	ND	0.73	ND	0.095	
100-41-4	Ethylbenzene	**1.0**	0.73	**0.24**	0.17	
179601-23-1	m,p-Xylenes	**3.7**	1.5	**0.84**	0.34	
95-47-6	o-Xylene	**1.4**	0.73	**0.31**	0.17	
98-82-8	Cumene	ND	0.73	ND	0.15	
108-67-8	1,3,5-Trimethylbenzene	ND	0.73	ND	0.15	
95-63-6	1,2,4-Trimethylbenzene	**0.95**	0.73	**0.19**	0.15	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Sample 36** CAS Project ID: P1204494
Client Project ID: **Sunoco IH Testing / 213402094** CAS Sample ID: P1204494-013

Test Code: EPA TO-15 Date Collected: 10/25/12
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16 Date Received: 10/31/12
Analyst: Lusine Hakobyan Date Analyzed: 11/5/12
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 1.00 Liter(s)
Test Notes:
Container ID: AC01790

Initial Pressure (psig): -2.23 Final Pressure (psig): 3.48

Canister Dilution Factor: 1.46

CAS #	Compound	Result µg/m³	MRL µg/m³	Result ppbV	MRL ppbV	Data Qualifier
1634-04-4	Methyl tert-Butyl Ether	ND	0.73	ND	0.20	
107-06-2	1,2-Dichloroethane	ND	0.73	ND	0.18	
71-43-2	Benzene	**0.94**	0.73	**0.29**	0.23	
108-88-3	Toluene	**4.0**	0.73	**1.1**	0.19	
106-93-4	1,2-Dibromoethane	ND	0.73	ND	0.095	
100-41-4	Ethylbenzene	**0.74**	0.73	**0.17**	0.17	
179601-23-1	m,p-Xylenes	**2.5**	1.5	**0.59**	0.34	
95-47-6	o-Xylene	**0.97**	0.73	**0.22**	0.17	
98-82-8	Cumene	ND	0.73	ND	0.15	
108-67-8	1,3,5-Trimethylbenzene	ND	0.73	ND	0.15	
95-63-6	1,2,4-Trimethylbenzene	**0.78**	0.73	**0.16**	0.15	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Sample 37**
Client Project ID: **Sunoco IH Testing / 213402094**

CAS Project ID: P1204494
CAS Sample ID: P1204494-014

Test Code: EPA TO-15
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16
Analyst: Lusine Hakobyan
Sample Type: 6.0 L Summa Canister
Test Notes:
Container ID: AC01886

Date Collected: 10/25/12
Date Received: 10/31/12
Date Analyzed: 11/5/12
Volume(s) Analyzed: 1.00 Liter(s)

Initial Pressure (psig): -3.04 Final Pressure (psig): 3.62

Canister Dilution Factor: 1.57

CAS #	**Compound**	**Result** µg/m³	MRL µg/m³	**Result** ppbV	MRL ppbV	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.79	ND	0.22	
107-06-2	1,2-Dichloroethane	ND	0.79	ND	0.19	
71-43-2	Benzene	**11**	0.79	**3.6**	0.25	
108-88-3	Toluene	**88**	0.79	**23**	0.21	
106-93-4	1,2-Dibromoethane	ND	0.79	ND	0.10	
100-41-4	Ethylbenzene	**11**	0.79	**2.5**	0.18	
179601-23-1	m,p-Xylenes	**42**	1.6	**9.7**	0.36	
95-47-6	o-Xylene	**9.1**	0.79	**2.1**	0.18	
98-82-8	Cumene	**1.3**	0.79	**0.26**	0.16	
108-67-8	1,3,5-Trimethylbenzene	**1.4**	0.79	**0.28**	0.16	
95-63-6	1,2,4-Trimethylbenzene	**3.9**	0.79	**0.79**	0.16	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client:	**Stantec Consulting Services, Inc.**		
Client Sample ID:	**Sample 38**	CAS Project ID:	P1204494
Client Project ID:	**Sunoco IH Testing / 213402094**	CAS Sample ID:	P1204494-015
Test Code:	EPA TO-15	Date Collected:	10/25/12
Instrument ID:	Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16	Date Received:	10/31/12
Analyst:	Lusine Hakobyan	Date Analyzed:	11/5/12
Sample Type:	6.0 L Summa Canister	Volume(s) Analyzed:	1.00 Liter(s)
Test Notes:			0.10 Liter(s)
Container ID:	AC01487		

Initial Pressure (psig): -2.38 Final Pressure (psig): 3.62

Canister Dilution Factor: 1.49

CAS #	**Compound**	**Result µg/m³**	MRL µg/m³	**Result ppbV**	MRL ppbV	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.75	ND	0.21	
107-06-2	1,2-Dichloroethane	ND	0.75	ND	0.18	
71-43-2	Benzene	**8.4**	0.75	**2.6**	0.23	
108-88-3	Toluene	**330**	7.5	**87**	2.0	**D**
106-93-4	1,2-Dibromoethane	ND	0.75	ND	0.097	
100-41-4	Ethylbenzene	**6.0**	0.75	**1.4**	0.17	
179601-23-1	m,p-Xylenes	**24**	1.5	**5.5**	0.34	
95-47-6	o-Xylene	**7.6**	0.75	**1.8**	0.17	
98-82-8	Cumene	**2.6**	0.75	**0.52**	0.15	
108-67-8	1,3,5-Trimethylbenzene	**3.9**	0.75	**0.80**	0.15	
95-63-6	1,2,4-Trimethylbenzene	**11**	0.75	**2.2**	0.15	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.
D = The reported result is from a dilution.

RESULTS OF ANALYSIS

Page 1 of 1

Client:	**Stantec Consulting Services, Inc.**		
Client Sample ID:	**Sample 39**	CAS Project ID:	P1204494
Client Project ID:	**Sunoco IH Testing / 213402094**	CAS Sample ID:	P1204494-016
Test Code:	EPA TO-15	Date Collected:	10/25/12
Instrument ID:	Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16	Date Received:	10/31/12
Analyst:	Lusine Hakobyan	Date Analyzed:	11/5/12
Sample Type:	6.0 L Summa Canister	Volume(s) Analyzed:	1.00 Liter(s)
Test Notes:			
Container ID:	AC01115		

Initial Pressure (psig): -3.59 Final Pressure (psig): 3.71

Canister Dilution Factor: 1.66

CAS #	**Compound**	**Result** **µg/m³**	MRL µg/m³	**Result** **ppbV**	MRL ppbV	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	**0.96**	0.83	**0.27**	0.23	
107-06-2	1,2-Dichloroethane	ND	0.83	ND	0.21	
71-43-2	Benzene	**1.4**	0.83	**0.45**	0.26	
108-88-3	Toluene	**6.4**	0.83	**1.7**	0.22	
106-93-4	1,2-Dibromoethane	ND	0.83	ND	0.11	
100-41-4	Ethylbenzene	**1.1**	0.83	**0.25**	0.19	
179601-23-1	m,p-Xylenes	**3.9**	1.7	**0.89**	0.38	
95-47-6	o-Xylene	**1.4**	0.83	**0.32**	0.19	
98-82-8	Cumene	ND	0.83	ND	0.17	
108-67-8	1,3,5-Trimethylbenzene	ND	0.83	ND	0.17	
95-63-6	1,2,4-Trimethylbenzene	**1.1**	0.83	**0.23**	0.17	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client:	**Stantec Consulting Services, Inc.**		
Client Sample ID:	**Sample 40**	CAS Project ID:	P1204494
Client Project ID:	**Sunoco IH Testing / 213402094**	CAS Sample ID:	P1204494-017
Test Code:	EPA TO-15	Date Collected:	10/25/12
Instrument ID:	Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16	Date Received:	10/31/12
Analyst:	Lusine Hakobyan	Date Analyzed:	11/5/12
Sample Type:	6.0 L Summa Canister	Volume(s) Analyzed:	1.00 Liter(s)
Test Notes:			
Container ID:	AC01243		

Initial Pressure (psig): -0.40 Final Pressure (psig): 3.96

Canister Dilution Factor: 1.30

CAS #	Compound	Result µg/m³	MRL µg/m³	Result ppbV	MRL ppbV	Data Qualifier
1634-04-4	Methyl tert-Butyl Ether	**1.6**	0.65	**0.43**	0.18	
107-06-2	1,2-Dichloroethane	ND	0.65	ND	0.16	
71-43-2	Benzene	**2.0**	0.65	**0.64**	0.20	
108-88-3	Toluene	**8.8**	0.65	**2.3**	0.17	
106-93-4	1,2-Dibromoethane	ND	0.65	ND	0.085	
100-41-4	Ethylbenzene	**1.4**	0.65	**0.33**	0.15	
179601-23-1	m,p-Xylenes	**5.4**	1.3	**1.2**	0.30	
95-47-6	o-Xylene	**1.8**	0.65	**0.42**	0.15	
98-82-8	Cumene	ND	0.65	ND	0.13	
108-67-8	1,3,5-Trimethylbenzene	ND	0.65	ND	0.13	
95-63-6	1,2,4-Trimethylbenzene	**1.5**	0.65	**0.31**	0.13	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Sample 41** CAS Project ID: P1204494
Client Project ID: **Sunoco IH Testing / 213402094** CAS Sample ID: P1204494-018

Test Code: EPA TO-15 Date Collected: 10/25/12
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16 Date Received: 10/31/12
Analyst: Lusine Hakobyan Date Analyzed: 11/5/12
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 1.00 Liter(s)
Test Notes:
Container ID: AC01218

Initial Pressure (psig): -3.00 Final Pressure (psig): 3.67

Canister Dilution Factor: 1.57

CAS #	**Compound**	**Result** **µg/m³**	MRL µg/m³	**Result** **ppbV**	MRL ppbV	**Data** **Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.79	ND	0.22	
107-06-2	1,2-Dichloroethane	ND	0.79	ND	0.19	
71-43-2	Benzene	**1.8**	0.79	**0.55**	0.25	
108-88-3	Toluene	**9.0**	0.79	**2.4**	0.21	
106-93-4	1,2-Dibromoethane	ND	0.79	ND	0.10	
100-41-4	Ethylbenzene	**1.3**	0.79	**0.31**	0.18	
179601-23-1	m,p-Xylenes	**5.2**	1.6	**1.2**	0.36	
95-47-6	o-Xylene	**1.9**	0.79	**0.44**	0.18	
98-82-8	Cumene	ND	0.79	ND	0.16	
108-67-8	1,3,5-Trimethylbenzene	**1.1**	0.79	**0.22**	0.16	
95-63-6	1,2,4-Trimethylbenzene	**3.1**	0.79	**0.64**	0.16	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Sample 42** CAS Project ID: P1204494
Client Project ID: **Sunoco IH Testing / 213402094** CAS Sample ID: P1204494-019

Test Code: EPA TO-15 Date Collected: 10/25/12
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16 Date Received: 10/31/12
Analyst: Lusine Hakobyan Date Analyzed: 11/5/12
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 1.00 Liter(s)
Test Notes:
Container ID: AC01179

Initial Pressure (psig): -1.52 Final Pressure (psig): 3.71

Canister Dilution Factor: 1.40

CAS #	Compound	Result µg/m³	MRL µg/m³	Result ppbV	MRL ppbV	Data Qualifier
1634-04-4	Methyl tert-Butyl Ether	ND	0.70	ND	0.19	
107-06-2	1,2-Dichloroethane	ND	0.70	ND	0.17	
71-43-2	Benzene	**1.7**	0.70	**0.53**	0.22	
108-88-3	Toluene	**8.2**	0.70	**2.2**	0.19	
106-93-4	1,2-Dibromoethane	ND	0.70	ND	0.091	
100-41-4	Ethylbenzene	**1.1**	0.70	**0.25**	0.16	
179601-23-1	m,p-Xylenes	**4.6**	1.4	**1.1**	0.32	
95-47-6	o-Xylene	**1.7**	0.70	**0.38**	0.16	
98-82-8	Cumene	ND	0.70	ND	0.14	
108-67-8	1,3,5-Trimethylbenzene	**0.87**	0.70	**0.18**	0.14	
95-63-6	1,2,4-Trimethylbenzene	**2.5**	0.70	**0.50**	0.14	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**

Client Sample ID: **Sample 43**
Client Project ID: **Sunoco IH Testing / 213402094**

CAS Project ID: P1204494
CAS Sample ID: P1204494-020

Test Code: EPA TO-15
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16
Analyst: Lusine Hakobyan
Sample Type: 6.0 L Summa Canister
Test Notes:
Container ID: AC00870

Date Collected: 10/25/12
Date Received: 10/31/12
Date Analyzed: 11/5/12
Volume(s) Analyzed: 1.00 Liter(s)

Initial Pressure (psig): -3.27 Final Pressure (psig): 3.76

Canister Dilution Factor: 1.62

CAS #	**Compound**	**Result** μg/m³	MRL μg/m³	**Result** ppbV	MRL ppbV	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.81	ND	0.22	
107-06-2	1,2-Dichloroethane	ND	0.81	ND	0.20	
71-43-2	Benzene	**1.2**	0.81	**0.37**	0.25	
108-88-3	Toluene	**10**	0.81	**2.7**	0.22	
106-93-4	1,2-Dibromoethane	ND	0.81	ND	0.11	
100-41-4	Ethylbenzene	ND	0.81	ND	0.19	
179601-23-1	m,p-Xylenes	**2.8**	1.6	**0.65**	0.37	
95-47-6	o-Xylene	**0.99**	0.81	**0.23**	0.19	
98-82-8	Cumene	ND	0.81	ND	0.16	
108-67-8	1,3,5-Trimethylbenzene	ND	0.81	ND	0.16	
95-63-6	1,2,4-Trimethylbenzene	**0.93**	0.81	**0.19**	0.16	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Sample 44**
Client Project ID: **Sunoco IH Testing / 213402094**

CAS Project ID: P1204494
CAS Sample ID: P1204494-021

Test Code: EPA TO-15
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16
Analyst: Lusine Hakobyan
Sample Type: 6.0 L Summa Canister
Test Notes:
Container ID: AC00993

Date Collected: 10/25/12
Date Received: 10/31/12
Date Analyzed: 11/5/12
Volume(s) Analyzed: 1.00 Liter(s)

Canister Dilution Factor: 1.00

CAS #	**Compound**	**Result** µg/m³	MRL µg/m³	**Result** ppbV	MRL ppbV	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.50	ND	0.14	
107-06-2	1,2-Dichloroethane	ND	0.50	ND	0.12	
71-43-2	Benzene	ND	0.50	ND	0.16	
108-88-3	Toluene	ND	0.50	ND	0.13	
106-93-4	1,2-Dibromoethane	ND	0.50	ND	0.065	
100-41-4	Ethylbenzene	ND	0.50	ND	0.12	
179601-23-1	m,p-Xylenes	ND	1.0	ND	0.23	
95-47-6	o-Xylene	ND	0.50	ND	0.12	
98-82-8	Cumene	ND	0.50	ND	0.10	
108-67-8	1,3,5-Trimethylbenzene	ND	0.50	ND	0.10	
95-63-6	1,2,4-Trimethylbenzene	ND	0.50	ND	0.10	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Method Blank**
Client Project ID: **Sunoco IH Testing / 213402094**

CAS Project ID: P1204494
CAS Sample ID: P121102-MB

Test Code: EPA TO-15
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16
Analyst: Lusine Hakobyan
Sample Type: 6.0 L Summa Canister
Test Notes:

Date Collected: NA
Date Received: NA
Date Analyzed: 11/2/12
Volume(s) Analyzed: 1.00 Liter(s)

Canister Dilution Factor: 1.00

CAS #	**Compound**	**Result** **µg/m³**	MRL µg/m³	**Result** **ppbV**	MRL ppbV	**Data** **Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.50	ND	0.14	
107-06-2	1,2-Dichloroethane	ND	0.50	ND	0.12	
71-43-2	Benzene	ND	0.50	ND	0.16	
108-88-3	Toluene	ND	0.50	ND	0.13	
106-93-4	1,2-Dibromoethane	ND	0.50	ND	0.065	
100-41-4	Ethylbenzene	ND	0.50	ND	0.12	
179601-23-1	m,p-Xylenes	ND	1.0	ND	0.23	
95-47-6	o-Xylene	ND	0.50	ND	0.12	
98-82-8	Cumene	ND	0.50	ND	0.10	
108-67-8	1,3,5-Trimethylbenzene	ND	0.50	ND	0.10	
95-63-6	1,2,4-Trimethylbenzene	ND	0.50	ND	0.10	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

RESULTS OF ANALYSIS

Page 1 of 1

Client:	**Stantec Consulting Services, Inc.**		
Client Sample ID:	**Method Blank**	CAS Project ID:	P1204494
Client Project ID:	**Sunoco IH Testing / 213402094**	CAS Sample ID:	P121105-MB
Test Code:	EPA TO-15	Date Collected:	NA
Instrument ID:	Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16	Date Received:	NA
Analyst:	Lusine Hakobyan	Date Analyzed:	11/5/12
Sample Type:	6.0 L Summa Canister	Volume(s) Analyzed:	1.00 Liter(s)
Test Notes:			

Canister Dilution Factor: 1.00

CAS #	**Compound**	**Result µg/m³**	MRL µg/m³	**Result ppbV**	MRL ppbV	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	ND	0.50	ND	0.14	
107-06-2	1,2-Dichloroethane	ND	0.50	ND	0.12	
71-43-2	Benzene	ND	0.50	ND	0.16	
108-88-3	Toluene	ND	0.50	ND	0.13	
106-93-4	1,2-Dibromoethane	ND	0.50	ND	0.065	
100-41-4	Ethylbenzene	ND	0.50	ND	0.12	
179601-23-1	m,p-Xylenes	ND	1.0	ND	0.23	
95-47-6	o-Xylene	ND	0.50	ND	0.12	
98-82-8	Cumene	ND	0.50	ND	0.10	
108-67-8	1,3,5-Trimethylbenzene	ND	0.50	ND	0.10	
95-63-6	1,2,4-Trimethylbenzene	ND	0.50	ND	0.10	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

SURROGATE SPIKE RECOVERY RESULTS

Client: **Stantec Consulting Services, Inc.**
Client Project ID: **Sunoco IH Testing / 213402094**
CAS Project ID: P1204494

Test Code: EPA TO-15
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16
Analyst: Lusine Hakobyan
Sample Type: 6.0 L Summa Canister(s)
Test Notes:

Date(s) Collected: 10/25/12
Date(s) Received: 10/31/12
Date(s) Analyzed: 11/2 - 11/5/12

Client Sample ID	**CAS Sample ID**	**1,2-Dichloroethane-d4** Percent Recovered	**Toluene-d8** Percent Recovered	**Bromofluorobenzene** Percent Recovered	Acceptance Limits	**Data Qualifier**
Method Blank	P121102-MB	**101**	**99**	**96**	70-130	
Method Blank	P121105-MB	**102**	**100**	**97**	70-130	
Lab Control Sample	P121102-LCS	**99**	**99**	**100**	70-130	
Lab Control Sample	P121105-LCS	**99**	**100**	**99**	70-130	
Sample 23	P1204494-001	**101**	**101**	**95**	70-130	
Sample 25	P1204494-002	**101**	**101**	**95**	70-130	
Sample 26	P1204494-003	**101**	**101**	**97**	70-130	
Sample 27	P1204494-004	**102**	**100**	**97**	70-130	
Sample 28	P1204494-005	**101**	**100**	**96**	70-130	
Sample 29	P1204494-006	**101**	**100**	**97**	70-130	
Sample 30	P1204494-007	**101**	**100**	**97**	70-130	
Sample 31	P1204494-008	**101**	**99**	**96**	70-130	
Sample 32	P1204494-009	**102**	**99**	**97**	70-130	
Sample 33	P1204494-010	**101**	**99**	**97**	70-130	
Sample 34	P1204494-011	**102**	**100**	**97**	70-130	
Sample 35	P1204494-012	**101**	**100**	**97**	70-130	
Sample 36	P1204494-013	**100**	**101**	**97**	70-130	
Sample 37	P1204494-014	**100**	**101**	**97**	70-130	
Sample 38	P1204494-015	**99**	**100**	**98**	70-130	
Sample 39	P1204494-016	**101**	**100**	**98**	70-130	
Sample 40	P1204494-017	**101**	**100**	**97**	70-130	
Sample 40	P1204494-017DUP	**100**	**100**	**96**	70-130	
Sample 41	P1204494-018	**101**	**101**	**97**	70-130	
Sample 42	P1204494-019	**100**	**102**	**96**	70-130	
Sample 43	P1204494-020	**101**	**101**	**98**	70-130	
Sample 44	P1204494-021	**100**	**101**	**96**	70-130	

Surrogate percent recovery is verified and accepted based on the on-column result.
Reported results are shown in concentration units and as a result of the calculation, may vary slightly from the on-column percent recovery.

LABORATORY CONTROL SAMPLE SUMMARY

Page 1 of 1

Client:	**Stantec Consulting Services, Inc.**		
Client Sample ID:	**Lab Control Sample**	CAS Project ID:	P1204494
Client Project ID:	**Sunoco IH Testing / 213402094**	CAS Sample ID:	P121102-LCS
Test Code:	EPA TO-15	Date Collected:	NA
Instrument ID:	Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16	Date Received:	NA
Analyst:	Lusine Hakobyan	Date Analyzed:	11/02/12
Sample Type:	6.0 L Summa Canister	Volume(s) Analyzed:	0.125 Liter(s)
Test Notes:			

CAS #	**Compound**	Spike Amount µg/m³	**Result µg/m³**	**% Recovery**	CAS Acceptance Limits	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	204	**187**	**92**	67-116	
107-06-2	1,2-Dichloroethane	208	**180**	**87**	70-118	
71-43-2	Benzene	208	**187**	**90**	66-121	
108-88-3	Toluene	208	**172**	**83**	67-111	
106-93-4	1,2-Dibromoethane	208	**182**	**88**	73-122	
100-41-4	Ethylbenzene	206	**170**	**83**	71-117	
179601-23-1	m,p-Xylenes	412	**328**	**80**	70-116	
95-47-6	o-Xylene	200	**163**	**82**	70-116	
98-82-8	Cumene	196	**160**	**82**	70-116	
108-67-8	1,3,5-Trimethylbenzene	208	**169**	**81**	71-121	
95-63-6	1,2,4-Trimethylbenzene	200	**165**	**83**	73-127	

Laboratory Control Sample percent recovery is verified and accepted based on the on-column result.
Reported results are shown in concentration units and as a result of the calculation, may vary slightly.

LABORATORY CONTROL SAMPLE SUMMARY

Page 1 of 1

Client:	**Stantec Consulting Services, Inc.**		
Client Sample ID:	**Lab Control Sample**	CAS Project ID:	P1204494
Client Project ID:	**Sunoco IH Testing / 213402094**	CAS Sample ID:	P121105-LCS
Test Code:	EPA TO-15	Date Collected:	NA
Instrument ID:	Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16	Date Received:	NA
Analyst:	Lusine Hakobyan	Date Analyzed:	11/05/12
Sample Type:	6.0 L Summa Canister	Volume(s) Analyzed:	0.125 Liter(s)
Test Notes:			

CAS #	**Compound**	Spike Amount µg/m³	**Result µg/m³**	**% Recovery**	CAS Acceptance Limits	**Data Qualifier**
1634-04-4	Methyl tert-Butyl Ether	204	**191**	**94**	67-116	
107-06-2	1,2-Dichloroethane	208	**184**	**88**	70-118	
71-43-2	Benzene	208	**190**	**91**	66-121	
108-88-3	Toluene	208	**178**	**86**	67-111	
106-93-4	1,2-Dibromoethane	208	**189**	**91**	73-122	
100-41-4	Ethylbenzene	206	**174**	**84**	71-117	
179601-23-1	m,p-Xylenes	412	**338**	**82**	70-116	
95-47-6	o-Xylene	200	**167**	**84**	70-116	
98-82-8	Cumene	196	**164**	**84**	70-116	
108-67-8	1,3,5-Trimethylbenzene	208	**173**	**83**	71-121	
95-63-6	1,2,4-Trimethylbenzene	200	**171**	**86**	73-127	

Laboratory Control Sample percent recovery is verified and accepted based on the on-column result.
Reported results are shown in concentration units and as a result of the calculation, may vary slightly.

LABORATORY DUPLICATE SUMMARY RESULTS

Page 1 of 1

Client: **Stantec Consulting Services, Inc.**
Client Sample ID: **Sample 40** CAS Project ID: P1204494
Client Project ID: **Sunoco IH Testing / 213402094** CAS Sample ID: P1204494-017DUP

Test Code: EPA TO-15 Date Collected: 10/25/12
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16 Date Received: 10/31/12
Analyst: Lusine Hakobyan Date Analyzed: 11/5/12
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 1.00 Liter(s)
Test Notes:
Container ID: AC01243

Initial Pressure (psig): -0.40 Final Pressure (psig): 3.96

Canister Dilution Factor: 1.30

Compound	Sample Result		**Duplicate Sample Result**		Average	**% RPD**	RPD	**Data**
	µg/m³	ppbV	**µg/m³**	ppbV	µg/m³		Limit	**Qualifier**
Methyl tert-Butyl Ether	1.55	0.431	1.57	0.436	1.56	**1**	25	
1,2-Dichloroethane	ND	ND	ND	ND	-	-	25	
Benzene	2.03	0.637	2.03	0.634	2.03	**0**	25	
Toluene	8.79	2.33	8.75	2.32	8.77	**0.5**	25	
1,2-Dibromoethane	ND	ND	ND	ND	-	-	25	
Ethylbenzene	1.45	0.333	1.43	0.329	1.44	**1**	25	
m,p-Xylenes	5.39	1.24	5.35	1.23	5.37	**0.7**	25	
o-Xylene	1.83	0.422	1.82	0.419	1.825	**0.5**	25	
Cumene	ND	ND	ND	ND	-	-	25	
1,3,5-Trimethylbenzene	ND	ND	ND	ND	-	-	25	
1,2,4-Trimethylbenzene	1.54	0.314	1.53	0.311	1.535	**0.7**	25	

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

November 9, 2016 Reference No. 11109626

Ms. Tiffani L. Doerr, PG
Evergreen Resources Management Operations
2 Righter Parkway, Suite No. 200
Wilmington, DE 19803

Dear Ms. Doerr:

Re: Air Data Evaluation –
Philadelphia Energy Solutions Complex

As requested, GHD Services, Inc. (GHD) has prepared this letter summarizing the approach and results of the air data collection activities that were performed in 2015/2016 at the Philadelphia Energy Solutions (PES) Complex (Site) on behalf of Philadelphia Refinery Operations, a Series of Evergreen Resources Group, LLC (Evergreen). This letter includes the air data collected in March 2015 at Area of Interest (AOI) 1 by Stantec and the 2016 data collected at AOIs 1, 2, 3, 5, 6, 7, 8, and 9 by GHD.

The procedures to obtain access, the sampling methodologies, the results of the indoor air sampling, and evaluation of the data are included herein for the samples collected in 2016. All detected concentrations of constituents in indoor air were below the Pennsylvania Department of Environmental Protection (PADEP) generic non-residential Statewide Health Standard (SHS) for indoor air except for one benzene result from the Control Room Building 6627 in AOI 6. However, this concentration is below the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL). No unacceptable risk to workers via indoor air inhalation was identified by these results.

1. Investigation Activities

During the 2015/2016 sampling event, Stantec and GHD collected indoor air samples from potentially occupied buildings not previously sampled as part of a vapor intrusion assessment. GHD performed the following activities as part of the 2016 air sampling activities at the Site.

1.1 Obtain of Work Permits

Prior to commencing work, Work Permits were obtained from PES. The Work Permits were for GHD's survey/inspection of buildings, collection of indoor air samples within those buildings, and collection of outdoor air samples around those buildings to establish background conditions for comparison to the indoor air samples. All work was conducted in accordance with applicable safety standards and GHD's Health and Safety protocol as presented in a site-specific Health and Safety Plan.

1.2 Building Survey and Inspection

After obtaining work permits and prior to indoor air sample collection, a detailed building survey and inspection was conducted to identify any potential indoor air sources of volatile organic compounds (VOCs) possibly already present within the building (e.g., smoking, cleaning products, building products, manufacturing chemicals, etc.), the number and frequency of occupants within the various buildings, and potential preferential migration pathways through the building slab (e.g., utility conduits, slab cracking, etc.). At each building GHD completed a Building Survey and Indoor Air Sampling Field Sheet.

1.3 Indoor and Outdoor Air Sampling

Each proposed indoor air sample location was selected based on occupancy and specific building characteristics such as building size and location of the occupied space within a building. The numbers of samples collected for each building was based on a combined approach from Appendix Z of the draft PADEP VI Guidance and professional judgement. The location of indoor and outdoor air samples is shown in Figure 1.

The samples were collected using 6-liter capacity Summa™ canisters in a suitable location(s) in each building at a representative breathing zone height (i.e., 3 to 5 feet above grade). Canisters were laboratory-certified clean in accordance with Appendix Z of the PADEP draft VI guidance. The canisters were fitted with a laboratory-calibrated critical orifice flow-regulation device sized to limit the indoor air sample collection flow rate to allow for 8-hour sample collection. Canisters maintained a minimum residual negative pressure of approximately 1 to 5 inches of mercury following sample collection.

Written documentation of all field activities, conditions, and sampling processes, including names of field personnel, dates and times, etc. were recorded. Documentation included building designation, building use, occupant information, and weather conditions at the time of sampling (temperature, barometric pressure, wind direction and speed, and humidity).

Outdoor air sampling locations were selected for collection of an air sample in each AOI. The outdoor locations were set at the same general elevation of the samples in the buildings and were in a position that is generally upwind of the buildings being assessed.

2. Data Evaluation

The detected concentrations in indoor air were screened in accordance with the generic screening criteria as presented in Table 1. Table 1 summarizes the indoor air data and compares the detected concentrations to the generic indoor air screening criteria from PADEP and USEPA, both calculated at a target cancer risk of 1×10^{-5} and a hazard quotient of 1. In addition, Table 1 also compares the indoor air results to 1/10th of the PADEP SHS, generic USEPA criteria calculated at a target cancer risk of 1×10^{-6} and a hazard quotient of 0.1, and occupational inhalation limits.

As shown on Table 1, all detected concentrations of constituents in indoor air were below the Pennsylvania generic non-residential SHS for indoor air except for one benzene result from the Control Room of Building 6627 in AOI 6. However, this concentration of 36 micrograms per cubic meter (ug/m^3) is below the OSHA PEL of 3,190 ug/m^3, which is the applicable standard at the Site.

The detected concentrations in ambient/outdoor air are presented in Table 2. Table 2 also includes outdoor air results from a nearby PADEP monitoring station and background residential indoor air levels as a point of reference.

3. Conclusions

The comparison of these detected concentrations in indoor air to generic non-residential criteria for indoor air and OSHA PELs did not identify any unacceptable risk to workers via indoor air inhalation at the Site.

The ambient/outdoor air results are within the range of background concentrations.

Should you require any additional information, please do not hesitate to contact us.

Yours truly,

GHD Services Inc.

Colleen Costello Francis C. Ramacciotti

Encl.

Figure 1 – Indoor Air and Ambient Air Sampling Locations
Table 1 – Air Sampling Data

cc: David Steele, GHD

Table 1
Indoor Air Sampling Data
Philadelphia Energy Systems Complex, on behalf of Evergreen Resources Group, LLC

Sample Location											**AOI1_AI-01**	**AOI1-AI-16-001**	**AOI2-AI-16-001**
											Indoor Air Inline Blender Bldg	**Control Room, Block BRM**	**Bio Area**
Sample Date											**13-Mar-15**	**22-Mar-16**	**22-Mar-16**
Sample ID											**AOI1_AI-01**	**IA-AOI1-2429**	**IA-AOI2-5920**
Sampling Company											**STANTEC**	**GHD**	**GHD**
Laboratory											**ALS**	**LL**	**LL**
Laboratory Work Order											**P1501053**	**MHF23**	**MHF23**
Laboratory Sample ID											**P1501053-001**	**8302469**	**8302470**
Sample Type	**Units**	**VI-PA^{A}**	**1/10th VI-PA^{B}**	**OSHA^{C}**	**USEPA RSL^{D}**	**USEPA RSL^{E}**	**ACGIH TLV^{F}**	**NIOSH^{G}**	**MH Air Tox**	**EPA Res IA**			
Volatile Organic Compounds													
BENZENE	µg/m3	16	1.6	3,190	16	1.6	1,600	319	2.59	29	4.2	***12*** ^{BE}	***3.7*** ^{BE}
1,2-DIBROMOETHANE (EDB)	µg/m3	0.2	0.02	153,700	0.2	0.02	n/v	346	n/v	n/v	ND (0.24)	ND (7.7)	ND (7.7)
1,2-DICHLOROETHANE (EDC)	µg/m3	4.7	0.47	202,400	4.7	0.47	40,500	4,000	0.16	0.2	ND (0.75)	ND (4.0)	ND (4.0)
ETHYLBENZENE	µg/m3	49	4.9	435,000	49	4.9	86,800	435,000	0.68	17	4	***7.1*** ^{BE}	ND (4.3)
ISOPROPYLBENZENE (CUMENE)	µg/m3	1,800	180	245,000	1,800	180	246,000	245,000	11.2	n/v	ND (0.75)	ND (4.9)	ND (4.9)
METHYL TERTIARY BUTYL ETHER	µg/m3	470	47	n/v	470	47	180,000	n/v	n/v	72	ND (0.75)	ND (3.6)	ND (3.6)
NAPHTHALENE	µg/m3	3.6	0.36	50,000	3.6	0.36	52,000	50,000	n/v	4.8*	ND (0.75)	ND (5.2)	ND (5.2)
TOLUENE	µg/m3	22,000	2,200	754,000	22,000	2,200	75,400	375,000	4.52	144	22	48	3.9
1,2,4-TRIMETHYLBENZENE**	µg/m3	31	3.1	n/v	260	26	123,000	125,000	1.12	19	6.3	6.6	ND (4.9)
1,3,5-TRIMETHYLBENZENE**	µg/m3	31	3.1	n/v	260	26	123,000	125,000	0.38	6.5	2	2.7 J	ND (4.9)
TOTAL XYLENE	µg/m3	440	44	435,000	440	44	434,000	435,000	3.14	63.5	24.4	38.9	1.9 J

Notes:

VI-PA^{A}	PADEP Indoor Air Statewide Health Standard Vapor Intrusion Screening Values, Non-Residential (Draft, July 2015).
VI-PA^{B}	1/10th of the PADEP Indoor Air Statewide Health Standard Vapor Intrusion Screening Values, Non-Residential (Draft, July 2015).
OSHA^{C}	Occupational Safety and Health Administration - Permissible Exposure Limits
USEPA RSL^{D}	United States Environmental Protection Agency Non-residential indoor air Cancer Risk of 1E-5 and Hazard Index of 1.
USEPA RSL^{E}	United States Environmental Protection Agency Non-residential indoor air Cancer Risk of 1E-6 and Hazard Index of 0.1.
**	The RSL for TMB were calculated using the September 2016 final IRIS RfD.
ACGIH TLV^{F}	American Conference of Governmental Industrial Hygienists - Threshold Limit Value
NIOSH^{G}	National Institute for Occupational Safety and Health - Recommended Exposure Limits
MH Air Tox	Marcus Hook Air Toxics Monitor 2015, maximum value of PADEP data accessed February 5, 2016.
EPA Res IA	USEPA Background Residential Indoor Air 2011, 95th percentile.
*	95th percentile value not provided, value is 90th percentile.
6.5 ^{A}	Concentration exceeds the VI-PA SHS
6.5 ^{A}	Concentration exceeds the indicated standard.
15.2	Measured concentration did not exceed the indicated standard.
ND (0.03)	Analyte was not detected at a concentration greater than the laboratory reporting limit.
n/v	No standard/guideline value.

Table 1
Indoor Air Sampling Data
Philadelphia Energy Systems Complex, on behalf of Evergreen Resources Group, LLC

Sample Location											**AOI1_AI-01**	**AOI1-AI-16-001**	**AOI2-AI-16-001**
											Indoor Air Inline Blender Bldg	**Control Room, Block BRM**	**Bio Area**
Sample Date											**13-Mar-15**	**22-Mar-16**	**22-Mar-16**
Sample ID											**AOI1_AI-01**	**IA-AOI1-2429**	**IA-AOI2-5920**
Sampling Company											**STANTEC**	**GHD**	**GHD**
Laboratory											**ALS**	**LL**	**LL**
Laboratory Work Order											**P1501053**	**MHF23**	**MHF23**
Laboratory Sample ID											**P1501053-001**	**8302469**	**8302470**
Sample Type	**Units**	**VI-PA**[A]	**1/10th VI-PA**[B]	**OSHA**[C]	**USEPA RSL**[D]	**USEPA RSL**[E]	**ACGIH TLV**[F]	**NIOSH**[G]	**MH Air Tox**	**EPA Res IA**			

J Indicates an estimated value.

Table 1
Indoor Air Sampling Data
Philadelphia Energy Systems Complex, on behalf of Evergreen Resources Group, LLC

Sample Location		**AOI2-AI-16-002**	**AOI2-AI-16-003**	**AOI2-AI-16-004**	**AOI2-AI-16-005**	**AOI2-AI-16-006**	**AOI3-AI-16-001**	**AOI3-AI-16-002**	**AOI3-AI-16-003**	**AOI3-AI-16-004**
		Bio Area, Bldg 6628	**Control Room, Kitchen, on Stove**	**Control Room**	**Control Room**	**Short Pier Building 11**	**Safway Trailer**	**AOI3 Central Warehouse 3324**	**Warehouse Near Seal/Safety Store**	**Central Warehouse Bldg 3324 Walled Office**
Sample Date		**22-Mar-16**	**22-Mar-16**	**22-Mar-16**	**22-Mar-16**	**28-Mar-16**	**22-Mar-16**	**22-Mar-16**	**22-Mar-16**	**22-Mar-16**
Sample ID		**IA-AOI2-6628**	**IA-AOI2-2435**	**IA-AOI2-6624**	**IA-AOI2-2520**	**IA-AOI2-011**	**IA-AOI3-SAFWAY**	**IA-AOI3-3324-1**	**IA-AOI3-3324-2**	**IA-AOI3-3324-3**
Sampling Company		**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**
Laboratory		**LL**	**LL**	**LL**	**LL**	**LL**	**LL**	**LL**	**LL**	**LL**
Laboratory Work Order		**MHF23**	**MHF23**	**MHF23**	**MHF23**	**MHF24**	**MHF23**	**MHF23**	**MHF23**	**MHF23**
Laboratory Sample ID		**8302471**	**8302472**	**8302473**	**8302474**	**8316891**	**8302476**	**8302477**	**8302478**	**8302479**
Sample Type	**Units**									
Volatile Organic Compounds										
BENZENE	µg/m3	***4.6***^{BE}	***2.8 J***^{BE}	***3.2***^{BE}	***5.9***^{BE}	1.3 J	***2.1 J***^{BE}	***2.4 J***^{BE}	***3.0 J***^{BE}	***3.0 J***^{BE}
1,2-DIBROMOETHANE (EDB)	µg/m3	ND (7.7)	ND (7.7)	ND (7.7)	ND (7.7)	ND (7.7)	ND (7.7)	ND (7.7)	ND (7.7)	ND (7.7)
1,2-DICHLOROETHANE (EDC)	µg/m3	ND (4.0)	ND (4.0)	ND (4.0)	ND (4.0)	ND (4.0)	ND (4.0)	ND (4.0)	ND (4.0)	ND (4.0)
ETHYLBENZENE	µg/m3	2.9 J	ND (4.3)	ND (4.3)	1.3 J	ND (4.3)	ND (4.3)	ND (4.3)	***6.2***^{BE}	1.0 J
ISOPROPYLBENZENE (CUMENE)	µg/m3	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)
METHYL TERTIARY BUTYL ETHER	µg/m3	ND (3.6)	ND (3.6)	ND (3.6)	ND (3.6)	ND (3.6)	ND (3.6)	ND (3.6)	ND (3.6)	ND (3.6)
NAPHTHALENE	µg/m3	ND (5.2)	ND (5.2)	ND (5.2)	***3.0 J***^{BE}	ND (5.2)	ND (5.2)	ND (5.2)	ND (5.2)	ND (5.2)
TOLUENE	µg/m3	8.9	2.6 J	3.0 J	4.4	4.3	1.8 J	3.5 J	13	22
1,2,4-TRIMETHYLBENZENE**	µg/m3	1.8 J	ND (4.9)	ND (4.9)	6.6	1.2 J	ND (4.9)	ND (4.9)	2.1 J	1.9 J
1,3,5-TRIMETHYLBENZENE**	µg/m3	ND (4.9)	ND (4.9)	ND (4.9)	2.2 J	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)
TOTAL XYLENE	µg/m3	11.5 J	3 J	3.07 J	6.9 J	3.9 J	ND (4.3)	1.4 J	36.3	3.8 J

Notes:

VI-PA^{A}	PADEP Indoor Air Statewide Health Standard Vapor Intrusion Screening Values, Non-Residential (Draft, July 2015).
VI-PA^{B}	1/10th of the PADEP Indoor Air Statewide Health Standard Vapor Intrusion Screening Values, Non-Residential (Draft, July 2015).
OSHA^{C}	Occupational Safety and Health Administration - Permissible Exposure Limits
USEPA RSL^{D}	United States Environmental Protection Agency Non-residential indoor air Cancer Risk of 1E-5 and Hazard Index of 1.
USEPA RSL^{E}	United States Environmental Protection Agency Non-residential indoor air Cancer Risk of 1E-6 and Hazard Index of 0.1.
**	The RSL for TMB were calculated using the September 2016 final IRIS RfD.
ACGIH TLV^{F}	American Conference of Governmental Industrial Hygienists - Threshold Limit Value
NIOSH^{G}	National Institute for Occupational Safety and Health - Recommended Exposure Limits
MH Air Tox	Marcus Hook Air Toxics Monitor 2015, maximum value of PADEP data accessed February 5, 2016.
EPA Res IA	USEPA Background Residential Indoor Air 2011, 95th percentile.
*	95th percentile value not provided, value is 90th percentile.
6.5^{A}	Concentration exceeds the VI-PA SHS
6.5^{A}	Concentration exceeds the indicated standard.
15.2	Measured concentration did not exceed the indicated standard.
ND (0.03)	Analyte was not detected at a concentration greater than the laboratory reporting limit.
n/v	No standard/guideline value.

Table 1
Indoor Air Sampling Data
Philadelphia Energy Systems Complex, on behalf of Evergreen Resources Group, LLC

Sample Location		AOI2-AI-16-002	AOI2-AI-16-003	AOI2-AI-16-004	AOI2-AI-16-005	AOI2-AI-16-006	AOI3-AI-16-001	AOI3-AI-16-002	AOI3-AI-16-003	AOI3-AI-16-004
		Bio Area, Bldg 6628	Control Room, Kitchen, on Stove	Control Room	Control Room	Short Pier Building 11	Safway Trailer	AOI3 Central Warehouse 3324	Warehouse Near Seal/Safety Store	Central Warehouse Bldg 3324 Walled Office
Sample Date		22-Mar-16	22-Mar-16	22-Mar-16	22-Mar-16	28-Mar-16	22-Mar-16	22-Mar-16	22-Mar-16	22-Mar-16
Sample ID		IA-AOI2-6628	IA-AOI2-2435	IA-AOI2-6624	IA-AOI2-2520	IA-AOI2-011	IA-AOI3-SAFWAY	IA-AOI3-3324-1	IA-AOI3-3324-2	IA-AOI3-3324-3
Sampling Company		GHD	GHD	GHD	GHD	GHD	GHD	GHD	GHD	GHD
Laboratory		LL	LL	LL	LL	LL	LL	LL	LL	LL
Laboratory Work Order		MHF23	MHF23	MHF23	MHF23	MHF24	MHF23	MHF23	MHF23	MHF23
Laboratory Sample ID		8302471	8302472	8302473	8302474	8316891	8302476	8302477	8302478	8302479
Sample Type	Units									

J Indicates an estimated value.

Table 1
Indoor Air Sampling Data
Philadelphia Energy Systems Complex, on behalf of Evergreen Resources Group, LLC

Sample Location		**AOI3-AI-16-005**	**AOI3-AI-16-006**	**AOI3-AI-16-007**	**AOI3-AI-16-008**	**AOI3-AI-16-009**	**AOI5-AI-16-001**	**AOI5-AI-16-002**	**AOI5-AI-16-003**	**AOI5-AI-16-004**
		Central 3324 Bldg Open Warehouse	**Central 3324 Bldg Open Warehouse**	**Central Warehouse Shipping/Receiving Warehouse**	**Tek-Solv-Trailer Southeast Corner of Trailer Lot**	**018 Buildiung, Main Contractor Processing Trailer with Skirt**	**Control Room**	**Dock Warf Office 2nd Floor**	**Sample on Desk**	**Dock Office, Brick Bldg, Steam Heat**
Sample Date		**22-Mar-16**	**22-Mar-16**	**22-Mar-16**	**28-Mar-16**	**29-Mar-16**	**28-Mar-16**	**28-Mar-16**	**28-Mar-16**	**28-Mar-16**
Sample ID		**IA-AOI3-3324-4**	**IA-AOI3-3324-5**	**IA-AOI3-3324-6**	**IA-AOI3-TRAILER13**	**IA-AOI3-018**	**IA-AOI5-625**	**IA-AOI5-526-2**	**IA-AOI5-526-1**	**IA-AOI5-501**
Sampling Company		**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**
Laboratory		**LL**	**LL**	**LL**	**LL**	**ESC**	**LL**	**LL**	**LL**	**LL**
Laboratory Work Order		**MHF23**	**MHF23**	**MHF23**	**MHF24**	**L827327**	**MHF24**	**MHF24**	**MHF24**	**MHF24**
Laboratory Sample ID		**8302480**	**8302481**	**8302482**	**8316882**	**L827327-01**	**8316884**	**8316885**	**8316886**	**8316887**
Sample Type	**Units**									
Volatile Organic Compounds										
BENZENE	µg/m3	***3.7*** ^{BE}	***3.4*** ^{BE}	***3.7*** ^{BE}	***1.8 J*** ^{BE}	***5.25*** ^{BE}	1.4 J	***4.3*** ^{BE}	***2.6 J*** ^{BE}	***4.4*** ^{BE}
1,2-DIBROMOETHANE (EDB)	µg/m3	ND (7.7)	ND (7.7)	ND (7.7)	ND (7.7)	ND (1.54)	ND (7.7)	ND (7.7)	ND (7.7)	ND (7.7)
1,2-DICHLOROETHANE (EDC)	µg/m3	ND (4.0)	ND (4.0)	ND (4.0)	ND (4.0)	ND (0.810)	ND (4.0)	ND (4.0)	ND (4.0)	ND (4.0)
ETHYLBENZENE	µg/m3	2.2 J	ND (4.3)	0.91 J	ND (4.3)	ND (0.867)	1.3 J	ND (4.3)	1.2 J	1.1 J
ISOPROPYLBENZENE (CUMENE)	µg/m3	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	1.13	9.8	18	8.6	ND (4.9)
METHYL TERTIARY BUTYL ETHER	µg/m3	0.75 J	ND (3.6)	ND (3.6)	ND (3.6)	ND (0.721)	ND (3.6)	ND (3.6)	ND (3.6)	ND (3.6)
NAPHTHALENE	µg/m3	ND (5.2)	ND (5.2)	ND (5.2)	ND (5.2)	ND (3.30)	ND (5.2)	ND (5.2)	ND (5.2)	ND (5.2)
TOLUENE	µg/m3	13 J	24 J	13	4.0	4.79	3.1 J	5.0	7.9	15
1,2,4-TRIMETHYLBENZENE**	µg/m3	1.8 J	1.1 J	1.6 J	ND (4.9)	1.23	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)
1,3,5-TRIMETHYLBENZENE**	µg/m3	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	ND (0.982)	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)
TOTAL XYLENE	µg/m3	9.2 J	1.9 J	3.8 J	3.9 J	2.23	4.9 J	1.7 J	4.1 J	3.8 J

Notes:

VI-PA^{A}	PADEP Indoor Air Statewide Health Standard Vapor Intrusion Screening Values, Non-Residential (Draft, July 2015).
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**	The RSL for TMB were calculated using the September 2016 final IRIS RfD.
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MH Air Tox	Marcus Hook Air Toxics Monitor 2015, maximum value of PADEP data accessed February 5, 2016.
EPA Res IA	USEPA Background Residential Indoor Air 2011, 95th percentile.
*	95th percentile value not provided, value is 90th percentile.
6.5 ^{A}	Concentration exceeds the VI-PA SHS
6.5 ^{A}	Concentration exceeds the indicated standard.
15.2	Measured concentration did not exceed the indicated standard.
ND (0.03)	Analyte was not detected at a concentration greater than the laboratory reporting limit.
n/v	No standard/guideline value.

Table 1
Indoor Air Sampling Data
Philadelphia Energy Systems Complex, on behalf of Evergreen Resources Group, LLC

Sample Location		AOI3-AI-16-005	AOI3-AI-16-006	AOI3-AI-16-007	AOI3-AI-16-008	AOI3-AI-16-009	AOI5-AI-16-001	AOI5-AI-16-002	AOI5-AI-16-003	AOI5-AI-16-004
		Central 3324 Bldg Open Warehouse	Central 3324 Bldg Open Warehouse	Central Warehouse Shipping/Receiving Warehouse	Tek-Solv-Trailer Southeast Corner of Trailer Lot	018 Buildiung, Main Contractor Processing Trailer with Skirt	Control Room	Dock Warf Office 2nd Floor	Sample on Desk	Dock Office, Brick Bldg, Steam Heat
Sample Date		22-Mar-16	22-Mar-16	22-Mar-16	28-Mar-16	29-Mar-16	28-Mar-16	28-Mar-16	28-Mar-16	28-Mar-16
Sample ID		IA-AOI3-3324-4	IA-AOI3-3324-5	IA-AOI3-3324-6	IA-AOI3-TRAILER13	IA-AOI3-018	IA-AOI5-625	IA-AOI5-526-2	IA-AOI5-526-1	IA-AOI5-501
Sampling Company		GHD	GHD	GHD	GHD	GHD	GHD	GHD	GHD	GHD
Laboratory		LL	LL	LL	LL	ESC	LL	LL	LL	LL
Laboratory Work Order		MHF23	MHF23	MHF23	MHF24	L827327	MHF24	MHF24	MHF24	MHF24
Laboratory Sample ID		8302480	8302481	8302482	8316882	L827327-01	8316884	8316885	8316886	8316887
Sample Type	Units									

J Indicates an estimated value.

Table 1
Indoor Air Sampling Data
Philadelphia Energy Systems Complex, on behalf of Evergreen Resources Group, LLC

Sample Location		**AOI5-AI-16-005**	**AOI5-AI-16-006**	**AOI6-AI-16-001**	**AOI6-AI-16-002**	**AOI6-AI-16-003**	**AOI6-AI-16-004**	**AOI6-AI-16-005**	**AOI6-AI-16-006**	**AOI6-AI-16-007**
		GP2 Dock	**034A/B Building**	**475 Building**	**745 Building**	**Control Room, 6627 Building**	**Truck Scale House, 6636 Building**	**Control Room, 739 Building**	**726 Building, Carpenter Shop**	**178 Building, Carpenter Trade Shop**
Sample Date		**28-Mar-16**	**28-Mar-16**	**28-Mar-16**	**28-Mar-16**	**28-Mar-16**	**28-Mar-16**	**28-Mar-16**	**29-Mar-16**	**29-Mar-16**
Sample ID		**IA-AOI5-GP DOCK 2**	**IA-AOI5-034A/B**	**IA-AOI6-475**	**IA-AOI6-745**	**IA-AOI6-6627**	**IA-AOI6-6636**	**IA-AOI6-739**	**IA-AOI6-726**	**IA-AOI6-178**
Sampling Company		**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**
Laboratory		**LL**	**LL**	**LL**	**LL**	**LL**	**LL**	**LL**	**ESC**	**ESC**
Laboratory Work Order		**MHF24**	**MHF24**	**MHF24**	**MHF24**	**MHF24**	**MHF24**	**MHF24**	**L827327**	**L827327**
Laboratory Sample ID		**8316888**	**8316889**	**8316892**	**8316893**	**8316894**	**8316895**	**8316896**	**L827327-02**	**L827327-03**
Sample Type	**Units**									
Volatile Organic Compounds										
BENZENE	µg/m3	***1.8 J***^{BE}	***1.8 J***^{BE}	***5.5***^{BE}	1.3 J	***36***^{ABDE}	***2.1 J***^{BE}	***4.5***^{BE}	***3.46***^{BE}	***5.05***^{BE}
1,2-DIBROMOETHANE (EDB)	µg/m3	ND (7.7)	ND (7.7)	ND (7.7)	ND (7.7)	ND (7.7)	ND (7.7)	ND (7.7)	ND (1.54)	ND (1.54)
1,2-DICHLOROETHANE (EDC)	µg/m3	ND (4.0)	ND (4.0)	ND (4.0)	ND (4.0)	ND (4.0)	ND (4.0)	ND (4.0)	ND (0.810)	ND (0.810)
ETHYLBENZENE	µg/m3	1.9 J	1.9 J	1.1 J	ND (4.3)	2.0 J	2.1 J	3.2 J	ND (0.867)	ND (0.867)
ISOPROPYLBENZENE (CUMENE)	µg/m3	ND (4.9)	1.5 J	9.1	ND (4.9)	7.8	ND (4.9)	2.8 J	1.45	1.60
METHYL TERTIARY BUTYL ETHER	µg/m3	ND (3.6)	ND (3.6)	ND (3.6)	ND (3.6)	ND (3.6)	ND (3.6)	ND (3.6)	ND (0.721)	ND (0.721)
NAPHTHALENE	µg/m3	ND (5.2)	ND (5.2)	ND (5.2)	ND (5.2)	ND (5.2)	ND (5.2)	ND (5.2)	ND (3.30)	ND (3.30)
TOLUENE	µg/m3	3.1 J	4.6	3.9	2.2 J	13	2.6 J	3.9	2.06	2.57
1,2,4-TRIMETHYLBENZENE**	µg/m3	1.1 J	12	1.4 J	ND (4.9)	3.6 J	1.1 J	ND (4.9)	ND (0.982)	ND (0.982)
1,3,5-TRIMETHYLBENZENE**	µg/m3	ND (4.9)	3.2 J	ND (4.9)	ND (4.9)	1.3 J	ND (4.9)	ND (4.9)	ND (0.982)	ND (0.982)
TOTAL XYLENE	µg/m3	7.7	11.1	4.7 J	3.3 J	11.9	9.8	14.1	ND (1.73)	1.76

Notes:

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MH Air Tox	Marcus Hook Air Toxics Monitor 2015, maximum value of PADEP data accessed February 5, 2016.
EPA Res IA	USEPA Background Residential Indoor Air 2011, 95th percentile.
*	95th percentile value not provided, value is 90th percentile.
6.5^{A}	Concentration exceeds the VI-PA SHS
6.5^{A}	Concentration exceeds the indicated standard.
15.2	Measured concentration did not exceed the indicated standard.
ND (0.03)	Analyte was not detected at a concentration greater than the laboratory reporting limit.
n/v	No standard/guideline value.

Table 1
Indoor Air Sampling Data
Philadelphia Energy Systems Complex, on behalf of Evergreen Resources Group, LLC

Sample Location		AOI5-AI-16-005	AOI5-AI-16-006	AOI6-AI-16-001	AOI6-AI-16-002	AOI6-AI-16-003	AOI6-AI-16-004	AOI6-AI-16-005	AOI6-AI-16-006	AOI6-AI-16-007
		GP2 Dock	034A/B Building	475 Building	745 Building	Control Room, 6627 Building	Truck Scale House, 6636 Building	Control Room, 739 Building	726 Building, Carpenter Shop	178 Building, Carpenter Trade Shop
Sample Date		28-Mar-16	28-Mar-16	28-Mar-16	28-Mar-16	28-Mar-16	28-Mar-16	28-Mar-16	29-Mar-16	29-Mar-16
Sample ID		IA-AOI5-GP DOCK 2	IA-AOI5-034A/B	IA-AOI6-475	IA-AOI6-745	IA-AOI6-6627	IA-AOI6-6636	IA-AOI6-739	IA-AOI6-726	IA-AOI6-178
Sampling Company		GHD	GHD	GHD	GHD	GHD	GHD	GHD	GHD	GHD
Laboratory		LL	LL	LL	LL	LL	LL	LL	ESC	ESC
Laboratory Work Order		MHF24	MHF24	MHF24	MHF24	MHF24	MHF24	MHF24	L827327	L827327
Laboratory Sample ID		8316888	8316889	8316892	8316893	8316894	8316895	8316896	L827327-02	L827327-03
Sample Type	Units									

J Indicates an estimated value.

Table 1
Indoor Air Sampling Data
Philadelphia Energy Systems Complex, on behalf of Evergreen Resources Group, LLC

Sample Location		AOI6-AI-16-008	AOI6-AI-16-009	AOI7-AI-16-001	AOI7-AI-16-002	AOI7-AI-16-003	AOI7-AI-16-004	AOI7-AI-16-005	AOI7-AI-16-006	AOI7-AI-16-007
		295 GP Office Building 1st Floor	295 GP Office Building 2nd Floor	595 Canteen Building	450 Elect Building, Computer Room	450 Building Elect Warehouse, Back Addition on Shelf	450 Building Elect Warehouse, North Side	450 Building Elect Warehouse, Walled area Middle Bldg, Elect Testing	450 Building Elect Warehouse Table East Side Near Open Offices	442 Building Firehouse Office Table Office
Sample Date		**29-Mar-16**	**29-Mar-16**	**29-Mar-16**	**29-Mar-16**	**29-Mar-16**	**29-Mar-16**	**29-Mar-16**	**29-Mar-16**	**29-Mar-16**
Sample ID		**IA-AOI6-295-1**	**IA-AOI6-295-2**	**IA-AOI7-595**	**IA-AOI7-450-1**	**IA-AOI7-450-2**	**IA-AOI7-450-3**	**IA-AOI7-450-4**	**IA-AOI7-450-5**	**IA-AOI7-442**
Sampling Company		**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**
Laboratory		**ESC**	**ESC**	**ESC**	**ESC**	**ESC**	**ESC**	**ESC**	**ESC**	**ESC**
Laboratory Work Order		**L827327**	**L827327**	**L827327**	**L827327**	**L827327**	**L827327**	**L827327**	**L827327**	**L827327**
Laboratory Sample ID		**L827327-05**	**L827327-06**	**L827327-07**	**L827327-08**	**L827327-09**	**L827327-10**	**L827327-11**	**L827327-12**	**L827327-13**
Sample Type	**Units**									
Volatile Organic Compounds										
BENZENE	µg/m3	***3.97***^{BE}	***3.94***^{BE}	***4.63***^{BE}	1.00	0.860	0.973	1.54	***1.99***^{BE}	***1.68***^{BE}
1,2-DIBROMOETHANE (EDB)	µg/m3	ND (1.54)	ND (1.54)	ND (1.54)	ND (1.54)	ND (1.54)	ND (1.54)	ND (1.54)	ND (1.54)	ND (1.54)
1,2-DICHLOROETHANE (EDC)	µg/m3	ND (0.810)	ND (0.810)	ND (0.810)	ND (0.810)	ND (0.810)	ND (0.810)	ND (0.810)	ND (0.810)	ND (0.810)
ETHYLBENZENE	µg/m3	ND (0.867)	0.960	ND (0.867)	1.12	ND (0.867)	ND (0.867)	1.19	2.58	1.38
ISOPROPYLBENZENE (CUMENE)	µg/m3	ND (0.983)	ND (0.983)	ND (0.983)	ND (0.983)	ND (0.983)	ND (0.983)	ND (0.983)	ND (0.983)	ND (0.983)
METHYL TERTIARY BUTYL ETHER	µg/m3	ND (0.721)	ND (0.721)	ND (0.721)	ND (0.721)	ND (0.721)	ND (0.721)	ND (0.721)	ND (0.721)	ND (0.721)
NAPHTHALENE	µg/m3	ND (3.30)	ND (3.30)	ND (3.30)	ND (3.30)	ND (3.30)	ND (3.30)	ND (3.30)	ND (3.30)	ND (3.30)
TOLUENE	µg/m3	3.12	3.11	5.51	10.5	3.15	4.12	8.91	49.8	19.1
1,2,4-TRIMETHYLBENZENE**	µg/m3	2.18	2.04	1.09	1.05	ND (0.982)	ND (0.982)	1.23	2.13	1.22
1,3,5-TRIMETHYLBENZENE**	µg/m3	ND (0.982)	ND (0.982)	ND (0.982)	ND (0.982)	ND (0.982)	ND (0.982)	ND (0.982)	ND (0.982)	ND (0.982)
TOTAL XYLENE	µg/m3	2.2	2.29	3.371	6.25	2.09	ND (1.73)	4.46	10.76	4.99

Notes:

VI-PA^{A}	PADEP Indoor Air Statewide Health Standard Vapor Intrusion Screening Values, Non-Residential (Draft, July 2015).
VI-PA^{B}	1/10th of the PADEP Indoor Air Statewide Health Standard Vapor Intrusion Screening Values, Non-Residential (Draft, July 2015).
OSHA^{C}	Occupational Safety and Health Administration - Permissible Exposure Limits
USEPA RSL^{D}	United States Environmental Protection Agency Non-residential indoor air Cancer Risk of 1E-5 and Hazard Index of 1.
USEPA RSL^{E}	United States Environmental Protection Agency Non-residential indoor air Cancer Risk of 1E-6 and Hazard Index of 0.1.
**	The RSL for TMB were calculated using the September 2016 final IRIS RfD.
ACGIH TLV^{F}	American Conference of Governmental Industrial Hygienists - Threshold Limit Value
NIOSH^{G}	National Institute for Occupational Safety and Health - Recommended Exposure Limits
MH Air Tox	Marcus Hook Air Toxics Monitor 2015, maximum value of PADEP data accessed February 5, 2016.
EPA Res IA	USEPA Background Residential Indoor Air 2011, 95th percentile.
*	95th percentile value not provided, value is 90th percentile.
6.5^{A}	Concentration exceeds the VI-PA SHS
6.5^{A}	Concentration exceeds the indicated standard.
15.2	Measured concentration did not exceed the indicated standard.
ND (0.03)	Analyte was not detected at a concentration greater than the laboratory reporting limit.
n/v	No standard/guideline value.

Table 1
Indoor Air Sampling Data
Philadelphia Energy Systems Complex, on behalf of Evergreen Resources Group, LLC

Sample Location		AOI6-AI-16-008	AOI6-AI-16-009	AOI7-AI-16-001	AOI7-AI-16-002	AOI7-AI-16-003	AOI7-AI-16-004	AOI7-AI-16-005	AOI7-AI-16-006	AOI7-AI-16-007
		295 GP Office Building 1st Floor	295 GP Office Building 2nd Floor	595 Canteen Building	450 Elect Building, Computer Room	450 Building Elect Warehouse, Back Addition on Shelf	450 Building Elect Warehouse, North Side	450 Building Elect Warehouse, Walled area Middle Bldg, Elect Testing	450 Building Elect Warehouse Table East Side Near Open Offices	442 Building Firehouse Office Table Office
Sample Date		29-Mar-16	29-Mar-16	29-Mar-16	29-Mar-16	29-Mar-16	29-Mar-16	29-Mar-16	29-Mar-16	29-Mar-16
Sample ID		IA-AOI6-295-1	IA-AOI6-295-2	IA-AOI7-595	IA-AOI7-450-1	IA-AOI7-450-2	IA-AOI7-450-3	IA-AOI7-450-4	IA-AOI7-450-5	IA-AOI7-442
Sampling Company		GHD	GHD	GHD	GHD	GHD	GHD	GHD	GHD	GHD
Laboratory		ESC	ESC	ESC	ESC	ESC	ESC	ESC	ESC	ESC
Laboratory Work Order		L827327	L827327	L827327	L827327	L827327	L827327	L827327	L827327	L827327
Laboratory Sample ID		L827327-05	L827327-06	L827327-07	L827327-08	L827327-09	L827327-10	L827327-11	L827327-12	L827327-13
Sample Type	Units									

J Indicates an estimated value.

Table 1
Indoor Air Sampling Data
Philadelphia Energy Systems Complex, on behalf of Evergreen Resources Group, LLC

Sample Location		AOI7-AI-16-008	AOI7-AI-16-009	AOI7-AI-16-010	AOI7-AI-16-011	AOI8-AI-16-001	AOI8-AI-16-002	AOI8-AI-16-003	AOI8-AI-16-004	
		711 Building, WTP	6622 Building, Control Room, Rear Table Center of Room	6626 Building, Control Room	6625 Building, Control Room, MF Unit	6642 Building, North Yard Trailers	6641 Building, North Yard Trailer	3326 Building North Yard Scale House	27 Building, North Yard Old Scale House	27 Building, North Yard Old Scale House
Sample Date		**29-Mar-16**	**29-Mar-16**	**29-Mar-16**	**29-Mar-16**	**29-Mar-16**	**29-Mar-16**	**29-Mar-16**	**29-Mar-16**	**29-Mar-16**
Sample ID		**IA-AOI7-711**	**IA-AOI7-6622**	**IA-AOI7-6626**	**IA-AOI7-6625**	**IA-AOI8-6642**	**IA-AOI8-6641**	**IA-AOI8-3326**	**IA-AOI8-27**	**IA-AOI8-27-DUP**
Sampling Company		**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**
Laboratory		**ESC**	**ESC**	**ESC**	**ESC**	**ESC**	**ESC**	**ESC**	**ESC**	**ESC**
Laboratory Work Order		**L827327**	**L827327**	**L827327**	**L827327**	**L827327**	**L827327**	**L827327**	**L827327**	**L827327**
Laboratory Sample ID		**L827327-14**	**L827327-16**	**L827327-17**	**L827327-18**	**L827327-19**	**L827327-20**	**L827327-21**	**L827327-22**	**L827327-23**
Sample Type	**Units**									**Field Duplicate**
Volatile Organic Compounds										
BENZENE	µg/m3	***2.22*** ^{BE}	***3.52*** ^{BE}	***3.36*** ^{BE}	***1.63*** ^{BE}	ND (0.639)	ND (0.639)	ND (0.639)	ND (0.639)	ND (0.639)
1,2-DIBROMOETHANE (EDB)	µg/m3	ND (1.54)	ND (1.54)	ND (1.54)	ND (1.54)	ND (1.54)	ND (1.54)	ND (1.54)	ND (1.54)	ND (1.54)
1,2-DICHLOROETHANE (EDC)	µg/m3	ND (0.810)	ND (0.810)	ND (0.810)	ND (0.810)	ND (0.810)	ND (0.810)	ND (0.810)	ND (0.810)	ND (0.810)
ETHYLBENZENE	µg/m3	ND (0.867)	***4.94*** ^{BE}	1.60	4.22	ND (0.867)	ND (0.867)	ND (0.867)	ND (0.867)	ND (0.867)
ISOPROPYLBENZENE (CUMENE)	µg/m3	ND (0.983)	1.27	2.09	ND (0.983)	ND (0.983)	ND (0.983)	ND (0.983)	ND (0.983)	ND (0.983)
METHYL TERTIARY BUTYL ETHER	µg/m3	ND (0.721)	ND (0.721)	ND (0.721)	ND (0.721)	ND (0.721)	ND (0.721)	ND (0.721)	ND (0.721)	ND (0.721)
NAPHTHALENE	µg/m3	ND (3.30)	ND (3.30)	ND (3.30)	ND (3.30)	ND (3.30)	ND (3.30)	ND (3.30)	ND (3.30)	ND (3.30)
TOLUENE	µg/m3	3.93	7.29	3.06	71.4	1.23	2.56	1.14	ND (0.753)	1.01
1,2,4-TRIMETHYLBENZENE**	µg/m3	2.94	21.6	3.81	6.40	ND (0.982)	ND (0.982)	ND (0.982)	ND (0.982)	ND (0.982)
1,3,5-TRIMETHYLBENZENE**	µg/m3	0.984	6.81	1.19	1.78	ND (0.982)	ND (0.982)	ND (0.982)	ND (0.982)	ND (0.982)
TOTAL XYLENE	µg/m3	3.5	24.69	7.19	17.05	ND (1.73)	ND (1.73)	1.78	ND (1.73)	ND (1.73)

Notes:

VI-PA^{A}	PADEP Indoor Air Statewide Health Standard Vapor Intrusion Screening Values, Non-Residential (Draft, July 2015).
VI-PA^{B}	1/10th of the PADEP Indoor Air Statewide Health Standard Vapor Intrusion Screening Values, Non-Residential (Draft, July 2015).
OSHA^{C}	Occupational Safety and Health Administration - Permissible Exposure Limits
USEPA RSL^{D}	United States Environmental Protection Agency Non-residential indoor air Cancer Risk of 1E-5 and Hazard Index of 1.
USEPA RSL^{E}	United States Environmental Protection Agency Non-residential indoor air Cancer Risk of 1E-6 and Hazard Index of 0.1.
**	The RSL for TMB were calculated using the September 2016 final IRIS RfD.
ACGIH TLV^{F}	American Conference of Governmental Industrial Hygienists - Threshold Limit Value
NIOSH^{G}	National Institute for Occupational Safety and Health - Recommended Exposure Limits
MH Air Tox	Marcus Hook Air Toxics Monitor 2015, maximum value of PADEP data accessed February 5, 2016.
EPA Res IA	USEPA Background Residential Indoor Air 2011, 95th percentile.
*	95th percentile value not provided, value is 90th percentile.
6.5 ^{A}	Concentration exceeds the VI-PA SHS
6.5 ^{A}	Concentration exceeds the indicated standard.
15.2	Measured concentration did not exceed the indicated standard.
ND (0.03)	Analyte was not detected at a concentration greater than the laboratory reporting limit.
n/v	No standard/guideline value.

Table 1
Indoor Air Sampling Data
Philadelphia Energy Systems Complex, on behalf of Evergreen Resources Group, LLC

Sample Location		AOI7-AI-16-008	AOI7-AI-16-009	AOI7-AI-16-010	AOI7-AI-16-011	AOI8-AI-16-001	AOI8-AI-16-002	AOI8-AI-16-003	AOI8-AI-16-004	
		711 Building, WTP	6622 Building, Control Room, Rear Table Center of Room	6626 Building, Control Room	6625 Building, Control Room, MF Unit	6642 Building, North Yard Trailers	6641 Building, North Yard Trailer	3326 Building North Yard Scale House	27 Building, North Yard Old Scale House	27 Building, North Yard Old Scale House
Sample Date		29-Mar-16	29-Mar-16	29-Mar-16	29-Mar-16	29-Mar-16	29-Mar-16	29-Mar-16	29-Mar-16	29-Mar-16
Sample ID		IA-AOI7-711	IA-AOI7-6622	IA-AOI7-6626	IA-AOI7-6625	IA-AOI8-6642	IA-AOI8-6641	IA-AOI8-3326	IA-AOI8-27	IA-AOI8-27-DUP
Sampling Company		GHD	GHD	GHD	GHD	GHD	GHD	GHD	GHD	GHD
Laboratory		ESC	ESC	ESC	ESC	ESC	ESC	ESC	ESC	ESC
Laboratory Work Order		L827327	L827327	L827327	L827327	L827327	L827327	L827327	L827327	L827327
Laboratory Sample ID		L827327-14	L827327-16	L827327-17	L827327-18	L827327-19	L827327-20	L827327-21	L827327-22	L827327-23
Sample Type	Units									Field Duplicate

J Indicates an estimated value.

Table 1
Indoor Air Sampling Data
Philadelphia Energy Systems Complex, on behalf of Evergreen Resources Group, LLC

Sample Location		**AOI9-AI-16-001**	**AOI9-AI-16-002**	
		SR2 Corner Office	**Loading Dock Office SR9**	**Loading Dock Office SR9**
Sample Date		**5-Apr-16**	**5-Apr-16**	**5-Apr-16**
Sample ID		**IA-AOI9-SR2**	**IA-AOI9-SR9**	**IA-AOI9-SR9-DUP**
Sampling Company		**GHD**	**GHD**	**GHD**
Laboratory		**LL**	**LL**	**LL**
Laboratory Work Order		**MHF26**	**MHF26**	**MHF26**
Laboratory Sample ID		**8322922**	**8322924**	**8322925**
Sample Type	**Units**			**Field Duplicate**
Volatile Organic Compounds				
BENZENE	µg/m3	1.3 J	0.71 J	0.64 J
1,2-DIBROMOETHANE (EDB)	µg/m3	ND (7.7)	ND (7.7)	ND (7.7)
1,2-DICHLOROETHANE (EDC)	µg/m3	ND (4.0)	ND (4.0)	ND (4.0)
ETHYLBENZENE	µg/m3	2.9 J	ND (4.3)	1.5 J
ISOPROPYLBENZENE (CUMENE)	µg/m3	ND (4.9)	ND (4.9)	ND (4.9)
METHYL TERTIARY BUTYL ETHER	µg/m3	ND (3.6)	ND (3.6)	ND (3.6)
NAPHTHALENE	µg/m3	ND (5.2)	ND (5.2)	ND (5.2)
TOLUENE	µg/m3	4.1	0.88 J	0.88 J
1,2,4-TRIMETHYLBENZENE**	µg/m3	1.2 J	ND (4.9)	ND (4.9)
1,3,5-TRIMETHYLBENZENE**	µg/m3	ND (4.9)	ND (4.9)	ND (4.9)
TOTAL XYLENE	µg/m3	14.5	1.1 J	7 J

Notes:

VI-PA^{A}	PADEP Indoor Air Statewide Health Standard Vapor Intrusion Screening Values, Non-Residential (Draft, July 2015).
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USEPA RSL^{E}	United States Environmental Protection Agency Non-residential indoor air Cancer Risk of 1E-6 and Hazard Index of 0.1.
**	The RSL for TMB were calculated using the September 2016 final IRIS RfD.
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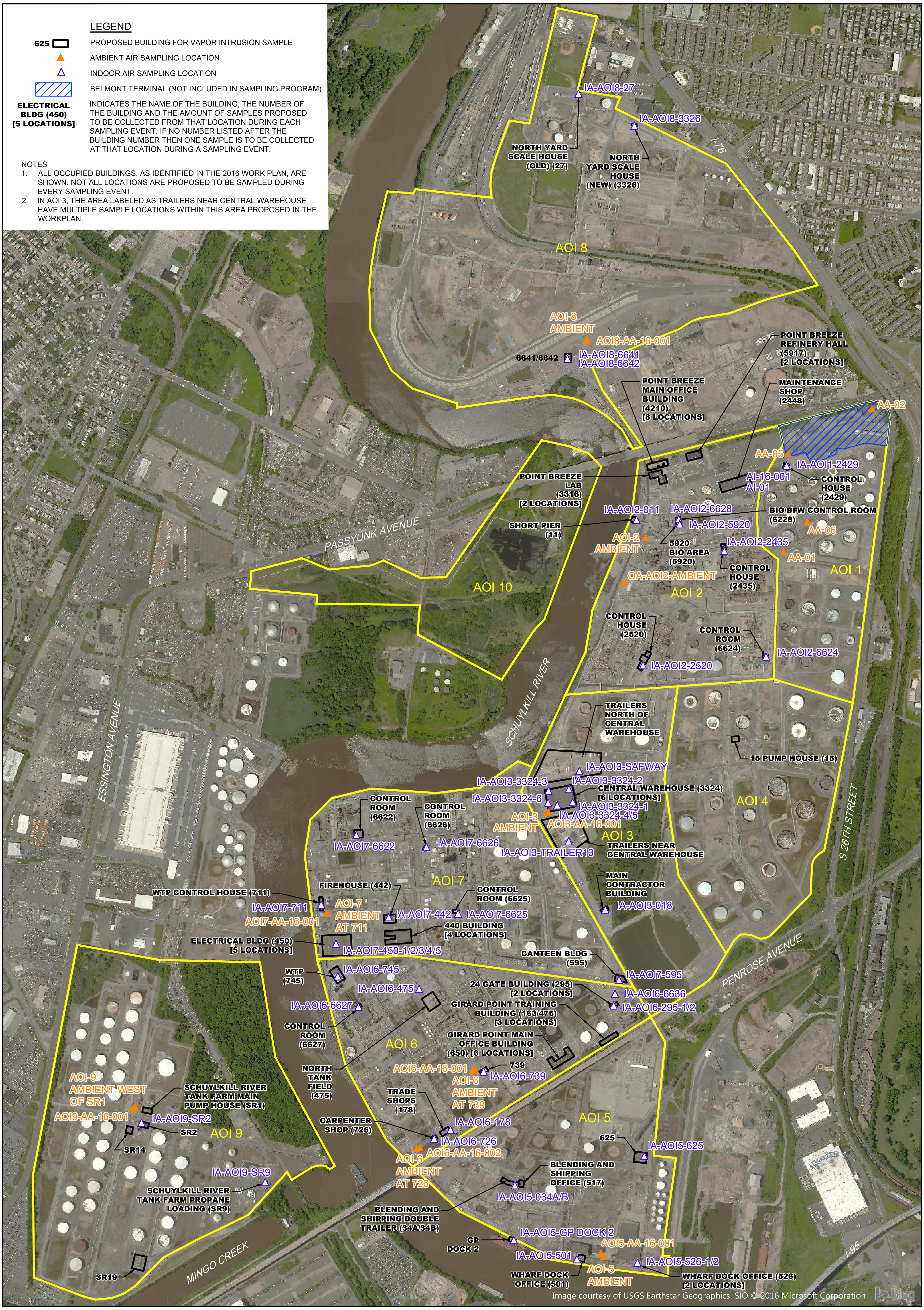
EPA Res IA	USEPA Background Residential Indoor Air 2011, 95th percentile.
*	95th percentile value not provided, value is 90th percentile.
6.5^{A}	Concentration exceeds the VI-PA SHS
6.5^{A}	Concentration exceeds the indicated standard.
15.2	Measured concentration did not exceed the indicated standard.
ND (0.03)	Analyte was not detected at a concentration greater than the laboratory reporting limit.
n/v	No standard/guideline value.

Table 1
Indoor Air Sampling Data
Philadelphia Energy Systems Complex, on behalf of Evergreen Resources Group, LLC

Sample Location		AOI9-AI-16-001	AOI9-AI-16-002	
		SR2 Corner Office	Loading Dock Office SR9	Loading Dock Office SR9
Sample Date		5-Apr-16	5-Apr-16	5-Apr-16
Sample ID		IA-AOI9-SR2	IA-AOI9-SR9	IA-AOI9-SR9-DUP
Sampling Company		GHD	GHD	GHD
Laboratory		LL	LL	LL
Laboratory Work Order		MHF26	MHF26	MHF26
Laboratory Sample ID		8322922	8322924	8322925
Sample Type	Units			Field Duplicate

J Indicates an estimated value.



LEGEND

625 ▭	PROPOSED BUILDING FOR VAPOR INTRUSION SAMPLE
▲	AMBIENT AIR SAMPLING LOCATION
△	INDOOR AIR SAMPLING LOCATION
▨	BELMONT TERMINAL (NOT INCLUDED IN SAMPLING PROGRAM)
ELECTRICAL BLDG (450) [5 LOCATIONS]	INDICATES THE NAME OF THE BUILDING, THE NUMBER OF THE BUILDING AND THE AMOUNT OF SAMPLES PROPOSED TO BE COLLECTED FROM THAT LOCATION DURING EACH SAMPLING EVENT. IF NO NUMBER LISTED AFTER THE BUILDING NUMBER THEN ONE SAMPLE IS TO BE COLLECTED AT THAT LOCATION DURING A SAMPLING EVENT.

NOTES
1. ALL OCCUPIED BUILDINGS, AS IDENTIFIED IN THE 2016 WORK PLAN, ARE SHOWN. NOT ALL LOCATIONS ARE PROPOSED TO BE SAMPLED DURING EVERY SAMPLING EVENT.
2. IN AOI 3, THE AREA LABELED AS TRAILERS NEAR CENTRAL WAREHOUSE HAVE MULTIPLE SAMPLE LOCATIONS WITHIN THIS AREA PROPOSED IN THE WORKPLAN.

Source: Microsoft Product Screen Shot(s) Reprinted with permission from Microsoft Corporation, Acquisition Date: June 2014, Accessed: 2016.

0 500 1000ft

Coordinate System:
PENNSYLVANIA SOUTH
NAD83

N

GHD

PHILADELPHIA ENERGY SOLUTIONS FACILITY
PHILADELPHIA, PENNSYLVANIA

11109626-00

Oct 20, 2016

INDOOR AIR AND AMBIENT AIR SAMPLING LOCATIONS

FIGURE 1

CAD File: P:\drawings\11109000s\11109626\11109626-CORR\11109626-00(DOER001)\11109626-00(DOER001)GN\11109626-00(DOER001)GN-WA001.dwg

Memorandum

To:	Colleen Costello	Ref. No.:	11109626
From:	Paul McMahon/adh/1 Pm	Date:	May 10, 2016
CC:	David Steele		

Re: **Analytical Results and Reduced Validation**
Air Investigation
Evergreen Resources Philadelphia
Philadelphia, Pennsylvania
March - April 2016

---

1. Introduction

The following document details a reduced validation of analytical results for air samples collected in support of the investigation at the Philadelphia, Pennsylvania site during March - April 2016. The samples were analyzed for volatile organic compounds (VOCs) by Eurofins Lancaster Laboratories Environmental, located in Lancaster, Pennsylvania and ESC Lab Sciences in Mount Juliet, Tennessee. A sample collection and analysis summary is presented in Table 1. A summary of the analytical methodology is presented in Table 2.

Copies of the fully executed chain of custody forms are attached.

Standard GHD report deliverables were submitted by the laboratory. The final results and supporting quality assurance/quality control (QA/QC) data were assessed. Evaluation of the data was based on information obtained from the chain of custody forms, finished report forms, method blank data, and recovery data from laboratory control samples (LCS).

The QA/QC criteria by which these data have been assessed are outlined in the analytical method referenced in Table 2 and applicable guidance from the "USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review", United States Environmental Protection Agency (USEPA) 540 R 08 01, June 2008.

2. Sample Holding Time and Preservation

The sample holding time criterion for the analyses is summarized in Table 2. The sample chain of custody documents and analytical reports were used to determine sample holding times. All samples were analyzed within the required holding times.

GHD Services Inc.
2055 Niagara Falls Boulevard Niagara Falls New York 14304 USA
T 716 297 6150 **F** 716 297 2265 **W** www.ghd.com

3. Laboratory Method Blank Analyses

Method blanks are prepared from a purified matrix and analyzed with investigative samples to determine the existence and magnitude of sample contamination introduced during the analytical procedures.

For this study, laboratory method blanks were analyzed at a minimum frequency of one per analytical batch.

Most method blank results were non-detect. Naphthalene was detected in one method blank; all associated sample results were non-detect and were not impacted.

4. Laboratory Control Sample Analyses

LCS are prepared and analyzed as samples to assess the analytical efficiencies of the method employed, independent of sample matrix effects.

For this study, LCS were analyzed at a minimum frequency of one per analytical batch.

The LCS contained all compounds of interest. All LCS recoveries were within the laboratory control limits, demonstrating acceptable analytical accuracy.

5. Field QA/QC Samples

To assess the analytical and sampling protocol precision, field duplicate samples were collected and submitted "blind" to the laboratory, as specified in Table 1. The relative percent differences (RPDs) associated with these duplicate samples must be less than 50 percent. If the reported concentration in either the investigative sample or its duplicate is less than five times the reporting limit (RL), the evaluation criterion is one times the RL value.

Most field duplicate results were within acceptable agreement, demonstrating acceptable sampling and analytical precision. Results that did show variability were qualified as estimated (see Table 3).

6. Analyte Reporting

The laboratories reported detected results down to the laboratory's method detection limit (MDL) for each analyte. Positive analyte detections less than the RL but greater than the MDL were qualified as estimated (J) unless qualified otherwise in this memorandum. Non-detect results were presented as non-detect at the RL.

7. Conclusion

Based on the assessment detailed in the foregoing, the data are acceptable with the noted qualifications.

Table 1

Sample Collection and Analysis Summary
Air Investigation
Evergreen Resources Philadelphia
Philadelphia, Pennsylvania
March - April 2016

						Analysis/Parameters	
Sample Identification	**Location**	**Matrix**	**Collection Date (mm/dd/yyyy)**	**Collection Time (Start) (hr:min)**	**Collection Time (Stop) (hr:min)**	**VOCs**	**Comments**
IA-AOI3-018	AOI3-AI-16-009	Air	03/29/2016	07:14	14:55	X	
IA-AOI6-726	AOI6-AI-16-006	Air	03/29/2016	07:37	15:39	X	
IA-AOI6-178	AOI6-AI-16-007	Air	03/29/2016	07:43	15:42	X	
IA-AOI6-OUTDOOR-032916	AOI6-AA-16-002	Air	03/29/2016	07:50	15:45	X	
IA-AOI6-295-1	AOI6-AI-16-008	Air	03/29/2016	08:02	15:54	X	
IA-AOI6-295-2	AOI6-AI-16-009	Air	03/29/2016	08:07	15:56	X	
IA-AOI7-595	AOI7-AI-16-001	Air	03/29/2016	08:21	16:04	X	
IA-AOI7-450-1	AOI7-AI-16-002	Air	03/29/2016	08:39	16:13	X	
IA-AOI7-450-2	AOI7-AI-16-003	Air	03/29/2016	08:48	16:18	X	
IA-AOI7-450-3	AOI7-AI-16-004	Air	03/29/2016	08:55	16:21	X	
IA-AOI7-450-4	AOI7-AI-16-005	Air	03/29/2016	08:58	15:23	X	
IA-AOI7-450-5	AOI7-AI-16-006	Air	03/29/2016	09:04	15:26	X	
IA-AOI7-442	AOI7-AI-16-007	Air	03/29/2016	09:19	16:38	X	
IA-AOI7-711	AOI7-AI-16-008	Air	03/29/2016	09:30	17:20	X	
IA-AOI7-OUTDOOR	AOI7-AA-16-001	Air	03/29/2016	09:28	17:01	X	
IA-AOI7-6622	AOI7-AI-16-009	Air	03/29/2016	09:40	17:30	X	
IA-AOI7-6626	AOI7-AI-16-0010	Air	03/29/2016	09:47	17:35	X	
IA-AOI7-6625	AOI7-AI-16-011	Air	03/29/2016	09:59	17:42	X	
IA-AOI8-6642	AOI8-AI-16-001	Air	03/29/2016	10:26	18:35	X	
IA-AOI8-6641	AOI8-AI-16-002	Air	03/29/2016	10:30	17:57	X	
IA-AOI8-3326	AOI8-AI-16-003	Air	03/29/2016	10:42	18:10	X	
IA-AOI8-27	AOI8-AI-16-004	Air	03/29/2016	10:52	18:16	X	
IA-AOI8-27-DUP	AOI8-AI-16-004	Air	03/29/2016	10:52	18:16	X	Duplicate of IA-AOI8-27
IA-AOI8-OUTDOOR	AOI8-AA-16-001	Air	03/29/2016	11:08	16:30	X	
						X	
IA-AOI1-2429	AOI1-AI-16-001	Air	03/22/2016	08:12	16:01	X	
IA-AOI2-5920	AOI2-AI-16-001	Air	03/22/2016	08:32	16:22	X	
IA-AOI2-6628	AOI2-AI-16-002	Air	03/22/2016	08:44	16:30	X	
IA-AIO2-2435	AOI2-AI-16-003	Air	03/22/2016	09:00	16:40	X	
IA-AIO2-6624	AOI2-AI-16-004	Air	03/22/2016	09:15	17:43	X	
IA-AIO2-2520	AOI2-AI-16-005	Air	03/22/2016	09:28	17:00	X	
IA-AOI2-AMBIENT	AOI2-AA-16-001	Air	03/22/2016	09:40	17:08	X	
IA-AOI3-SAFWAY	AOI3-AI-16-001	Air	03/22/2016	10:00	18:43	X	

Table 1

Sample Collection and Analysis Summary
Air Investigation
Evergreen Resources Philadelphia
Philadelphia, Pennsylvania
March - April 2016

Sample Identification	Location	Matrix	Collection Date (mm/dd/yyyy)	Collection Time (Start) (hr:min)	Collection Time (Stop) (hr:min)	Analysis/Parameters VOCs	Comments
IA-AOI3-3324-1	AOI3-AI-16-002	Air	03/22/2016	10:19	18:05	X	
IA-AIO3-3324-2	AOI3-AI-16-003	Air	03/22/2016	10:39	18:02	X	
IA-AOI3-3324-3	AOI3-AI-16-004	Air	03/22/2016	10:47	18:33	X	
IA-AOI3-3324-4	AOI3-AI-16	Air	03/22/2016	10:59	18:30	X	
IA-AOI3-3324-5	AOI3-AI-16	Air	03/22/2016	10:59	18:30	X	Duplicate of IA-AOI3-3324-4
IA-AOI3-3324-6	AOI3-AI-16-007	Air	03/22/2016	11:02	18:35	X	
IA-AOI9-SR2	AOI9-AI-16-001	Air	04/05/2016	08:09	16:09	X	
IA-AOI9-OUTDOOR	AOI9-AA-16-001	Air	04/05/2016	08:23	15:24	X	
IA-AOI9-SR9	AOI9-AI-16-002	Air	04/05/2016	08:43	16:15	X	
IA-AOI9-SR9-DUP	AOI9-AI-16-002	Air	04/05/2016	08:43	16:15	X	Duplicate of IA-AOI9-SR9
IA-AOI3-TRAILER13	AOI3-AI-16-008	Air	03/28/2016	07:47	15:35	X	
IA-AOI3-OUTDOOR	AOI3-AA-16-001	Air	03/28/2016	07:58	15:40	X	
IA-AOI5-625	AOI5-AI-16-001	Air	03/28/2016	08:27	15:57	X	
IA-AOI5-526-2	AOI5-AI-16-002	Air	03/28/2016	08:45	16:17	X	
IA-AOI5-526-1	AOI5-AI-16-003	Air	03/28/2016	08:52	17:17	X	
IA-AOI5-501	AOI5-AI-16-004	Air	03/28/2016	09:04	16:31	X	
IA-AOI5-GPDOCK-2	AOI5-AI-16-005	Air	03/28/2016	09:23	17:01	X	
IA-AOI5-034A/B	AOI5-AI-16-006	Air	03/28/2016	09:36	17:30	X	
IA-AOI5-OUTDOOR	AOI5-AA-16-001	Air	03/28/2016	09:45	17:08	X	
IA-AOI2-011	AOI2-AI-16-006	Air	03/28/2016	10:07	17:42	X	
IA-AOI2-475	AOI6-AI-16-001	Air	03/28/2016	10:23	18:23	X	
IA-AOI6-745	AOI6-AI-16-002	Air	03/28/2016	10:33	18:00	X	
IA-AOI6-6627	AOI6-AI-16-003	Air	03/28/2016	10:42	18:08	X	
IA-AOI6-6636	AOI6-AI-16-004	Air	03/28/2016	10:57	18:18	X	
IA-AOI6-739	AOI6-AI-16-005	Air	03/28/2016	11:10	18:33	X	
IA-AOI6-OUTDOOR-739	AOI6-AA-16-001	Air	03/28/2016	11:15	18:29	X	

Notes:

VOCs - Volatile Organic Compounds

Table 2

Analytical Method and Holding Time Criterion
Air Investigation
Evergreen Resources Philadelphia
Philadelphia, Pennsylvania
March - April 2016

Parameter	Method	Matrix	Holding Time Collection to Analysis (Days)
Volatile Organic Compounds (VOCs)	TO-15	Air	30

Notes:

EPA Method TO-15 - "Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air", EPA-625/R-96/010b, January 1999

Table 3

Qualified Sample Data Due to Variability in Field Duplicate Results
Air Investigation
Evergreen Resources Philadelphia
Philadelphia, Pennsylvania
March - April 2016

Parameter	Analyte	RPD/Diff		Sample ID	Qualified Result	Field Duplicate Sample ID	Qualified Result	Units
VOCs	Toluene	59	11	IA-AOI3-3324-4	13 J	IA-AOI3-3324-5	24 J	µg/m^3
	m/p-Xylene	97	3.6		5.5 J		1.9 J	µg/m^3

Notes:

Diff	- Difference (i.e., >1X RL)
RPD	- Relative Percent Difference
J	- Estimated concentration

Summa Canister Field Test Data/Chain of Custody

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For Eurofins Lancaster Laboratories Environmental use only

Acct. # 10177 Group # 1649037 Sample # 8302469-82 Bottle Order (SCR) # ____

Client Information

Client: EVERGREEN

Account #

Project Name/#: PHILA REFINERY

Project Manager: DAVE STEELE

P.O. #

Sampler: Rich Burns

Quote #

Name of state where samples were collected: PA

Turnaround Time Requested (TAT) (circle one)

Standard [✓ Rush (specify)] ____

Data Package Required? Yes No

EDD Required? Yes No

	Temperature (F)		Pressure ("Hg)	
	Start	Stop	Start	Stop
Ambient				
Maximum				
Minimum				

Analyses Requested

Sample Identification	Start Date/Time (24-hour clock)	Stop Date/Time (24-hour clock)	Canister Pressure in Field ("Hg) (Start)	Canister Pressure in Field ("Hg) (Stop)	Interior Temp. (F) (Start)	Interior Temp. (F) (Stop)	Flow Reg. ID	Can ID	Can Size (L)	Controller Flowrate (mL/min)	EPA TO-15 ☐ BTEX ☐ MTBE	EPA 18	EPA 25 (select range below)	Helium as tracer	O2/CO2	Library Search	
IA-AOI1-2429	0812	1601	-30	-9	66.1	72	236464	1372	6	10.7	X						
IA-AOI2-5920	0832	1622	-30	-7	70	71	824841	1373	6	10.4	X						
IA-AOI2-6628	0844	1630	-30	-14	71	70	399352	1374	6	10.1	X						
IA-AOI2-2435	0900	1640	-30	-9	62	68	675018	1375	6	10.7	X						
IA-AOI2-6624	0915	1743	-30	-17	64	71	415317	1376	6	10.5	X						
IA-A012-2500	0928	1700	-30	-10	63	71	399388	1377	6	10.0	X						
OA-A012-AMBIENT	0940	1708	-30	-7	—	—	336682	1378	6	10.7	X						
IA-A013-SAFWAY	1000	1843	-29	-12	61	70	339251	1379	6	10.0	X						
IA-A013-3324-1	1019	1805	-30	-10	60	72	675022	1349	6	10.1	X						
IA-A013-3324-2	1039	18022	-30	-8	64	74	303934	1350	6	10.5	X						
IA-A013-3324-3	1047	1833	-30	-10.5	66	72	824852	1351	6	10.3	X						

Instructions/QC Requirements & Comments

See SHORT LIST OF VOCS ON SSOW

EPA 25 (check one)

☐ C1 - C4
☐ C2 - C10
☐ C1 - C10
☐ C4 - C10 (GRO)
☐ C2 - C4

Canisters Shipped by:	Date/Time:	Canisters Received by:	Date/Time:	Relinquished by:	Date/Time:	Received by:	Date/Time:
23:36	3/18/16	Rich Burns					
Relinquished by:	**Date/Time:**	**Received by:**	**Date/Time:**	**Relinquished by:**	**Date/Time:**	**Received by:**	**Date/Time:**
Rich Burns	3/22 0830		3-23-16 0830				
Relinquished by:	**Date/Time:**	**Received by:**	**Date/Time:**	**Relinquished by:**	**Date/Time:**	**Received by:**	**Date/Time:**
	3-23-16 1341						3/23/16 1545

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7056 1015

Summa Canister Field Test Data/Chain of Custody

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For Eurofins Lancaster Laboratories Environmental use only
Acct. # 10177 Group # 1644037 Sample # 8302409-82 Bottle Order (SCR) # ____________

Client Information

Client: EVERGREEN
Account #:
Project Name/#: EVERGREEN PHILA REFINERY
Project Manager: DAVE STEELE
P.O. #:
Sampler: RICH BURNS
Quote #:
Name of state where samples were collected: PA

Turnaround Time Requested (TAT) (circle one)

Standard [✓ Rush (specify)] ____________

Data Package Required? Yes No

EDD Required? Yes No

	Temperature (F)		Pressure ("Hg)	
	Start	Stop	Start	Stop
Ambient				
Maximum				
Minimum				

Analyses Requested

Sample Identification	Start Date/Time (24-hour clock)	1830 Stop Date/Time (24-hour clock)	Canister Pressure in Field ("Hg) (Start)	Canister Pressure in Field ("Hg) (Stop)	Interior Temp. (F) (Start)	Interior Temp. (F) (Stop)	Flow Reg. ID	Can ID	Can Size (L)	Controller Flowrate (mL/min)	EPA TO - 15	EPA 18 ☐ BTEX ☐ MTBE	EPA 25 (select range below)	Helium as tracer	O2/CO2	Library Search	
IA-AOI3-3324-4	1059	~~1828~~	-30	-10	66	73	337701	1352	6	10.5	X						
IA-AOI3-3324-5	1059	~~1828~~	-30	-9	66	73	204636	1353	6	10.2	X						
IA-AOI3-3324-6	1102	1835	-30	-9	64	73	415324	1354	6	10.6	X						
							329155	1355	6	10.3							
							338046	1356	6	10.4							
							824845	1357	6	10.2							
							993910	1381	6	10.3							
							710628	1382	6	10.6							
							342379	1383	6	10.5							
							824856	1384	6	10.7							
							824844	1385	6	10.4							

Instructions/QC Requirements & Comments

EPA 25 (check one)
☐ C1 - C4
☐ C2 - C10
☐ C1 - C10
☐ C4 - C10 (GRO)
☐ C2 - C4

Canisters Shipped by: 23:30	Date/Time: 3/18/16	Canisters Received by: Rich Burns	Date/Time: 3.22/0730	Relinquished by:	Date/Time:	Received by:	Date/Time:
Relinquished by: Rich Burns	Date/Time: 3-23 830	Received by:	Date/Time: 3-23-16 0830	Relinquished by:	Date/Time:	Received by:	Date/Time:
Relinquished by:	Date/Time: 3-23-16 1241	Received by:	Date/Time:	Relinquished by:	Date/Time:	Received by:	Date/Time: 3/23/16 1545

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Summa Canister Field Test Data/Chain of Cust

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For Eurofins Lancaster Laboratories Environmental use only
Acct. # 10177 Group # 1646959 Sample # 8316882-97 Bottle Order (SCR) # ______

Client Information

Client: Evergreen
Account #:
Project Name/#: PES
Project Manager: Dave Steele
P.O. #:
Sampler: Rich Burns
Quote #:
Name of state where samples were collected: PA

Turnaround Time Requested (TAT) (circle one)

[✓ Standard] Rush (specify) ______

Data Package Required? Yes No

EDD Required? Yes No

	Temperature (F)		Pressure ("Hg)	
	Start	Stop	Start	Stop
Ambient				
Maximum				
Minimum				

Analyses Requested

Sample Identification	3.28.16 Start Date/Time (24-hour clock)	3.28.16 Stop Date/Time (24-hour clock)	Canister Pressure in Field ("Hg) (Start)	Canister Pressure in Field ("Hg) (Stop)	Interior Temp. (F) (Start)	Interior Temp. (F) (Stop)	Flow Reg. ID	Can ID	Can Size (L)	Controller Flowrate (mL/min)	EPA TO-15	EPA 18 ☐ BTEX ☐ MTBE	EPA 25 (select range below)	Helium as tracer	O2/CO2	Library Search
IA-A013-TRAILER 13	0747	1535	-29.5	-7	72.5	74	329159	1355	6		X					
IA-A013-OUTDOOR	0758	1540	-29.5	-1	—	—	415304	1387	6		X					
IA-A015-625	0827	1557	-30	-9	69	74	415271	1385	6		X					
IA-A015-526-2	0845	1617	-30	-9	69	74	824844	1386	6		X					
IA-A015-526-1	0852	1717	-30	-10	63	70	710536	1360	6		X					
IA-A015-501	0904	1631	-30	-6.5	70	80	710595	1388	6		X					
IA-A015-GP DOCK 2	0923	1701	-30	-9	72	83	415275	1359	6		X					
IA-A015-034A/B	0936	1730	-30	-7	68	70	824845	1381	6		X					
IA-A015-OUTDOOR	0945	1708	-30	-7	—	—	338046	1366	6		X					
IA-A012-011	1007	1742	-28.5	-7	67	73	993910	1357	6		X					
IA-A012-475 +	1023	1823	-30	-10+	68	71	809827	1362	6		X					

701-6 per PM.

Instructions/QC Requirements & Comments

see SSOW for petroleum short list.

Page 1 of 2

6 Boxes

EPA 25 (check one)

☐ C1 - C4 ☐ C2 - C10
☐ C1 - C10 ☐ C4 - C10 (GRO)
☐ C2 - C4

Canisters Shipped by: 23:30	Date/Time: 3/18/16	Canisters Received by:	Date/Time:	Relinquished by:	Date/Time:	Received by:	Date/Time:
Relinquished by: Rich Burns	Date/Time: 4.1.16 1545	Received by: Warehouse	Date/Time: 4.1.16 1545	Relinquished by:	Date/Time:	Received by:	Date/Time:
Relinquished by:	Date/Time: 4/4/16 0840	Received by:	Date/Time: 4/4/16 0840	Relinquished by:	Date/Time: 4-4-16 1630	Received by:	Date/Time: 4/4/16 1630

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7056 10

Summa Canister Field Test Data/Chain of Custody

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For Eurofins Lancaster Laboratories Environmental use only
Acct. # 10177 Group # 1646959 Sample # 8316887-97 Bottle Order (SCR) # ______

Client Information

Client: Evergreen
Account #:
Project Name/#: PES
Project Manager: Dave Steele
P.O. #:
Sampler: Rick Burns
Quote #:
Name of state where samples were collected: VA

Turnaround Time Requested (TAT) (circle one)

[✓ Standard] Rush (specify) ______

Data Package Required? Yes No

EDD Required? Yes No

	Temperature (F)		Pressure ("Hg)	
	Start	Stop	Start	Stop
Ambient				
Maximum				
Minimum				

Analyses Requested

Sample Identification	3.28.16 Start Date/Time (24-hour clock)	3.28.16 Stop Date/Time (24-hour clock)	Canister Pressure in Field ("Hg) (Start)	Canister Pressure in Field ("Hg) (Stop)	Interior Temp. (F) (Start)	Interior Temp. (F) (Stop)	Flow Reg. ID	Can ID	Can Size (L)	Controller Flowrate (mL/min)	EPA TO-15	EPA 18	☐ BTEX ☐ MTBE	EPA 25 (select range below)	Helium as tracer	O2/CO2	Library Search	
IA-A016-745	1033	1800	-30	-9.5	68	68	824836	1363	6		X							
IA-A016-6627	1042	1808	-30	-8	65	72	303421	1361	6		X							
IA-A016-6636	1057	1818	-20	-2	64	70	342379	1384	6		X							
IA-A016-739	1110	1833	-30	-8.5	66	67	710628	1382	6		X							
IA-A016-outdoor 739	1115	1829	-23	-23	—	—	824856	1383	6		X							
									6									
									6									
									6									

Instructions/QC Requirements & Comments

see SSOW for petroleum shortlist
Page 2 of 2

EPA 25 (check one)
☐ C1 - C4 ☐ C2 - C10
☐ C1 - C10 ☐ C4 - C10 (GRO)
☐ C2 - C4

Canisters Shipped by: 23:30	Date/Time: 3/18/16	Canisters Received by:	Date/Time:	Relinquished by:	Date/Time:	Received by:	Date/Time:
Relinquished by:	Date/Time: 4.4.16 1545	Received by:	Date/Time: 4.4.16 1545	Relinquished by:	Date/Time:	Received by:	Date/Time:
Relinquished by:	Date/Time: 4/4/16 0840	Received by:	Date/Time: 4-4-16 0840	Relinquished by:	Date/Time: 4-4-16 1630	Received by:	Date/Time: 4/4/16 1630

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7058 10

Summa Canister Field Test Data/Chain of Custody

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For Eurofins Lancaster Laboratories Environmental use only
Acct. # 10177 Group # 1648332 Sample # 8322922-5 Bottle Order (SCR) # ____

Client Information

Client: Evergreen
Account #:
Project Name/#: PES
Project Manager: DAVE STEELE
P.O. #:
Sampler: RICH BURNS
Quote #:
Name of state where samples were collected: PA

Turnaround Time Requested (TAT) (circle one): [✓ Standard] Rush (specify) ____

Data Package Required? Yes No

EDD Required? Yes No

	Temperature (F) Start	Temperature (F) Stop	Pressure ("Hg) Start	Pressure ("Hg) Stop
Ambient				
Maximum				
Minimum				

Sample Identification	4.5.16 Start Date/Time (24-hour clock)	4.5.16 Stop Date/Time (24-hour clock)	Canister Pressure in Field ("Hg) (Start)	Canister Pressure in Field ("Hg) (Stop)	Interior Temp. (F) (Start)	Interior Temp. (F) (Stop)	Flow Reg. ID	Can ID	Can Size (L)	Controller Flowrate (mL/min)	EPA TO-15 ☐ BTEX ☐ MTBE	EPA 18	EPA 25 (select range below)	Helium as tracer	O2/CO2	Library Search
IA-AOI9-SR2	0809	1609	-30	8	59	60	710568	1203	6	10.6	X					
IA-AOI9-OUTDOOR	0823	1524	-30	0	—	—	344364	1255	6	10.3	X					
IA-AOI9-SR9	0843	1615	-29	8	70	70	252265	1282	6	10.5	X					
IA-AOI9-SR9-DUP	0843	1615	-30	6	70	70	336758	1260	6	10.7	X					

Instructions/QC Requirements & Comments

2 Boxes
Order # 186547

EPA 25 (check one)
☐ C1 - C4 ☐ C2 - C10
☐ C1 - C10 ☐ C4 - C10 (GRO)
☐ C2 - C4

Canisters Shipped by: 13:47	Date/Time: 3/31/16	Canisters Received by:	Date/Time:	Relinquished by:	Date/Time:	Received by:	Date/Time:
Relinquished by:	Date/Time:	Received by:	Date/Time: 4.7.16 1105	Relinquished by:	Date/Time:	Received by:	Date/Time:
Relinquished by:	Date/Time: 4.7.16 1629	Received by:	Date/Time:	Relinquished by:	Date/Time:	Received by:	Date/Time: 4/7/16 1629

unoco/GHD

055 Niagara Falls Boulevard
iagara Falls, NY 14304

Billing Information:

Paul McMahon
1755 Wittington Pl., Ste. 500
Dallas, TX 75234

eport to:
aul McMahon

Email To: Paul.McMahon@ghd.com, David.Steele@ghd.com, Richard.Burns@ghd.com

roject
escription: **Sunoco/Evergeen**

City/State Collected: Phila, PA

hone: **716-297-6150**

ax:

Client Project # **11102524**

Lab Project # **SUNGHD-11102524**

ollected by (print): Rick Burns

Site/Facility ID # PES

P.O. #

ollected by (signature):

Rush? (Lab MUST Be Notified)
____ Same Day 200%
____ Next Day 100%
____ Two Day 50%
____ Three Day 25%

Date Results Needed

Email? __No X__Yes
FAX? __No __Yes

mmediately
acked on Ice N____ Y____

Analysis / Container / Preservative

Chain of Custody Page 1 of __

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Fax: 615-758-5859

L# L827327

Table #

Acctnum: **SUNGHD**
Template: **T110832**
Prelogin: **P546860**
TSR: 134 - Mark W. Beasley
PB:

Shipped Via: **FedEX Standard**

Sample ID	Comp/Grab	Matrix *	Depth	Date	Time	No. of Cntrs	TO-15 Summa	Rem./Contaminant	Sample # (lab only)
IA-A013-018	—	Air	—	3.29.16	0714/1455	1	X		-01
IA-A016-726	—	Air	—	3.29.16	0737/1539	1	X		-02
IA-A016-178	—	Air	—	3.29.16	0743/1542	1	X		-03
IA-A016-OUTDOOR-032916	—	Air	—	3.29.16	0750/1545	1	X		-04
IA-A016-295-1	—	Air	—	3.29.16	0802/1554	1	X		-05
IA-A016-295-2	—	Air	—	3.29.16	0807/1556	1	X		-06
IA-A017-595	—	Air	—	3.29.16	0821/1604	1	X		-07
IA-A017-450-1	—	Air	—	3.29.16	0839/1613	1	X		-08
IA-A017-450-2	—	Air	—	3.29.16	0848/1618	1	X		-09
IA-A017-450-3	—	Air	—	3.29.16	0855/1621	1	X		-10

* Matrix: SS - Soil GW - Groundwater WW - WasteWater DW - Drinking Water OT - Other______

6711 0333 3505 3457
3480 3468
3479 3446

pH _____ Temp _____
Flow _____ Other _____

Remarks: see SSOW for Short List TO-15
6 Large Boxes, 1 small Box

Hold #

Condition: (lab use only) TD

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)
	4.1.16	1500	FedEx
Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)
Relinquished by: (Signature)	Date:	Time:	Received for lab by: (Signature)

Samples returned via: ☐ UPS ☒ FedEx ☐ Courier ☐ ____

Temp: Amb. °C Bottles Received: 25

Date: 4-4-16 Time: 0930

COC Seal Intact: ___Y ___N ✓ NA ok

pH Checked:

NCF:

Chain of Custody Page 2 of

ESC
LAB SCIENCES
YOUR LAB OF CHOICE

12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

unoco/GHD

055 Niagara Falls Boulevard
iagara Falls, NY 14304

Billing Information:

Paul McMahon
1755 Wittington Pl., Ste. 500
Dallas, TX 75234

Email To: Paul.McMahon@ghd.com, David.Steele@ghd.com, Richard.Burns@ghd.com

eport to:
aul McMahon

roject
escription: Sunoco/Evergeen

City/State Collected: Phila, PA

hone: 716-297-6150
ax:

Client Project # 11102524

Lab Project # SUNGHD-11102524

ollected by (print): Rich Burns

Site/Facility ID # PES

P.O. #

ollected by (signature):

Immediately Packed on Ice N____ Y____

Rush? (Lab MUST Be Notified)
____ Same Day 200%
____ Next Day 100%
____ Two Day 50%
____ Three Day 25%

Date Results Needed

Email? ___No X__Yes
FAX? ___No ___Yes

L # L827327

Table #

Acctnum: SUNGHD
Template: T110832
Prelogin: P546860
TSR: 134 - Mark W. Beasley
PB:
Shipped Via: FedEX Standard

Analysis / Container / Preservative

Sample ID	Comp/Grab	Matrix *	Depth	Date	Time	No. of Cntrs	TO-15 Summa	Rem./Contaminant	Sample # (lab only)
IA-A017-450-4	—	Air	—	3.29.16	0858/1523	1	X		-11
IA-A017-450-5	—	Air	—	3.29.16	0904/1526	1	X		-12
IA-A017-442	—	Air	—	3.29.16	0919/1628	1	X		-13
IA-A017-711	—	Air	—	3.29.16	0930/1720	1	X		-14
IA-A017-OUTDOOR	—	Air	—	3.29.16	0928/1701	1	X		-15
IA-A017-6622	—	Air	—	3.29.16	0940/1730	1	X		-16
IA-A017-6626	—	Air	—	3.29.16	0947/1735	1	X		-17
IA-A017-6625	—	Air	—	3.29.16	0959/1742	1	X		-18
IA-A018-6642	—	Air	—	3.29.16	1026/1835	1	X		-19
IA-A018-6641	—	Air	—	3.29.16	1030/1757	1	X		-20

* Matrix: SS - Soil GW - Groundwater WW - WasteWater DW - Drinking Water OT - Other________

Remarks: SEE SSOW FOR SHORT LIST TO-15

pH ________ Temp ________

Flow ________ Other ________

Hold #

Condition: (lab use only) TD OK

COC Seal Intact: ___Y ___N ✓ NA

pH Checked:

NCF:

Samples returned via: ☐ UPS
☒ FedEx ☐ Courier ☐ ______

Relinquished by : (Signature)	Date: 4.1.16	Time: 1500	Received by: (Signature) FedEx
Relinquished by : (Signature)	Date:	Time:	Received by: (Signature)
Relinquished by : (Signature)	Date:	Time:	Received for lab by: (Signature)

Temp: Amb. °C Bottles Received: 25

Date: 4.4.16 Time: 0930

Chain of Custody Page 3 of 3

ESC LAB SCIENCES

12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

Sunoco/GHD

2055 Niagara Falls Boulevard
Niagara Falls, NY 14304

Billing Information:

Paul McMahon
1755 Wittington Pl., Ste. 500
Dallas, TX 75234

Email To: Paul.McMahon@ghd.com, David.Steele@ghd.com, Richard.Burns@ghd.com

Report to: Paul McMahon

Project Description: Sunoco/Evergeen

City/State Collected: PHILA, PA

Phone: 716-297-6150

Fax:

Client Project # 11102524

Lab Project # SUNGHD-11102524

Collected by (print): Rich Burns

Site/Facility ID # PES

P.O. #

Collected by (signature): Rich Burns

Rush? (Lab MUST Be Notified)
___ Same Day 200%
___ Next Day 100%
___ Two Day 50%
___ Three Day 25%

Date Results Needed

Immediately Packed on Ice N ___ Y ___

Email? ___No X Yes

FAX? ___No ___Yes

L #

Table #

Acctnum: SUNGHD

Template: T110832

Prelogin: P546860

TSR: 134 - Mark W. Beasley

PB:

Shipped Via: FedEX Standard

Analysis / Container / Preservative

Sample ID	Comp/Grab	Matrix *	Depth	Date	Time	No. of Cntrs	TO-15 Summa	Rem./Contaminant	Sample # (lab only)
IA-A018-3326	—	Air	—	3.29.16	1042/1810	1	X		-21
IA-A018-27	—	Air	—	3.29.16	1052/1816	1	X		-22
IA-A018-27-DUP	—	Air	—	3.29.16	1052/1816	1	X		-23
IA-A018-OUTDOOR	—	Air	—	3.29.16	1103/1830	1	X		-24
		Air				1	X		~~-25~~
		Air				1	X		~~-26~~
		Air				1	X		
		Air				1	X		
		Air				1	X		
		Air				1	X		
FIELD BLANK	—	Air	—	3.29.16	—	1	X		-25

* Matrix: SS - Soil GW - Groundwater WW - WasteWater DW - Drinking Water OT - Other___

Remarks: FIELD BLANK CAN 1792 SEE SSOW FOR TO-15 SHORT LIST

pH ___ Temp ___

Flow ___ Other ___

Hold #

Relinquished by : (Signature)	Date:	Time:	Received by: (Signature)
Rich Burns	4.1.16	1500	FEDEX
Relinquished by : (Signature)	Date:	Time:	Received by: (Signature)
Relinquished by : (Signature)	Date:	Time:	Received for lab by: (Signature)

Samples returned via: ☐ UPS ☒ FedEx ☐ Courier ☐ ___

Temp: Amb. °C Bottles Received: 25

Date: 4.4.16 Time: 0930

Condition: (lab use only) TD ✓

COC Seal Intact: ___Y ___N ___NA

pH Checked:

NCF:

Table
March and April 2016 Air Sampling Data
Philadelphia Refinery Operations, a series of Evergreen Resources Group, LLC

DRAFT

							AOI 1	AOI 2						
Sample Location							**AOI1-AI-16-001**	**AOI2-AA-16-001**	**AOI2-AI-16-001**	**AOI2-AI-16-002**	**AOI2-AI-16-003**	**AOI2-AI-16-004**	**AOI2-AI-16-005**	**AOI2-AI-16-006**
							Control Room, Block BRM	**Outdoor Near River**	**Bio Area**	**Bio Area, Bldg 6628**	**Control Room, Kitchen, on Stove**	**Control Room**	**Control Room**	**Short Pier Building 11**
Sample Date							**22-Mar-16**	**22-Mar-16**	**22-Mar-16**	**22-Mar-16**	**22-Mar-16**	**22-Mar-16**	**22-Mar-16**	**28-Mar-16**
Sample ID							**IA-AOI1-2429**	**OA-AOI2-AMBIENT**	**IA-AOI2-5920**	**IA-AOI2-6628**	**IA-AOI2-2435**	**IA-AOI2-6624**	**IA-AOI2-2520**	**IA-AOI2-011**
Sampling Company							**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**
Laboratory							**LL**	**LL**	**LL**	**LL**	**LL**	**LL**	**LL**	**LL**
Laboratory Work Order							**MHF23**	**MHF23**	**MHF23**	**MHF23**	**MHF23**	**MHF23**	**MHF23**	**MHF24**
Laboratory Sample ID							**8302469**	**8302475**	**8302470**	**8302471**	**8302472**	**8302473**	**8302474**	**8316891**
Sample Type	**Units**	**VI-PA**	**OSHA**	**USEPA RSL**	**ACGIH TLV**	**NIOSH**								
Volatile Organic Compounds														
BENZENE	µg/m3	16^{A}	3190^{B}	1.6^{CD}	1600^{E}	319^{F}	***12*** ^{CD}	***1.9 J*** ^{CD}	***3.7*** ^{CD}	***4.6*** ^{CD}	***2.8 J*** ^{CD}	***3.2*** ^{CD}	***5.9*** ^{CD}	1.3 J
1,2-DIBROMOETHANE (EDB)	µg/m3	0.2^{A}	153800^{B}	0.02^{CD}	n/v	346^{F}	*ND (7.7)*	*ND (7.7)*	*ND (7.7)*	*ND (7.7)*	*ND (7.7)*	*ND (7.7)*	*ND (7.7)*	*ND (7.7)*
1,2-DICHLOROETHANE (EDC)	µg/m3	4.7^{A}	202500^{B}	0.47^{CD}	40500^{E}	4000^{F}	*ND (4.0)*	*ND (4.0)*	*ND (4.0)*	*ND (4.0)*	*ND (4.0)*	*ND (4.0)*	*ND (4.0)*	*ND (4.0)*
ETHYLBENZENE	µg/m3	49^{A}	435000^{B}	4.9^{CD}	86800^{E}	435000^{F}	***7.1*** ^{CD}	1.5 J	ND (4.3)	2.9 J	ND (4.3)	ND (4.3)	1.3 J	ND (4.3)
ISOPROPYLBENZENE (CUMENE)	µg/m3	1800^{A}	245000^{B}	1800^{C} 180^{D}	246000^{E}	245000^{F}	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)
M, P-XYLENES	µg/m3	n/v	435000^{B}	44^{CD}	434000^{E}	435000^{F}	29	3.9 J	1.9 J	7.5	2.1 J	2.1 J	4.5	2.8 J
METHYL TERTIARY BUTYL ETHER	µg/m3	470^{A}	n/v	47^{CD}	180000^{E}	n/v	ND (3.6)	ND (3.6)	ND (3.6)	ND (3.6)	ND (3.6)	ND (3.6)	ND (3.6)	ND (3.6)
NAPHTHALENE	µg/m3	n/v	50000^{B}	0.36^{CD}	52000^{E}	50000^{F}	*ND (5.2)*	*ND (5.2)*	*ND (5.2)*	*ND (5.2)*	*ND (5.2)*	*ND (5.2)*	***3.0 J*** ^{CD}	*ND (5.2)*
O-XYLENE (1,2-DIMETHYLBENZENE)	µg/m3	n/v	435000^{B}	44^{CD}	434000^{E}	435000^{F}	9.9	2.8 J	ND (4.3)	4.0 J	0.90 J	0.97 J	2.4 J	1.1 J
TOLUENE	µg/m3	22000^{A}	754000^{B}	22000^{C} 2200^{D}	75400^{E}	375000^{F}	48	1.3 J	3.9	8.9	2.6 J	3.0 J	4.4	4.3
1,2,4-TRIMETHYLBENZENE	µg/m3	31^{A}	n/v	31^{C} 3.1^{D}	123000^{E}	125000^{F}	***6.6*** ^{D}	*ND (4.9)*	*ND (4.9)*	1.8 J	*ND (4.9)*	*ND (4.9)*	***6.6*** ^{D}	1.2 J
1,3,5-TRIMETHYLBENZENE	µg/m3	31^{A}	n/v	n/v	123000^{E}	125000^{F}	2.7 J	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	2.2 J	ND (4.9)

Notes:

VI-PA	PADEP Vapor Intrusion Screening Values
^{A}	Indoor Air Statewide Health Standard Vapor Intrusion Screening Values, Non-Residential (Draft, July 2015)
OSHA	Occupational Safety and Health Administration
^{B}	Permissible Exposure Limits
USEPA RSL	United States Environmental Protection Agency
^{C}	Regional Screening Level for Non-residential indoor air Hazard Index of 1.0.
^{D}	Regional Screening Level for Non-residential indoor air Hazard Index of 0.1.
ACGIH TLV	American Conference of Governmental Industrial Hygienists
^{E}	Threshold Limit Value
NIOSH	National Institute for Occupational Safety and Health
^{F}	Recommended Exposure Limits
6.5 ^{A}	Concentration exceeds the indicated standard.
15.2	Measured concentration did not exceed the indicated standard.
ND (0.50)	Laboratory reporting limit was greater than the applicable standard.
ND (0.03)	Analyte was not detected at a concentration greater than the laboratory reporting limit.
n/v	No standard/guideline value.
J	Indicates an estimated value.

Table
March and April 2016 Air Sampling Data
Philadelphia Refinery Operations, a series of Evergreen Resources Group, LLC

							AOI 3									
Sample Location							**AOI3-AA-16-001** **Outdoor Ambient Near Central Warehouse**	**AOI3-AI-16-001** **Safway Trailer**	**AOI3-AI-16-002** **AOI3 Central Warehouse 3324**	**AOI3-AI-16-003** **Warehouse Near Seal/Safety Store**	**AOI3-AI-16-004** **Central Warehouse Bldg 3324 Walled Office**	**AOI3-AI-16-005** **Central 3324 Bldg Open Warehouse**	**AOI3-AI-16-006** **Central 3324 Bldg Open Warehouse**	**AOI3-AI-16-007** **Central Warehouse Shipping/Receiving Warehouse**	**AOI3-AI-16-008** **Tek-Solv-Trailer Southeast Corner of Trailer Lot**	**AOI3-AI-16-009** **018 Buildiung, Main Contractor Processing Trailer with Skirt**
Sample Date							**28-Mar-16**	**22-Mar-16**	**22-Mar-16**	**22-Mar-16**	**22-Mar-16**	**22-Mar-16**	**22-Mar-16**	**22-Mar-16**	**28-Mar-16**	**29-Mar-16**
Sample ID							**IA-AOI3-OUTDOOR**	**IA-AOI3-SAFWAY**	**IA-AOI3-3324-1**	**IA-AOI3-3324-2**	**IA-AOI3-3324-3**	**IA-AOI3-3324-4**	**IA-AOI3-3324-5**	**IA-AOI3-3324-6**	**IA-AOI3-TRAILER13**	**IA-AOI3-018**
Sampling Company							**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**
Laboratory							**LL**	**LL**	**LL**	**LL**	**LL**	**LL**	**LL**	**LL**	**LL**	**ESC**
Laboratory Work Order							**MHF24**	**MHF23**	**MHF23**	**MHF23**	**MHF23**	**MHF23**	**MHF23**	**MHF23**	**MHF24**	**L827327**
Laboratory Sample ID							**8316883**	**8302476**	**8302477**	**8302478**	**8302479**	**8302480**	**8302481**	**8302482**	**8316882**	**L827327-01**
Sample Type	**Units**	**VI-PA**	**OSHA**	**USEPA RSL**	**ACGIH TLV**	**NIOSH**										
Volatile Organic Compounds																
BENZENE	µg/m3	16^{A}	3190^{B}	1.6^{CD}	1600^{E}	319^{F}	1.5 J	***2.1 J*** ^{CD}	***2.4 J*** ^{CD}	***3.0 J*** ^{CD}	***3.0 J*** ^{CD}	***3.7*** ^{CD}	***3.4*** ^{CD}	***3.7*** ^{CD}	***1.8 J*** ^{CD}	***5.25*** ^{CD}
1,2-DIBROMOETHANE (EDB)	µg/m3	0.2^{A}	153800^{B}	0.02^{CD}	n/v	346^{F}	*ND (7.7)*	*ND (7.7)*	*ND (7.7)*	*ND (7.7)*	*ND (7.7)*	*ND (7.7)*	*ND (7.7)*	*ND (7.7)*	*ND (7.7)*	*ND (1.54)*
1,2-DICHLOROETHANE (EDC)	µg/m3	4.7^{A}	202500^{B}	0.47^{CD}	40500^{E}	4000^{F}	*ND (4.0)*	*ND (4.0)*	*ND (4.0)*	*ND (4.0)*	*ND (4.0)*	*ND (4.0)*	*ND (4.0)*	*ND (4.0)*	*ND (4.0)*	*ND (0.810)*
ETHYLBENZENE	µg/m3	49^{A}	435000^{B}	4.9^{CD}	86800^{E}	435000^{F}	ND (4.3)	ND (4.3)	ND (4.3)	***6.2*** ^{CD}	1.0 J	2.2 J	ND (4.3)	0.91 J	ND (4.3)	ND (0.867)
ISOPROPYLBENZENE (CUMENE)	µg/m3	1800^{A}	245000^{B}	1800^{C} 180^{D}	246000^{E}	245000^{F}	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	1.13
M, P-XYLENES	µg/m3	n/v	435000^{B}	44^{CD}	434000^{E}	435000^{F}	2.7 J	ND (4.3)	1.4 J	27	2.4 J	5.5 J	1.9 J	2.5 J	2.7 J	2.23
METHYL TERTIARY BUTYL ETHER	µg/m3	470^{A}	n/v	47^{CD}	180000^{E}	n/v	ND (3.6)	ND (3.6)	ND (3.6)	ND (3.6)	ND (3.6)	0.75 J	ND (3.6)	ND (3.6)	ND (3.6)	ND (0.721)
NAPHTHALENE	µg/m3	n/v	50000^{B}	0.36^{CD}	52000^{E}	50000^{F}	*ND (5.2)*	*ND (5.2)*	*ND (5.2)*	*ND (5.2)*	*ND (5.2)*	*ND (5.2)*	*ND (5.2)*	*ND (5.2)*	*ND (5.2)*	*ND (3.30)*
O-XYLENE (1,2-DIMETHYLBENZENE)	µg/m3	n/v	435000^{B}	44^{CD}	434000^{E}	435000^{F}	1.1 J	ND (4.3)	ND (4.3)	9.3	1.4 J	3.7 J	ND (4.3)	1.3 J	1.2 J	ND (0.867)
TOLUENE	µg/m3	22000^{A}	754000^{B}	22000^{C} 2200^{D}	75400^{E}	375000^{F}	4.5	1.8 J	3.5 J	13	22	13 J	24 J	13	4.0	4.79
1,2,4-TRIMETHYLBENZENE	µg/m3	31^{A}	n/v	31^{C} 3.1^{D}	123000^{E}	125000^{F}	*ND (4.9)*	*ND (4.9)*	*ND (4.9)*	2.1 J	1.9 J	1.8 J	1.1 J	1.6 J	*ND (4.9)*	1.23
1,3,5-TRIMETHYLBENZENE	µg/m3	31^{A}	n/v	n/v	123000^{E}	125000^{F}	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	ND (0.982)

Notes:

VI-PA	PADEP Vapor Intrusion Screening Values
A	Indoor Air Statewide Health Standard Vapor Intrusion Screening Values, Non-Residential (Draft, July 2015)
OSHA	Occupational Safety and Health Administration
B	Permissible Exposure Limits
USEPA RSL	United States Environmental Protection Agency
C	Regional Screening Level for Non-residential indoor air Hazard Index of 1.0.
D	Regional Screening Level for Non-residential indoor air Hazard Index of 0.1.
ACGIH TLV	American Conference of Governmental Industrial Hygienists
E	Threshold Limit Value
NIOSH	National Institute for Occupational Safety and Health
F	Recommended Exposure Limits
6.5 ^{A}	Concentration exceeds the indicated standard.
15.2	Measured concentration did not exceed the indicated standard.
ND (0.50)	Laboratory reporting limit was greater than the applicable standard.
ND (0.03)	Analyte was not detected at a concentration greater than the laboratory reporting limit.
n/v	No standard/guideline value.
J	Indicates an estimated value.

Table
March and April 2016 Air Sampling Data
Philadelphia Refinery Operations, a series of Evergreen Resources Group, LLC

							AOI 5						
Sample Location							**AOI5-AA-16-001**	**AOI5-AI-16-001**	**AOI5-AI-16-002**	**AOI5-AI-16-003**	**AOI5-AI-16-004**	**AOI5-AI-16-005**	**AOI5-AI-16-006**
							by Warf on Bldg Dock	**Control Room**	**Dock Warf Office 2nd Floor**	**Sample on Desk**	**Dock Office, Brick Bldg, Steam Heat**	**GP2 Dock**	**034A/B Building**
Sample Date							**28-Mar-16**	**28-Mar-16**	**28-Mar-16**	**28-Mar-16**	**28-Mar-16**	**28-Mar-16**	**28-Mar-16**
Sample ID							**IA-AOI5-OUTDOOR**	**IA-AOI5-625**	**IA-AOI5-526-2**	**IA-AOI5-526-1**	**IA-AOI5-501**	**IA-AOI5-GP DOCK 2**	**IA-AOI5-034A/B**
Sampling Company							**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**
Laboratory							**LL**	**LL**	**LL**	**LL**	**LL**	**LL**	**LL**
Laboratory Work Order							**MHF24**	**MHF24**	**MHF24**	**MHF24**	**MHF24**	**MHF24**	**MHF24**
Laboratory Sample ID							**8316890**	**8316884**	**8316885**	**8316886**	**8316887**	**8316888**	**8316889**
Sample Type	**Units**	**VI-PA**	**OSHA**	**USEPA RSL**	**ACGIH TLV**	**NIOSH**							
Volatile Organic Compounds													
BENZENE	µg/m3	16^{A}	3190^{B}	1.6^{CD}	1600^{E}	319^{F}	***2.4 J*** ^{CD}	1.4 J	***4.3*** ^{CD}	***2.6 J*** ^{CD}	***4.4*** ^{CD}	***1.8 J*** ^{CD}	***1.8 J*** ^{CD}
1,2-DIBROMOETHANE (EDB)	µg/m3	0.2^{A}	153800^{B}	0.02^{CD}	n/v	346^{F}	*ND (7.7)*	*ND (7.7)*	*ND (7.7)*	*ND (7.7)*	*ND (7.7)*	*ND (7.7)*	*ND (7.7)*
1,2-DICHLOROETHANE (EDC)	µg/m3	4.7^{A}	202500^{B}	0.47^{CD}	40500^{E}	4000^{F}	*ND (4.0)*	*ND (4.0)*	*ND (4.0)*	*ND (4.0)*	*ND (4.0)*	*ND (4.0)*	*ND (4.0)*
ETHYLBENZENE	µg/m3	49^{A}	435000^{B}	4.9^{CD}	86800^{E}	435000^{F}	1.6 J	1.3 J	ND (4.3)	1.2 J	1.1 J	1.9 J	1.9 J
ISOPROPYLBENZENE (CUMENE)	µg/m3	1800^{A}	245000^{B}	1800^{C} 180^{D}	246000^{E}	245000^{F}	2.5 J	9.8	18	8.6	ND (4.9)	ND (4.9)	1.5 J
M, P-XYLENES	µg/m3	n/v	435000^{B}	44^{CD}	434000^{E}	435000^{F}	2.5 J	3.4 J	1.7 J	2.9 J	2.7 J	5.3	7.6
METHYL TERTIARY BUTYL ETHER	µg/m3	470^{A}	n/v	47^{CD}	180000^{E}	n/v	ND (3.6)	ND (3.6)	ND (3.6)	ND (3.6)	ND (3.6)	ND (3.6)	ND (3.6)
NAPHTHALENE	µg/m3	n/v	50000^{B}	0.36^{CD}	52000^{E}	50000^{F}	*ND (5.2)*	*ND (5.2)*	*ND (5.2)*	*ND (5.2)*	*ND (5.2)*	*ND (5.2)*	*ND (5.2)*
O-XYLENE (1,2-DIMETHYLBENZENE)	µg/m3	n/v	435000^{B}	44^{CD}	434000^{E}	435000^{F}	ND (4.3)	1.5 J	ND (4.3)	1.2 J	1.1 J	2.4 J	3.5 J
TOLUENE	µg/m3	22000^{A}	754000^{B}	22000^{C} 2200^{D}	75400^{E}	375000^{F}	1.7 J	3.1 J	5.0	7.9	15	3.1 J	4.6
1,2,4-TRIMETHYLBENZENE	µg/m3	31^{A}	n/v	31^{C} 3.1^{D}	123000^{E}	125000^{F}	*ND (4.9)*	*ND (4.9)*	*ND (4.9)*	*ND (4.9)*	*ND (4.9)*	1.1 J	***12*** ^{D}
1,3,5-TRIMETHYLBENZENE	µg/m3	31^{A}	n/v	n/v	123000^{E}	125000^{F}	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	3.2 J

Notes:

VI-PA	PADEP Vapor Intrusion Screening Values
^{A}	Indoor Air Statewide Health Standard Vapor Intrusion Screening Values, Non-Residential (Draft, July 2015)
OSHA	Occupational Safety and Health Administration
^{B}	Permissible Exposure Limits
USEPA RSL	United States Environmental Protection Agency
^{C}	Regional Screening Level for Non-residential indoor air Hazard Index of 1.0.
^{D}	Regional Screening Level for Non-residential indoor air Hazard Index of 0.1.
ACGIH TLV	American Conference of Governmental Industrial Hygienists
^{E}	Threshold Limit Value
NIOSH	National Institute for Occupational Safety and Health
^{F}	Recommended Exposure Limits
6.5 ^{A}	Concentration exceeds the indicated standard.
15.2	Measured concentration did not exceed the indicated standard.
ND (0.50)	Laboratory reporting limit was greater than the applicable standard.
ND (0.03)	Analyte was not detected at a concentration greater than the laboratory reporting limit.
n/v	No standard/guideline value.
J	Indicates an estimated value.

Table
March and April 2016 Air Sampling Data
Philadelphia Refinery Operations, a series of Evergreen Resources Group, LLC

DRAFT

	Units	VI-PA	OSHA	USEPA RSL	ACGIH TLV	NIOSH	AOI 6										
Sample Location							**AOI6-AA-16-001**	**AOI6-AA-16-002**	**AOI6-AI-16-001**	**AOI6-AI-16-002**	**AOI6-AI-16-003**	**AOI6-AI-16-004**	**AOI6-AI-16-005**	**AOI6-AI-16-006**	**AOI6-AI-16-007**	**AOI6-AI-16-008**	**AOI6-AI-16-009**
							Outdoor	**Ambient Outdoor Near Carpenter Shop Open Area**	**475 Building**	**745 Building**	**Control Room, 6627 Building**	**Truck Scale House, 6636 Building**	**Control Room, 739 Building**	**726 Building, Carpenter Shop**	**178 Building, Carpenter Trade Shop**	**295 GP Office Building 1st Floor**	**295 GP Office Building 2nd Floor**
Sample Date							**28-Mar-16**	**29-Mar-16**	**28-Mar-16**	**28-Mar-16**	**28-Mar-16**	**28-Mar-16**	**28-Mar-16**	**29-Mar-16**	**29-Mar-16**	**29-Mar-16**	**29-Mar-16**
Sample ID							**IA-AOI6-OUTDOOR 739**	**IA-AOI6-OUTDOOR-032916**	**IA-AOI6-475**	**IA-AOI6-745**	**IA-AOI6-6627**	**IA-AOI6-6636**	**IA-AOI6-739**	**IA-AOI6-726**	**IA-AOI6-178**	**IA-AOI6-295-1**	**IA-AOI6-295-2**
Sampling Company							**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**
Laboratory							**LL**	**ESC**	**LL**	**LL**	**LL**	**LL**	**LL**	**ESC**	**ESC**	**ESC**	**ESC**
Laboratory Work Order							**MHF24**	**L827327**	**MHF24**	**MHF24**	**MHF24**	**MHF24**	**MHF24**	**L827327**	**L827327**	**L827327**	**L827327**
Laboratory Sample ID							**8316897**	**L827327-04**	**8316892**	**8316893**	**8316894**	**8316895**	**8316896**	**L827327-02**	**L827327-03**	**L827327-05**	**L827327-06**
Sample Type																	
Volatile Organic Compounds																	
BENZENE	μg/m3	16^{A}	3190^{B}	1.6^{CD}	1600^{E}	319^{F}	***1.8 J***^{CD}	***3.95***^{CD}	***5.5***^{CD}	1.3 J	***36***^{ACD}	***2.1 J***^{CD}	***4.5***^{CD}	***3.46***^{CD}	***5.05***^{CD}	***3.97***^{CD}	***3.94***^{CD}
1,2-DIBROMOETHANE (EDB)	μg/m3	0.2^{A}	153800^{B}	0.02^{CD}	n/v	346^{F}	*ND (11)*	*ND (1.54)*	*ND (7.7)*	*ND (7.7)*	*ND (7.7)*	*ND (7.7)*	*ND (7.7)*	*ND (1.54)*	*ND (1.54)*	*ND (1.54)*	*ND (1.54)*
1,2-DICHLOROETHANE (EDC)	μg/m3	4.7^{A}	202500^{B}	0.47^{CD}	40500^{E}	4000^{F}	*ND (5.6)*	*ND (0.810)*	*ND (4.0)*	*ND (4.0)*	*ND (4.0)*	*ND (4.0)*	*ND (4.0)*	*ND (0.810)*	*ND (0.810)*	*ND (0.810)*	*ND (0.810)*
ETHYLBENZENE	μg/m3	49^{A}	435000^{B}	4.9^{CD}	86800^{E}	435000^{F}	*ND (6.0)*	ND (0.867)	1.1 J	ND (4.3)	2.0 J	2.1 J	3.2 J	ND (0.867)	ND (0.867)	ND (0.867)	0.960
ISOPROPYLBENZENE (CUMENE)	μg/m3	1800^{A}	245000^{B}	1800^{C} 180^{D}	246000^{E}	245000^{F}	1.5 J	1.72	9.1	ND (4.9)	7.8	ND (4.9)	2.8 J	1.45	1.60	ND (0.983)	ND (0.983)
M, P-XYLENES	μg/m3	n/v	435000^{B}	44^{CD}	434000^{E}	435000^{F}	2.3 J	ND (1.73)	3.5 J	2.2 J	8.3	5.8	8.8	ND (1.73)	1.76	2.20	2.29
METHYL TERTIARY BUTYL ETHER	μg/m3	470^{A}	n/v	47^{CD}	180000^{E}	n/v	ND (5.0)	ND (0.721)	ND (3.6)	ND (3.6)	ND (3.6)	ND (3.6)	ND (3.6)	ND (0.721)	ND (0.721)	ND (0.721)	ND (0.721)
NAPHTHALENE	μg/m3	n/v	50000^{B}	0.36^{CD}	52000^{E}	50000^{F}	***4.1 J***^{CD}	*ND (3.30)*	*ND (5.2)*	*ND (5.2)*	*ND (5.2)*	*ND (5.2)*	*ND (5.2)*	*ND (3.30)*	*ND (3.30)*	*ND (3.30)*	*ND (3.30)*
O-XYLENE (1,2-DIMETHYLBENZENE)	μg/m3	n/v	435000^{B}	44^{CD}	434000^{E}	435000^{F}	1.4 J	ND (0.867)	1.2 J	1.1 J	3.6 J	4.0 J	5.3	ND (0.867)	ND (0.867)	ND (0.867)	ND (0.867)
TOLUENE	μg/m3	22000^{A}	754000^{B}	22000^{C} 2200^{D}	75400^{E}	375000^{F}	2.1 J	2.85	3.9	2.2 J	13	2.6 J	3.9	2.06	2.57	3.12	3.11
1,2,4-TRIMETHYLBENZENE	μg/m3	31^{A}	n/v	31^{C} 3.1^{D}	123000^{E}	125000^{F}	*ND (6.8)*	ND (0.982)	1.4 J	*ND (4.9)*	***3.6 J***^{D}	1.1 J	*ND (4.9)*	ND (0.982)	ND (0.982)	2.18	2.04
1,3,5-TRIMETHYLBENZENE	μg/m3	31^{A}	n/v	n/v	123000^{E}	125000^{F}	ND (6.8)	ND (0.982)	ND (4.9)	ND (4.9)	1.3 J	ND (4.9)	ND (4.9)	ND (0.982)	ND (0.982)	ND (0.982)	ND (0.982)

Notes:

VI-PA	PADEP Vapor Intrusion Screening Values
^{A}	Indoor Air Statewide Health Standard Vapor Intrusion Screening Values, Non-Residential (Draft, July 2015)
OSHA	Occupational Safety and Health Administration
^{B}	Permissible Exposure Limits
USEPA RSL	United States Environmental Protection Agency
^{C}	Regional Screening Level for Non-residential indoor air Hazard Index of 1.0.
^{D}	Regional Screening Level for Non-residential indoor air Hazard Index of 0.1.
ACGIH TLV	American Conference of Governmental Industrial Hygienists
^{E}	Threshold Limit Value
NIOSH	National Institute for Occupational Safety and Health
^{F}	Recommended Exposure Limits
6.5^{A}	Concentration exceeds the indicated standard.
15.2	Measured concentration did not exceed the indicated standard.
ND (0.50)	Laboratory reporting limit was greater than the applicable standard.
ND (0.03)	Analyte was not detected at a concentration greater than the laboratory reporting limit.
n/v	No standard/guideline value.
J	Indicates an estimated value.

Stantec

Table
March and April 2016 Air Sampling Data
Philadelphia Refinery Operations, a series of Evergreen Resources Group, LLC

							AOI 7											
Sample Location							**AOI7-AA-16-001**	**AOI7-AI-16-001**	**AOI7-AI-16-002**	**AOI7-AI-16-003**	**AOI7-AI-16-004**	**AOI7-AI-16-005**	**AOI7-AI-16-006**	**AOI7-AI-16-007**	**AOI7-AI-16-008**	**AOI7-AI-16-009**	**AOI7-AI-16-010**	**AOI7-AI-16-011**
							Ambient, Near WTP Fence	**595 Canteen Building**	**450 Elect Building, Computer Room**	**450 Building Elect Warehouse, Back Addition on Shelf**	**450 Building Elect Warehouse, North Side**	**450 Building Elect Warehouse, Walled area Middle Bldg, Elect Testing**	**450 Building Elect Warehouse Table East Side Near Open Offices**	**442 Building Firehouse Office Table Office**	**711 Building, WTP**	**6622 Building, Control Room, Rear Table Center of Room**	**6626 Building, Control Room**	**6625 Building, Control Room, MF Unit**
Sample Date							**29-Mar-16**	**29-Mar-16**	**29-Mar-16**	**29-Mar-16**	**29-Mar-16**	**29-Mar-16**	**29-Mar-16**	**29-Mar-16**	**29-Mar-16**	**29-Mar-16**	**29-Mar-16**	**29-Mar-16**
Sample ID							**IA-AOI7-OUTDOOR**	**IA-AOI7-595**	**IA-AOI7-450-1**	**IA-AOI7-450-2**	**IA-AOI7-450-3**	**IA-AOI7-450-4**	**IA-AOI7-450-5**	**IA-AOI7-442**	**IA-AOI7-711**	**IA-AOI7-6622**	**IA-AOI7-6626**	**IA-AOI7-6625**
Sampling Company							**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**
Laboratory							**ESC**	**ESC**	**ESC**	**ESC**	**ESC**	**ESC**	**ESC**	**ESC**	**ESC**	**ESC**	**ESC**	**ESC**
Laboratory Work Order							**L827327**	**L827327**	**L827327**	**L827327**	**L827327**	**L827327**	**L827327**	**L827327**	**L827327**	**L827327**	**L827327**	**L827327**
Laboratory Sample ID							**L827327-15**	**L827327-07**	**L827327-08**	**L827327-09**	**L827327-10**	**L827327-11**	**L827327-12**	**L827327-13**	**L827327-14**	**L827327-16**	**L827327-17**	**L827327-18**
Sample Type	**Units**	**VI-PA**	**OSHA**	**USEPA RSL**	**ACGIH TLV**	**NIOSH**												
Volatile Organic Compounds																		
BENZENE	µg/m3	16^{A}	3190^{B}	1.6^{CD}	1600^{E}	319^{F}	1.32	***4.63*** ^{CD}	1.00	0.860	0.973	1.54	***1.99*** ^{CD}	***1.68*** ^{CD}	***2.22*** ^{CD}	***3.52*** ^{CD}	***3.36*** ^{CD}	***1.63*** ^{CD}
1,2-DIBROMOETHANE (EDB)	µg/m3	0.2^{A}	153800^{B}	0.02^{CD}	n/v	346^{F}	*ND (1.54)*	*ND (1.54)*	*ND (1.54)*	*ND (1.54)*	*ND (1.54)*	*ND (1.54)*	*ND (1.54)*	*ND (1.54)*	*ND (1.54)*	*ND (1.54)*	*ND (1.54)*	*ND (1.54)*
1,2-DICHLOROETHANE (EDC)	µg/m3	4.7^{A}	202500^{B}	0.47^{CD}	40500^{E}	4000^{F}	*ND (0.810)*	*ND (0.810)*	*ND (0.810)*	*ND (0.810)*	*ND (0.810)*	*ND (0.810)*	*ND (0.810)*	*ND (0.810)*	*ND (0.810)*	*ND (0.810)*	*ND (0.810)*	*ND (0.810)*
ETHYLBENZENE	µg/m3	49^{A}	435000^{B}	4.9^{CD}	86800^{E}	435000^{F}	ND (0.867)	ND (0.867)	1.12	ND (0.867)	ND (0.867)	1.19	2.58	1.38	ND (0.867)	***4.94*** ^{CD}	1.60	4.22
ISOPROPYLBENZENE (CUMENE)	µg/m3	1800^{A}	245000^{B}	1800^{C} 180^{D}	246000^{E}	245000^{F}	ND (0.983)	ND (0.983)	ND (0.983)	ND (0.983)	ND (0.983)	ND (0.983)	ND (0.983)	ND (0.983)	ND (0.983)	1.27	2.09	ND (0.983)
M, P-XYLENES	µg/m3	n/v	435000^{B}	44^{CD}	434000^{E}	435000^{F}	1.99	2.48	4.58	2.09	ND (1.73)	3.14	7.89	3.63	2.46	16.9	5.15	12.3
METHYL TERTIARY BUTYL ETHER	µg/m3	470^{A}	n/v	47^{CD}	180000^{E}	n/v	ND (0.721)	ND (0.721)	ND (0.721)	ND (0.721)	ND (0.721)	ND (0.721)	ND (0.721)	ND (0.721)	ND (0.721)	ND (0.721)	ND (0.721)	ND (0.721)
NAPHTHALENE	µg/m3	n/v	50000^{B}	0.36^{CD}	52000^{E}	50000^{F}	*ND (3.30)*	*ND (3.30)*	*ND (3.30)*	*ND (3.30)*	*ND (3.30)*	*ND (3.30)*	*ND (3.30)*	*ND (3.30)*	*ND (3.30)*	*ND (3.30)*	*ND (3.30)*	*ND (3.30)*
O-XYLENE (1,2-DIMETHYLBENZENE)	µg/m3	n/v	435000^{B}	44^{CD}	434000^{E}	435000^{F}	ND (0.867)	0.891	1.67	ND (0.867)	ND (0.867)	1.32	2.87	1.36	1.04	7.79	2.04	4.75
TOLUENE	µg/m3	22000^{A}	754000^{B}	22000^{C} 2200^{D}	75400^{E}	375000^{F}	4.05	5.51	10.5	3.15	4.12	8.91	49.8	19.1	3.93	7.29	3.06	71.4
1,2,4-TRIMETHYLBENZENE	µg/m3	31^{A}	n/v	31^{C} 3.1^{D}	123000^{E}	125000^{F}	ND (0.982)	1.09	1.05	ND (0.982)	ND (0.982)	1.23	2.13	1.22	2.94	***21.6*** ^{D}	***3.81*** ^{D}	***6.40*** ^{D}
1,3,5-TRIMETHYLBENZENE	µg/m3	31^{A}	n/v	n/v	123000^{E}	125000^{F}	ND (0.982)	ND (0.982)	ND (0.982)	ND (0.982)	ND (0.982)	ND (0.982)	ND (0.982)	ND (0.982)	0.984	6.81	1.19	1.78

Notes:

VI-PA	PADEP Vapor Intrusion Screening Values
^{A}	Indoor Air Statewide Health Standard Vapor Intrusion Screening Values, Non-Residential (Draft, July 2015)
OSHA	Occupational Safety and Health Administration
^{B}	Permissible Exposure Limits
USEPA RSL	United States Environmental Protection Agency
^{C}	Regional Screening Level for Non-residential indoor air Hazard Index of 1.0.
^{D}	Regional Screening Level for Non-residential indoor air Hazard Index of 0.1.
ACGIH TLV	American Conference of Governmental Industrial Hygienists
^{E}	Threshold Limit Value
NIOSH	National Institute for Occupational Safety and Health
^{F}	Recommended Exposure Limits
6.5 ^{A}	Concentration exceeds the indicated standard.
15.2	Measured concentration did not exceed the indicated standard.
ND (0.50)	Laboratory reporting limit was greater than the applicable standard.
ND (0.03)	Analyte was not detected at a concentration greater than the laboratory reporting limit.
n/v	No standard/guideline value.
J	Indicates an estimated value.

Table
March and April 2016 Air Sampling Data
Philadelphia Refinery Operations, a series of Evergreen Resources Group, LLC

DRAFT

							AOI 8						AOI 9				QC
Sample Location							**AOI8-AA-16-001**	**AOI8-AI-16-001**	**AOI8-AI-16-002**	**AOI8-AI-16-003**	**AOI8-AI-16-004**		**AOI9-AA-16-001**	**AOI9-AI-16-001**	**AOI9-AI-16-002**		**FIELD_BLANK**
							Ambient, Near 6641 on Concrete Block	**6642 Building, North Yard Trailers**	**6641 Building, North Yard Trailer**	**3326 Building North Yard Scale House**	**27 Building, North Yard Old Scale House**	**27 Building, North Yard Old Scale House**	**Outdoor**	**SR2 Corner Office**	**Loading Dock Office SR9**	**Loading Dock Office SR9**	
Sample Date							**29-Mar-16**	**29-Mar-16**	**29-Mar-16**	**29-Mar-16**	**29-Mar-16**	**29-Mar-16**	**5-Apr-16**	**5-Apr-16**	**5-Apr-16**	**5-Apr-16**	**29-Mar-16**
Sample ID							**IA-AOI8-OUTDOOR**	**IA-AOI8-6642**	**IA-AOI8-6641**	**IA-AOI8-3326**	**IA-AOI8-27**	**IA-AOI8-27-DUP**	**IA-AOI9-OUTDOOR**	**IA-AOI9-SR2**	**IA-AOI9-SR9**	**IA-AOI9-SR9-DUP**	**FIELD BLANK**
Sampling Company							**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**	**GHD**
Laboratory							**ESC**	**ESC**	**ESC**	**ESC**	**ESC**	**ESC**	**LL**	**LL**	**LL**	**LL**	**ESC**
Laboratory Work Order							**L827327**	**L827327**	**L827327**	**L827327**	**L827327**	**L827327**	**MHF26**	**MHF26**	**MHF26**	**MHF26**	**L827327**
Laboratory Sample ID							**L827327-24**	**L827327-19**	**L827327-20**	**L827327-21**	**L827327-22**	**L827327-23**	**8322923**	**8322922**	**8322924**	**8322925**	**L827327-25**
Sample Type	**Units**	**VI-PA**	**OSHA**	**USEPA RSL**	**ACGIH TLV**	**NIOSH**						**Field Duplicate**				**Field Duplicate**	**Field Blank**
Volatile Organic Compounds																	
BENZENE	µg/m3	16^{A}	3190^{B}	1.6^{CD}	1600^{E}	319^{F}	ND (0.639)	ND (0.639)	ND (0.639)	ND (0.639)	ND (0.639)	ND (0.639)	***1.8 J***^{CD}	1.3 J	0.71 J	0.64 J	ND (0.639)
1,2-DIBROMOETHANE (EDB)	µg/m3	0.2^{A}	153800^{B}	0.02^{CD}	n/v	346^{F}	*ND (1.54)*	*ND (1.54)*	*ND (1.54)*	*ND (1.54)*	*ND (1.54)*	*ND (1.54)*	*ND (7.7)*	*ND (7.7)*	*ND (7.7)*	*ND (7.7)*	*ND (1.54)*
1,2-DICHLOROETHANE (EDC)	µg/m3	4.7^{A}	202500^{B}	0.47^{CD}	40500^{E}	4000^{F}	*ND (0.810)*	*ND (0.810)*	*ND (0.810)*	*ND (0.810)*	*ND (0.810)*	*ND (0.810)*	*ND (4.0)*	*ND (4.0)*	*ND (4.0)*	*ND (4.0)*	*ND (0.810)*
ETHYLBENZENE	µg/m3	49^{A}	435000^{B}	4.9^{CD}	86800^{E}	435000^{F}	ND (0.867)	ND (0.867)	ND (0.867)	ND (0.867)	ND (0.867)	ND (0.867)	ND (4.3)	2.9 J	ND (4.3)	1.5 J	ND (0.867)
ISOPROPYLBENZENE (CUMENE)	µg/m3	1800^{A}	245000^{B}	1800^{C} 180^{D}	246000^{E}	245000^{F}	ND (0.983)	ND (0.983)	ND (0.983)	ND (0.983)	ND (0.983)	ND (0.983)	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	ND (0.983)
M, P-XYLENES	µg/m3	n/v	435000^{B}	44^{CD}	434000^{E}	435000^{F}	ND (1.73)	ND (1.73)	ND (1.73)	1.78	ND (1.73)	ND (1.73)	2.4 J	8.9	1.1 J	4.0 J	ND (1.73)
METHYL TERTIARY BUTYL ETHER	µg/m3	470^{A}	n/v	47^{CD}	180000^{E}	n/v	ND (0.721)	ND (0.721)	ND (0.721)	ND (0.721)	ND (0.721)	ND (0.721)	ND (3.6)	ND (3.6)	ND (3.6)	ND (3.6)	ND (0.721)
NAPHTHALENE	µg/m3	n/v	50000^{B}	0.36^{CD}	52000^{E}	50000^{F}	*ND (3.30)*	*ND (3.30)*	*ND (3.30)*	*ND (3.30)*	*ND (3.30)*	*ND (3.30)*	*ND (5.2)*	*ND (5.2)*	*ND (5.2)*	*ND (5.2)*	*ND (3.30)*
O-XYLENE (1,2-DIMETHYLBENZENE)	µg/m3	n/v	435000^{B}	44^{CD}	434000^{E}	435000^{F}	ND (0.867)	ND (0.867)	ND (0.867)	ND (0.867)	ND (0.867)	ND (0.867)	1.1 J	5.6	ND (4.3)	3.0 J	ND (0.867)
TOLUENE	µg/m3	22000^{A}	754000^{B}	22000^{C} 2200^{D}	75400^{E}	375000^{F}	8.26	1.23	2.56	1.14	ND (0.753)	1.01	3.3 J	4.1	0.88 J	0.88 J	ND (0.753)
1,2,4-TRIMETHYLBENZENE	µg/m3	31^{A}	n/v	31^{C} 3.1^{D}	123000^{E}	125000^{F}	ND (0.982)	ND (0.982)	ND (0.982)	ND (0.982)	ND (0.982)	ND (0.982)	1.0 J	1.2 J	*ND (4.9)*	*ND (4.9)*	ND (0.982)
1,3,5-TRIMETHYLBENZENE	µg/m3	31^{A}	n/v	n/v	123000^{E}	125000^{F}	ND (0.982)	ND (0.982)	ND (0.982)	ND (0.982)	ND (0.982)	ND (0.982)	ND (4.9)	ND (4.9)	ND (4.9)	ND (4.9)	ND (0.982)

Notes:

VI-PA	PADEP Vapor Intrusion Screening Values
^{A}	Indoor Air Statewide Health Standard Vapor Intrusion Screening Values, Non-Residential (Draft, July 2015)
OSHA	Occupational Safety and Health Administration
^{B}	Permissible Exposure Limits
USEPA RSL	United States Environmental Protection Agency
^{C}	Regional Screening Level for Non-residential indoor air Hazard Index of 1.0.
^{D}	Regional Screening Level for Non-residential indoor air Hazard Index of 0.1.
ACGIH TLV	American Conference of Governmental Industrial Hygienists
^{E}	Threshold Limit Value
NIOSH	National Institute for Occupational Safety and Health
^{F}	Recommended Exposure Limits
6.5^{A}	Concentration exceeds the indicated standard.
15.2	Measured concentration did not exceed the indicated standard.
ND (0.50)	Laboratory reporting limit was greater than the applicable standard.
ND (0.03)	Analyte was not detected at a concentration greater than the laboratory reporting limit.
n/v	No standard/guideline value.
J	Indicates an estimated value.

APPENDIX G

LNAPL CHARACTERIZATION

AOI 3 LNAPL Characterization Summary Table
Philadelphia Energy Solutions Refining Complex
Philadelphia, Pennsylvania

Interpretation of Product Types, Proportions, and Weathering							Similarities to Other Samples in Study		
Characterization Results Compiled for CCR (TGI Job No. 04046 - Analyzed in March 2004)									
Well ID	**Density g/cc (60°F)**	**LNAPL Type(s)**	**New LNAPL Classifcation[1]**	**Torkelson LNAPL Type(s)**	**Proportion (%)**	**Weathering**	**Quite Similar To**	**Fairly Similar To**	**Somewhat Similar To**
S-21	0.9281	Residual Oil	Heavy Distillate	Residual Oil	100	Extreme	S-92 & S-158	N-78 & S-142	All other residual oils in the study except A-133
S-59	0.8039	Gasoline	Light/Middle Distillate	?Gasoline	60	Severe		B-39, B-129, S-78, S-117, & S-138	All other gasolines in study
				Middle Distillate	40	Extreme			All other middle distillates in the study
S-60	0.7898	Aviation Gasoline	Light/Middle Distillate	Aviation Gasoline	80	Extreme	S-103	WP-9-2	All other aviation gasolines in study
				Middle Distillate	20				All other middle distillates in the study
S-68/S-29	0.855	Middle Distillate	Middle Distillate	Middle Distillate	100	Highly		S-29	All other middle distillates in the study
BF-106	0.8199	Condensate	Light/Middle Distillate	Condensate	100	Highly			S-130
BF-107	0.8671	Middle Distillate	Middle Distillate	Middle Distillate	100	Severe	S-32, S-53, S-56, & S-97		All other middle distillates in the study
Characterization Results Compiled for AOI 3 Site Characterization Activities (TGI Job No. 10099 - Analyzed in July 2010)									
S-285	0.8921	Middle Distillate	Middle Distillate	Middle Distillate	80	Extreme	Unique		
				Heavier Material	20				All other heavier materials in the study
				Unknown Lt. Material	<1		Unique		
Characterization Results Compiled for AOI 3 Site Characterization Activities (PES Laboratory- Analyzed in July 2016)									
S-410	0.8838	Degraded diesel or No. 2 fuel oil with minor amount of naptha or gasoline	Middle Distillate	NA	NA	NA	NA	NA	NA

Notes:

[1] New LNAPL site-wide classifications adopted as of July 2016

[2] LNAPL type for S-410 was classified by Pace Analytical Energy Services, LLC.

Heavier material could either be crude oil or residual oil.

g/cc - Grams per cubic centimeter

TGI - Torkelson Geochemistry, Inc.

NA - Not Applicable

API - American Petroleum Institute

? - Tentative identification

CCR - 2004 Sunoco Current Conditions Report

LNAPL - Light Non Aqueous Phase Liquid

2004 and 2010 LNAPL results reported were analyzed by TGI.

2004 and 2010 product interpretations were provided by TGI.

S-410 LNAPL sample was analyzed by an on-site PES facility laboratory. The density was calculated using the laboratory reported API Gravity of 28.6 degrees API.

API calculation provides a specific gravity result that is approximately equal to density.

Torkelson Geochemistry, Inc.

CHAIN-OF-CUSTODY RECORD

2528 S. Columbia Place
Tulsa, OK 74114-3233

Phone: 918-749-8441 e-mail: BTorkelson@torkelsongeochemistry.com
Fax: 918-749-6005

Page 1 of 1

Project: Sunoco, Inc. Philadelphia Refinery
Location: 3144 Passyunk Avenue, Philadelphia, PA 19145
Proj. No.: AOIs 2, 3, & 7 SCRs/RIRs
P.O.:
Sampled By: Tim Delk

Report/Bill To: Langan Engineering & Env'l Services
Address: P.O. Box 1569
Doylestown, PA 18901-0219
Phone: 215.491.6500
Fax: 215.491.6501
e-mail: dwebster@langan.com

Additional Instructions

Samples to be analyzed for Fingerprint (GC Characterization) and Density. Include a "Brief Description/Interpretation" of LNAPL, to be consistent with existing LNAPL types for Sunoco Philadelphia. Must have data results no later than July 30, 2010.

Requested Turn-Around Time: Data needed by July 30th

							PRESERVATIVES					ANALYSES REQUESTED													
	ITEM NO.	SAMPLE DESCRIPTION	DATE	MATRIX	LAB NO.	Total # OF Vials	None					Fingerprint-GC Characterizati	Density	Viscosity	Water Surface Tension	NAPL Surface Tension	NAPL/Water Interfac. Tens.	Lead	Sulfur						REMARKS
AOI-3	1	S-282	7/15/10	Prod		1	X					X	X												Include a "Brief Description/Interpretation" of LNAPL, to be
AOI-3	2	S-285				1																			consistent with existing LNAPL types for Sunoco Philadelphia.
AOI 2	3	S-297				1																			
AOI 2	4	S-313				1																			Times S-282-0950
AOI 2	5	S-315				1																			S-285-1115
AOI-7	6	C-143	7/15/10	Prod		1	X					X	X												S-297-1100
	7																								S-313-1035
	8																								S-315-1020
	9																								C-143-1130
	10																								

	RELINQUISHED BY	ACCEPTED BY	DATE	TIME
		T S DRAKE WAREHOUSE	07-16	
	RELEASED TO FED EX EXP.	SAME DATE		
		Bruce Torkelson	7-19-10	0845

Torkelson Geochemistry, Inc.

Sunoco, Inc., Philadelphia Refinery
Sample ID : S-297
Acquired : Jul 20, 2010 10:38:19

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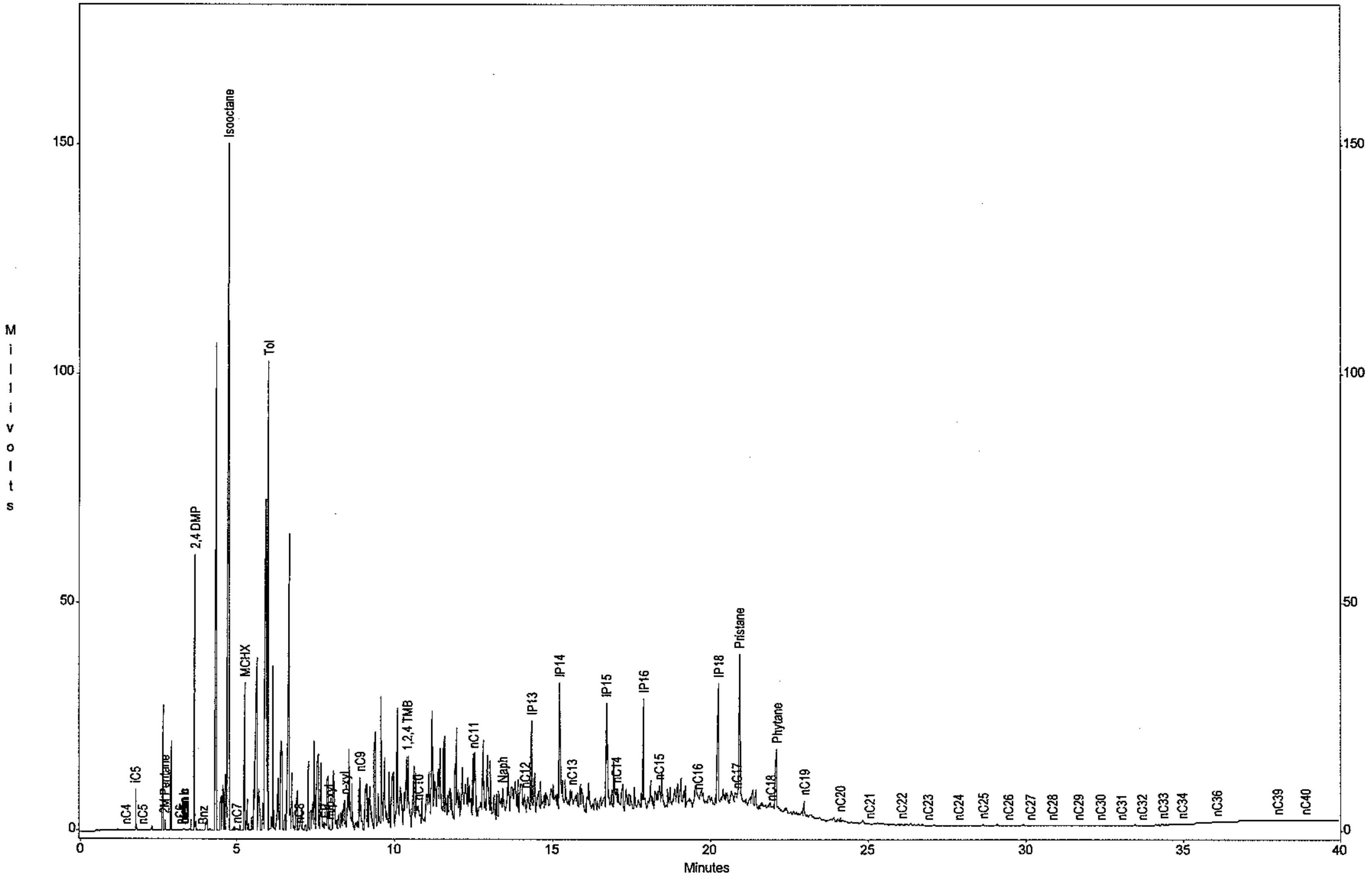

Torkelson Geochemistry, Inc.

Sunoco, Inc., Philadelphia Refinery
Sample ID : S-313
Acquired : Jul 20, 2010 14:02:27

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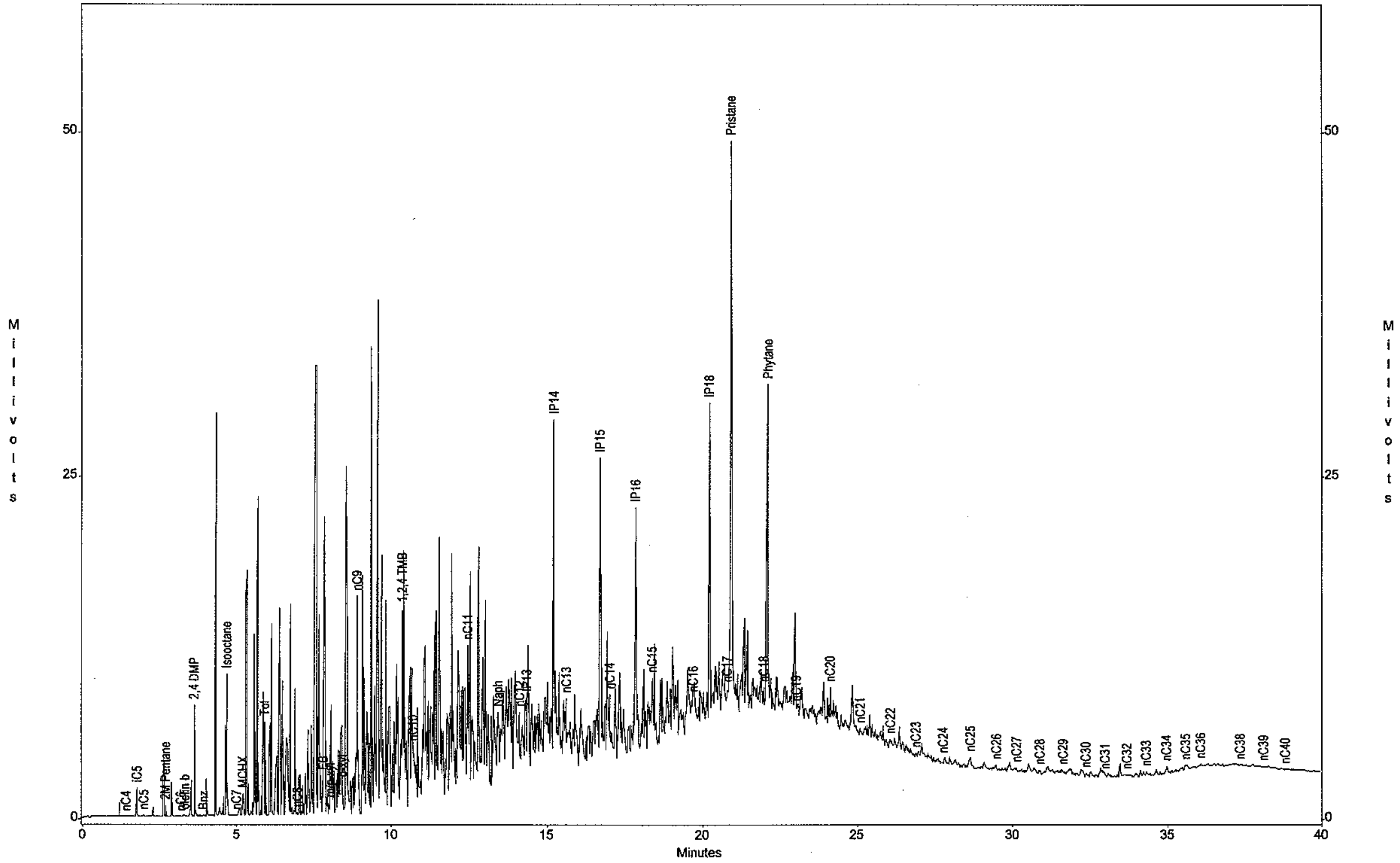

Torkelson Geochemistry, Inc.

Sunoco, Inc., Philadelphia Refinery
Sample ID : S-315
Acquired : Jul 20, 2010 13:11:48

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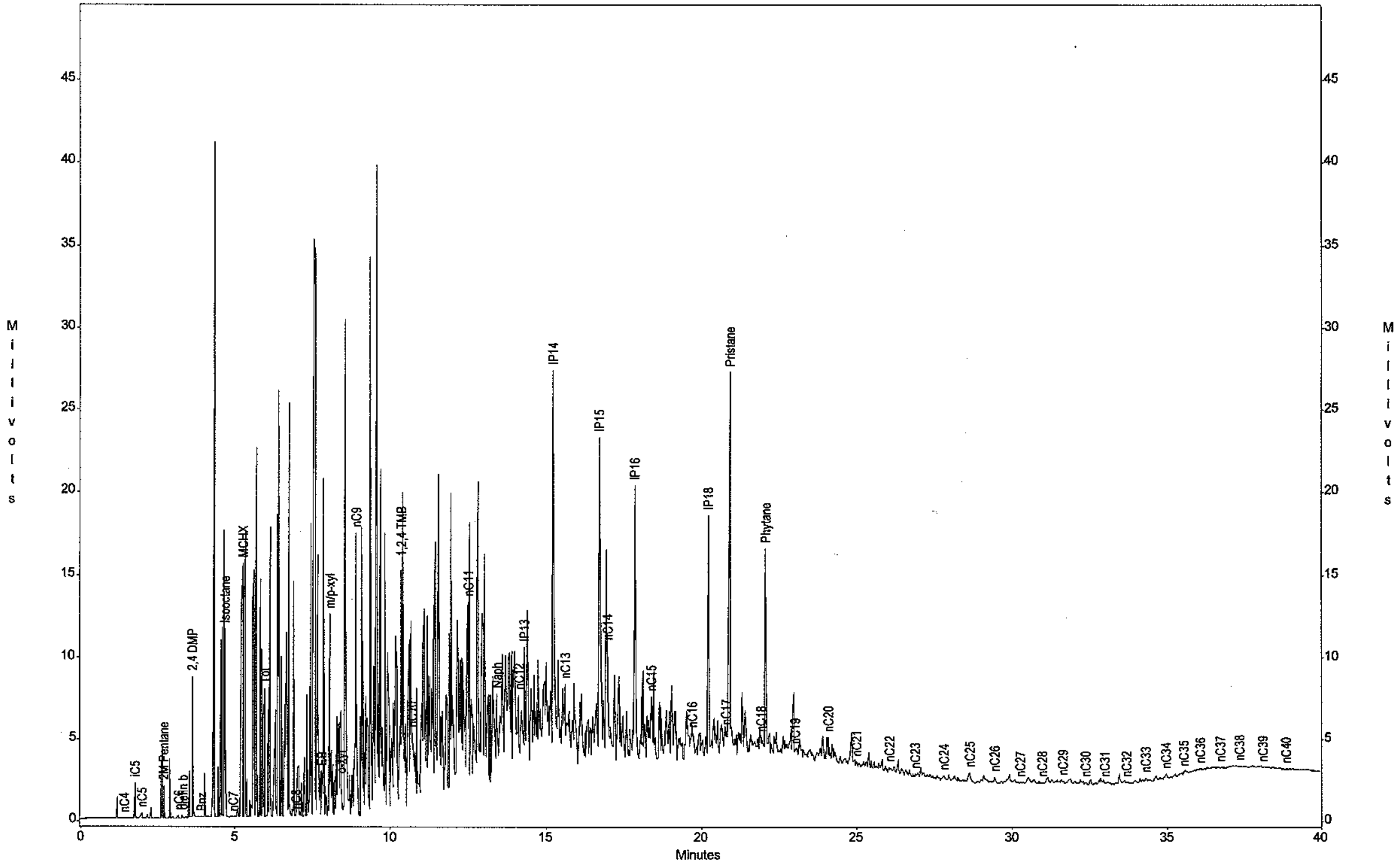

Torkelson Geochemistry, Inc.

Sunoco, Inc., Philadelphia Refinery
Sample ID : C-143
Acquired : Jul 20, 2010 11:28:51

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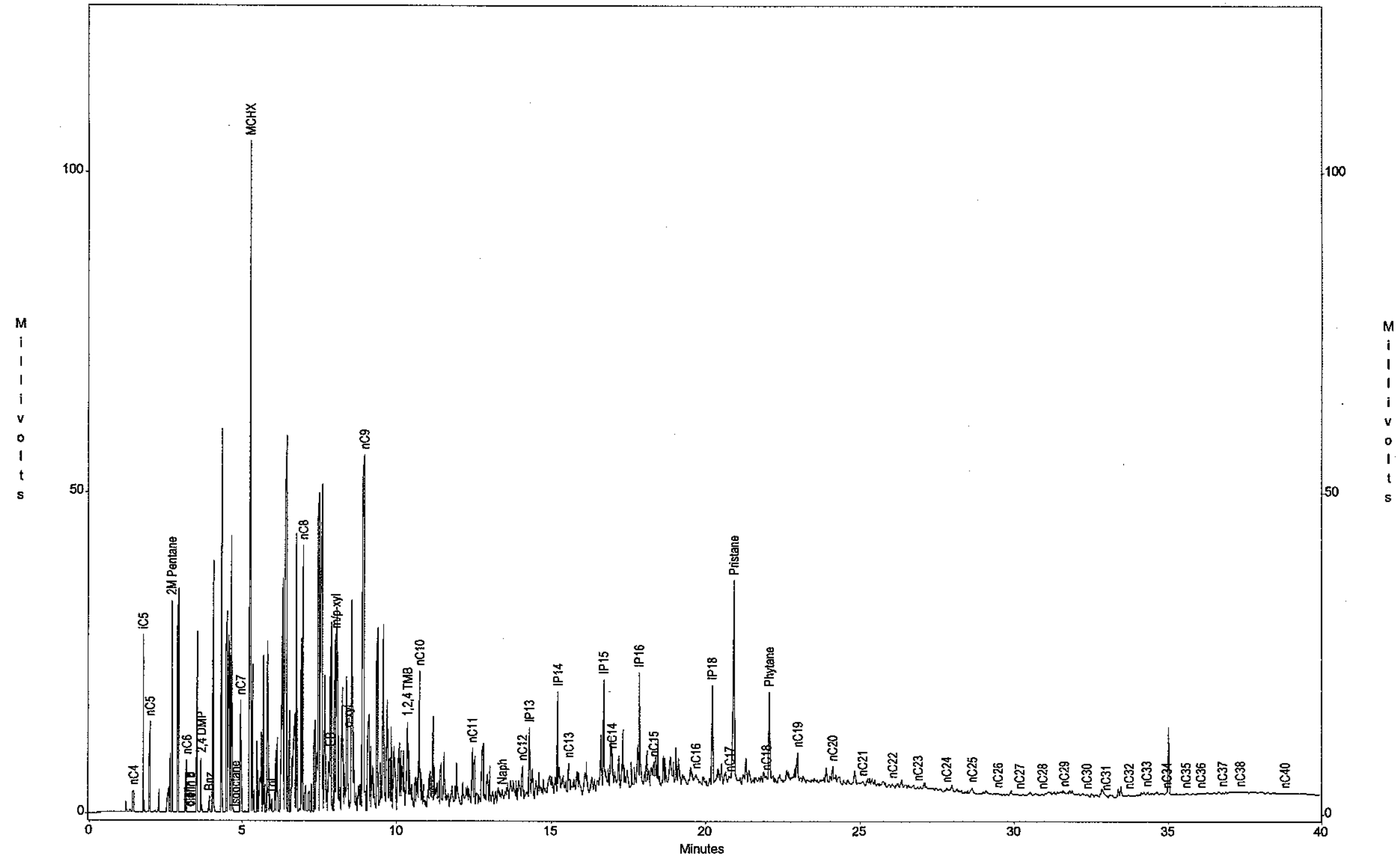

Torkelson Geochemistry, Inc.

Sunoco, Inc., Philadelphia Refinery
Sample ID : S-282
Acquired : Jul 20, 2010 12:19:51

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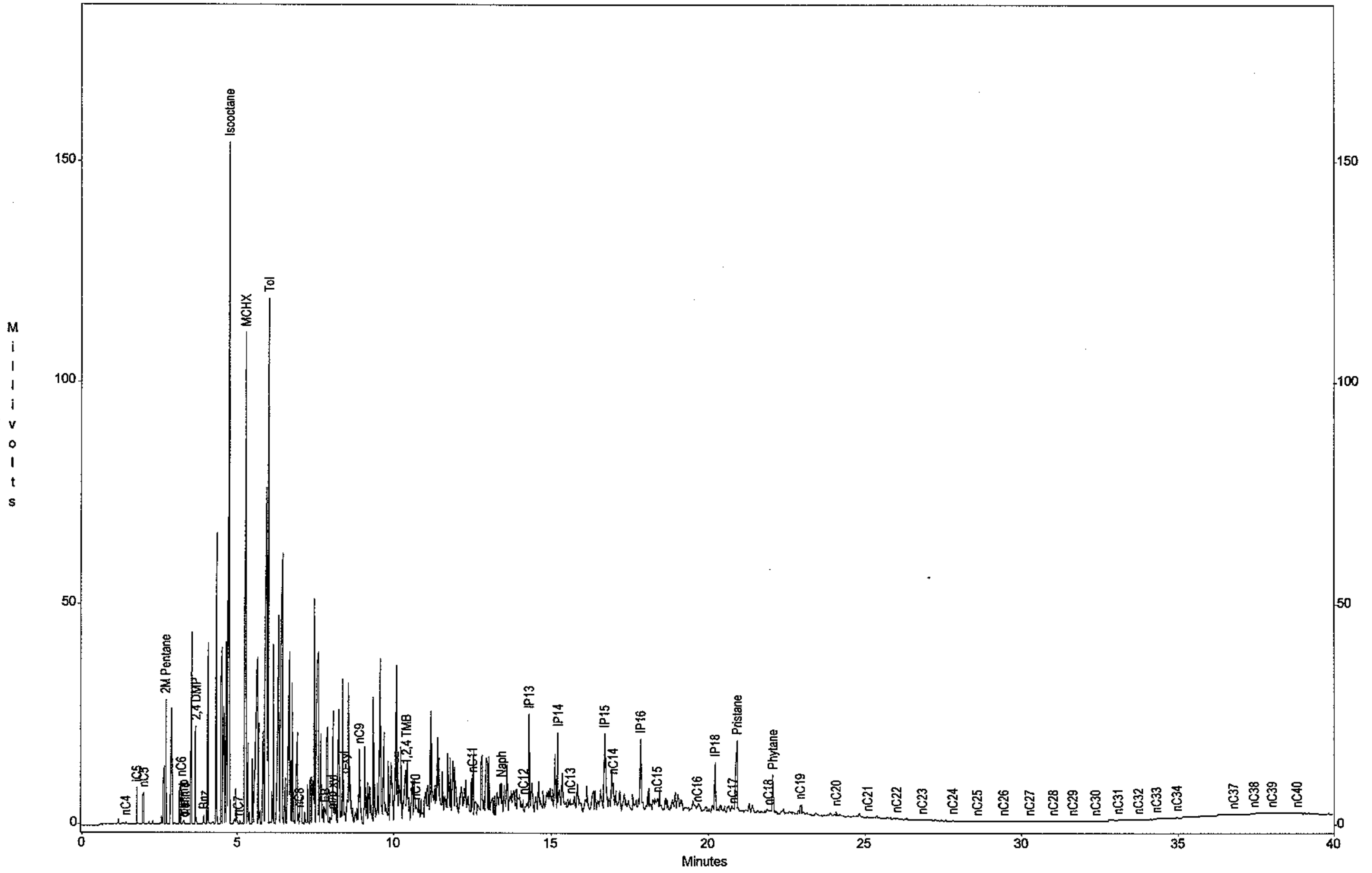

Torkelson Geochemistry, Inc.

Sunoco, Inc., Philadelphia Refinery
Sample ID : S-285
Acquired : Jul 20, 2010 15:01:23

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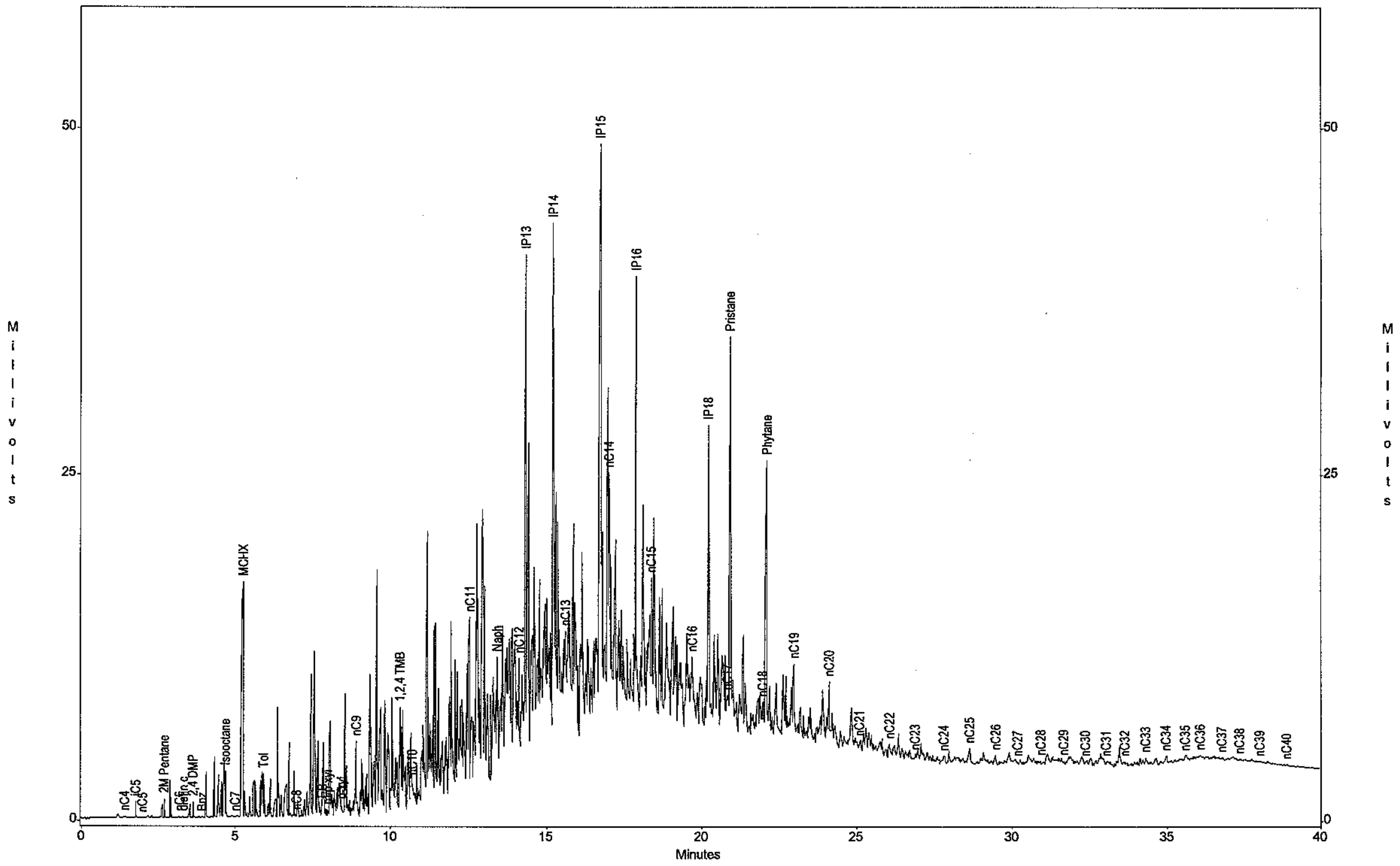

Torkelson Geochemistry, Inc.

Sunoco, Inc., Philadelphia Refinery
Sample ID : Gas/Dies/Wax std
Acquired : Jul 20, 2010 09:47:53

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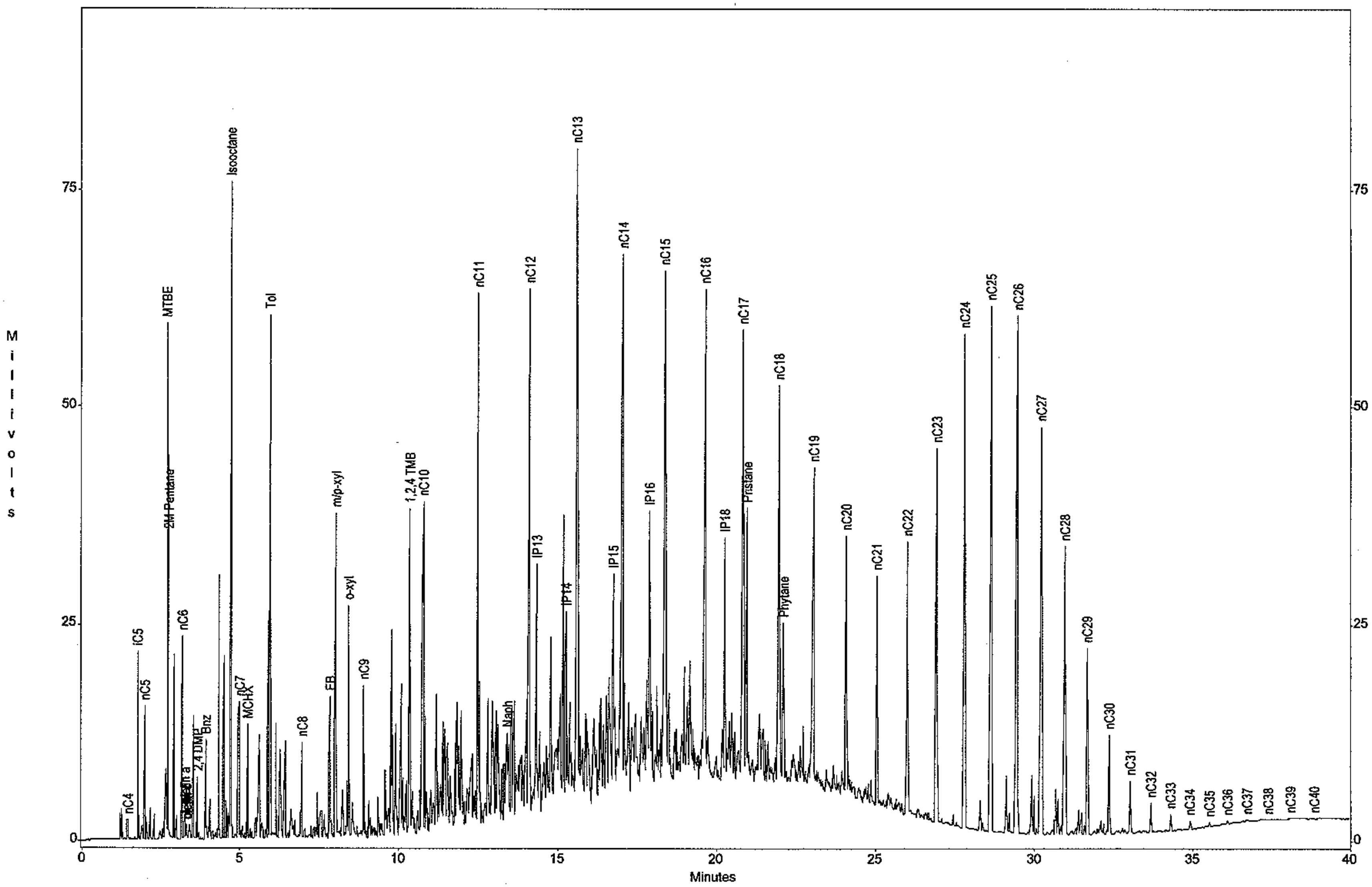

Torkelson Geochemistry, Inc.

Sunoco, Inc., Philadelphia Refinery
Sample ID : C-143
Acquired : Jul 20, 2010 11:28:51

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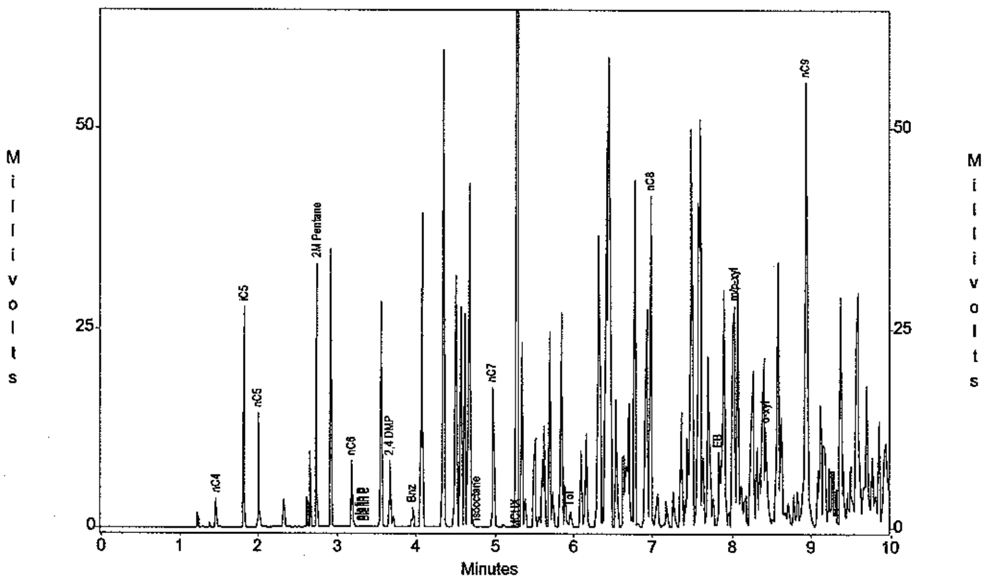

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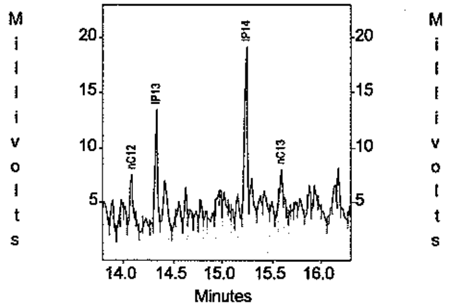

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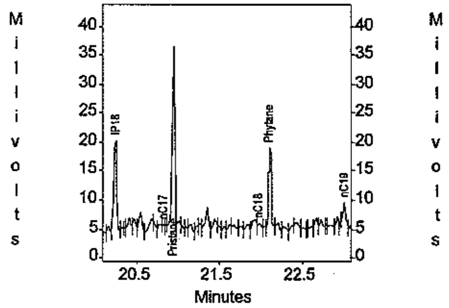

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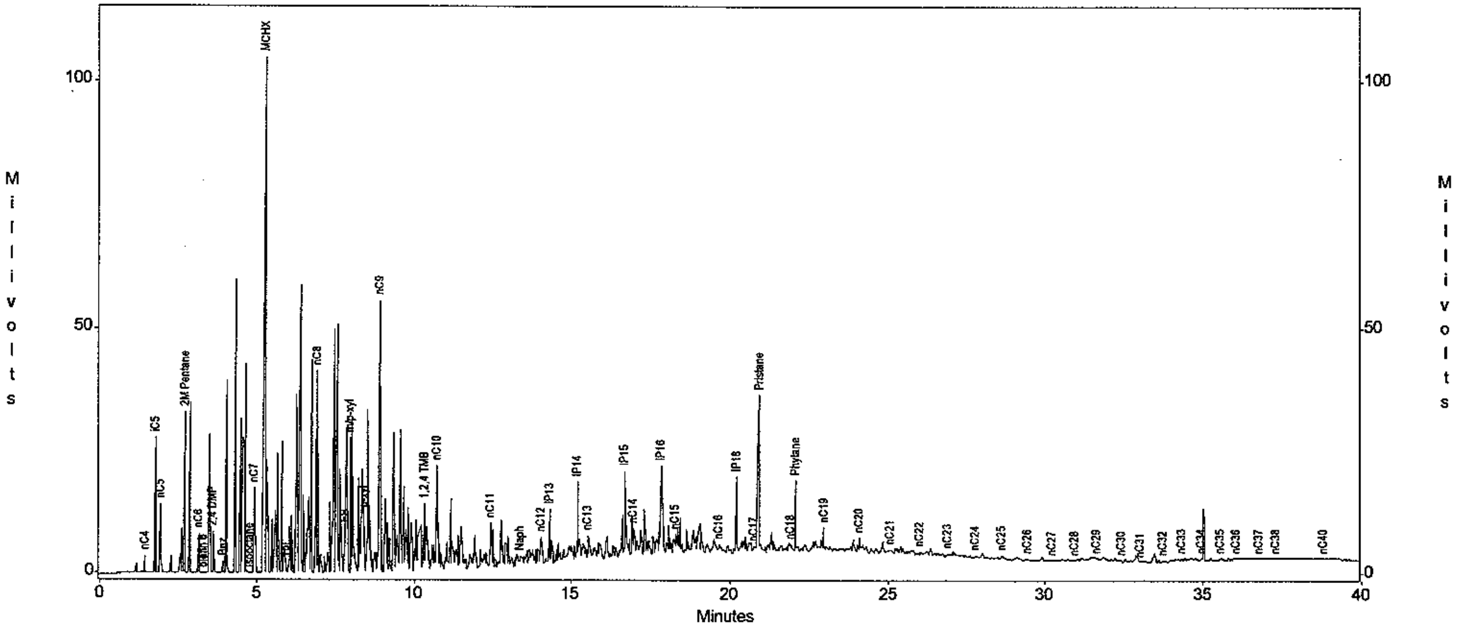

Channel A Results

Peak	Area	Height
nC4	2466	3538
iC5	20859	27746
nC5	11629	14336
MTBE	0	0
2M Pentane	30030	33150
nC6	8194	8347
olefin a	31	22
olefin b	87	79
olefin c	170	131
2.4 DMP	8824	8480
Bnz	3262	2470
Isooctane	66	28
nC7	20862	17512
MCHX	175772	104822
Tol	3534	2045
nC8	56205	41636
EB	13984	9360
m/p-xyl	48704	27779
o-xyl	27084	12423
nC9	103249	55760
1.2.4 TMB	21432	13604
nC10	35696	21414
nC11	18458	9121
Naph	5146	2309
nC12	13846	5931
IP13	23181	11735
IP14	30530	17192
nC13	12747	6018
IP15	37102	18746
nC14	22855	7069
IP16	37790	19641
nC15	19382	5566
nC16	7722	3124
IP18	42487	17021
nC17	5390	2594
Pristane	81585	33254
nC18	6651	2466
Phytane	41071	15565
nC19	18528	5838
nC20	8963	3423
nC21	2753	766
nC22	2350	782
nC23	1492	493
nC24	1618	483
nC25	2799	700
nC26	1023	328
nC27	200	104
nC28	304	155
nC29	741	432
nC30	386	214
nC31	93	36
nC32	333	172
nC33	1103	305
nC34	46	61
nC35	190	102
nC36	147	91
nC37	30	46
nC38	39	44
nC39	0	0
nC40	108	28

Torkelson Geochemistry, Inc.

Sunoco, Inc., Philadelphia Refinery
Sample ID : S-282
Acquired : Jul 20, 2010 12:19:51

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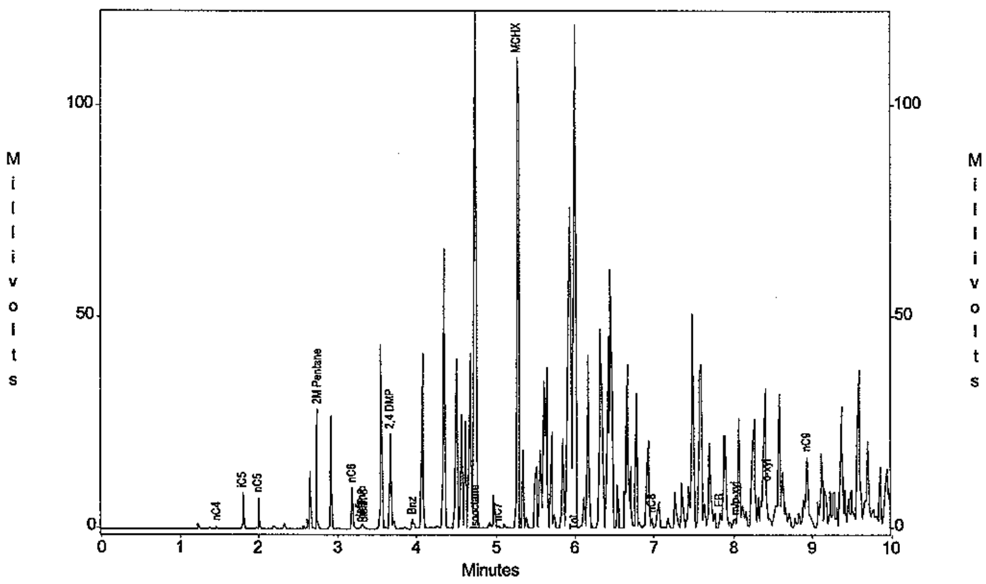

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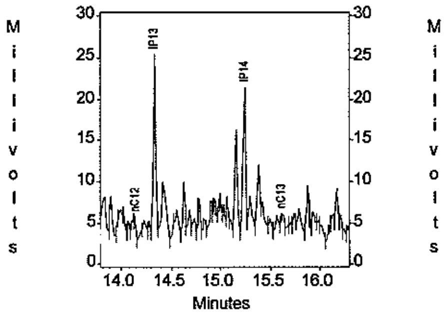

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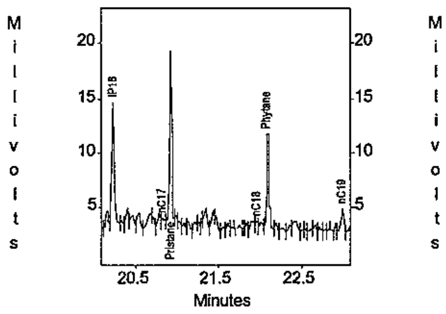

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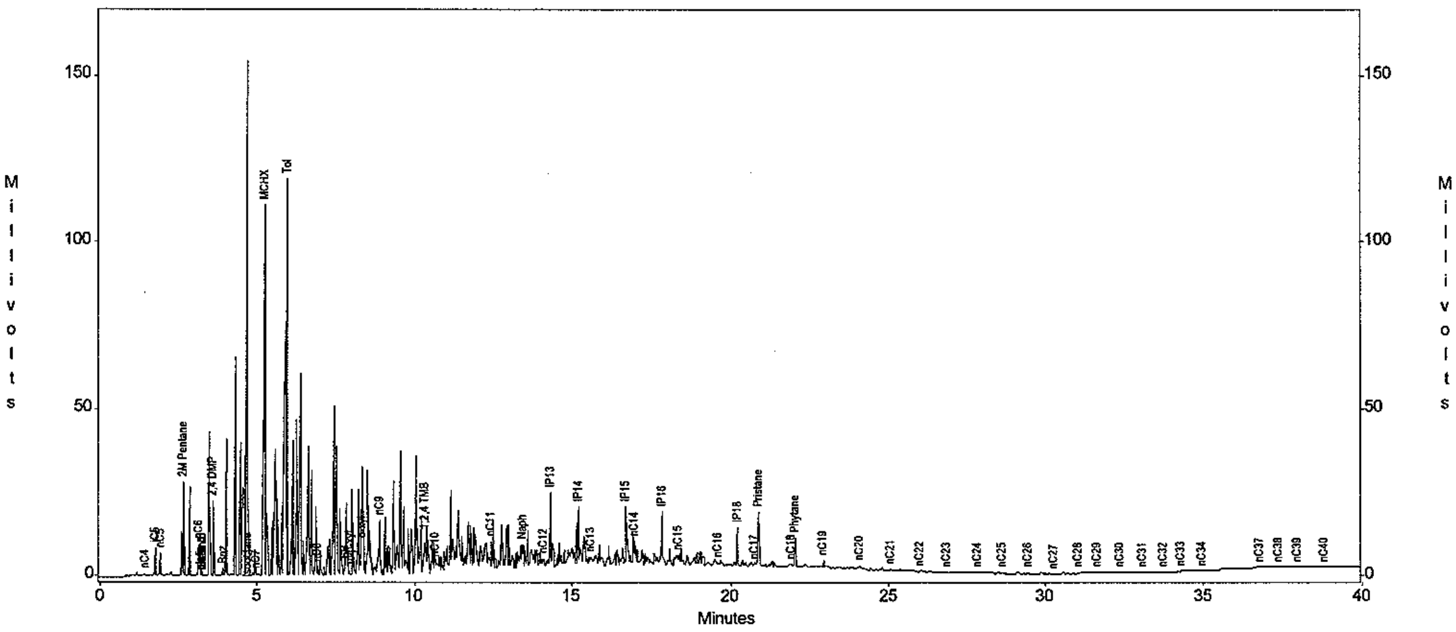


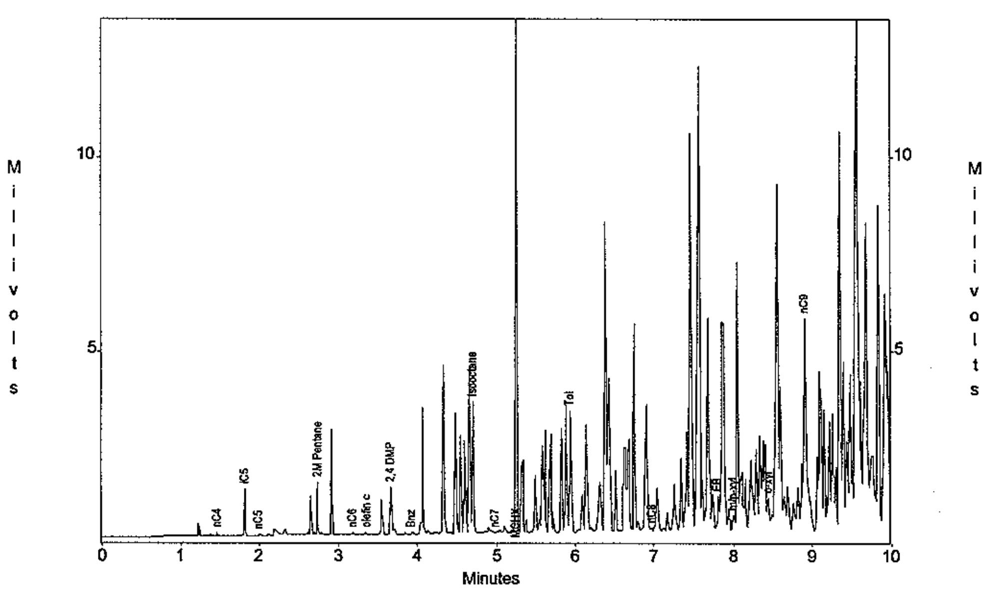
Channel A Results

Peak	Area	Height
nC4	413	613
iC5	6385	8603
nC5	5842	7271
MTBE	0	0
2M Pentane	25979	28465
nC6	9651	9598
olefin a	267	250
olefin b	1116	1001
olefin c	589	445
2.4 DMP	23606	22556
Bnz	3163	2349
Isooctane	299102	154391
nC7	888	627
MCHX	192023	111391
Tol	214424	118961
nC8	3212	2532
EB	5400	3705
m/p-xyl	3713	2192
o-xyl	11140	10112
nC9	31252	16912
1.2.4 TMB	16970	11670
nC10	7402	3235
nC11	16239	8213
Naph	17069	7443
nC12	5874	3289
IP13	40678	22930
IP14	31468	18695
nC13	9703	3413
IP15	34942	18125
nC14	19906	7423
IP16	32439	16402
nC15	4793	2130
nC16	1643	1046
IP18	27814	11563
nC17	3811	1060
Pristane	35702	16445
nC18	1769	888
Phytane	19965	8901
nC19	5124	2134
nC20	2822	1087
nC21	1171	384
nC22	295	180
nC23	76	43
nC24	487	191
nC25	1267	251
nC26	563	163
nC27	247	58
nC28	72	37
nC29	194	59
nC30	198	50
nC31	83	34
nC32	67	37
nC33	53	34
nC34	90	43
nC35	0	0
nC36	0	0
nC37	78	40
nC38	58	27
nC39	128	26
nC40	45	17

Torkelson Geochemistry, Inc.

Sunoco, Inc., Philadelphia Refinery
Sample ID : S-285
Acquired : Jul 20, 2010 15:01:23

c:\ezchrom\chrom\10099\s-285 -- Channel A



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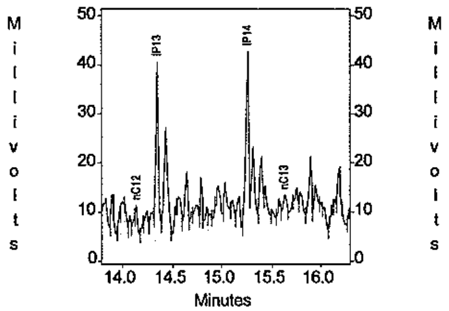

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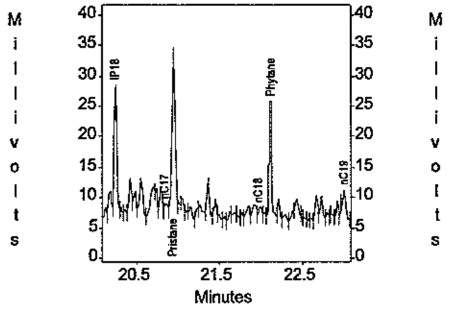

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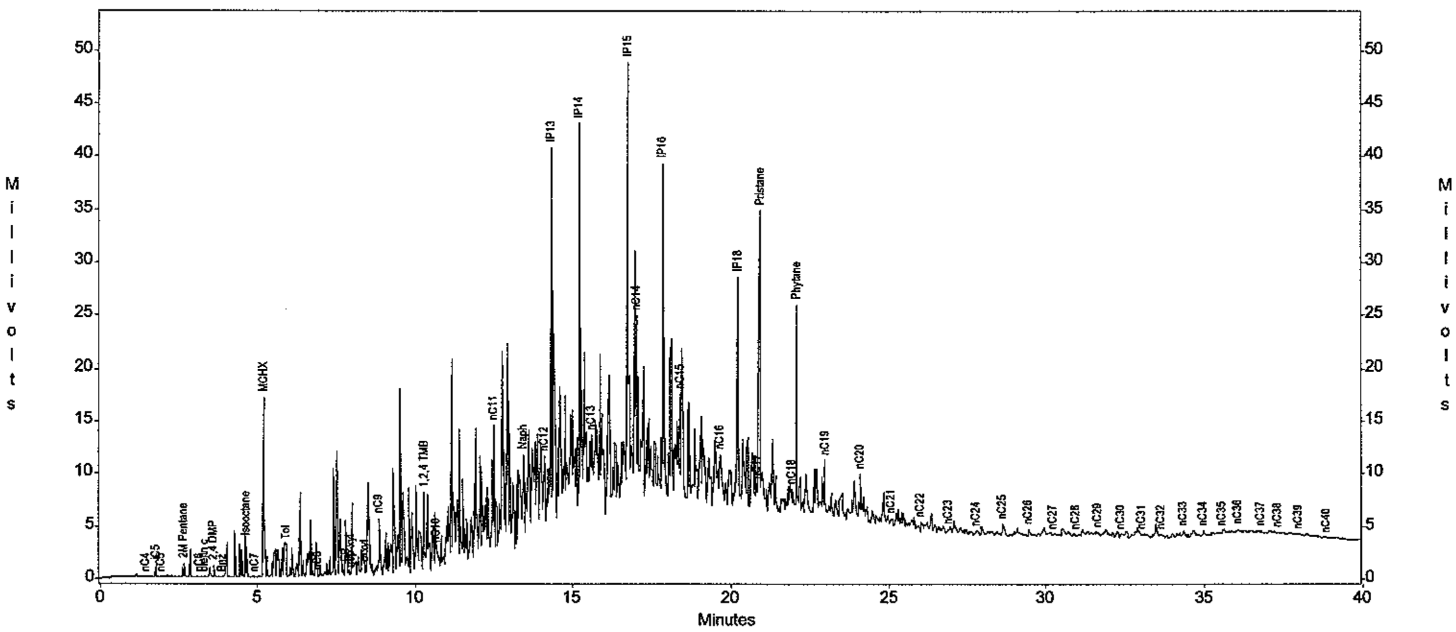

Channel A Results

Peak	Area	Height
nC4	74	75
iC5	935	1227
nC5	49	49
MTBE	0	0
2M Pentane	1281	1375
nC6	31	25
olefin a	0	0
olefin b	0	0
olefin c	38	21
2,4 DMP	1378	1191
Bnz	60	34
Isooctane	3866	3421
nC7	52	32
MCHX	19867	17102
Tol	3987	3133
nC8	115	101
EB	1313	890
m/p-xyl	560	381
o-xyl	974	607
nC9	9894	5486
1,2,4 TMB	13195	7526
nC10	3833	1930
nC11	18896	11773
Naph	29599	8698
nC12	16460	7837
IP13	70772	36698
IP14	73665	37957
nC13	26993	8099
IP15	87311	41720
nC14	43137	17507
IP16	63159	31225
nC15	26231	9973
nC16	15970	5080
IP18	51741	22060
nC17	9435	2736
Pristane	74194	28622
nC18	6456	2642
Phytane	47968	20155
nC19	16910	5754
nC20	12299	4931
nC21	1813	915
nC22	3026	976
nC23	986	421
nC24	1418	548
nC25	5649	1122
nC26	2012	674
nC27	646	257
nC28	559	289
nC29	346	224
nC30	414	137
nC31	221	166
nC32	210	201
nC33	679	318
nC34	277	189
nC35	315	128
nC36	147	91
nC37	221	147
nC38	83	50
nC39	39	46
nC40	265	85

Torkelson Geochemistry, Inc.

Sunoco, Inc., Philadelphia Refinery
Sample ID : S-297
Acquired : Jul 20, 2010 10:38:19

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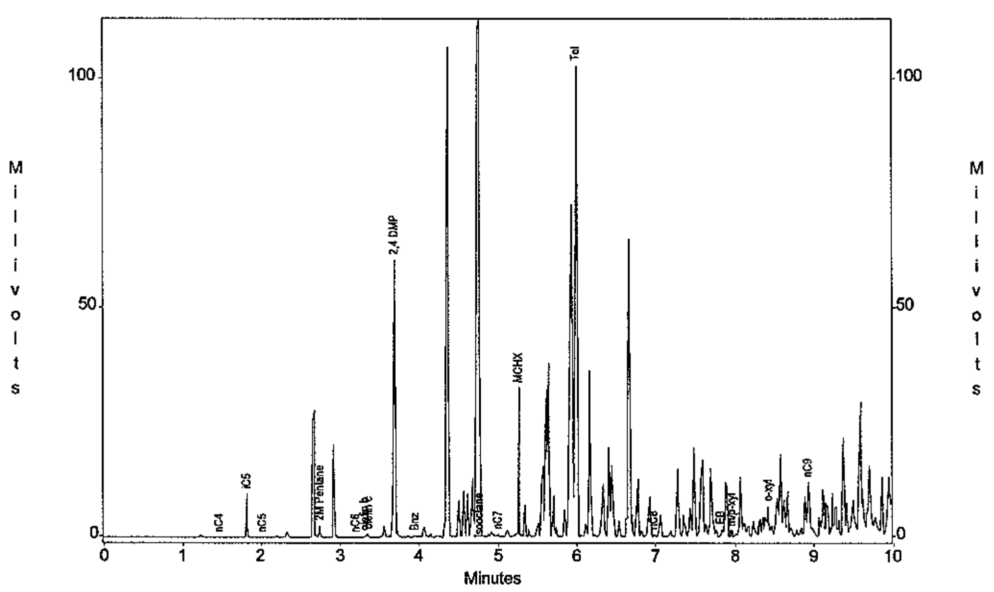

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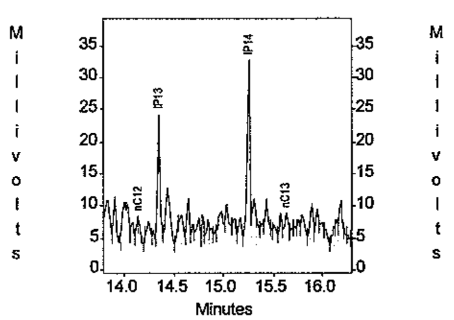

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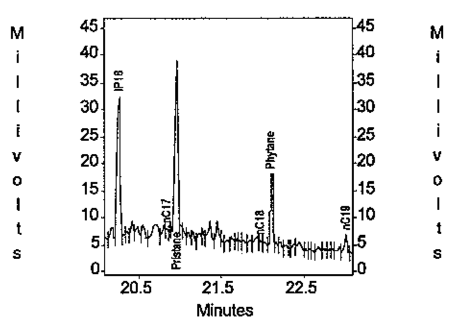

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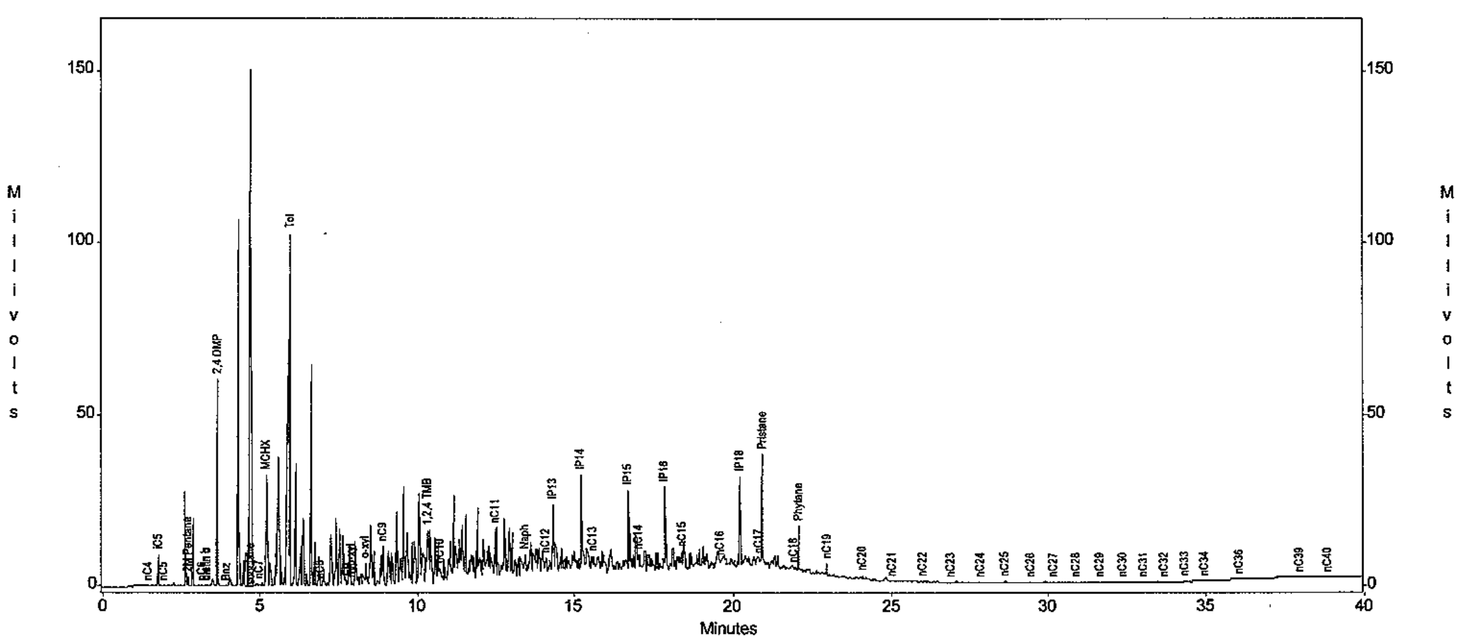


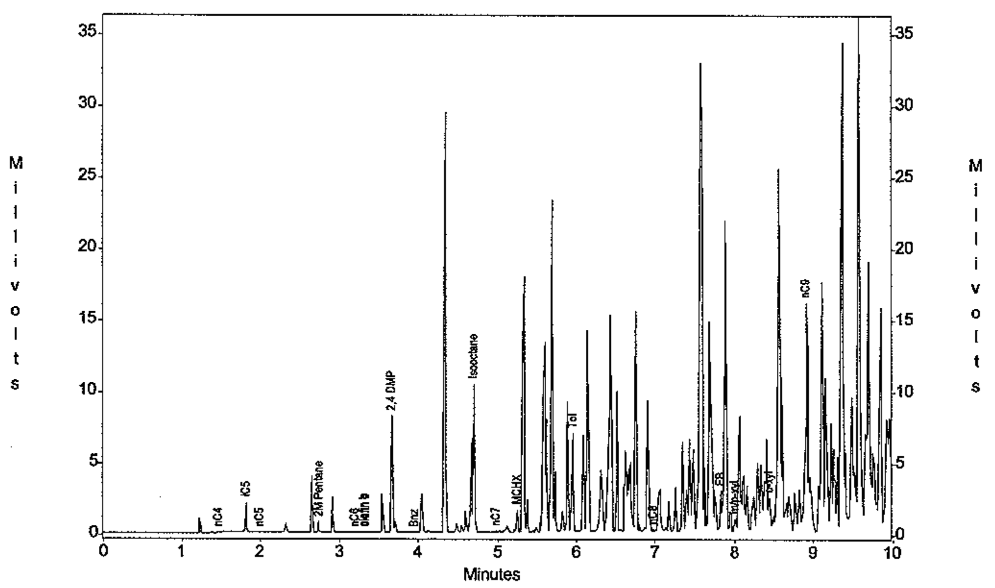
Channel A Results

Peak	Area	Height
nC4	63	70
iC5	6808	9247
nC5	38	29
MTBE	0	0
2M Pentane	2502	2620
nC6	33	27
olefin a	0	0
olefin b	204	205
olefin c	519	439
2.4 DMP	66668	60475
Bnz	255	199
Isooctane	289515	150440
nC7	564	490
MCHX	39219	32508
Tol	175037	102734
nC8	494	408
EB	2428	1514
m/p-xyl	2065	1194
o-xyl	9020	6516
nC9	21246	11819
1,2,4 TMB	24547	15782
nC10	7811	4107
nC11	28557	14648
Naph	11705	6052
nC12	5991	3837
IP13	37220	20236
IP14	51503	28733
nC13	14185	4971
IP15	43217	24055
nC14	9199	5114
IP16	46807	24547
nC15	9104	3937
nC16	6142	3334
IP18	70459	28211
nC17	9949	4347
Pristane	97158	35244
nC18	5392	2411
Phytane	36753	15011
nC19	12604	4082
nC20	2542	998
nC21	134	132
nC22	650	210
nC23	166	124
nC24	671	199
nC25	1842	348
nC26	626	208
nC27	305	113
nC28	282	79
nC29	212	80
nC30	159	42
nC31	46	25
nC32	92	38
nC33	40	25
nC34	393	78
nC35	0	0
nC36	706	50
nC37	0	0
nC38	0	0
nC39	184	31
nC40	72	26

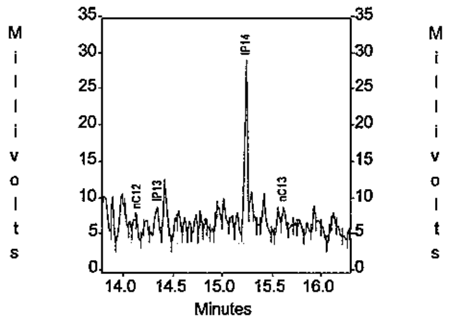
Torkelson Geochemistry, Inc.

Sunoco, Inc., Philadelphia Refinery
Sample ID : S-313
Acquired : Jul 20, 2010 14:02:27

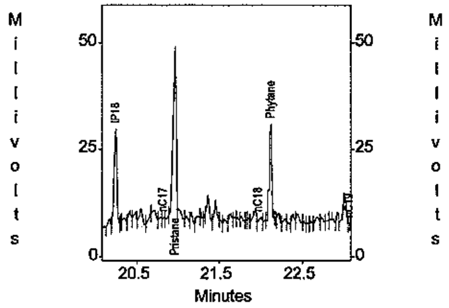
c:\ezchrom\chrom\10099\s-313 -- Channel A



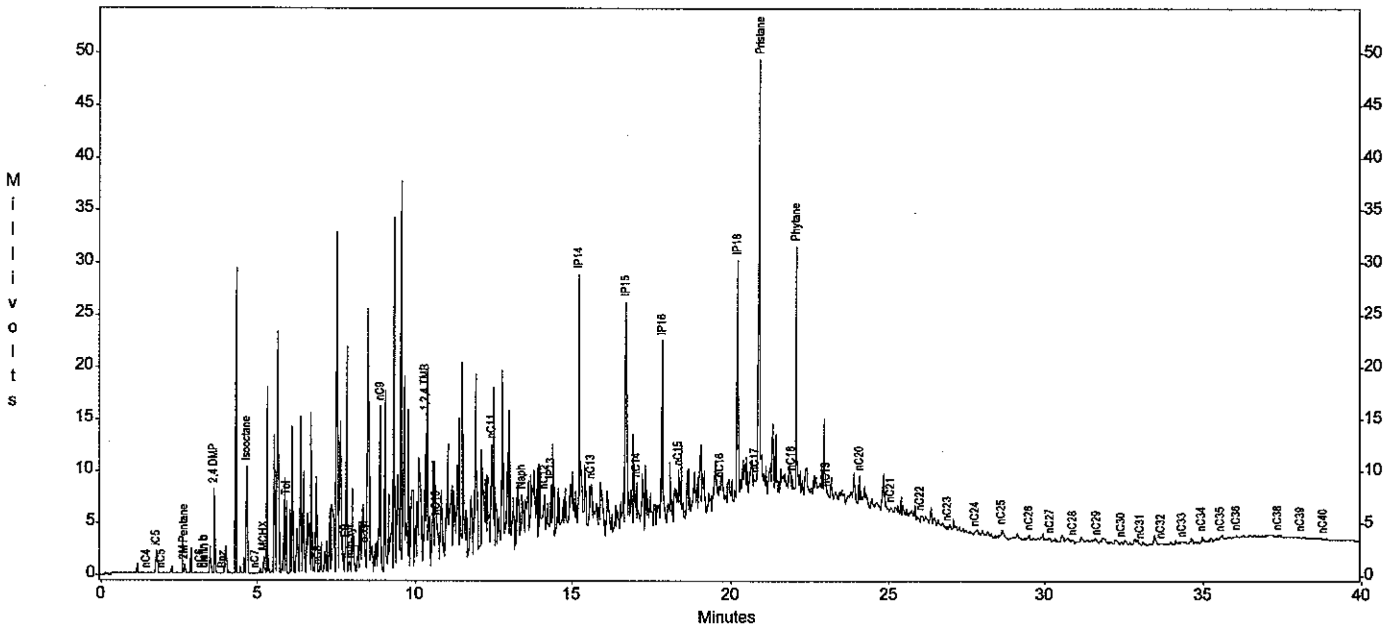
c:\ezchrom\chrom\10099\s-313 -- Channel A



c:\ezchrom\chrom\10099\s-313 -- Channel A



c:\ezchrom\chrom\10099\s-313 -- Channel A



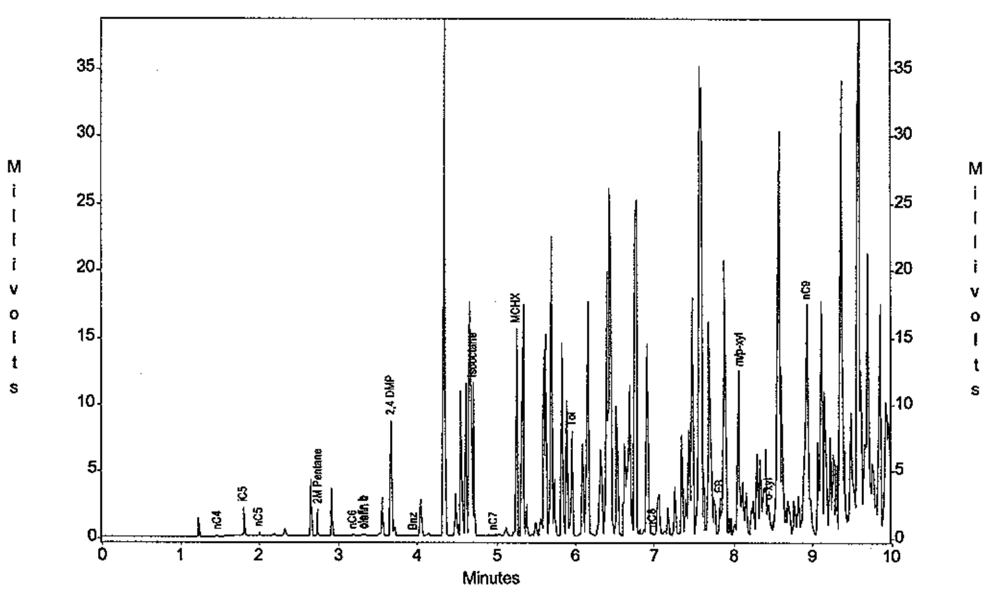
Channel A Results

Peak	Area	Height
nC4	16	22
iC5	1590	2144
nC5	95	103
MTBE	0	0
2M Pentane	760	789
nC6	16	13
olefin a	0	0
olefin b	61	61
olefin c	78	58
2.4 DMP	8270	8163
Bnz	37	30
Isooctane	11514	10348
nC7	100	42
MCHX	1989	1596
Tol	8229	6883
nC8	257	195
EB	4111	2895
m/p-xyl	1267	849
o-xyl	4538	2332
nC9	29478	15964
1.2.4 TMB	23119	14585
nC10	9201	4073
nC11	19588	9934
Naph	8387	4416
nC12	7127	4106
IP13	19074	5165
IP14	45567	25286
nC13	14478	5003
IP15	31594	20987
nC14	11210	4286
IP16	34225	17843
nC15	8342	3862
nC16	3575	2279
IP18	55874	23036
nC17	4206	2132
Pristane	112261	41951
nC18	4111	1874
Phytane	58620	23953
nC19	292	373
nC20	7346	3081
nC21	2093	802
nC22	1841	688
nC23	751	290
nC24	685	361
nC25	4194	898
nC26	1443	448
nC27	774	282
nC28	74	107
nC29	664	278
nC30	483	201
nC31	209	141
nC32	249	151
nC33	875	233
nC34	2082	486
nC35	302	139
nC36	159	136
nC37	0	0
nC38	77	69
nC39	65	46
nC40	45	48

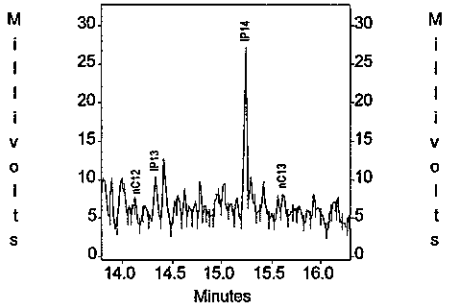
Torkelson Geochemistry, Inc.

Sunoco, Inc., Philadelphia Refinery
Sample ID : S-315
Acquired : Jul 20, 2010 13:11:48

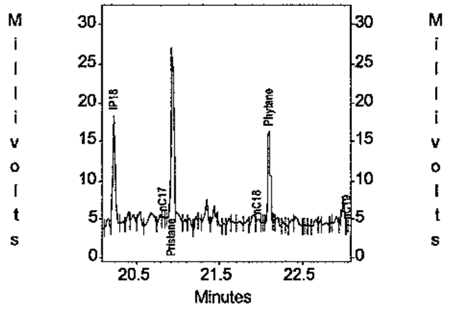
c:\ezchrom\chrom\10099\s-315 -- Channel A



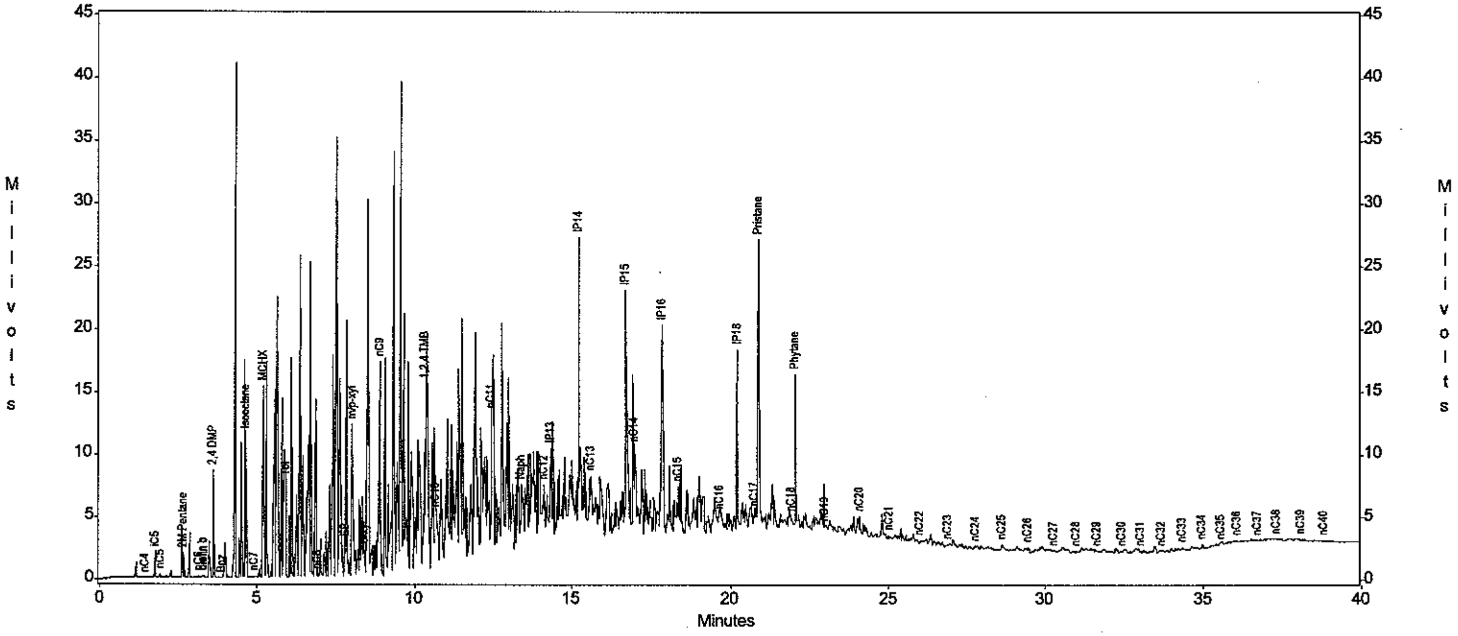
c:\ezchrom\chrom\10099\s-315 -- Channel A



c:\ezchrom\chrom\10099\s-315 -- Channel A



c:\ezchrom\chrom\10099\s-315 -- Channel A



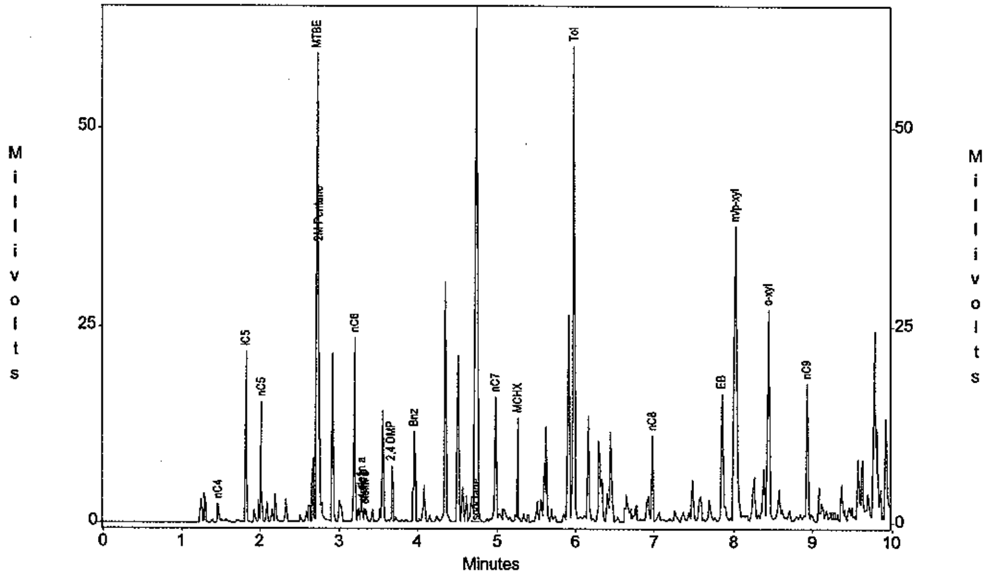
Channel A Results

Peak	Area	Height
nC4	30	35
iC5	1591	2136
nC5	274	308
MTBE	0	0
2M Pentane	1840	1931
nC6	151	137
olefin a	0	0
olefin b	155	146
olefin c	161	128
2.4 DMP	8780	8580
Bnz	62	36
Isooctane	12393	11504
nC7	62	58
MCHX	18767	15448
Tol	9212	7764
nC8	223	165
EB	3937	2792
m/p-xyl	18376	12334
o-xyl	4392	2242
nC9	31438	17237
1.2.4 TMB	22878	14899
nC10	9224	4129
nC11	21185	10648
Naph	10213	4860
nC12	5306	3225
IP13	20513	6660
IP14	42857	23771
nC13	13743	4809
IP15	37552	19705
nC14	19613	7049
IP16	29613	16621
nC15	6110	3008
nC16	2286	1629
IP18	34525	14832
nC17	3622	1831
Pristane	54083	23565
nC18	3688	1441
Phytane	30393	12911
nC19	1055	712
nC20	3019	1436
nC21	563	302
nC22	835	349
nC23	396	209
nC24	1606	305
nC25	3112	629
nC26	1065	359
nC27	70	63
nC28	225	81
nC29	263	180
nC30	387	134
nC31	176	103
nC32	179	79
nC33	224	100
nC34	1290	295
nC35	50	34
nC36	402	100
nC37	76	40
nC38	110	54
nC39	42	22
nC40	97	50

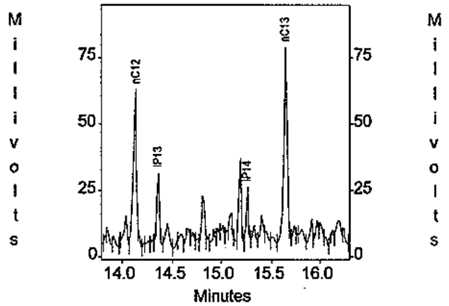
Torkelson Geochemistry, Inc.

Sunoco, Inc., Philadelphia Refinery
Sample ID : Gas/Dies/Wax std
Acquired : Jul 20, 2010 09:47:53

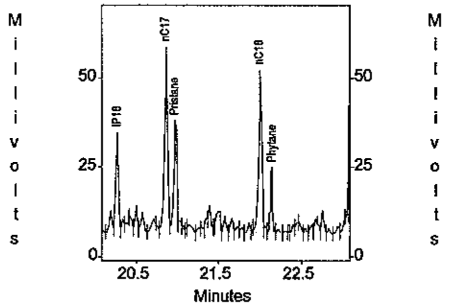
c:\ezchrom\chrom\10099\gadiwax2 – Channel A



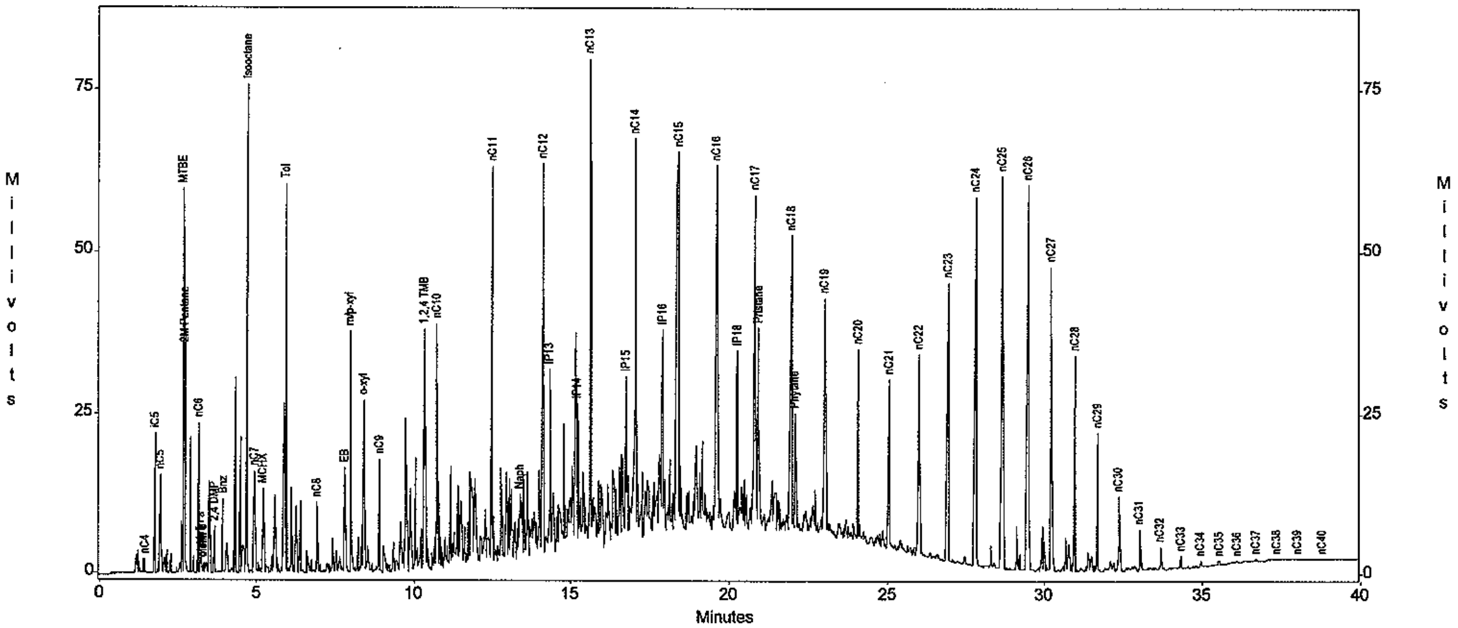
c:\ezchrom\chrom\10099\gadiwax2 – Channel A



c:\ezchrom\chrom\10099\gadiwax2 – Channel A



c:\ezchrom\chrom\10099\gadiwax2 – Channel A



Channel A Results

Peak	Area	Height
nC4	1984	2368
iC5	15414	21815
nC5	11667	15453
MTBE	49307	59479
2M Pentane	33096	34918
nC6	22200	23338
olefin a	3612	3418
olefin b	1724	1722
olefin c	1971	1548
2,4 DMP	7274	7143
Bnz	14167	11489
Isooctane	105230	75635
nC7	19179	15820
MCHX	15682	13181
Tol	85518	60313
nC8	13430	11072
EB	23107	16349
m/p-xyl	81108	37519
o-xyl	39737	26870
nC9	24717	17590
1.2.4 TMB	68131	37505
nC10	61257	38172
nC11	124394	61224
Naph	19825	9956
nC12	128262	60646
IP13	52562	28790
IP14	40766	22703
nC13	176610	75744
IP15	39477	24563
nC14	151755	60419
IP16	75003	32151
nC15	156310	59696
nC16	142887	57295
IP18	65882	28620
nC17	129725	52397
Pristane	74492	31831
nC18	97720	45871
Phytane	40775	18464
nC19	83344	36711
nC20	61701	30048
nC21	54890	26638
nC22	68336	31525
nC23	106107	43174
nC24	160461	57025
nC25	186168	60645
nC26	183641	59685
nC27	134561	46943
nC28	82385	33357
nC29	45276	21535
nC30	21360	11336
nC31	11214	6091
nC32	6031	3388
nC33	3267	1886
nC34	1852	992
nC35	1084	567
nC36	546	285
nC37	326	167
nC38	241	92
nC39	236	68
nC40	153	45

Torkelson Geochemistry, Inc.

Density Measurements

Paar DMA 512 / DMA 60 ASTM Method 4052

Sample	Density gm/ml	Temp. of Measurement	Job Number	Date
C-143	0.8676	60F	10099	7/20/10
S-282	0.8104	60F	10099	7/20/10
S-285	0.8921	60F	10099	7/20/10
S-297	0.8229	60F	10099	7/20/10
S-313	0.8694	60F	10099	7/20/10
S-315	0.8552	60F	10099	7/20/10

Torkelson Geochemistry, Inc.
2528 S. Columbia Place
Tulsa, OK 74114-3233
Phone: 918-749-8441
Fax: 918-749-6005
e-mail: BTorkelson@aol.com

CHAIN-OF-CUSTODY RECORD

Project: Sun- Philadelphia Refinery COA
Location: Philadelphia, PA

Proj. No.:
P.O.:
Sampled By: M. Brad Spancake & Tim Delk

Report/Bill To: Colleen Costell0
Address: 30 South 17th St, Suite 1500
Philadelphia, PA 19103

Phone: 215.864.0640
Fax: 215.864.0671
e-mail:

Additional Instructions

Requested Turn-Around Time:

	ITEM NO.	SAMPLE DESCRIPTION	DATE	MATRIX	LAB NO.	Total # OF Vials	PRESERVATIVES	ANALYSES REQUESTED		REMARKS
							None	GC Characterization	Specific Gravity	
	1	B-130	2/27/04	Product		1	X	X	X	
	2	A-14	↓	↓		1	X	X	X	
	3	SRTF MW-1				1	X	X	X	
	4	B-129				1	X	X	X	
	5	WP 9-2	3/1/04			1	X	X	X	
AOF3	6	BF-107	↓			1	X	X	X	
	7	S-33				1	X	X	X	
AOF3	8	BF-106				1	X	X	X	
	9	A-22				1	X	X	X	
	10	S-100				1	X	X	X	

RELINQUISHED BY	ACCEPTED BY	DATE	TIME
M. Brad	FedEx	3/1/04	
	Bruce Torkelson	3-2-04	1705

Torkelson Geochemistry, Inc.

2528 S. Columbia Place
Tulsa, OK 74114-3233

Phone: 918-749-8441
Fax: 918-749-6005
e-mail: BTorkelson@aol.com

CHAIN-OF-CUSTODY RECORD

Project: Sun- Philadelphia Refinery COA
Location: Philadelphia, PA
Proj. No.:
P.O.:
Sampled By: M. Brad Spancake & Tim Delk

Report/Bill To: Colleen Costell0
Address: 30 South 17th St, Suite 1500
Philadelphia, PA 19103
Phone: 215.864.0640
Fax: 215.864.0671
e-mail:

Additional Instructions

Requested Turn-Around Time:

AOI 3

						PRESERVATIVES					ANALYSES REQUESTED													
ITEM NO.	SAMPLE DESCRIPTION	DATE	MATRIX	LAB NO.	Total # OF Vials	None					GC Characterization	Specific Gravity												REMARKS
1	S-68	2/27/04	Product		1	X					X	X												Sorbent Pad Sample
2	S-104	↓	↓		1	X					X	X												" " "
3	S-158				1	X					X	X												
4	S-142				1	X					X	X												Sorbent Pad Sample
5	S-138				1	X					X	X												
6	S-130				1	X					X	X												
7	S-92				1	X					X	X												
8	S-162				1	X					X	X												
9	S-82				1	X					X	X												Sorbent Pad Sample
10	S-89				1	X					X	X												

RELINQUISHED BY	ACCEPTED BY	DATE	TIME
M Brad	FED EX	3/1/04	
	Bruce Torkelson	3-2-04	1705

Torkelson Geochemistry, Inc.

2528 S. Columbia Place
Tulsa, OK 74114-3233

Phone: 918-749-8441 e-mail: BTorkelson@aol.com
Fax: 918-749-6005

CHAIN-OF-CUSTODY RECORD

Project: Sun- Philadelphia Refinery COA
Location: Philadelphia, PA

Proj. No.:
P.O.:
Sampled By: M. Brad Spancake & Tim Delk

Report/Bill To: Colleen Costell0
Address: 30 South 17th St, Suite 1500
Philadelphia, PA 19103

Phone: 215.864.0640
Fax: 215.864.0671
e-mail:

Additional Instructions

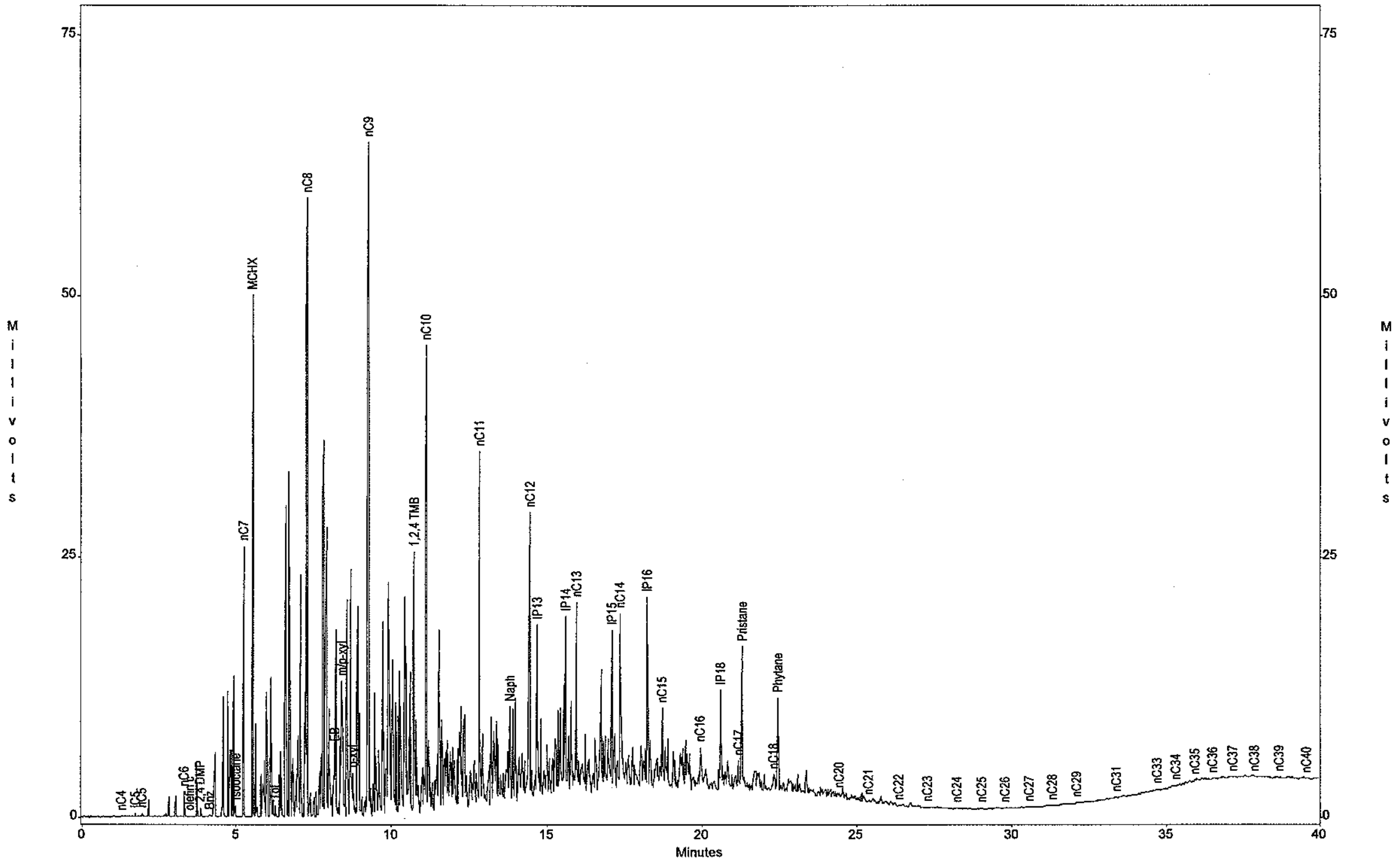
Requested Turn-Around Time:

ITEM NO.	SAMPLE DESCRIPTION	DATE	MATRIX	LAB NO.	Total # OF Vials	PRESERVATIVES	ANALYSES REQUESTED		REMARKS
						None	GC Characterization	Specific Gravity	
1	S-29	2/27/04	Product		1	X	X	X	
2	S-32	↓	↓		1	X	X	X	
3	S-56	↓	↓		1	X	X	X	
4	S-97	↓	↓		1	X	X	X	
5	S-103	↓	↓		1	X	X	X	
6	S-104	↓	↓		1	X	X	X	
7	S-124	↓	↓		1	X	X	X	
A013 - 8	S-21	↓	↓		1	X	X	X	
A013 - 9	S-59	↓	↓		1	X	X	X	
A013 - 10	S-60	↓	↓		1	X	X	X	

RELINQUISHED BY	ACCEPTED BY	DATE	TIME
M Brad	FED EX	3/1/04	
		3-2-04	1705

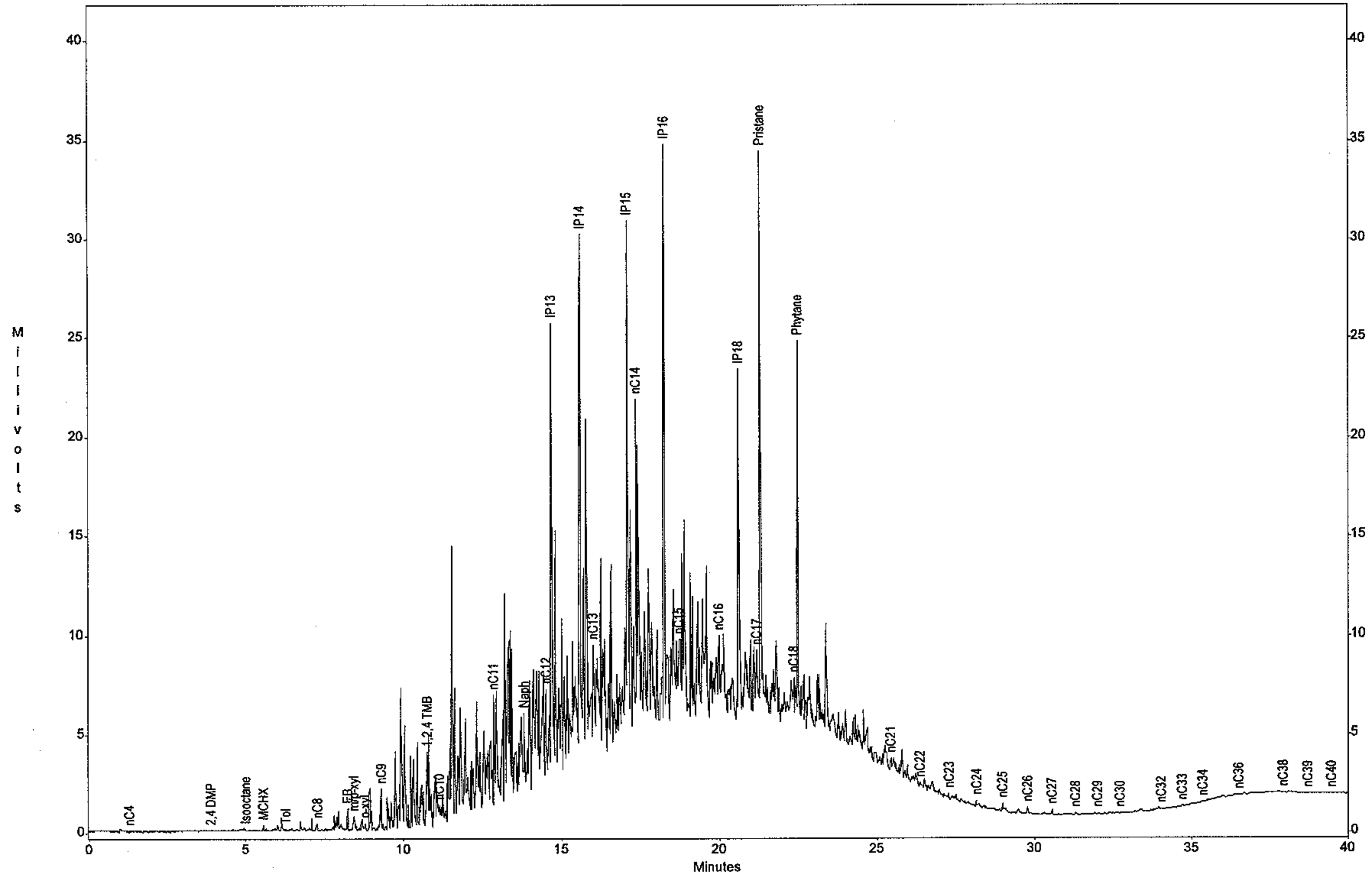
Sun - Philadelphia Refinery COA
Sample ID : BF-106
Acquired : Mar 07, 2004 18:06:23

c:\ezchrom\chrom\04046\bf-106 -- Channel A



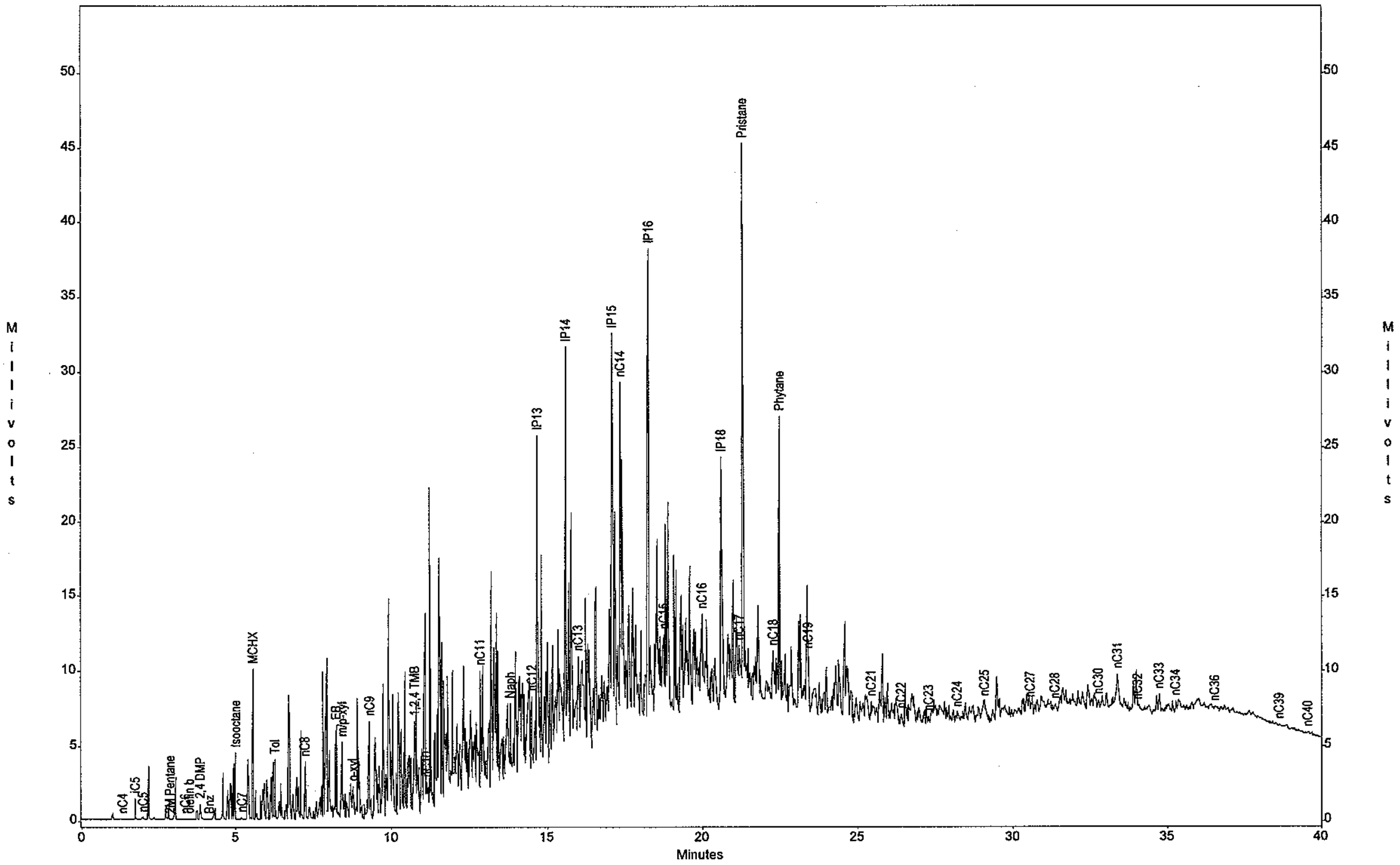
Sun - Philadelphia Refinery COA
Sample ID : BF-107
Acquired : Mar 06, 2004 07:21:31

c:\ezchrom\chrom\04046\bf-107 -- Channel A

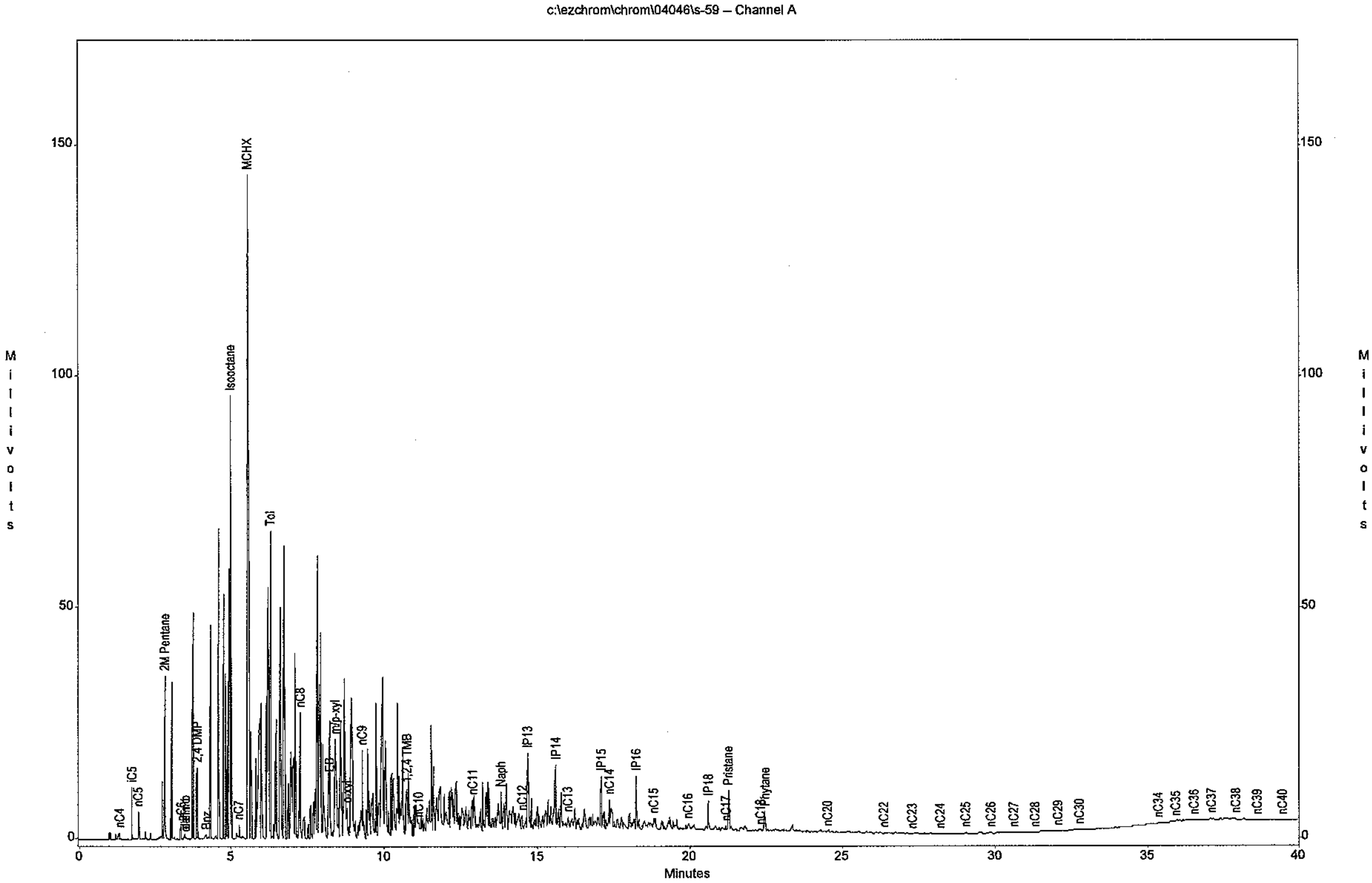


Sun - Philadelphia Refinery COA
Sample ID : S-21
Acquired : Mar 08, 2004 09:27:02

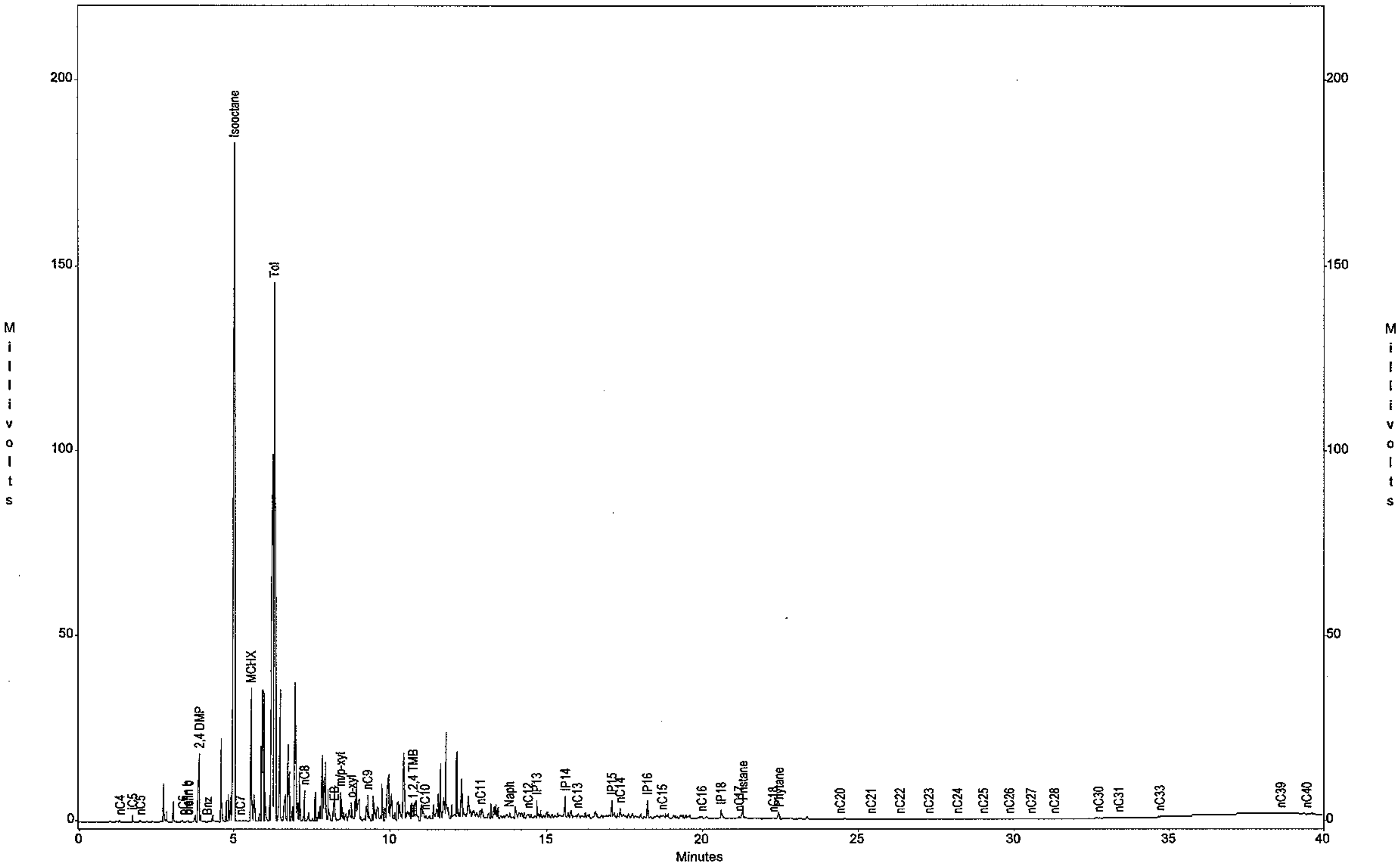
c:\ezchrom\chrom\04046\s-21 -- Channel A



Sun - Philadelphia Refinery COA
Sample ID : S-59
Acquired : Mar 08, 2004 11:53:37

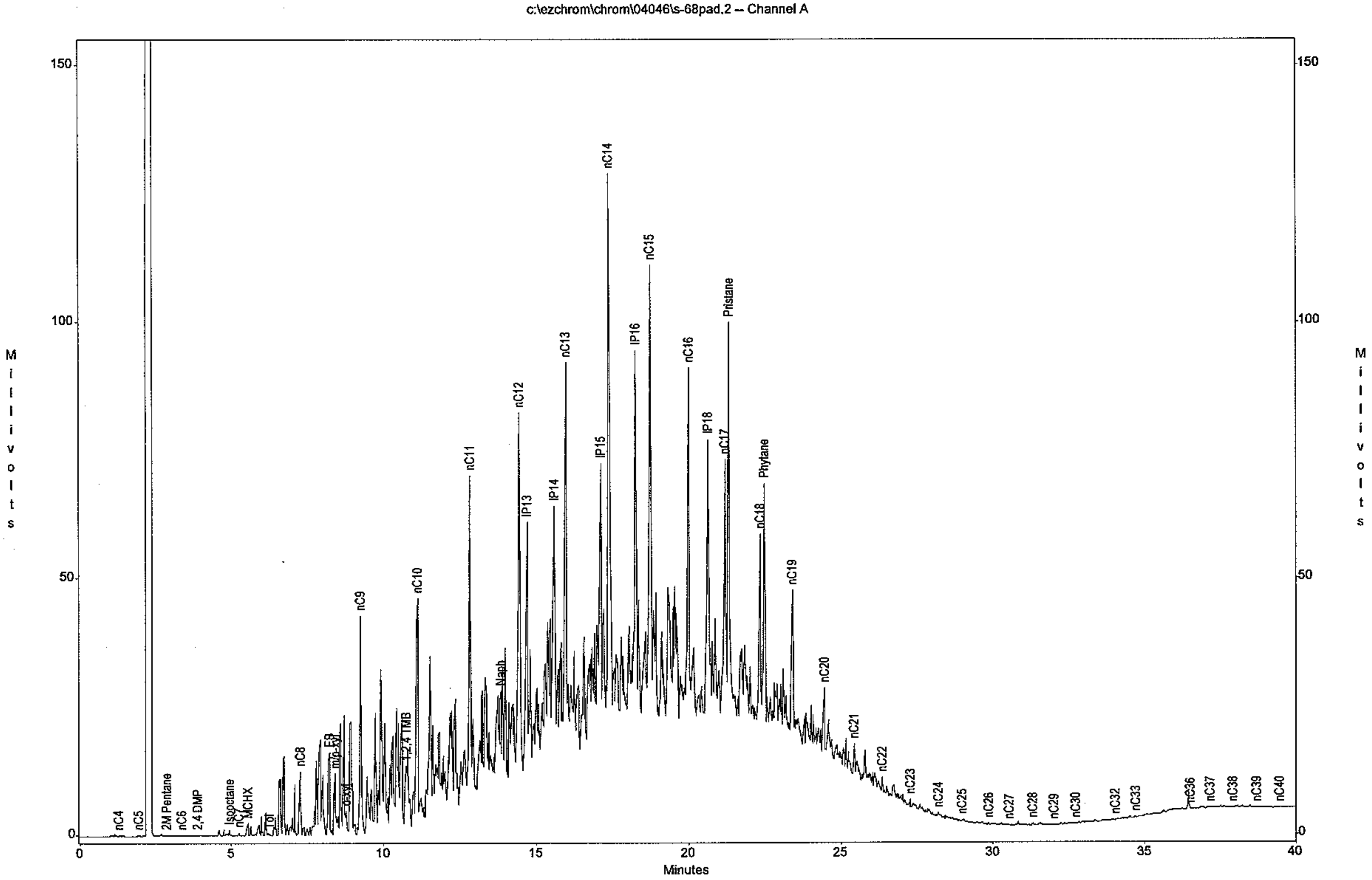


Sun - Philadelphia Refinery COA
Sample ID : S-60
Acquired : Mar 06, 2004 13:54:31



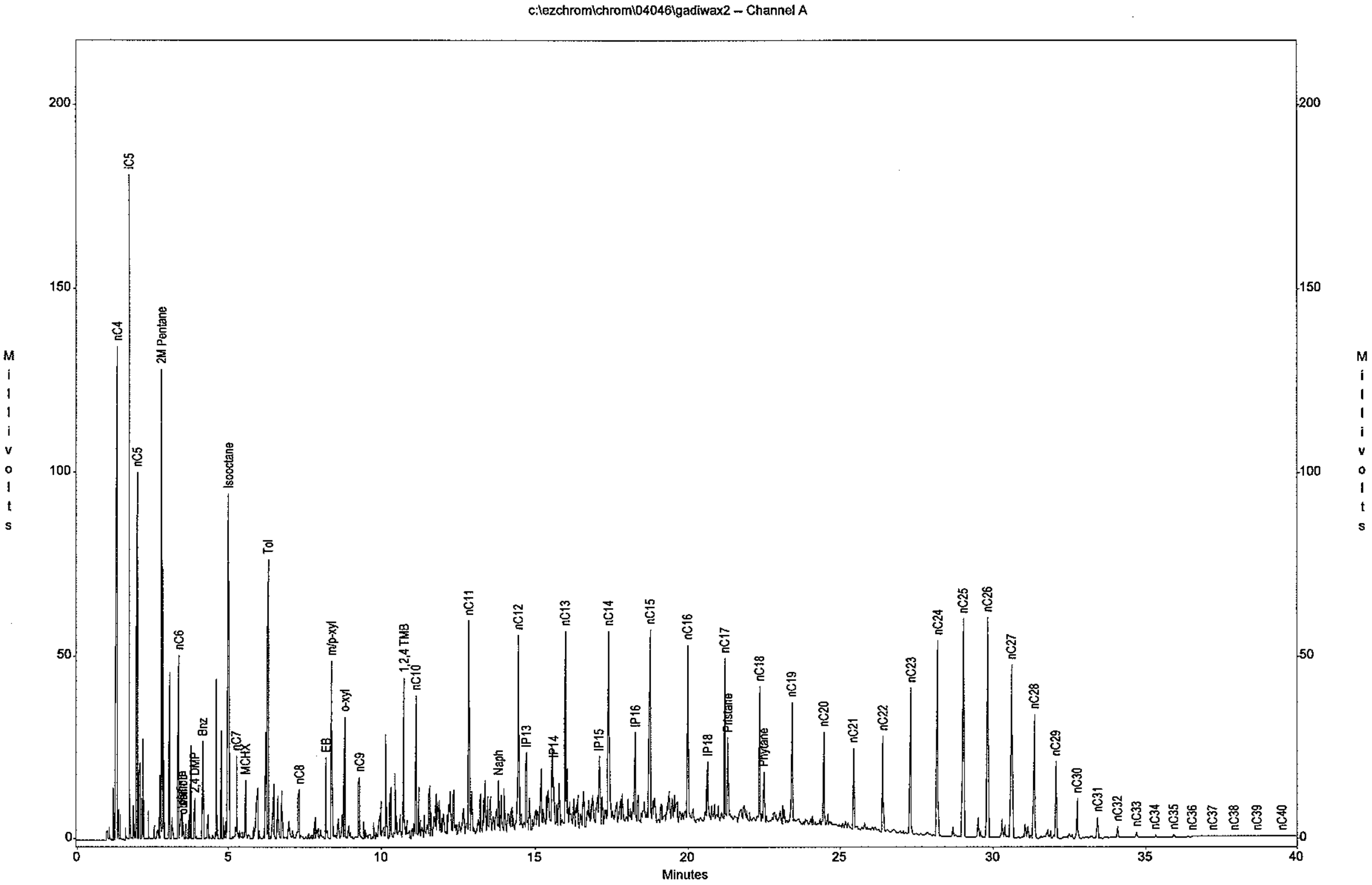
c:\ezchrom\chrom\04046\s-60.2 -- Channel A

Sun - Philadelphia Refinery COA
Sample ID : S-68 Pad
Acquired : Mar 09, 2004 13:21:33



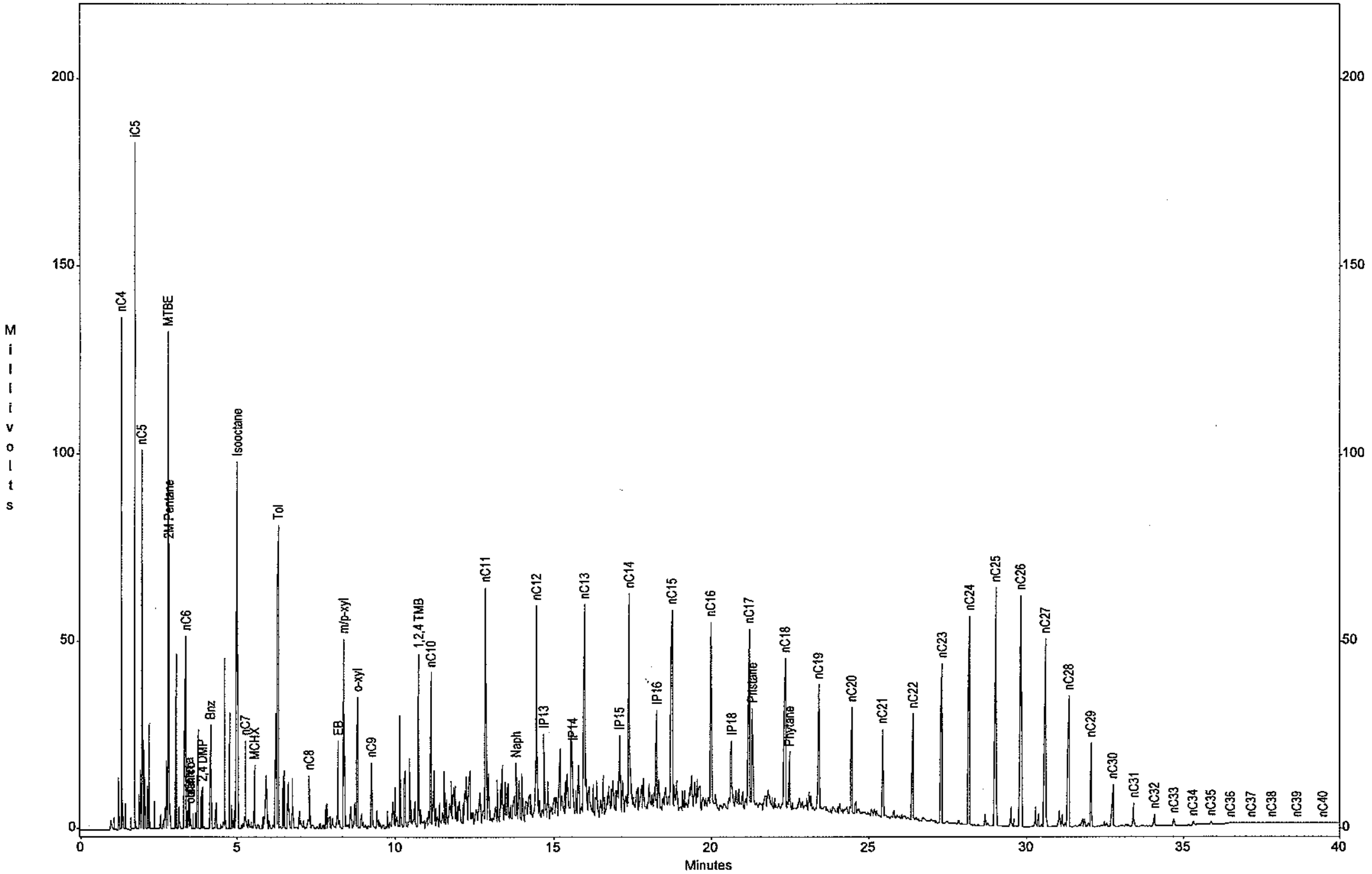
c:\ezchrom\chrom\04046\s-68pad.2 -- Channel A

Sun - Philadelphia Refinery COA
Sample ID : Gas/Dies/Wax std
Acquired : Mar 05, 2004 10:14:50



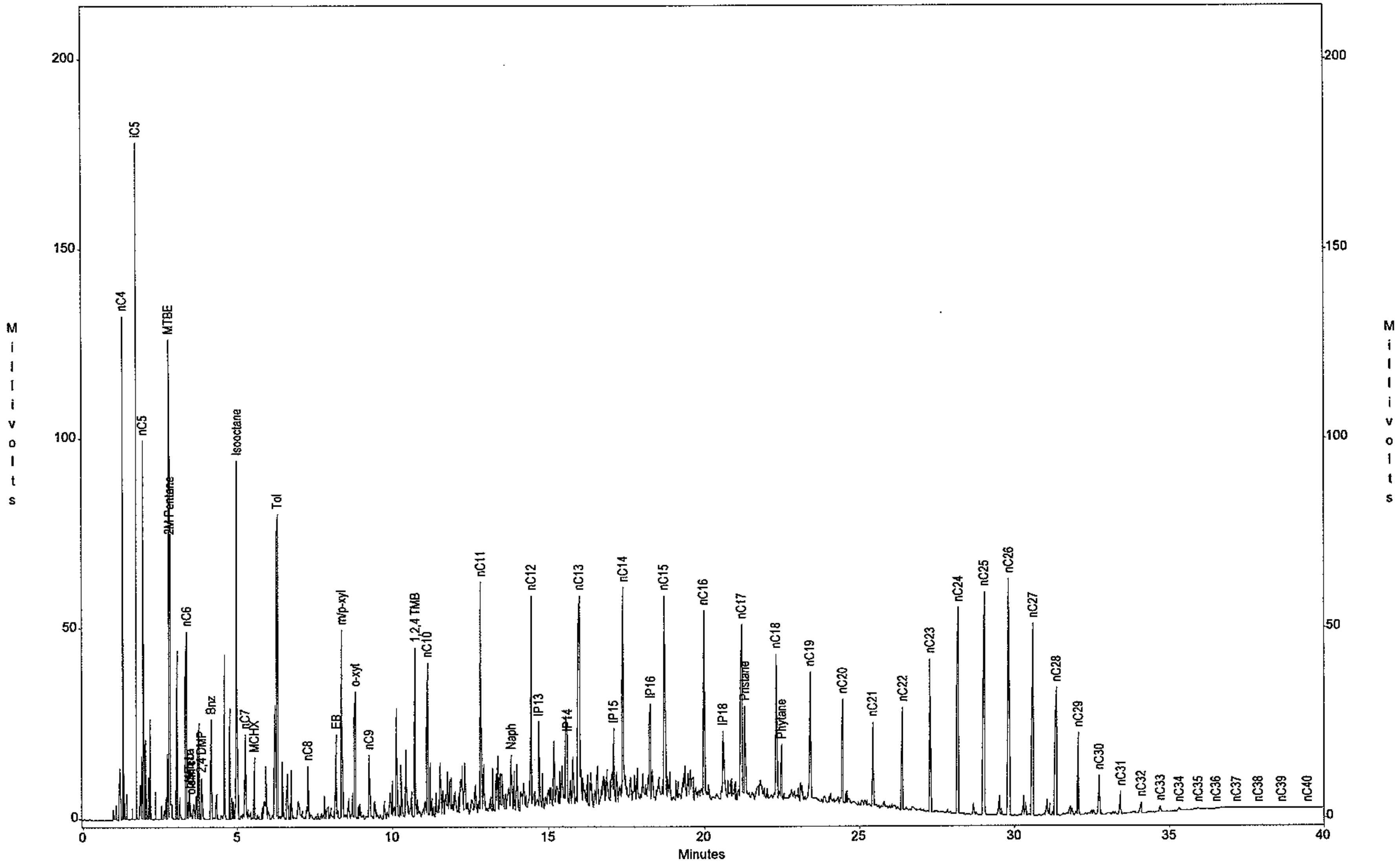
Sun - Philadelphia Refinery COA
Sample ID : Gas/Dies/Wax std
Acquired : Mar 06, 2004 11:29:07

c:\ezchrom\chrom\04046\gadiwax2.2 -- Channel A

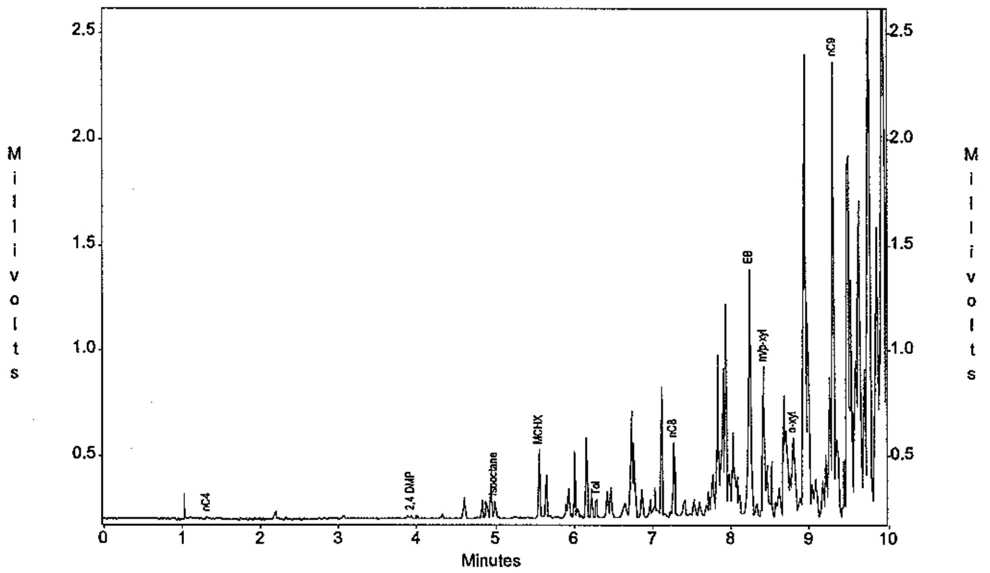


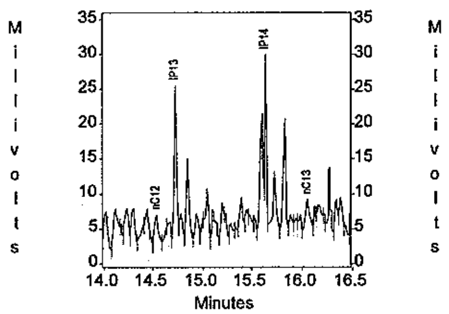
Sun - Philadelphia Refinery COA
Sample ID : Gas/Dies/Wax std
Acquired : Mar 07, 2004 16:27:47

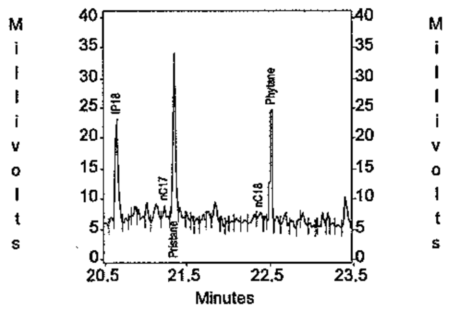
c:\ezchrom\chrom\04046\gadiwax2.3 – Channel A



Sun - Philadelphia Refinery COA
Sample ID : BF-107
Acquired : Mar 06, 2004 07:21:31


c:\ezchrom\chrom\04046\bf-107 – Channel A


c:\ezchrom\chrom\04046\bf-107 – Channel A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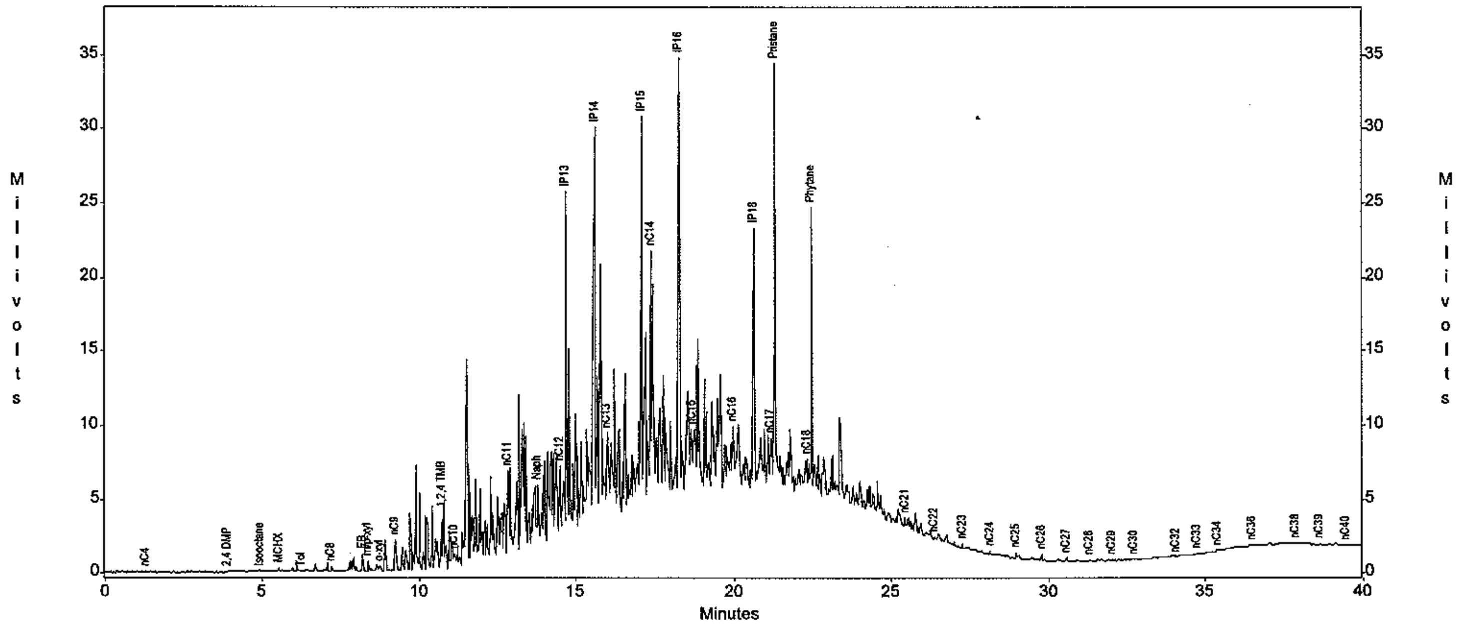
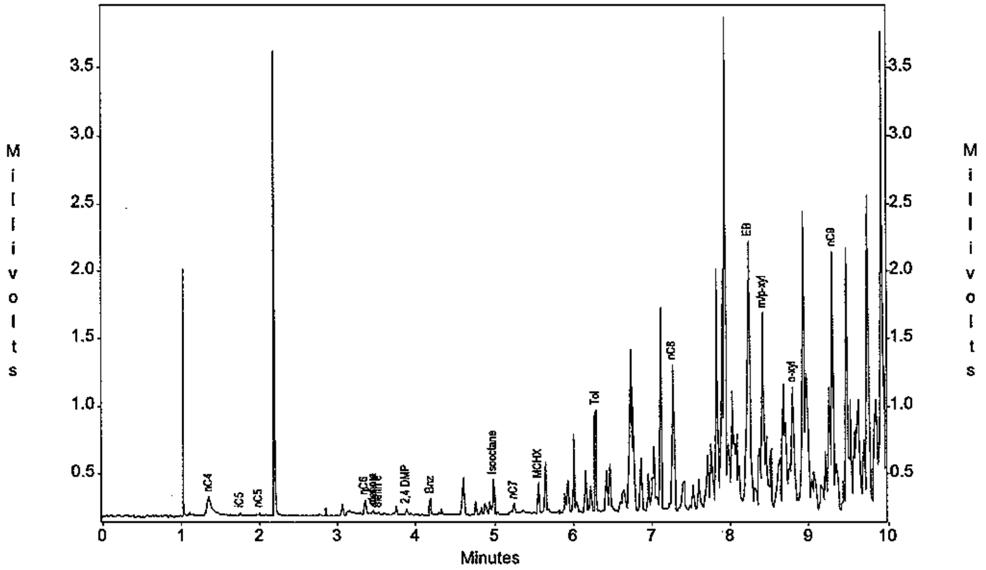

c:\ezchrom\chrom\04046\bf-107 – Channel A

Channel A Results

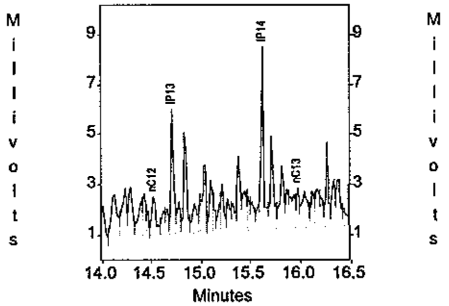
Peak	Area	Height
nC4	13	12
iC5	0	0
nC5	0	0
MTBE	0	0
2M Pentane	0	0
nC6	0	0
olefin a	0	0
olefin b	0	0
olefin c	0	0
2,4 DMP	24	20
Bnz	0	0
Isooctane	99	83
nC7	0	0
MCHX	401	324
Tol	117	86
nC8	609	359
EB	2028	1178
m/p-xyl	1016	719
o-xyl	866	379
nC9	3349	2159
1,2,4 TMB	7033	3840
nC10	1513	962
nC11	9472	5380
Naph	4093	3199
nC12	12791	4610
IP13	37819	22933
IP14	39386	26307
nC13	18055	5488
IP15	52150	26291
nC14	35532	17059
IP16	52242	29258
nC15	16863	3830
nC16	12798	4315
IP18	46094	17941
nC17	13574	3914
Pristane	66583	29184
nC18	10276	2855
Phytane	43578	19910
nC19	0	0
nC20	0	0
nC21	1262	662
nC22	1020	226
nC23	539	324
nC24	588	330
nC25	812	459
nC26	858	396
nC27	795	268
nC28	383	164
nC29	98	65
nC30	160	48
nC31	0	0
nC32	49	17
nC33	240	70
nC34	238	54
nC35	0	0
nC36	21	15
nC37	0	0
nC38	25	13
nC39	130	21
nC40	30	11

Sun - Philadelphia Refinery COA
Sample ID : C-65
Acquired : Mar 07, 2004 17:16:51

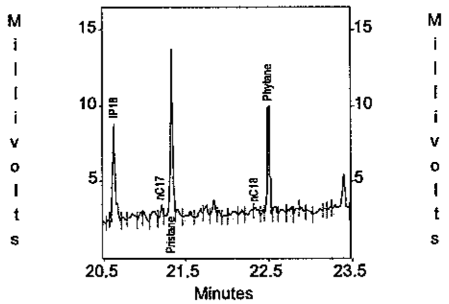
c:\ezchrom\chrom\04046\c-65 – Channel A



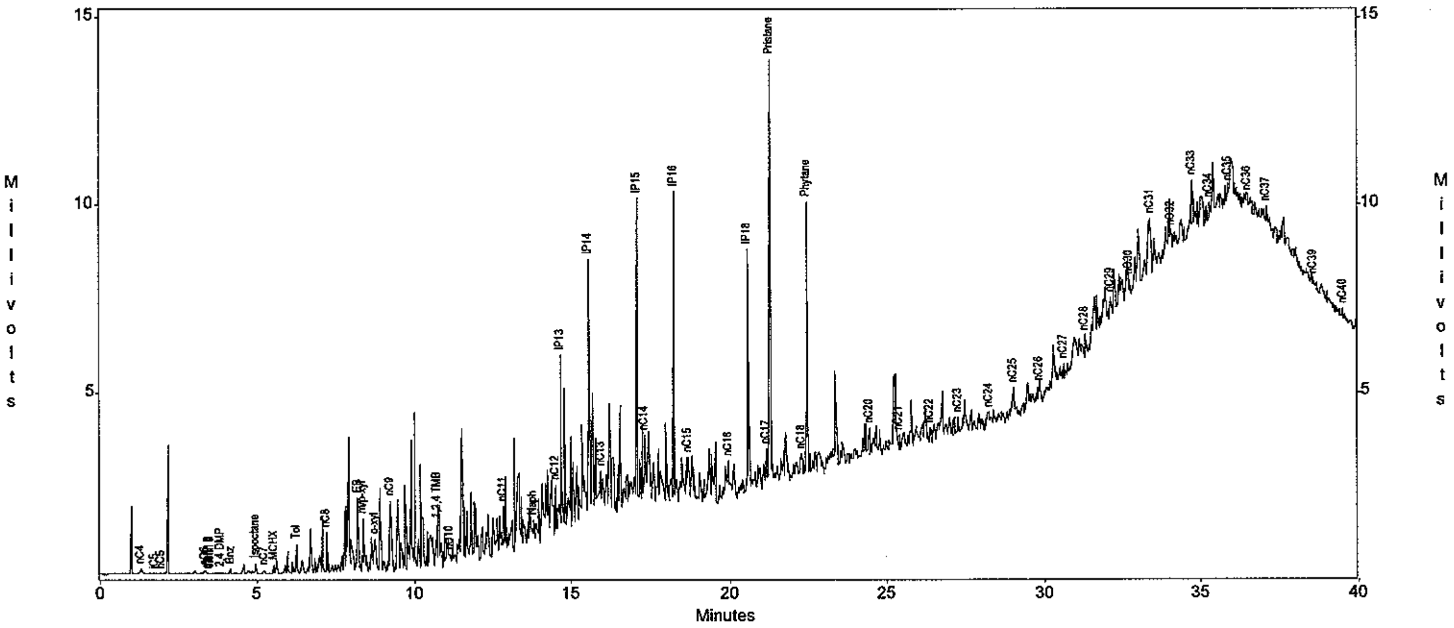
c:\ezchrom\chrom\04046\c-65 – Channel A



c:\ezchrom\chrom\04046\c-65 – Channel A



c:\ezchrom\chrom\04046\c-65 – Channel A

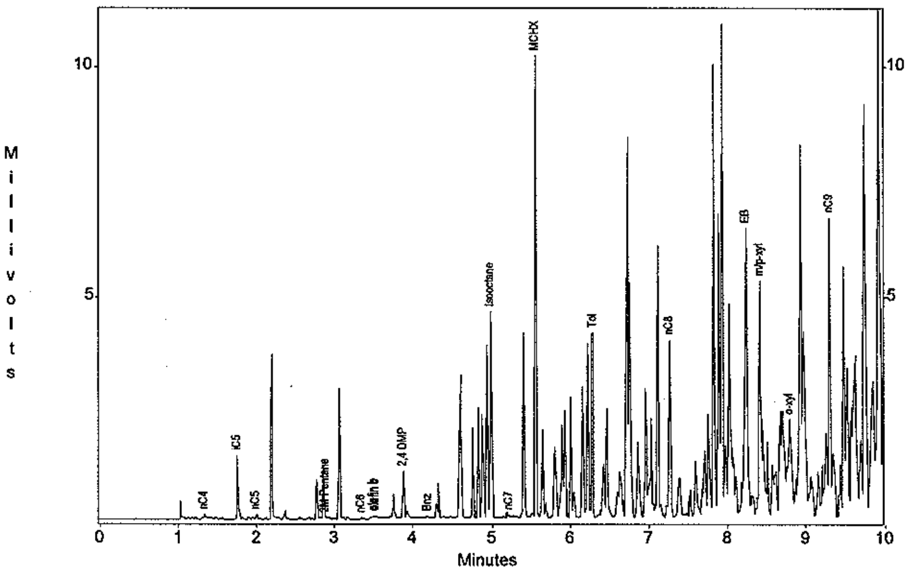


Channel A Results

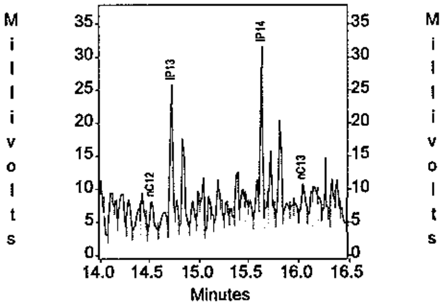
Peak	Area	Height
nC4	567	142
iC5	24	28
nC5	23	20
MTBE	0	0
2M Pentane	0	0
nC6	108	98
olefin a	30	24
olefin b	24	21
olefin c	20	15
2,4 DMP	48	46
Bnz	164	126
Isooctane	320	262
nC7	176	83
MCHX	305	231
Tol	1038	763
nC8	1936	1101
EB	3286	2009
m/p-xyl	2033	1478
o-xyl	1803	913
nC9	2933	1926
1,2,4 TMB	2667	1204
nC10	566	322
nC11	2542	1211
Naph	1390	767
nC12	4665	1542
IP13	8801	4973
IP14	13517	7349
nC13	3565	1621
IP15	13973	8682
nC14	5577	2312
IP16	14719	8603
nC15	6540	1449
nC16	4880	973
IP18	15505	6591
nC17	2145	1096
Pristane	24195	11436
nC18	2451	729
Phytane	15305	7390
nC19	0	0
nC20	4566	882
nC21	1105	497
nC22	352	181
nC23	1962	508
nC24	2731	438
nC25	4415	829
nC26	2430	542
nC27	1494	458
nC28	922	465
nC29	667	386
nC30	702	342
nC31	1968	693
nC32	710	210
nC33	3154	1201
nC34	424	290
nC35	304	222
nC36	202	165
nC37	452	355
nC38	0	0
nC39	402	161
nC40	593	250

Sun - Philadelphia Refinery COA
Sample ID : S-21
Acquired : Mar 08, 2004 09:27:02

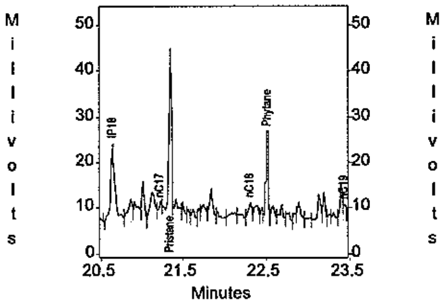
c:\ezchrom\chrom\04046\s-21 -- Channel A



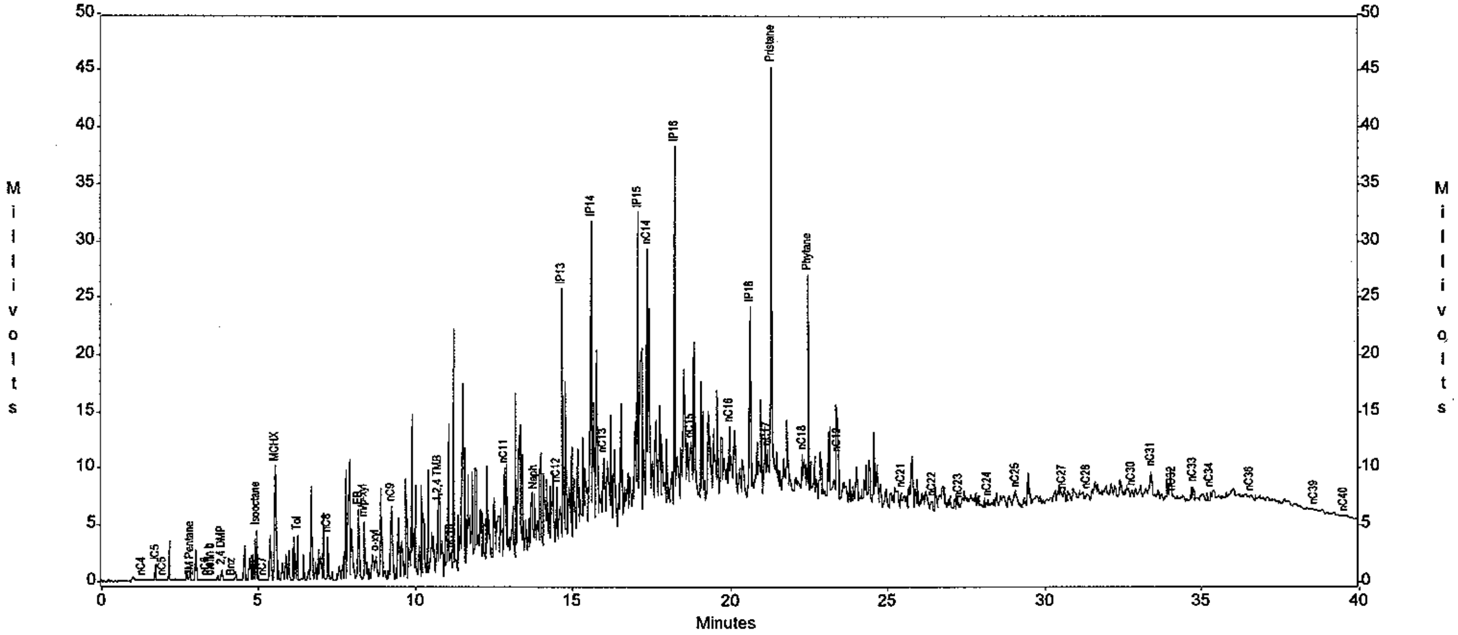
c:\ezchrom\chrom\04046\s-21 -- Channel A



c:\ezchrom\chrom\04046\s-21 -- Channel A



c:\ezchrom\chrom\04046\s-21 -- Channel A

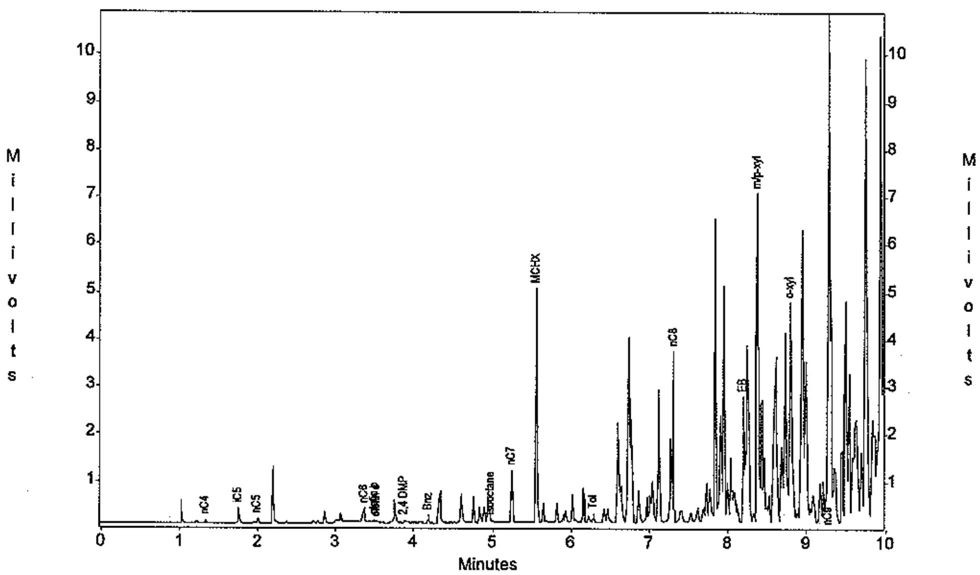


Channel A Results

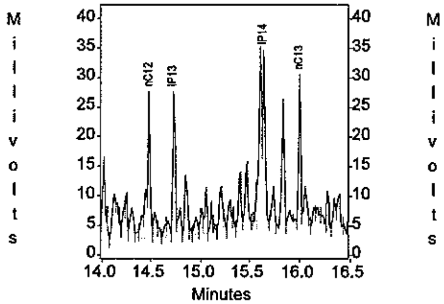
Peak	Area	Height
nC4	68	79
iC5	1109	1379
nC5	97	112
MTBE	0	0
2M Pentane	30	15
nC6	32	28
olefin a	0	0
olefin b	68	55
olefin c	72	60
2,4 DMP	1162	1042
Bnz	95	47
Isooctane	5320	4503
nC7	129	99
MCHX	12322	10100
Tol	5090	4051
nC8	5915	3874
EB	10184	6286
m/p-xyl	7662	5176
o-xyl	3804	2132
nC9	9938	6528
1,2,4 TMB	12471	6271
nC10	3017	1855
nC11	14161	7904
Naph	11853	5132
nC12	13991	5067
IP13	38329	22346
IP14	42474	27537
nC13	22167	6485
IP15	52339	27002
nC14	54414	23440
IP16	57130	31425
nC15	19283	5014
nC16	12229	5222
IP18	56444	16857
nC17	11370	4368
Pristane	98055	38024
nC18	13918	4291
Phytane	43495	20030
nC19	9306	4360
nC20	0	0
nC21	2721	1368
nC22	4460	904
nC23	795	432
nC24	2976	731
nC25	9455	1463
nC26	0	0
nC27	2068	872
nC28	2100	556
nC29	0	0
nC30	1392	562
nC31	5132	1695
nC32	255	0
nC33	3317	1087
nC34	1060	632
nC35	0	0
nC36	318	155
nC37	0	0
nC38	0	0
nC39	498	133
nC40	400	124

Sun - Philadelphia Refinery COA
Sample ID : S-29
Acquired : Mar 06, 2004 21:24:57

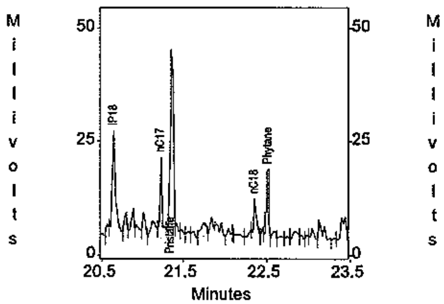
c:\ezchrom\chrom\04046\s-29 – Channel A



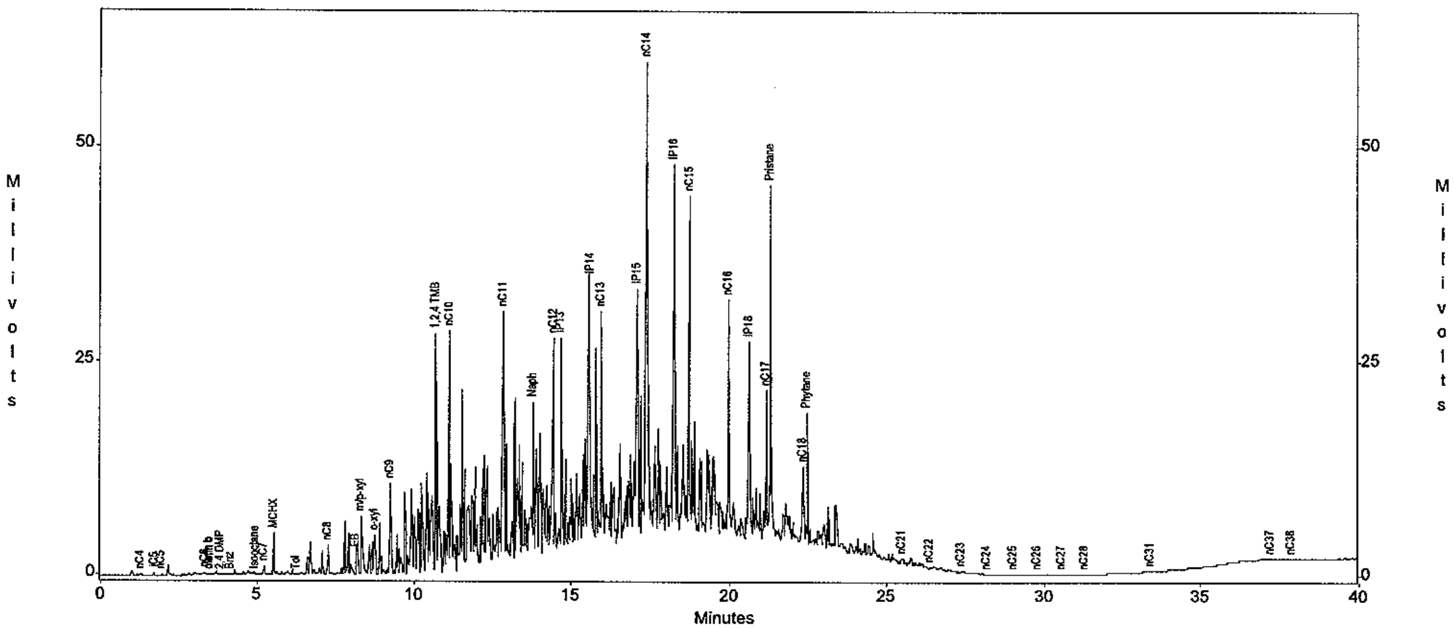
c:\ezchrom\chrom\04046\s-29 – Channel A



c:\ezchrom\chrom\04046\s-29 – Channel A



c:\ezchrom\chrom\04046\s-29 – Channel A

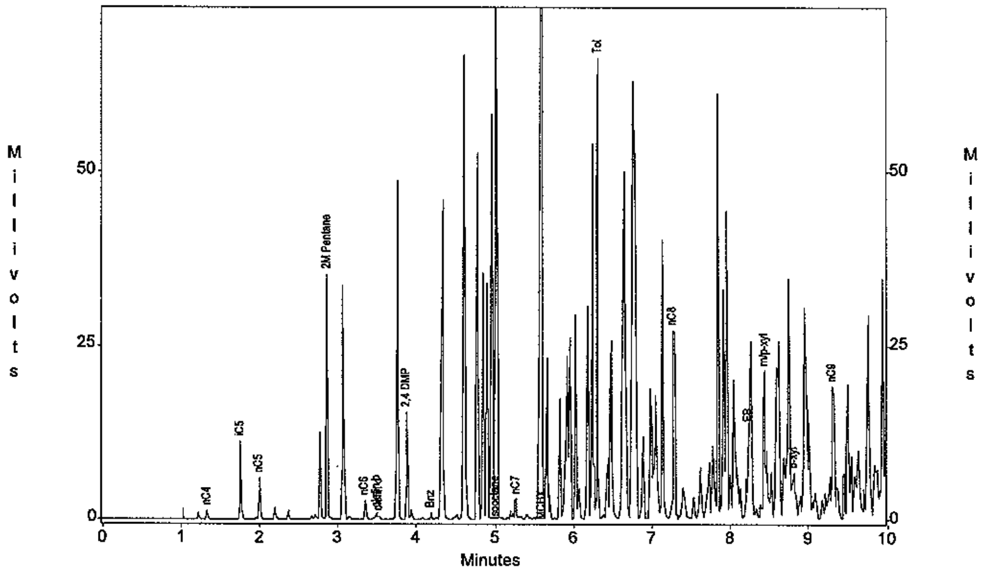


Channel A Results

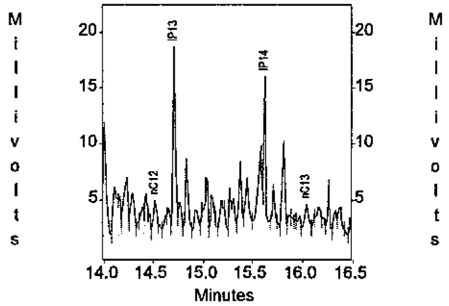
Peak	Area	Height
nC4	51	71
iC5	262	327
nC5	85	97
MTBE	0	0
2M Pentane	0	0
nC6	333	324
olefin a	0	0
olefin b	42	37
olefin c	32	24
2,4 DMP	66	55
Bnz	191	150
Isooctane	105	73
nC7	1288	1117
MCHX	5965	4958
Tol	306	187
nC8	4509	3625
EB	3816	2696
m/p-xyl	9689	6981
o-xyl	7407	4653
nC9	15844	10735
1,2,4 TMB	44639	27982
nC10	43392	28274
nC11	45001	29197
Naph	30031	17905
nC12	37257	24833
IP13	38822	24531
IP14	44656	30086
nC13	38615	25236
IP15	47098	29209
nC14	107065	55460
IP16	80262	42892
nC15	68663	38177
nC16	50647	27023
IP18	65432	23201
nC17	34281	17543
Pristane	95533	41540
nC18	20251	8806
Phytane	31665	15281
nC19	0	0
nC20	0	0
nC21	2489	555
nC22	317	166
nC23	205	86
nC24	246	39
nC25	250	40
nC26	138	50
nC27	128	45
nC28	59	30
nC29	0	0
nC30	0	0
nC31	173	27
nC32	0	0
nC33	0	0
nC34	0	0
nC35	0	0
nC36	0	0
nC37	142	31
nC38	27	15
nC39	0	0
nC40	0	0

Sun - Philadelphia Refinery COA
Sample ID : S-59
Acquired : Mar 08, 2004 11:53:37

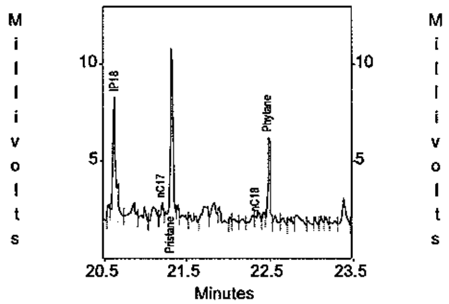
c:\ezchrom\chrom\04046\s-59 – Channel A



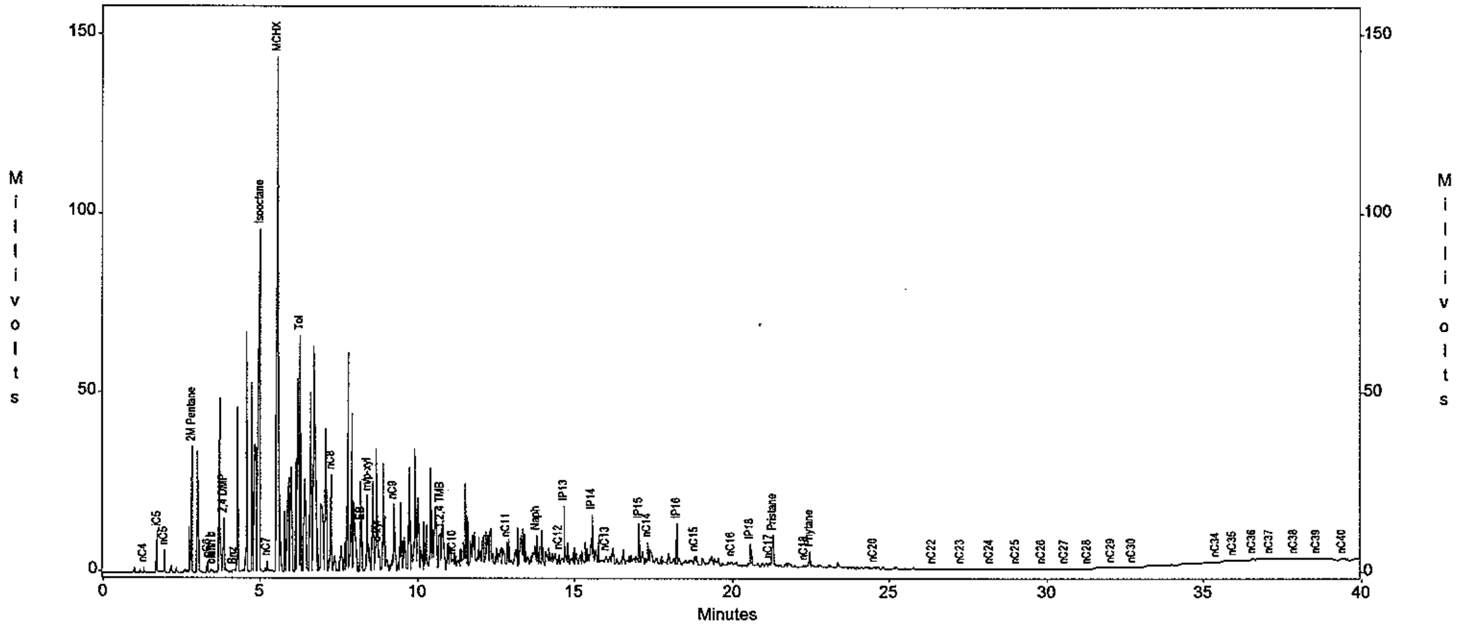
c:\ezchrom\chrom\04046\s-59 – Channel A



c:\ezchrom\chrom\04046\s-59 – Channel A



c:\ezchrom\chrom\04046\s-59 – Channel A

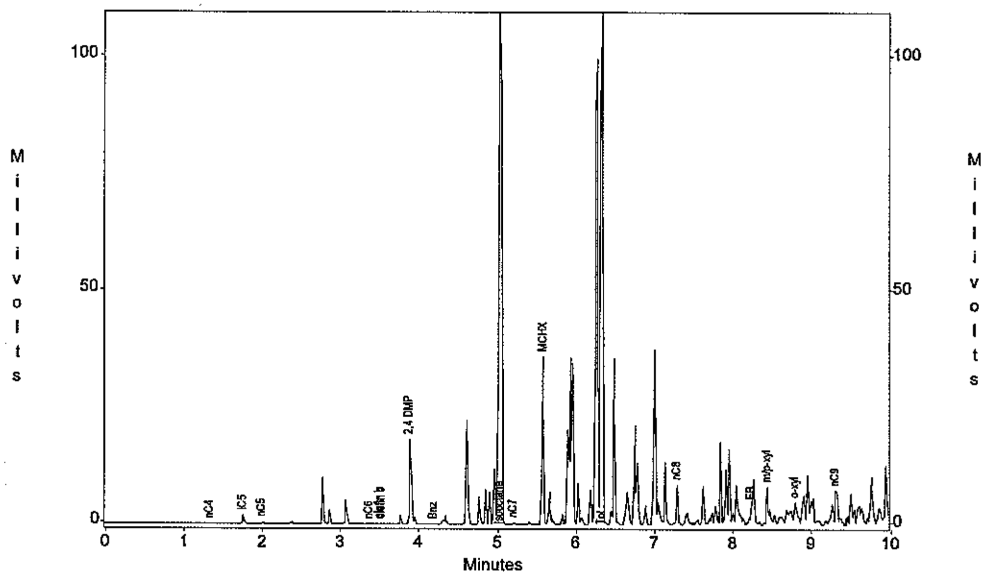


```
Channel A Results

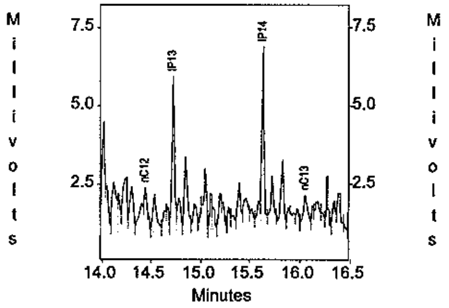
Peak          Area      Height
------------------------------
nC4            796        1253
iC5           8790       11308
nC5           5003        6081
MTBE             0           0
2M Pentane   33578       35340
nC6           2779        2698
olefin a         0           0
olefin b      1010         961
olefin c       718         564
2,4 DMP      16845       15499
Bnz           1277         960
Isooctane   127550       95750
nC7           3902        2951
MCHX        235014      143729
Tol          88911       66356
nC8          38664       27230
EB           11901       13321
m/p-xyl      30634       21454
o-xyl        14906        6722
nC9          29253       19131
1,2,4 TMB    16425       10313
nC10          7657        2660
nC11         12486        6585
Naph         13669        8513
nC12          6475        2890
IP13         25912       16556
IP14         19794       13545
nC13          6951        2380
IP15         15913       10976
nC14         11395        6328
IP16         19616       11680
nC15          4060        2371
nC16          6206        1428
IP18         17152        6413
nC17          1893         956
Pristane     19794        8959
nC18          1829         422
Phytane       9314        4519
nC19             0           0
nC20           846         342
nC21             0           0
nC22           551         102
nC23           159          88
nC24           999         140
nC25          1169         175
nC26           418         120
nC27           637          72
nC28           243          55
nC29           406          80
nC30           266          81
nC31             0           0
nC32             0           0
nC33             0           0
nC34           515         129
nC35           170          73
nC36           309          68
nC37           237          58
nC38            48          16
nC39           443          80
nC40           860         115
```

Sun - Philadelphia Refinery COA
Sample ID : S-60
Acquired : Mar 06, 2004 13:54:31

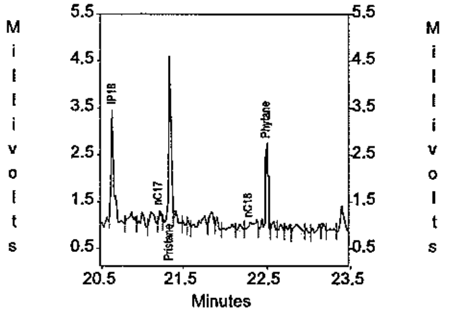
c:\ezchrom\chrom\04046\s-60.2 – Channel A



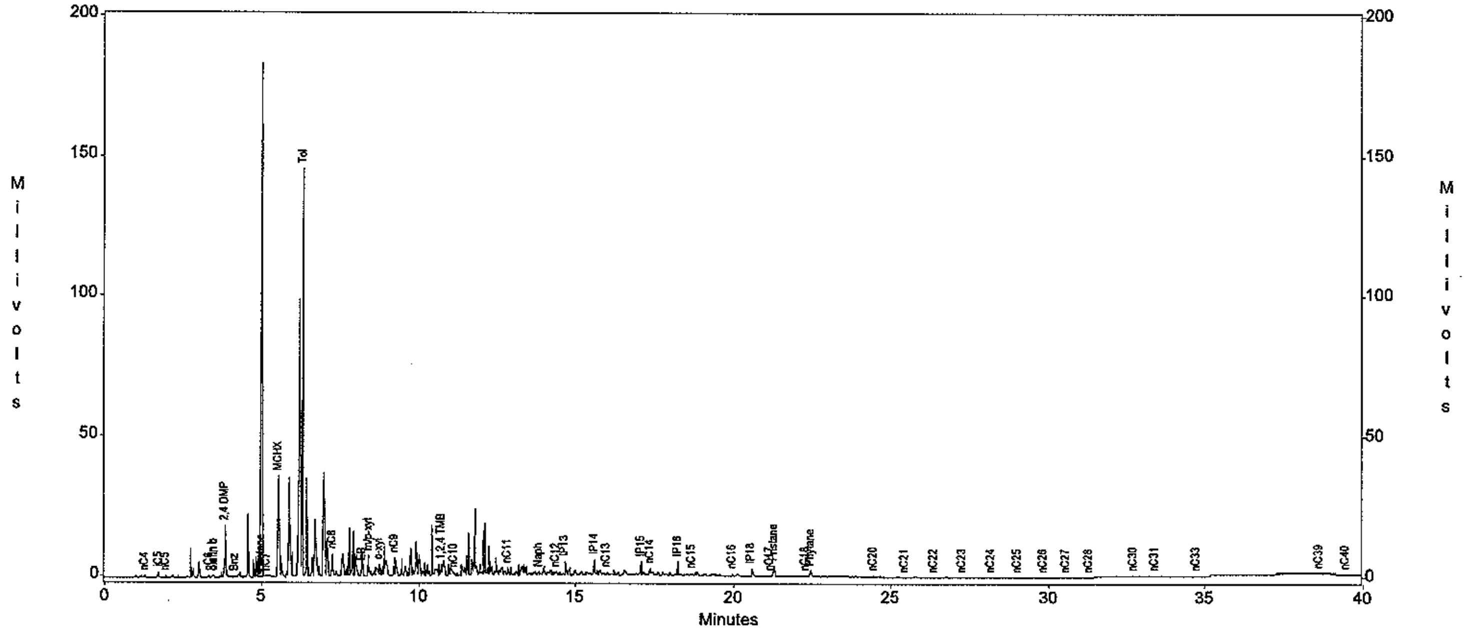
c:\ezchrom\chrom\04046\s-60.2 – Channel A



c:\ezchrom\chrom\04046\s-60.2 – Channel A



c:\ezchrom\chrom\04046\s-60.2 – Channel A

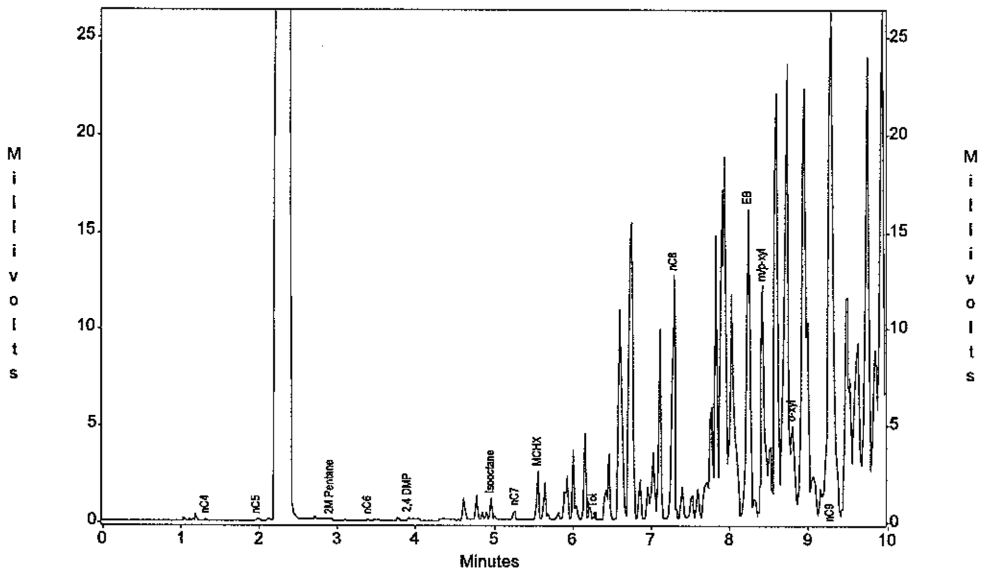


Channel A Results

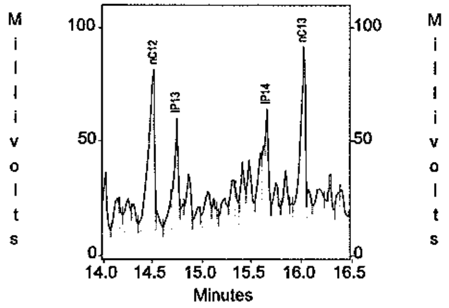
Peak	Area	Height
nC4	27	37
iC5	1378	1717
nC5	114	136
MTBE	0	0
2M Pentane	0	0
nC6	42	36
olefin a	0	0
olefin b	41	35
olefin c	63	47
2,4 DMP	19732	18177
Bnz	67	38
Isooctane	325902	183410
nC7	168	129
MCHX	44484	36100
Tol	245108	145617
nC8	11974	8493
EB	3374	4310
m/p-xyl	10585	7988
o-xyl	10585	4817
nC9	11030	7330
1,2,4 TMB	11539	4506
nC10	2528	1452
nC11	6735	2801
Naph	2984	1732
nC12	2958	1475
IP13	8106	4977
IP14	8643	5681
nC13	2478	910
IP15	8270	4897
nC14	5922	2742
IP16	8047	4941
nC15	2429	590
nC16	2420	556
IP18	5471	2389
nC17	753	383
Pristane	7916	3669
nC18	1366	189
Phytane	4264	1880
nC19	0	0
nC20	681	148
nC21	265	98
nC22	258	46
nC23	99	55
nC24	457	64
nC25	803	108
nC26	315	77
nC27	257	47
nC28	194	49
nC29	0	0
nC30	75	21
nC31	446	92
nC32	0	0
nC33	410	48
nC34	0	0
nC35	0	0
nC36	0	0
nC37	0	0
nC38	0	0
nC39	41	15
nC40	69	22

Sun - Philadelphia Refinery COA
Sample ID : S-68 Pad
Acquired : Mar 09, 2004 13:21:33

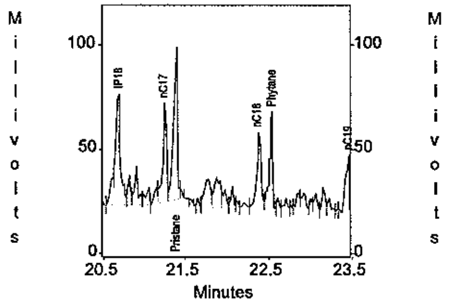
c:\ezchrom\chrom\04046\s-68pad.2 – Channel A



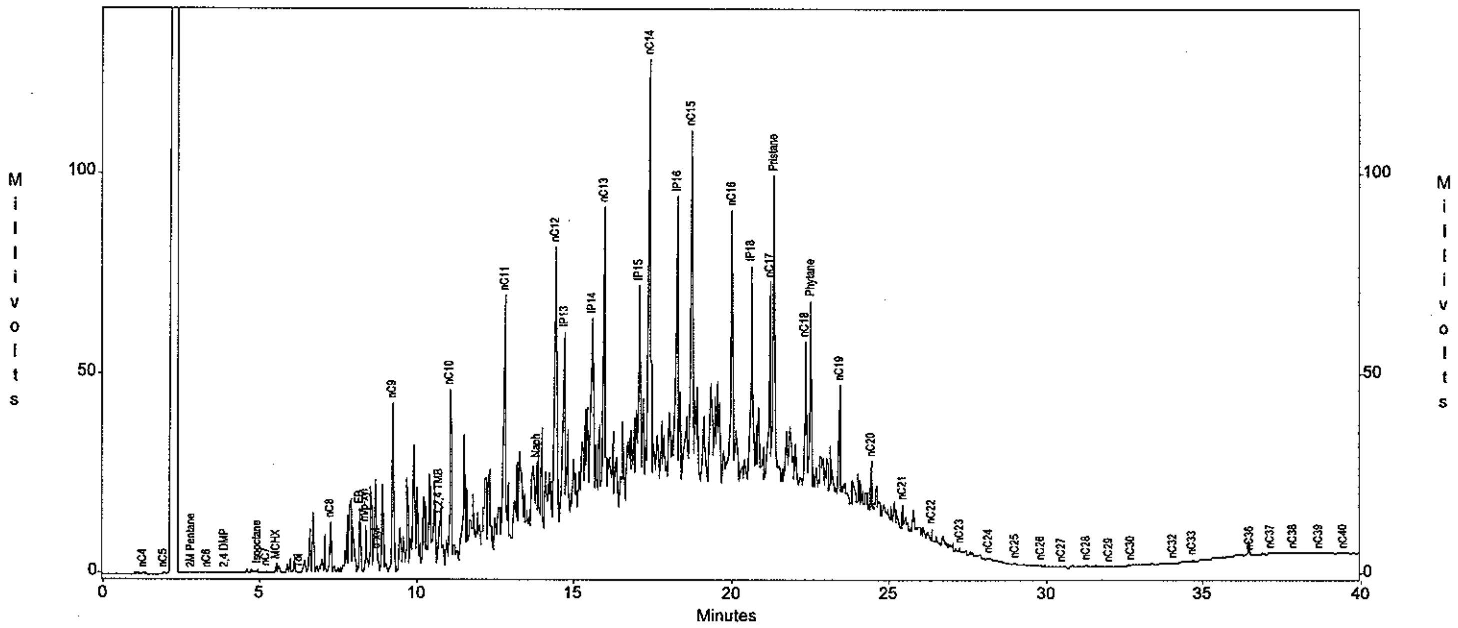
c:\ezchrom\chrom\04046\s-68pad.2 – Channel A



c:\ezchrom\chrom\04046\s-68pad.2 – Channel A



c:\ezchrom\chrom\04046\s-68pad.2 – Channel A

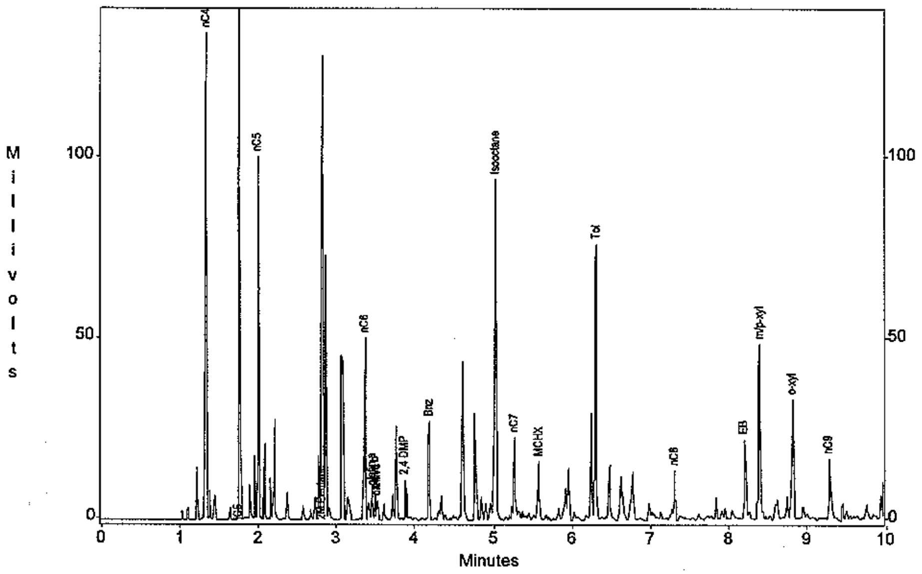


Channel A Results

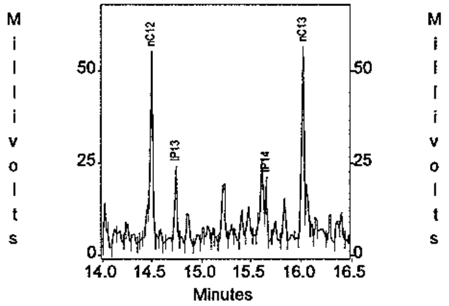
Peak	Area	Height
nC4	41	23
iC5	0	0
nC5	97	39
MTBE	0	0
2M Pentane	50	44
nC6	27	25
olefin a	0	0
olefin b	0	0
olefin c	0	0
2,4 DMP	148	117
Bnz	0	0
Isooctane	1802	1110
nC7	723	498
MCHX	4121	2543
Tol	663	357
nC8	23710	12610
EB	48420	15964
m/p-xyl	30284	11996
o-xyl	16235	4665
nC9	125600	42495
1,2,4 TMB	49594	12099
nC10	134641	43947
nC11	195930	63121
Naph	49959	18694
nC12	177272	70866
IP13	138784	48932
IP14	104878	49727
nC13	252811	76722
IP15	168029	49973
nC14	345005	104221
IP16	186438	67623
nC15	309322	87692
nC16	206115	65138
IP18	201010	53708
nC17	141902	48292
Pristane	235075	74130
nC18	117898	37367
Phytane	154983	47849
nC19	115791	29314
nC20	33859	12849
nC21	11676	6143
nC22	6997	3064
nC23	3512	1498
nC24	3229	785
nC25	3163	427
nC26	532	220
nC27	1150	265
nC28	1546	525
nC29	210	57
nC30	273	93
nC31	0	0
nC32	139	83
nC33	729	191
nC34	0	0
nC35	0	0
nC36	124	45
nC37	314	138
nC38	268	79
nC39	88	47
nC40	1044	109

Sun - Philadelphia Refinery COA
Sample ID : Gas/Dies/Wax std
Acquired : Mar 05, 2004 10:14:50

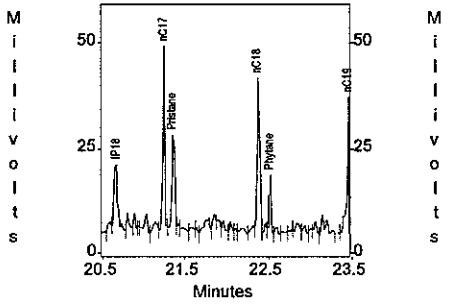
c:\ezchrom\chrom\04046\gadiwax2 – Channel A



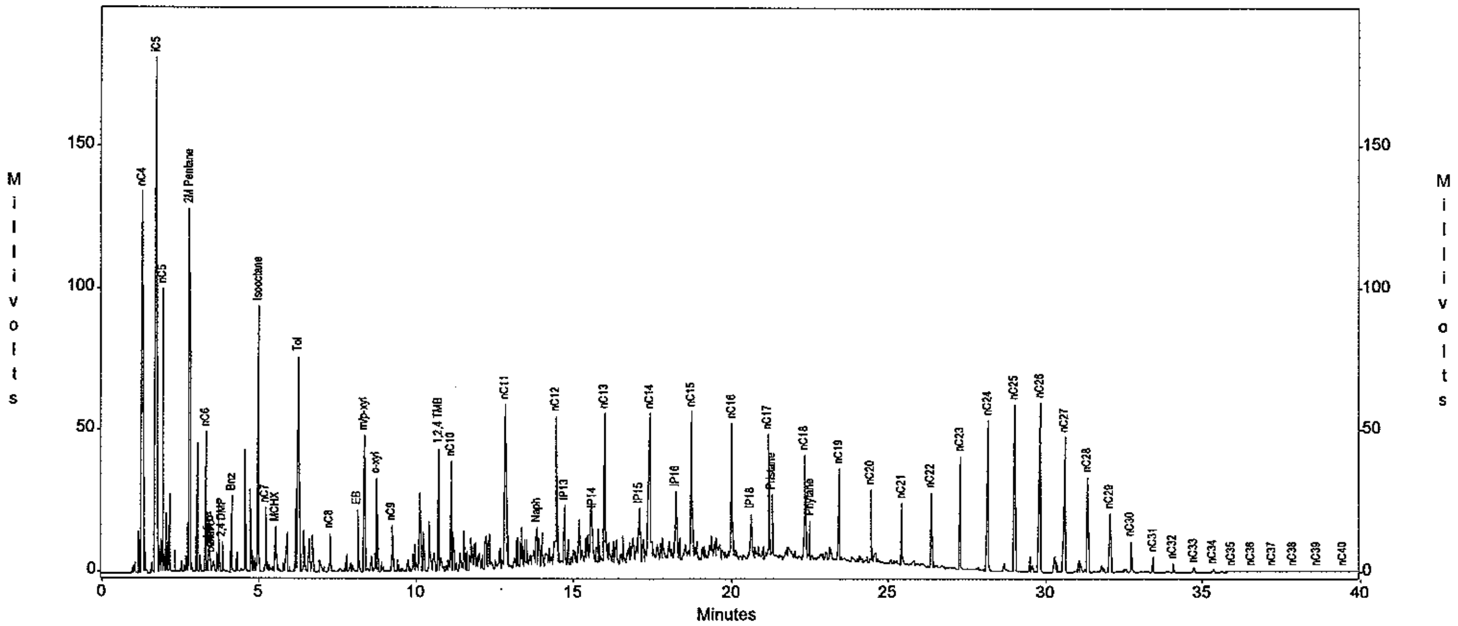
c:\ezchrom\chrom\04046\gadiwax2 – Channel A



c:\ezchrom\chrom\04046\gadiwax2 – Channel A



c:\ezchrom\chrom\04046\gadiwax2 – Channel A

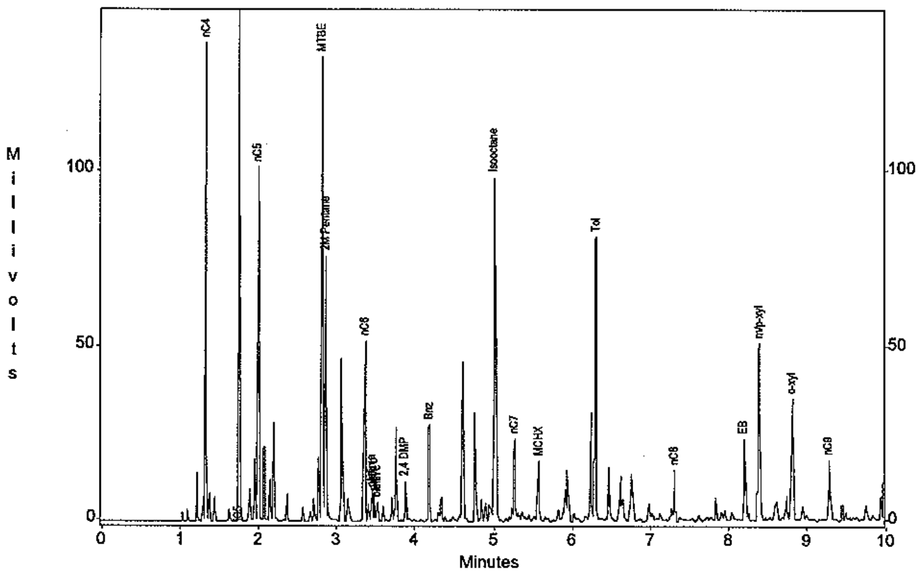


Channel A Results

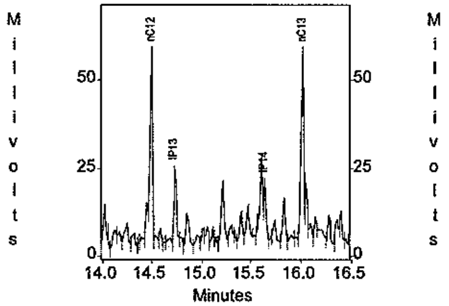
Peak	Area	Height
nC4	76324	134418
iC5	125697	181328
nC5	73607	100180
MTBE	0	0
2M Pentane	125882	128303
nC6	50848	50159
olefin a	9257	8012
olefin b	7096	7246
olefin c	5741	5209
2,4 DMP	11717	11007
Bnz	34021	27022
Isooctane	131604	94025
nC7	28641	22911
MCHX	20811	16248
Tol	125348	76234
nC8	17073	13806
EB	30382	22407
m/p-xyl	79762	48711
o-xyl	47102	33207
nC9	24070	16777
1,2,4 TMB	72129	43739
nC10	57840	39063
nC11	103371	58108
Naph	25460	14283
nC12	89711	53298
IP13	35566	21510
IP14	24622	17633
nC13	89976	52606
IP15	36521	19016
nC14	125559	52513
IP16	45684	24554
nC15	100204	52753
nC16	106353	48603
IP18	48327	16426
nC17	84413	44714
Pristane	51017	23376
nC18	67604	37326
Phytane	29173	14070
nC19	63991	32590
nC20	46362	25707
nC21	38755	22106
nC22	48811	26567
nC23	76713	39972
nC24	117301	53494
nC25	138486	59360
nC26	142113	60095
nC27	109196	47455
nC28	69480	33913
nC29	38149	20797
nC30	20512	10921
nC31	10070	5608
nC32	5237	2932
nC33	2822	1643
nC34	1556	907
nC35	803	499
nC36	479	261
nC37	285	129
nC38	200	75
nC39	115	45
nC40	84	27

Sun - Philadelphia Refinery COA
Sample ID : Gas/Dies/Wax std
Acquired : Mar 06, 2004 11:29:07

c:\ezchrom\chrom\04046\gadiwax2.2 – Channel A



c:\ezchrom\chrom\04046\gadiwax2.2 – Channel A



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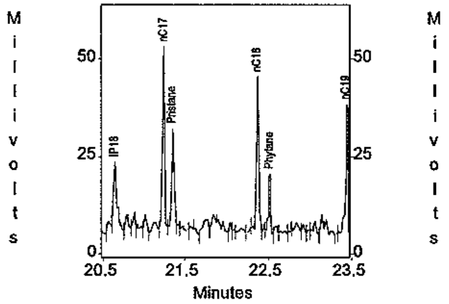

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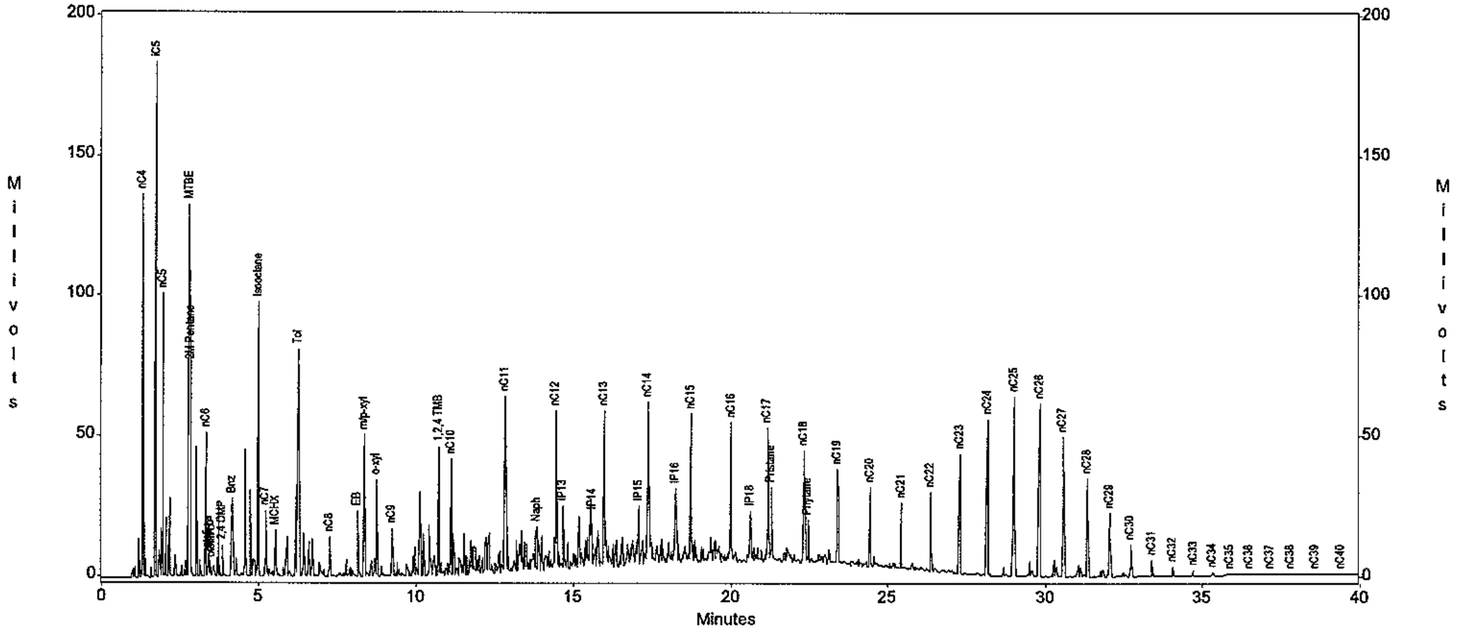

Channel A Results

Peak	Area	Height
nC4	77458	136558
iC5	128744	183286
nC5	75526	101085
MTBE	128144	132765
2M Pentane	69925	75907
nC6	52780	51587
olefin a	9581	8348
olefin b	7328	7361
olefin c	5995	5340
2,4 DMP	12106	11305
Bnz	35354	27900
Isooctane	137200	98040
nC7	30024	23818
MCHX	21837	17163
Tol	130835	81258
nC8	18106	14621
EB	32373	23606
m/p-xyl	84188	50805
o-xyl	49868	34944
nC9	28694	17851
1,2,4 TMB	73652	45692
nC10	61839	41682
nC11	111185	62682
Naph	27486	15961
nC12	96922	57306
IP13	38469	23100
IP14	24187	17833
nC13	101176	56029
IP15	42255	21856
nC14	142941	59197
IP16	54663	27834
nC15	114595	54351
nC16	114660	50580
IP18	56358	18729
nC17	92736	47895
Pristane	54986	26608
nC18	75561	40240
Phytane	31599	15655
nC19	70996	33254
nC20	52053	28326
nC21	40971	23744
nC22	52801	28682
nC23	83935	42583
nC24	128314	55675
nC25	150243	63886
nC26	153225	61778
nC27	117341	50227
nC28	74472	35384
nC29	40653	22326
nC30	20232	11478
nC31	10756	6096
nC32	5612	3324
nC33	3034	1777
nC34	1676	946
nC35	900	547
nC36	560	286
nC37	374	159
nC38	201	82
nC39	149	57
nC40	114	35

Sun - Philadelphia Refinery COA
Sample ID : Gas/Dies/Wax std
Acquired : Mar 07, 2004 16:27:47

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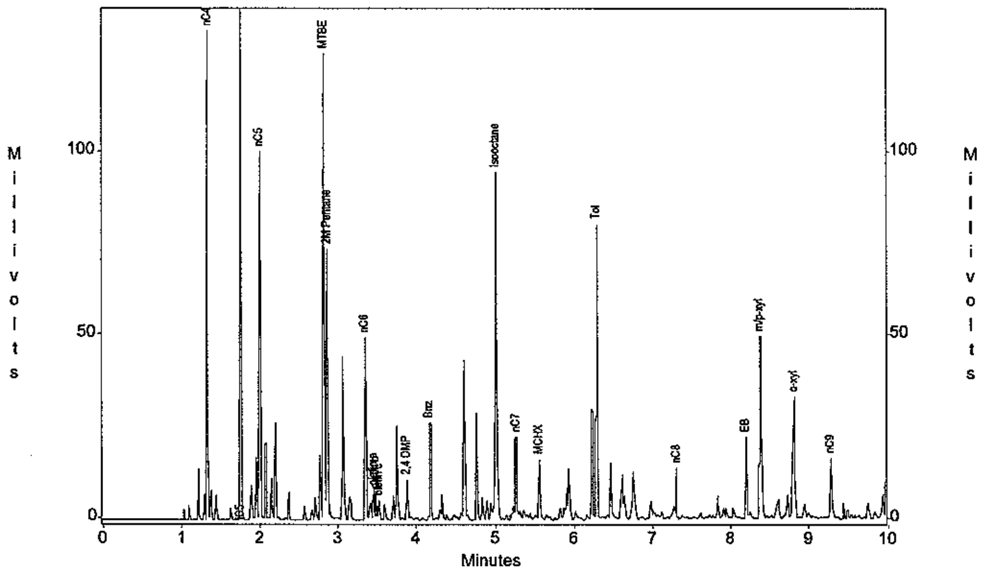

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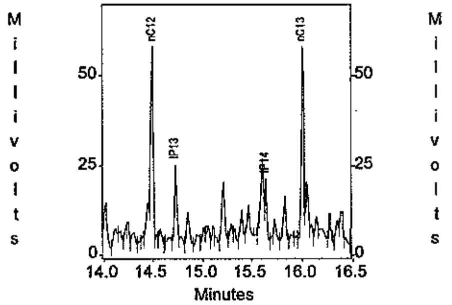

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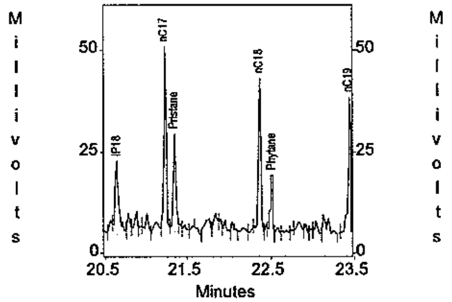

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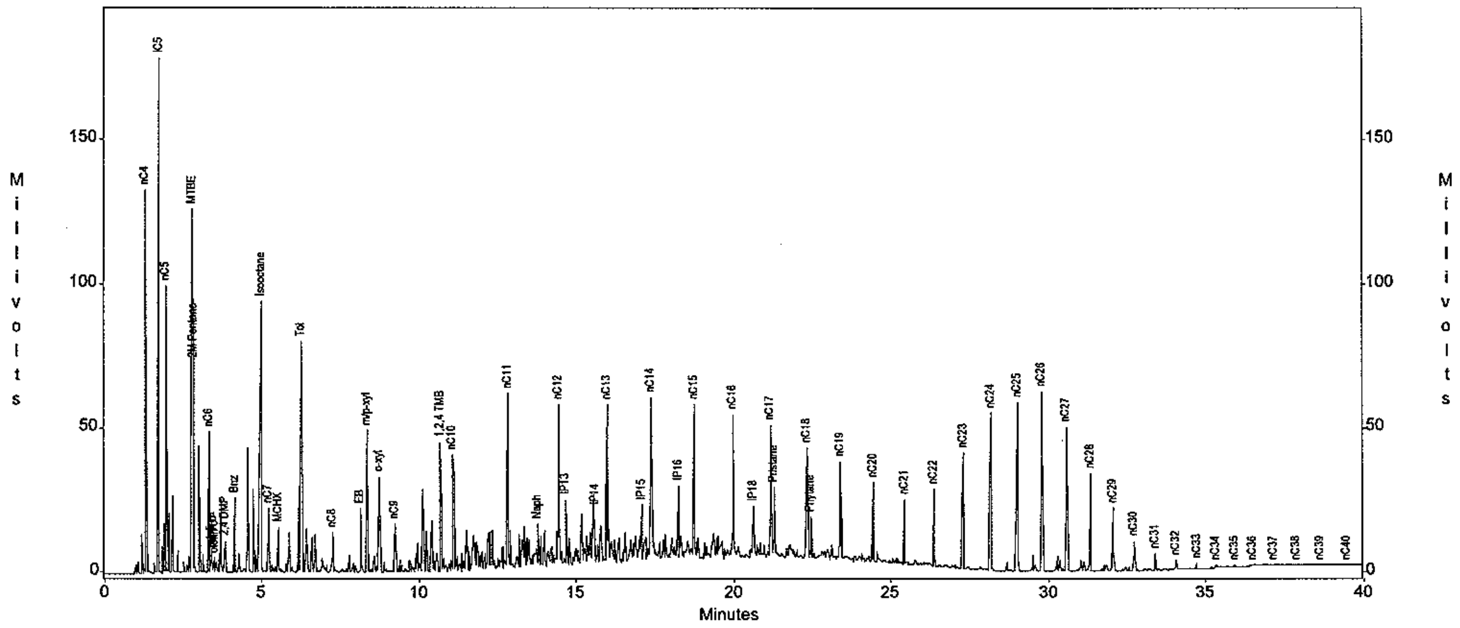

Channel A Results

Peak	Area	Height
nC4	73277	132589
iC5	122397	178292
nC5	72111	99927
MTBE	120053	126296
2M Pentane	67309	73384
nC6	50110	49331
olefin a	9060	8035
olefin b	6897	6990
olefin c	5633	5009
2,4 DMP	11448	10863
Bnz	33610	26331
Isooctane	131090	94376
nC7	28645	22570
MCHX	20551	16158
Tol	124718	80339
nC8	17171	14000
EB	30742	22465
m/p-xyl	81647	49629
o-xyl	47338	33265
nC9	27340	17017
1,2,4 TMB	70044	44193
nC10	59484	40762
nC11	107019	60555
Naph	26087	15252
nC12	93349	56487
IP13	37261	22961
IP14	23534	17207
nC13	97647	55033
IP15	40713	20552
nC14	137643	57277
IP16	52746	26623
nC15	110085	54657
nC16	115273	50330
IP18	54821	18200
nC17	88744	46155
Pristane	52604	24413
nC18	72412	38407
Phytane	30125	14657
nC19	71773	34120
nC20	49409	27517
nC21	39259	22392
nC22	50700	27374
nC23	79711	40253
nC24	121096	54615
nC25	142086	58736
nC26	145134	62459
nC27	111056	50452
nC28	70506	33745
nC29	38493	21488
nC30	19227	10452
nC31	10144	5823
nC32	5288	3046
nC33	2883	1634
nC34	1617	885
nC35	828	504
nC36	575	264
nC37	300	148
nC38	265	108
nC39	113	48
nC40	70	26

Torkelson Geochemistry, Inc.

Density Measurements

Paar DMA 512 / DMA 60 | ASTM Method 4052

Sample	Density gm/ml @ 60F	Job Number	Date
A-13	0.9015	04046	3/8/04
A-14	0.9143	04046	3/9/04
A-22	0.9356	04046	3/9/04
A-47	0.8926	04046	3/8/04
A-133	qns	04046	3/9/04
B-39	0.8734	04046	3/8/04
B-43	0.9161	04046	3/9/04
B-129	0.8645	04046	3/9/04
B-130	0.9306	04046	3/8/04
B-144	0.8654	04046	3/9/04
BF-106	0.8199	04046	3/9/04
BF-107	0.8671	04046	3/8/04
C-65	0.9162	04046	3/9/04
C-106	0.9306	04046	3/9/04
C-107	0.9371	04046	3/8/04
N-14	0.9299	04046	3/9/04
N-25	0.0402	04046	3/8/04
N-35	0.9205	04046	3/9/04
N-48	0.9049	04046	3/9/04
N-52	0.8613	04046	3/8/04
N-68	0.9211	04046	3/9/04
N-79	0.8169	04046	3/9/04
PZ-204	0.9016	04046	3/8/04
PZ-502	0.9155	04046	3/9/04
S-21	0.9281	04046	3/9/04
S-29	0.8550	04046	3/8/04
S-32	0.8665	04046	3/8/04
S-33	0.8578	04046	3/9/04
S-50	0.7508	04046	3/8/04
S-56	0.8684	04046	3/9/04
S-59	0.8039	04046	3/9/04
S-60	0.7898	04046	3/8/04
S-76	0.7851	04046	3/8/04
S-79	0.8406	04046	3/8/04
S-81	0.7948	04046	3/9/04
S-89	0.8523	04046	3/8/04
S-92	0.9156	04046	3/9/04
S-97	0.8653	04046	3/8/04
S-100	0.7930	04046	3/9/04
S-103	0.7978	04046	3/9/04
S-104	0.8787	04046	3/8/04
S-117	0.8236	04046	3/9/04
S-124	0.8223	04046	3/9/04
S-130	0.8623	04046	3/8/04
S-138	0.8957	04046	3/9/04
S-158	0.8692	04046	3/9/04
S-162	0.7498	04046	3/8/04
SRTF MW-1	0.7705	04046	3/9/04
West Yard W8	0.9121	04046	3/9/04

WP 9-2	0.8114	04046	3/9/04

09:04:33

Sample Results Reports

07/27/16

Sample Date	25-JUL-16		
Sample ID	204371688		
Batch Number			
User SampleID	20160725-688		
Sample Type	PBPSSO POLLOCK STREET SEWER OUTFALL		
Tag	07/25/16 1000		
Material Name	MISC. UNDEFINED PRODUCT	Material Type	PLANT SAMPLE
Condition	ONLINE		
EPA Batch #			
Comments	C-97 AT 10:00 AM - CHEMIST TO DETERMINE SIM DIS METHOD AND MUST REVIEW RESULTS		

Component	Result	Units	Inspec	Low	High
API OBSERVED	32.1	deg API	N/A		
TEMPERATURE	60.0	deg F	N/A		
API GRAVITY	32.1	deg API	N/A		
INITIAL BOILING POINT (GC)		deg F			
01 % (GC)	132.4	deg F	N/A		
02 % (GC)	148.0	deg F	N/A		
03 % (GC)	184.8	deg F	N/A		
04 % (GC)	191.0	deg F	N/A		
05 % (GC)	197.4	deg F	N/A		
10 % (GC)	239.0	deg F	N/A		
20 % (GC)	310.6	deg F	N/A		
30 % (GC)	384.4	deg F	N/A		
40 % (GC)	448.2	deg F	N/A		
50 % (GC)	504.2	deg F	N/A		
60 % (GC)	564.4	deg F	N/A		
70 % (GC)	636.8	deg F	N/A		
80 % (GC)	736.2	deg F	N/A		
90 % (GC)	872.6	deg F	N/A		
95 % (GC)	958.6	deg F	N/A		
END POINT (GC)	1008.0	deg F	N/A		
BROMINE NUMBER		NONE			
SULFUR	0.5818	wt.%	N/A		
SULFUR FOR COA	5818	ppm	N/A		

Sample Results Reports

Sample Date	25-JUL-16		
Sample ID	204371689		
Batch Number			
User SampleID	20160725-689		
Sample Type	PBPSSO POLLOCK STREET SEWER OUTFALL		
Tag	07/25/16 1020		
Material Name	MISC. UNDEFINED PRODUCT	Material Type	PLANT SAMPLE
Condition	ONLINE		
EPA Batch #			
Comments	F BOX AT 10:20 AM - CHEMIST TO DETERMINE SIM DIS METHOD AND MUST REVIEW RESULTS		

Component	Result	Units	Inspec	Low	High
API OBSERVED	34.1	deg API	N/A		
TEMPERATURE	60.0	deg F	N/A		
API GRAVITY	34.1	deg API	N/A		
INITIAL BOILING POINT (GC)	219.2	deg F	N/A		
01 % (GC)	242.2	deg F	N/A		
02 % (GC)	260.6	deg F	N/A		
03 % (GC)	282	deg F	N/A		
04 % (GC)	299.4	deg F	N/A		
05 % (GC)	314.8	deg F	N/A		
10 % (GC)	437.6	deg F	N/A		
20 % (GC)	717	deg F	N/A		
30 % (GC)	759.6	deg F	N/A		
40 % (GC)	790.4	deg F	N/A		
50 % (GC)	817.8	deg F	N/A		
60 % (GC)	843.6	deg F	N/A		
70 % (GC)	871.6	deg F	N/A		
80 % (GC)	904.2	deg F	N/A		
90 % (GC)	945.2	deg F	N/A		
95 % (GC)	979.6	deg F	N/A		
END POINT (GC)	1008.4	deg F	N/A		
BROMINE NUMBER		NONE			
SULFUR	0.0435	wt.%	N/A		
SULFUR FOR COA	435	ppm	N/A		

Sample Results Reports

Sample Date	25-JUL-16		
Sample ID	204371690		
Batch Number			
User SampleID	20160725-690		
Sample Type	PBPSSO POLLOCK STREET SEWER OUTFALL		
Tag	07/25/16 1100		
Material Name	MISC. UNDEFINED PRODUCT	Material Type	PLANT SAMPLE
Condition	ONLINE		
EPA Batch #			
Comments	B-148 AT 11:00 AM - CHEMIST TO DETERMINE SIM DIS METHOD AND MUST REVIEW RESULTS		

Component	Result	Units	Inspec	Low	High
API OBSERVED	30.4	deg API	N/A		
TEMPERATURE	60.0	deg F	N/A		
API GRAVITY	30.4	deg API	N/A		
INITIAL BOILING POINT (GC)	268.4	deg F	N/A		
01 % (GC)	289.6	deg F	N/A		
02 % (GC)	317.6	deg F	N/A		
03 % (GC)	337.8	deg F	N/A		
04 % (GC)	356.4	deg F	N/A		
05 % (GC)	367.8	deg F	N/A		
10 % (GC)	406.2	deg F	N/A		
20 % (GC)	483.6	deg F	N/A		
30 % (GC)	578.4	deg F	N/A		
40 % (GC)	707.2	deg F	N/A		
50 % (GC)	773.4	deg F	N/A		
60 % (GC)	823	deg F	N/A		
70 % (GC)	869.6	deg F	N/A		
80 % (GC)	915.4	deg F	N/A		
90 % (GC)	971	deg F	N/A		
95 % (GC)	989.4	deg F	N/A		
END POINT (GC)	1010.2	deg F	N/A		
BROMINE NUMBER		NONE			
SULFUR	0.1965	wt.%	N/A		
SULFUR FOR COA	1965	ppm	N/A		

Sample Date	25-JUL-16		
Sample ID	204371691		
Batch Number			
User SampleID	20160725-691		
Sample Type	PBPSSO POLLOCK STREET SEWER OUTFALL		
Tag	07/25/16 1120		
Material Name	MISC. UNDEFINED PRODUCT	Material Type	PLANT SAMPLE
Condition	ONLINE		
EPA Batch #			
Comments	B-149 AT 11:20 AM - CHEMIST TO DETERMINE SIM DIS METHOD AND MUST REVIEW RESULTS		

Component	Result	Units	Inspec	Low	High
API OBSERVED	29.6	deg API	N/A		
TEMPERATURE	60.0	deg F	N/A		
API GRAVITY	29.6	deg API	N/A		
INITIAL BOILING POINT (GC)	307.6	deg F	N/A		
01 % (GC)	307.6	deg F	N/A		
02 % (GC)	307.6	deg F	N/A		
03 % (GC)	347.4	deg F	N/A		
04 % (GC)	392.4	deg F	N/A		
05 % (GC)	399.4	deg F	N/A		
10 % (GC)	400.4	deg F	N/A		
20 % (GC)	402.8	deg F	N/A		
30 % (GC)	404	deg F	N/A		
40 % (GC)	407.4	deg F	N/A		
50 % (GC)	409.6	deg F	N/A		
60 % (GC)	468.2	deg F	N/A		
70 % (GC)	474.2	deg F	N/A		
80 % (GC)	494	deg F	N/A		
90 % (GC)	586.8	deg F	N/A		
95 % (GC)	745.8	deg F	N/A		
END POINT (GC)	1004.6	deg F	N/A		
BROMINE NUMBER		NONE			
SULFUR	0.0775	wt.%	N/A		
SULFUR FOR COA	775	ppm	N/A		

Sample Date	25-JUL-16		
Sample ID	204371692		
Batch Number			
User SampleID	20160725-692		
Sample Type	PBPSSO POLLOCK STREET SEWER OUTFALL		
Tag	07/25/16 1140		
Material Name	MISC. UNDEFINED PRODUCT	Material Type	PLANT SAMPLE
Condition	ONLINE		
EPA Batch #			
Comments	B-150 AT 11:40 AM - CHEMIST TO DETERMINE SIM DIS METHOD AND MUST REVIEW RESULTS		

Component	Result	Units	Inspec	Low	High
API OBSERVED	31.8	deg API	N/A		
TEMPERATURE	60.0	deg F	N/A		
API GRAVITY	31.8	deg API	N/A		
INITIAL BOILING POINT (GC)	159.2	deg F	N/A		
01 % (GC)	178.4	deg F	N/A		
02 % (GC)	178.4	deg F	N/A		
03 % (GC)	178.4	deg F	N/A		
04 % (GC)	178.4	deg F	N/A		
05 % (GC)	178.4	deg F	N/A		
10 % (GC)	178.4	deg F	N/A		
20 % (GC)	178.4	deg F	N/A		
30 % (GC)	235.6	deg F	N/A		
40 % (GC)	309	deg F	N/A		
50 % (GC)	334.8	deg F	N/A		
60 % (GC)	401.6	deg F	N/A		
70 % (GC)	402.8	deg F	N/A		
80 % (GC)	437.6	deg F	N/A		
90 % (GC)	477.8	deg F	N/A		
95 % (GC)	551.4	deg F	N/A		
END POINT (GC)	989.2	deg F	N/A		
BROMINE NUMBER		NONE			
SULFUR	0.0498	wt.%	N/A		
SULFUR FOR COA	498	ppm	N/A		

Sample Results Reports

Sample Date	25-JUL-16		
Sample ID	204371693		
Batch Number			
User SampleID	20160725-693		
Sample Type	PBPSSO POLLOCK STREET SEWER OUTFALL		
Tag	07/25/16 1200		
Material Name	MISC. UNDEFINED PRODUCT	Material Type	PLANT SAMPLE
Condition	ONLINE		
EPA Batch #			
Comments	S-382 AT 12:00 PM - CHEMIST TO DETERMINE SIM DIS METHOD AND MUST REVIEW RESULTS		

Component	Result	Units	Inspec	Low	High
API OBSERVED	69	deg API	N/A		
TEMPERATURE	60.0	deg F	N/A		
API GRAVITY	69	deg API	N/A		
INITIAL BOILING POINT (GC)		deg F			
01 % (GC)		deg F			
02 % (GC)		deg F			
03 % (GC)		deg F			
04 % (GC)		deg F			
05 % (GC)		deg F			
10 % (GC)		deg F			
20 % (GC)	132.4	deg F	N/A		
30 % (GC)	132.4	deg F	N/A		
40 % (GC)	148.0	deg F	N/A		
50 % (GC)	172.0	deg F	N/A		
60 % (GC)	178.4	deg F	N/A		
70 % (GC)	191.0	deg F	N/A		
80 % (GC)	191.0	deg F	N/A		
90 % (GC)	232.4	deg F	N/A		
95 % (GC)	232.4	deg F	N/A		
END POINT (GC)	991.4	deg F	N/A		
BROMINE NUMBER		NONE			
SULFUR	0.0000	wt.%	N/A		
SULFUR FOR COA	0	ppm	N/A		

Sample Results Reports

Sample Date	25-JUL-16		
Sample ID	204371694		
Batch Number			
User SampleID	20160725-694		
Sample Type	PBPSSO POLLOCK STREET SEWER OUTFALL		
Tag	07/25/16 1240		
Material Name	MISC. UNDEFINED PRODUCT	Material Type	PLANT SAMPLE
Condition	ONLINE		
EPA Batch #			
Comments	S-410 AT 12:40 PM - CHEMIST TO DETERMINE SIM DIS METHOD AND MUST REVIEW RESULTS		

Component	Result	Units	Inspec	Low	High
API OBSERVED	28.6	deg API	N/A		
TEMPERATURE	60.0	deg F	N/A		
API GRAVITY	28.6	deg API	N/A		
INITIAL BOILING POINT (GC)	197.4	deg F	N/A		
01 % (GC)	216	deg F	N/A		
02 % (GC)	245.6	deg F	N/A		
03 % (GC)	270.4	deg F	N/A		
04 % (GC)	285.8	deg F	N/A		
05 % (GC)	297.4	deg F	N/A		
10 % (GC)	346.2	deg F	N/A		
20 % (GC)	414.2	deg F	N/A		
30 % (GC)	473	deg F	N/A		
40 % (GC)	517.8	deg F	N/A		
50 % (GC)	563.2	deg F	N/A		
60 % (GC)	604	deg F	N/A		
70 % (GC)	665.4	deg F	N/A		
80 % (GC)	761.8	deg F	N/A		
90 % (GC)	877.6	deg F	N/A		
95 % (GC)	952.2	deg F	N/A		
END POINT (GC)	1007.2	deg F	N/A		
BROMINE NUMBER		NONE			
SULFUR	0.6680	wt.%	N/A		
SULFUR FOR COA	6680	ppm	N/A		

Sample Results Reports

Sample Date	25-JUL-16
Sample ID	204371695
Batch Number	
User SampleID	20160725-695
Sample Type	PBPSSO POLLOCK STREET SEWER OUTFALL
Tag	07/25/16 1315
Material Name	MISC. UNDEFINED PRODUCT
Condition	ONLINE
EPA Batch #	
Comments	S-368 AT 13:15 PM - CHEMIST TO DETERMINE SIM DIS METHOD AND MUST REVIEW RESULTS

Material Type PLANT SAMPLE

Component	Result	Units	Inspec	Low	High
API OBSERVED	31.9	deg API	N/A		
TEMPERATURE	60.0	deg F	N/A		
API GRAVITY	31.9	deg API	N/A		
INITIAL BOILING POINT (GC)	184.8	deg F	N/A		
01 % (GC)	229	deg F	N/A		
02 % (GC)	274.2	deg F	N/A		
03 % (GC)	295.4	deg F	N/A		
04 % (GC)	313.4	deg F	N/A		
05 % (GC)	323.4	deg F	N/A		
10 % (GC)	361.4	deg F	N/A		
20 % (GC)	420	deg F	N/A		
30 % (GC)	457.6	deg F	N/A		
40 % (GC)	490.6	deg F	N/A		
50 % (GC)	521.2	deg F	N/A		
60 % (GC)	556.8	deg F	N/A		
70 % (GC)	591.2	deg F	N/A		
80 % (GC)	630	deg F	N/A		
90 % (GC)	685.8	deg F	N/A		
95 % (GC)	740.4	deg F	N/A		
END POINT (GC)	1001	deg F	N/A		
BROMINE NUMBER		NONE			
SULFUR	0.1630	wt.%	N/A		
SULFUR FOR COA	1630	ppm	N/A		

Sample Results Reports

Sample Date	25-JUL-16		
Sample ID	204371696		
Batch Number			
User SampleID	20160725-696		
Sample Type	PBPSSO POLLOCK STREET SEWER OUTFALL		
Tag	07/25/16 1330		
Material Name	MISC. UNDEFINED PRODUCT	Material Type	PLANT SAMPLE
Condition	ONLINE		
EPA Batch #			
Comments	S-348 AT 13:30 PM - CHEMIST TO DETERMINE SIM DIS METHOD AND MUST REVIEW RESULTS		

Component	Result	Units	Inspec	Low	High
API OBSERVED	28.4	deg API	N/A		
TEMPERATURE	60.0	deg F	N/A		
API GRAVITY	28.4	deg API	N/A		
INITIAL BOILING POINT (GC)	242.2	deg F	N/A		
01 % (GC)	268.4	deg F	N/A		
02 % (GC)	289.6	deg F	N/A		
03 % (GC)	304.8	deg F	N/A		
04 % (GC)	316.2	deg F	N/A		
05 % (GC)	324.8	deg F	N/A		
10 % (GC)	357.6	deg F	N/A		
20 % (GC)	404	deg F	N/A		
30 % (GC)	441.2	deg F	N/A		
40 % (GC)	473	deg F	N/A		
50 % (GC)	503.2	deg F	N/A		
60 % (GC)	535.8	deg F	N/A		
70 % (GC)	579.4	deg F	N/A		
80 % (GC)	650.4	deg F	N/A		
90 % (GC)	799	deg F	N/A		
95 % (GC)	896	deg F	N/A		
END POINT (GC)	1002.4	deg F	N/A		
BROMINE NUMBER		NONE			
SULFUR	0.7454	wt.%	N/A		
SULFUR FOR COA	7454	ppm	N/A		

APPENDIX H

DATA USABILITY ASSESSMENT

LANGAN
ENGINEERING & ENVIRONMENTAL SERVICES

Technical Memorandum

2700 Kelly Road, Suite 200 Warrington, PA 18976 T: 215.491.6500 F: 215.491.6501
Mailing Address: P.O. Box 1569 Doylestown, PA 18901

To: Meredith Mayes, Langan Staff Engineer

From: Kevin Nelson, Langan Staff Chemist

Date: July 18, 2016

Re: Data Usability Summary Report
For PES Facility AOI3
Samples Collected June 2015 through April 2016
Langan Project No.: 2574602

This data usability assessment was performed in accordance with the USEPA Contract Laboratory Program "National Functional Guidelines for Superfund Organic Methods Data Review" (USEPA-540R-014-002, August 2014), and the "National Functional Guidelines for Inorganic Superfund Data Review" (USEPA-540R-013-001, August 2014).

Data usability assessment includes review of the analytical data to verify that data are easily traceable and sufficiently complete to permit logical reconstruction by a qualified individual other than the originator. Items subject to review in this memorandum include holding times, sample preservation, sample extraction and digestion, laboratory blanks, laboratory control samples, system monitoring compounds, matrix spike/spike duplicate recoveries, and overall system performance.

For the purposes of this investigation, ten percent of groundwater and soil results summarized in twenty-four laboratory sample delivery groups (SDGs) provided by SGS-Accutest Laboratories and Pace Analytical Services, Inc. were evaluated in the sections below for usability. The samples selected for review are listed in the table below. These samples were collected from June 2015 through April 2016 by Aquaterra Technologies on behalf of Philadelphia Refinery Operations, a series of Evergreen Resources Group, LLC (Evergreen) Samples were analyzed for volatile organic compounds (VOCS), semi-volatile organic compounds (SVOCs), lead and wet chemistry parameters by the following methods:

- VOCs via USEPA SW-846 Method 8260B, 8260C and 8011
- SVOCs via USEPA SW-846 Method 8260C SIM (Selected Ion Monitoring) and 8270D
- Lead via USEPA SW-846 6010B and 6010C
- Percent Moisture by SM2547 G-97

A complete list of SDGs and associated investigative samples included in the AOI 3 data usability assessment is as follows:

SDG	Lab ID	Client ID	Sampling Date	Parameters
30173155	30173155001	AOI3_BH-16-5_0-2_021016	2/10/2016	Lead, %Moisture
30173155	30173155002	AOI5_BH-16-1-0-2-021016	2/10/2016	SVOCs, %Moisture
JC6121	JC6121-1	AOI4_S-415_0-2_101215	10/13/2015	VOCs, SVOCs, Lead
JC6121	JC6121-2	AOI4_S-415_16-18_101215	10/12/2015	VOCs, SVOCs, Lead
JC6121	JC6121-3	AOI3_S-412_0-2_101315	10/13/2015	VOCs, SVOCs, Lead
30150234	30150234001	AOI3_S-280_060815	6/8/2015	VOCs, SVOCs, Lead
30150234	30150234002	AOI3_S-280D_0608125	6/8/2015	VOCs, SVOCs, Lead
30150234	30150234003	AOI3_S-283_060815	6/8/2015	VOCs, SVOCs, Lead
30150234	30150234004	AOI3_S-284_060815	6/8/2015	VOCs, SVOCs, Lead
30176086	30176086001	AOI3-S-5-030916	3/9/2016	VOCs, SVOCs, Lead
30176086	30176086002	AOI3-S-410-030916	3/9/2016	VOCs, SVOCs, Lead
30176086	30176086003	AOI3-S-285-030916	3/9/2016	VOCs, SVOCs, Lead
30176086	30176086004	AOI3-S-113_030916	3/9/2016	VOCs, SVOCs, Lead
30176086	30176086005	AOI3-S-60-030916	3/9/2016	VOCs, SVOCs, Lead

As a result of the review process, the following qualifiers may be assigned to the data in accordance with the USEPA's guidelines and best professional judgment:

R – The sample results are unusable due to the quality of the data generated because certain criteria were not met. The analyte may or may not be present in the sample.

J – The analyte was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample.

UJ – The analyte was not detected at a level greater than or equal to the reporting limit (RL); however, the reported RL is approximate and may be inaccurate or imprecise.

U – The analyte was analyzed for, but was not detected at a level greater than or equal to the level of the RL or the sample concentration for results impacted by blank contamination.

NJ – The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.

If any validation qualifiers are assigned these qualifiers should supersede any laboratory-applied qualifiers. Data that is not qualified as a result of this data validation is considered acceptable on the basis of the items specified for review. Data that is qualified as "R" are not sufficiently valid and technically supportable to be used for data interpretation. Data that is otherwise qualified due to minor data quality anomalies are usable, as qualified.

VALIDATOR-APPLIED QUALIFICATION

Client Sample ID	***Analysis***	***Analyte***	***CAS #***	***Validator Qualifier***
AOI5_BH-16-1-0-2-021016	SVOCs	Benzo(a)pyrene	50-32-8	J
AOI3_BH-16-5_0-2_021016	Lead	Lead	7439-92-1	J

Summary of Findings (by Method):

VOCs via USEPA Method 8260C:

The laboratory duplicate for sample JC6828-3 exhibited a relative percent difference (RPD) greater than the control limit (i.e. >20%) for toluene (200%). The original sample result was less than two times the RL; this non-conformance does not affect the sample results.

SVOCs via USEPA Method 8270D and 8270C SIM:

The matrix spike/spike duplicate for parent sample 30173155002 recovered benzo(a)pyrene above the control limit (i.e. >113%). The associated positive detection in the parent sample may be biased high and has been qualified as "J".

The matrix spike/spike duplicate for parent sample JC6129-1 recovered benzo(b)fluoranthene and pyrene above their respective control limits. The parent sample was not site-specific; this non-conformance does not affect the sample results.

Lead via USEPA Method 6010B:

The matrix spike for parent sample 30173179001 recovered lead above the control limit (i.e. >125%). The sample used was not site-specific and thus does not affect the reported results.

The sample duplicate for batch MPRP/17599 exhibited a relative percent difference (RPD) greater than the control limits (i.e. >20%) for lead (35%). The associated result in sample 30173155001 may be affected by indeterminate bias and has been qualified as "J".

Percent Moisture:

The laboratory duplicate for batch PMST/5944 exhibited an RPD greater than the control limit. The associated results for samples 30173155001 and 30173155002 may be indeterminately biased.

Summary and Conclusions

For the purposes of this investigation, sample results were summarized in twenty-four sample delivery groups provided by SGS-Accutest Laboratories and Pace Analytical Services, Inc. Ten percent of the reported results were evaluated in the sections above for usability.

On the basis of this evaluation, the analytical laboratories appear to have followed the specified analytical methods according to the provisions of the methods, with the exception of the errors discussed above. If a given fraction or SDG is not mentioned above, that indicates that all specified criteria were met. All data are usable for characterizing the site and identifying compounds of concern.

Signed:

Kevin Nelson
Staff Chemist

APPENDIX I

QUALITATIVE FATE AND TRANSPORT ANALYSIS

APPENDIX I
Qualitative Fate & Transport Assessment
Remedial Investigation Report – AOI 3
PES Refining Complex
Philadelphia, Pennsylvania

Introduction

In September 2015, representatives from Evergreen's team, the Pennsylvania Department of Environmental Protection (PADEP) and the United States Environmental Protection Agency (EPA) met to discuss the fate and transport (F&T) approach for the Complex. It was agreed upon during the meeting that initial AOI Remedial Investigation Reports (RIRs) would provide a qualitative F&T assessment and a Complex-wide groundwater flow and contaminant transport model would be presented for the Complex as part of a separate report. The Complex-wide model will provide a quantitative F&T assessment for the Complex utilizing a Complex-wide numerical groundwater flow and contaminant transport model currently being developed by Stantec Consulting Corporation (Stantec) and other consultants on behalf of Evergreen.

This appendix contains the qualitative F&T assessment for AOI 3. The assessment includes information regarding the following conditions in AOI 3:

- Geologic framework;
- Hydrogeologic conditions;
- Hydrologic conditions;
- Anthropogenic features (such as the retention ponds/basins at the Guard Basin/Four Pond areas);
- Constituent of concern (COC) plume stability; and
- Potential receptors.

The purpose of this assessment is to qualitatively evaluate the potential fate and transport of dissolved COCs in groundwater and to refine the current conceptual site model (CSM) for AOI 3.

Framework Summary

General Geologic Framework

The generalized stratigraphic section within AOI 3 is shown on Figure I-1. The Complex is located within the up-dip limits of the Atlantic Coastal Plain, generally within two miles of the "Fall Line," where crystalline bedrock of the Appalachian foothills intersects the ground surface (subcrops/outcrops). The Atlantic Coastal Plain is a physiographic province that is defined as having relatively flat topography and as being underlain by a characteristic wedge of unconsolidated sediments that thicken in a southeasterly direction, away from sediment source areas in the Appalachian Mountains. These sediments were deposited atop a sloping bedrock surface in complex fluvial, estuarine, and marginal marine environments along the passive Atlantic margin. Overall, subsidence of the Piedmont land surface in conjunction with cyclical sea-level fluctuations have been the primary controlling mechanisms driving periods of deposition, non-deposition and erosion in the Atlantic Coastal Plain (Trapp and Meisler, 1992). In general, the resulting sedimentary record in the vicinity of the Complex is complicated, largely incomplete, and under-represented by only Cretaceous and Quaternary deposits, separated by a regional disconformity. A general summary of those deposits that are identified in AOI 3 is presented below.

Anthropogenic Fill

Throughout most of the Complex, the surface is covered by anthropogenic fill. These materials are heterogeneous and have been described on borehole logs as a mixture of compacted soil and anthropogenic debris, including sand, clay, silt, gravel, cinders, concrete, asphalt, crushed stone, ash, glass, brick fragments, and wood.

Quaternary Deposits

A recent (Holocene) Alluvium deposit is present throughout most of the Complex beneath the anthropogenic fill. The Holocene Alluvium generally consists of predominantly gray, muddy deposits with occasional sandy, gravelly, and organic-rich lenses. These sediments were deposited in dynamic floodplain, channel, and marsh environments through the Holocene. The Trenton Gravel is present throughout most of the Complex beneath the Holocene Alluvium. The Trenton Gravel is of Pleistocene Age and is a very heterogeneous unit comprised of a predominant brown to gray sand, gravel and minor amounts of clay (Owens and Minard, 1979).

Cretaceous Deposits

The Cretaceous deposits in the area are configured in a southeasterly-thickening wedge, overlain by the much younger Quaternary deposits, and underlain by bedrock of the Wissahickon Formation. The wedge is made up of a series of vertically alternating aquifers and confining units called the Potomac-Raritan-Magothy (PRM) aquifer system.

Where present, the geological units of the PRM progressively pinch out to the northwest. The PRM aquifer system consists of six units:

- Upper Clay unit;
- Upper Sand unit;
- Middle Clay unit;
- Middle Sand unit;
- Lower Clay unit, and
- Lower Sand unit.

AOI 3-Specific Geological Framework

In AOI 3, surface materials consist of anthropogenic fill and Holocene Alluvium with a combined thickness ranging from approximately 7.5 to 30 feet.

Beneath the fill and Holocene Alluvium is the Trenton Gravel which is older Pleistocene age alluvium. The Trenton Gravel has a maximum thickness of approximately 20 feet in AOI 3. Below the Trenton Gravel are units of the PRM aquifer system.

The shallowest PRM unit present in AOI 3 is the Upper Clay. The Upper Clay most likely occurs as thin discontinuous lenses overlying the Upper Sand, where present, and ranges in thickness from approximately zero to 6 feet (monitoring well S-284D).

The Upper Sand is present throughout the majority of the interior of AOI 3, and pinches out to the northwest and the south. The Upper Sand ranges in thickness from approximately zero to 18.75 feet.

The Middle Clay is discontinuous throughout AOI 3, but where present appears thickest in the north and the south. The Middle Clay ranges in thickness from approximately zero to 15 feet. The Middle Clay appears to be absent in the center of AOI 3. Where both units are present, the Middle Clay overlies the Middle Sand.

The Middle Sand is present throughout most of AOI 3 eventually pinching out in the southern portion of the AOI. The Middle Sand in AOI 3 ranges in thickness from approximately zero to 20 feet. The Middle Sand typically overlies the Lower Clay in the PRM aquifer system.

However, due to non-deposition or erosion of the Lower Clay in AOI 3, the Middle Sand directly overlies the Lower Sand throughout most of AOI 3.

The Lower Clay is discontinuous throughout most of AOI 3, with only thin deposits in the north and thicker deposits beneath the Guard Basin/Four Pond area. The Lower Clay ranges in thickness from approximately zero to 18.5 feet throughout AOI 3. In the Guard Basin/Four Pond area, the Middle Sand is absent, and the Middle Clay directly overlies the Lower Clay. In this area, the combined clay units have a maximum thickness of approximately 29.5 feet.

Underneath the Lower Clay is the Lower Sand, which ranges from approximately 16 to 30.5 feet in thickness throughout AOI 3. Where the Lower Clay is absent, the Middle Sand and Lower Sand have a maximum observed combined thickness of approximately 47.5 feet (monitoring well S-284D).

Beneath the Lower Sand is the Wissahickon Schist bedrock. The weathered zone of the Wissahickon Schist was encountered between approximately 69 feet (monitoring well C-129D in AOI 7 just west of the AOI 3 boundary) and 92 feet (monitoring well S-280D) below ground surface (bgs).

General Hydrogeologic Framework

The hydrogeologic frame work is defined by grouping geologic units that are laterally extensive and have similar hydrogeologic properties. The generalized hydrostratigraphy of the Complex consists of seven layers (Schreffler, 2001, Sloto 1988) listed and described below:

- Layer 1: Combined anthropogenic fill, Holocene Alluvium and Trenton Gravel;
- Layer 2: Upper Clay unit of the PRM;
- Layer 3: Upper Sand unit of the PRM;
- Layer 4: Middle Clay unit of the PRM;
- Layer 5: Middle Sand unit of the PRM;
- Layer 6: Lower Clay unit of the PRM, and
- Layer 7: Lower Sand unit of the PRM.

AOI-3-Specific Hydrogeologic Framework

Several wells screened in the anthropogenic fill and the Holocene Alluvium throughout AOI 3 exhibit slightly higher hydraulic head elevations (perched conditions) than the wells screened in the Trenton Gravel (generally 2 to 3 feet difference). Perched conditions are also apparent in the capped past disposal areas (PDAs) east of Solid Waste Management Unit (SWMU) #3 – Guard Basin. Head values in the PDA areas are greater than 10 feet higher than values observed in the underlying Trenton Gravel. Based on the elevated head values observed in monitoring wells screened within the anthropogenic fill and Holocene Alluvium, there appears to be a perched aquifer in the southern half of AOI 3, as well as isolated perched areas in the north (monitoring well S-382).

Beneath the perched aquifer, it is assumed the head values observed in the Trenton Gravel and Upper Sand are representative of the water table. The water table aquifer throughout the Complex has been defined as the "unconfined aquifer." However, AOI 3 low permeability Holocene Alluvium deposits (primarily silt and clay) appear to act as a confining unit to the underlying Trenton Gravel and Upper Sand, and separate the perched aquifer and "unconfined aquifer" in the southern half of AOI 3. The unconfined aquifer consists of the combined Trenton Gravel, Upper Clay (where present), and Upper Sand (where present). Beneath the unconfined aquifer, the Middle Sand is partially confined by the discontinuous Middle Clay. Beneath the Middle Sand, the Lower Clay acts as a semi-confining unit to the Lower Sand. Where the Lower Clay is absent, the Middle Sand directly overlies the Lower Sand. Therefore, the Middle Sand, Lower Clay, and the Lower Sand comprise the "lower aquifer", which is semi-confined. The lower aquifer lies above the Wissahickon Schist bedrock.

The head differences measured in December 2015 between paired monitoring wells in the unconfined and lower aquifers (e.g., S-280/S-280D, S-284/S-284D, BF-106/BF-108, S-12/S-13, S-20/S-22, S-10/S-8) ranged between 0.33 feet (BF-106/BF-108) to 2.13 feet (S-10/S-8). The observed head differences correspond to downward vertical hydraulic gradients ranging between 0.005 to 0.05 feet/feet (ft/ft). The vertical hydraulic gradient is greatest in the southern portion of AOI 3 where the two aquifers are separated by the combined Middle and Lower Clay (combined thickness of approximately 29.5 feet), and lowest in the center of AOI 3 where the Middle Clay is absent and the two aquifers are hydraulically connected.

AOI-3 Groundwater Flow Patterns

Interpreted groundwater flow patterns and hydraulic gradients in the perched aquifer, unconfined aquifer, and lower aquifer within AOI 3 are depicted on groundwater elevation maps created using groundwater gauging data collected by Aquaterra Technologies, Inc. (Aquaterra) in June and December 2015 (Figures I-2 through I-7). A comprehensive gauging of the lower aquifer was not completed in June 2015; therefore, groundwater contour figures for the lower aquifer were created for May 2015 and December 2015 gauging events.

The perched aquifer is locally present in the southern half of AOI 3 where the Holocene Alluvium underlies significant fill deposits. Several wells are screened within this perched aquifer. Based on the groundwater elevations as shown in Figures I-2 and I-3, the following observations can be made regarding the perched aquifer:

- Groundwater recharge of the perched aquifer occurs at the potentiometric high centered on the area just east of the Guard Basin where fill deposits are thickest within AOI 3. From this point, perched groundwater flows radially outward under a typical hydraulic gradient of 0.05 feet/feet (ft/ft).
- Perched groundwater is assumed to eventually recharge the unconfined aquifer by vertical infiltration through areas of thinner or more permeable Holocene Alluvium deposits.

The unconfined aquifer is the combined Trenton Gravel, Upper Clay and Upper Sand, which makes up the water table aquifer. Based on the groundwater elevations within the unconfined aquifer as shown in Figures I-4 and I-5, the following observations can be made:

- Groundwater recharge to the unconfined aquifer within AOI 3 appears to occur in the north where Holocene alluvium deposits are thinner, and in the south due to the overlying perched aquifer and storm water retention basins.
- From these potentiometric high points, the potentiometric surface of the unconfined aquifer roughly follows the elevation of the top of the Middle Clay within AOI 3. Unconfined groundwater flow from the north and the south converges towards the center of AOI 3 where the elevation of the top of the Middle Clay is lowest and the clay unit eventually pinches out. Where the Middle Clay is absent, the unconfined

aquifer recharges the lower aquifer.

- Groundwater in the unconfined aquifer flows from the north under a typical hydraulic gradient of 0.0006 ft/ft, and from the south under a typical hydraulic gradient of 0.001 ft/ft.
- A small depression of groundwater centered on monitoring well S-59 was observed during both gauging events. The cause for this localized groundwater depression is unknown, but this feature coincides with an LNAPL plume (mix of light/middle distillate) and appears to contribute to the immobility of this LNAPL mass. An additional small groundwater depression is centered on monitoring well S-283. The cause for this feature is also unknown.

As defined above, the Middle Sand, Lower Clay, and the Lower Sand comprise the lower aquifer, which is semi-confined. As previously stated, the unconfined aquifer recharges the lower aquifer where the Middle Clay is absent at the center of AOI 3. Interpreted groundwater flow patterns and hydraulic gradients in the lower aquifer within AOI 3 are depicted on groundwater elevation maps (Figures I-6 and I-7). These lower aquifer gauging events correspond with the unconfined aquifer gauging events. The lower aquifer wells were not gauged during the June 2015 groundwater sampling event in AOI 3; therefore, the May 2015 gauging data for the lower aquifer wells was utilized. Groundwater flow in the lower aquifer is generally consistent for both gauging events and is toward the southwest under a typical gradient of 0.00065 ft/ft.

Aquifer Properties

Hydraulic Conductivity of Fill/Alluvium Aquifer

In August 1997, a nearly 7-day pump test was performed at recovery well RW-2 within AOI 3 (IST, 1998). During the pump test, RW-2 was pumped at a constant rate of 225 gallons per minute (gpm), and data loggers/transducers recorded water-level changes in fourteen observation monitoring wells. Distance-drawdown data indicated the area of influence extended approximately 1,680 feet from the pumping well with a relatively isotropic response in the unconfined aquifer. The hydraulic conductivity of the unconfined aquifer was estimated to be greater than 400 feet per day (ft/d). The hydraulic conductivity value derived from the pumping test at RW-2 is consistent with published literature values of the Trenton Gravel which range between approximately 15 to 2,900 ft/day and have a mean of 430 ft/day (Low et. al, 2002).

Published hydraulic conductivity estimates for the lower sand range between 123 to 152 ft/day with a mean of 135 ft/day (Paulachok, 1991). In the calibrated groundwater flow model created by the United States Geologic Survey (USGS) (Schreffler, 2001), the unconfined aquifer has a hydraulic conductivity of 5.47 ft/day and the lower aquifer has a hydraulic conductivity of 164 ft/day. Hydraulic conductivity estimates from the 2001 groundwater flow model for unconfined and lower aquifer appear generally consistent with site-specific values used in previous modeling efforts and available literature values.

Porosity

In 2015, four soil samples of the Trenton Gravel within AOI 3 were collected to determine soil properties of the unconfined aquifer (Appendix D of the AOI 3 RIR). Two soil samples were collected from each boring location during the boring advancement for monitoring wells S-412 and S-411. Soil samples were collected from approximately 10.7 to 11.5 feet bgs and 12.6 to 13.4 feet bgs at S-412. Soil samples were also collected from approximately 10.5 to 11.3 feet bgs and 15.2 to 15.7 feet bgs at S-411. Based on the geotechnical analyses, the samples collected from S-412 are described as dark brown silty sand with gravel and varying amounts of clay with total porosity ranging from 0.248 to 0.290, and effective porosity ranging from 0.066 to 0.083. The samples collected from S-411 are described as brown clay with sand/sand and gravel with total porosity ranging from 0.319 to 0.334, and effective porosity ranging from 0.104 to 0.149. The average total and effective porosities of the four samples are 0.298 and 0.101, respectively. In the calibrated groundwater flow model created by the USGS (Schreffler, 2001), a porosity of 0.3 was used for the unconfined and lower aquifer. The effective porosity values obtained from the 2015 Shelby Tube analysis are lower than the value used in the USGS groundwater flow model.

Groundwater Seepage Velocities

Groundwater seepage velocity is an estimate of the rate of groundwater movement through the pores in a geologic material. Seepage velocity does not take into account processes such as dispersion, sorption or biotransformation, which can significantly affect the migration of dissolved COCs relative to groundwater. The calculation of seepage velocity also assumes homogenous aquifer conditions and a uniform hydraulic gradient. The seepage velocity equation is:

$$V_x = \frac{K \times i}{n_e}$$

Where:

V_x = seepage velocity (Length/Time)
K = hydraulic conductivity (Length/Time)
i = hydraulic gradient (unitless)
n_e = effective porosity (unitless)

For the unconfined aquifer with K = 400 ft/day, i = 0.0006 to 0.001 and n_e = 0.101, the seepage velocity is 2.38 ft/day (869 ft/year) to 3.96 ft/day (1,445 ft/year) (Table I-1). For the lower aquifer with a K = 164 ft/day, i = 0.00065 and n_e = 0.3, the seepage velocity is 0.36 ft/d or 130 feet per year (ft/yr). These seepage velocities are conservative and do not incorporate a retardation factor. Compound specific seepage velocities with retardation factor incorporated for each COC are provided in Table I-1.

Hydrology

Topography and Drainage

Based on a LiDAR ground surface topography dataset from January 2010, AOI 3 ground surface elevations range from approximately two feet below mean sea level in the Four Pond Area to approximately 26 feet above mean sea level (amsl) at the northern end of AOI 3 (Figure I-8). The ground surface throughout most of the AOI is generally flat and is broken up by tank containment berms in the north end of the property, a few gently sloping hills within the vegetated area in the center of the AOI, and the retention ponds in the Four Ponds area.

Rainfall

Average yearly precipitation at Philadelphia International Airport, located approximately one mile southwest of AOI 3, is 41.45 inches (www.usclimatedata.com). A significant portion of precipitation does not reach the water table due to several processes. In AOI 3, some of the precipitation becomes runoff that is redirected by impermeable surfaces such as roadways and above ground storage tanks (Figure I-9) and is intercepted by storm water control facilities. Some precipitation likely returns to the atmosphere through evapotranspiration by vegetation, where present.

Surface Water Bodies

Existing surface water bodies in the vicinity of AOI 3 include the Schuylkill River, located to the northwest and the Guard Basin/Four Pond areas in the southern portion of the property. Based on a review of available historical maps and photos, a small tributary (formerly Jones Creek) to the Schuylkill River was once present within AOI 3 (Figure I-10). The current surface water features within AOI 3 are shown on Figure I-11.

The major surface water body near AOI 3 is the Schuylkill River. The USGS river gauging station located at the Fairmount Dam, several miles upriver from AOI 3, recorded a mean surface water discharge rate of 2,773 cubic feet per second (cfs) between 1932 and 2005. The lowest elevation of the Schuylkill riverbed near AOI 3 is approximately 45 feet below mean sea level where the bottom has been dredged. The average stage of the Schuylkill River at AOI 3 is approximately 0.5 feet amsl (Schreffler, 2001).

Anthropogenic Site Features

The following section only describes anthropogenic features that have the potential to influence subsurface fate and transport of COCs (i.e., groundwater flow and LNAPL mobility). There are currently no active remediation systems within AOI 3; therefore, pumping does not influence local groundwater flow. Two retention ponds are located in the Guard Basin/Four Ponds area (Figure I-12). It is likely the retention ponds provide recharge to the unconfined aquifer. These basins/ponds handle permitted storm water for the facility and are not considered to be surface water receptors. As previously stated, historically capped PDAs located immediately east of the Guard Basin appear to be creating perched groundwater conditions in the southeast portion of AOI 3. There is no sheet pile wall/bulkhead present along the AOI 3 boundary and the Schuylkill River.

Constituents of Concern, Groundwater Plumes, and Plume Stability

Areas where COC concentrations in groundwater are above their respective PADEP non-residential medium-specific concentrations (MSCs) have been grouped into two primary groundwater source areas:

- The "Northern Plume" is in the vicinity of monitoring wells S-280, S-411, S-414, and S-382 and extends down to the center of the AOI 3 where the clay units are absent; and
- The "Southern Plumes" are in the vicinity of monitoring wells S-16, S-20, and S-288.

These plume areas are shown in Figure I-13. Historically, the following COCs have been detected in perched and unconfined aquifer wells at concentrations exceeding their respective PADEP non-residential groundwater MSCs:

- Perched Aquifer: 1,2-dibromoethane (EDB), benzene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,hi,)perylene, chrysene, lead, methyl tertiary butyl ether (MTBE), and toluene.
- Unconfined Aquifer: 1,2,4-trimethylbenzene (1,2,4-TMB), EDB, benzene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,hi,)perylene, chrysene, lead, MTBE, naphthalene, and toluene.

For the AOI 3 dissolved groundwater plume assessments, groundwater concentration trends for benzene and MTBE, the most mobile of the COCs, were the focus; and only the COCs that consistently exceeded the PADEP non-residential groundwater MSCs were included in the groundwater concentration trend graphs for select monitoring well locations.

For monitoring wells screened in the lower aquifer, EDB, benzene, lead, and MTBE are the only COCs historically detected at concentrations above their respective PADEP non-residential groundwater MSCs. This is discussed further below:

- EDB exceeded the PADEP non-residential groundwater MSC of 0.05 micrograms per liter (ug/l) at four of the seven lower aquifer wells sampled during the June 2015 event, with the highest detected concentration of 0.086 ug/l at monitoring well S-8. However, EDB was not detected in any of the six lower aquifer wells sampled, including monitoring well S-8, during the most-recent AOI 3 groundwater sampling event in December 2015.
- During the two most-recent groundwater sampling events (June and December 2015), benzene was detected at concentrations exceeding the PADEP non-residential MSC at three lower aquifer monitoring well locations (S-284D, S-69D, and S-22).

- MTBE was also detected exceeding the PADEP non-residential groundwater MSC at three lower aquifer monitoring well locations (S-8, S-13, and BF-108) during these most-recent sampling events.

Trend graphs for benzene and MTBE concentrations in groundwater were created for lower aquifer monitoring wells S-8, S-13, S-22, S-69D, S-284D, and BF-108 to assess plume stability in the lower aquifer.

Plume Stability Assessment

The persistence of the dissolved plumes was assessed by plotting COC concentration versus time from wells located in each plume. With sufficient analytical data, a decreasing COC concentration trend in a well can be interpreted as the presence of a shrinking plume with respect to that COC at that location. Similarly, an increasing trend can be interpreted as an expanding plume area (EPA, 2002). No significant changes in groundwater concentration can be interpreted as a stable plume. Using multiple wells in a single plume, the overall stability of the plume can be assessed.

In addition to evaluating COCs over time in the wells, plume stability at AOI 3 was also assessed using a series of iso-concentration maps that depict the horizontal distribution of benzene and MTBE in the perched, unconfined, and lower aquifers. Over time, a reduction, redistribution of mass, and/or a decrease in extent can indicate plume attenuation. Conclusions drawn regarding overall plume stability in AOI 3 are preliminary and qualitative.

Plume stability assessment in AOI 3 is described below.

Northern Plume

The Northern Plume begins at the northwestern portion of AOI 3 and extends down to monitoring well BF-106 near the center of the AOI. The highest concentrations of benzene within AOI 3 were detected at monitoring wells S-382, S-414, and S-280. These wells are representative of the “source area” for the Northern Plume. Prior to the installation and sampling of monitoring wells S-382 and S-414, monitoring well S-280 historically exhibited the highest benzene concentrations within AOI 3. Since 2015, monitoring well S-382 exhibits the highest benzene concentrations within AOI 3. Groundwater concentration trend graphs of benzene and toluene detected in monitoring wells S-280, S-382, S-414, S-284 (benzene only), S-383 (benzene only), and BF-106 were created using analytical results from 2010 through 2016 where available (Figures I-14 thru I-19).

Monitoring well S-382 appears to be screened across the Holocene Alluvium and Trenton Gravel, and relatively higher hydraulic head elevations in at S-382 indicate perched groundwater may be infiltrating the well. Monitoring well S-382 was installed in 2013 and has been sampled three times (August 2013, June 2015, and December 2015). Since August 2013, concentrations of benzene have increased from 1.1 ug/l (August 2013) to 146,000 ug/l (December 2015), and concentrations of toluene have increased from 0.25 ug/l (August 2013) to 79,600 (December 2015). This five orders of magnitude increase in benzene and toluene concentrations at monitoring well S-382 indicate this portion of the Northern Plume is expanding.

Monitoring well S-280 is an unconfined aquifer monitoring well installed in 2010, and has been sampled three times (July 2010, June 2015, and December 2015). Based on the concentration trends of benzene and toluene, this area of the Northern Plume is assumed to be stable or shrinking.

Monitoring well S-414 is an unconfined aquifer monitoring well located approximately 219 feet northeast of monitoring well S-382. Monitoring well S-414 was installed in 2015, and has only been sampled twice; once during the December 2015 groundwater sampling event and a second time during a limited groundwater sampling event in April 2016. Therefore, this well lacks the minimum sampling rounds to perform a reliable concentration trend/plume stability analysis. However, it should be noted that concentrations of benzene and toluene at monitoring well S-414 have both significantly decreased between the sampling events in December 2015 and April 2016, from 93,700 ug/l to 48,900 ug/l and 30,700 ug/l to 4,980 ug/l, respectively. Based on the limited sampling data at monitoring well S-414, it is unclear if the observed concentrations of benzene and toluene are indicative of the decreasing trends at this well or temporal variability.

Monitoring well S-284 is an unconfined aquifer monitoring well located on the downgradient/side-gradient edge of the Northern Plume. As mentioned above, monitoring well S-284 is screened across the anthropogenic fill and the Trenton Gravel, and variable head conditions may indicate this well at times may receive perched groundwater. From July 2010 to June 2015, benzene was not detected at monitoring well S-284. During the December 2015 groundwater sampling, a benzene concentration of 61.8 ug/l was detected at monitoring well S-284.

Monitoring well S-383 is an unconfined monitoring well located south of the Northern Plume source area. From August 2013 to December 2015, benzene concentrations at monitoring well S-383 have increased greater than two orders of magnitude (1 ug/l to 651 ug/l). The observed increasing trends at monitoring wells S-284 and S-383 indicate the Northern Plume has not reached steady-state.

Monitoring well BF-106 is an unconfined aquifer monitoring well screened within the Trenton Gravel and on top of an apparent thin lens of the Upper Clay. Monitoring well BF-106 is located where the Middle Clay is pinching out or absent and unconfined groundwater appears to recharge the lower aquifer (combined Middle Sand, Lower Clay, and Lower Sand). Based on the July 2010 benzene iso-concentration map (Figure I-22) it appears the groundwater impacts observed in monitoring well BF-106 were originally not related to the Northern Plume. However, based on the December 2015 benzene iso-concentration map (Figure I-23), it appears the Northern Plume has merged with, the groundwater impacts observed in monitoring well BF-106. Groundwater concentration trend graphs for 1,2,4-TMB, benzene, and naphthalene at monitoring well BF-106 were created using groundwater analytical results from December 2009 through December 2015, where available (Figure I-19). Based on the concentration trends observed at monitoring well BF-106, it appears COC trends are stable or shrinking with respect to benzene, 1,2,4-TMB, and naphthalene.

Groundwater iso-concentration maps for benzene in the perched and unconfined aquifer were created using analytical results from July 2010 and December 2015 sampling events (Figures I-20 through I-23). Groundwater iso-concentration maps for MTBE in the unconfined aquifer were also created using the results from July 2010 and December 2015 sampling events (Figures I-24 and I-25). MTBE has not been detected in perched aquifer monitoring wells exceeding the PADEP non-residential groundwater MSC since November 2005 (monitoring well S-1). Interpreting the figures, the following observations can be made for the Northern Plume:

- The source area for the Northern Plume initially was located in the vicinity of monitoring well S-280. Based on the benzene and toluene concentrations observed at monitoring well S-280, it appears this portion of the Northern Plume is stable or shrinking.

- Groundwater impacts in the vicinity of monitoring wells S-382 and S-414 indicate an expanding plume or possibly a more recent impact in this area. Based on the well construction of S-382, it is unclear whether the impacts observed in this well are from perched groundwater or the unconfined aquifer. However, it is assumed that recent impacts would occur as a shallow or surficial release and be present in the perched groundwater.
- Dissolved phase COCs from the Northern Plume source area(s) are being transported in the unconfined aquifer southeast towards the center of the site, where the Middle Clay is absent.
- The Northern Plume does not appear to correspond with any of the known free-phase LNAPL sources in AOI 3.

Southern Plumes

The Southern Plumes consist primarily of isolated benzene plumes in both the perched and unconfined aquifer, and an MTBE plume in the unconfined aquifer. The benzene plumes in the perched aquifer are locally present at monitoring wells S-288 and S-409/S-410. The benzene plume in the unconfined aquifer is centered on monitoring well S-16. The MTBE plume is located just east of the Guard Basin, in the vicinity of the PDAs. Groundwater concentration trend graphs of COCs detected in monitoring wells S-16, S-288, S-20, and S-23 were created using analytical results from 2009 through 2015 where available (Figures I-26 through I-29).

- <u>Benzene Plume</u>
    - Based on the benzene concentration trend at perched aquifer monitoring well S-288, this isolated benzene plume appears to be stable or shrinking.
    - Based on the observed COC concentration trends at unconfined aquifer monitoring well S-16, this benzene plume appears to be stable.
    - Based on the July 2010 and December 2015 benzene iso-concentration maps for the perched aquifer (Figures I-20 and I-21), the lateral extent of the benzene plume centered on monitoring well S-288 in the perched aquifer, and the benzene plume centered on monitoring well S-16 in the unconfined aquifer both appear to be shrinking or stable.
    - The small plume in the perched aquifer at monitoring wells S-409 and S-410 is most likely related to middle distillate LNAPL identified in monitoring well S-410, however benzene detections are relatively low (7.1 and 10.5 µg/l).

- MTBE Plume
    - Monitoring well S-20 appears to be the source area well for the MTBE plume. Based on the MTBE concentration trend at monitoring well S-20, the MTBE plume appears to be stable.
    - The MTBE plume is located on a potentiometric high point in the unconfined aquifer where vertical recharge from the overlying perched aquifer may occur. Radial flow from this potentiometric high, appears to have contributed to divergent transport of MTBE, in the direction of monitoring wells S-16 ad S-23.
    - Based on the MTBE concentration trend at monitoring well S-23 the MTBE plume appears to be stable or shrinking.
    - Based on the MTBE concentration trend at monitoring well S-16, the MTBE plume appears to be stable or shrinking.
    - The similar lateral extent of the MTBE plume observed in the July 2010 and December 2015 iso-concentration maps (Figures I-24 and I-25) further support that the MTBE plume is stable or shrinking.
    - The small LNAPL plume centered on monitoring well S-19 could potentially be the source for the MTBE plume. The LNAPL in this well has not been sampled for fingerprinting analysis, but is assumed to be heavy distillate. This assumption is based on the LNAPL fingerprinting analysis completed for the nearby monitoring well S-21. If the LNAPL present in monitoring well S-19 is in fact heavy distillate, it is unlikely this is the source for the MTBE plume.

Lower Aquifer COC Trends

Figures I-30 through I-35 display COC trend graphs for the lower aquifer wells (S-8, S-13, S-22, S-69D, S-284D, and BF-108) that had concentrations of benzene and/or MTBE above their respective PADEP non-residential groundwater MSCs. A summary of the observed trends is below:

- Based on the MTBE concentration trend in monitoring well S-8, dissolved phase impacts in this well appear to be stable or shrinking.
- MTBE concentrations display an increasing trend in monitoring well S-13. The source of the increasing MTBE concentrations at S-13 is unclear, however, it does not appear to be a result of MTBE being transported downward from the unconfined aquifer based on

the relative concentrations observed in the two aquifers. Evergreen will continue to monitor and evaluate MTBE trends at monitoring well S-13, and the potential source area will be evaluated in the Complex-wide Cleanup Plan.

- Based on the benzene and MTBE concentration trends in monitoring well S-22, dissolved phase impacts in this well appear to be stable or shrinking.
- Both monitoring wells S-69D and S-284D displayed increases in benzene concentrations during the most recent sampling event in December 2015. The observed increase of dissolved phase benzene concentrations within the lower aquifer in this area is possibly related to the increased benzene concentrations observed in monitoring wells S-382 and S-414. Evergreen will continue to monitor COC trends in the unconfined and lower aquifer, to evaluate the observed increase of benzene concentrations in the unconfined aquifer (Northern Plume), potential future extent of this plume, and potential interaction with the lower aquifer.
- Based on the MTBE concentration trend in monitoring well BF-108, dissolved phase impacts in this well appear to be stable or shrinking.

Groundwater iso-concentration maps for benzene and MTBE in the lower aquifer were created using analytical results from the July 2010 and December 2015 sampling events (Figures I-36 through I-39). Interpreting the iso-concentration figures, the following observations can be made for the lower aquifer plumes:

- <u>Benzene</u>
    - The small benzene plume surrounding monitoring well S-22 appears to be stable or shrinking and is unrelated to the benzene plume observed at monitoring wells S-69D and S-284D.
    - The larger benzene plume at monitoring wells S-69D and S-284D was not observed during the July 2010 sampling event. This plume appears to be expanding and most likely extends into the lower aquifer beneath AOI 7.
    - The larger plume in the northern portion of AOI 3 is located in the area where the Middle and Lower Clay units are pinching out or absent; indicating the presence of this plume may be related to the increasing benzene concentrations observed in the unconfined aquifer at monitoring wells S-382 and S-414.

- MTBE
  - There appears to be two distinct MTBE plumes within the lower aquifer beneath AOI 3.
  - The MTBE plume surrounding monitoring wells S-13 and S-22 appears to be expanding based on the increasing concentrations observed at monitoring well S-13. This MTBE plume may extend into the lower aquifer beneath both AOI 7 and AOI 4.
  - The MTBE plume surrounding monitoring well BF-108 appears to be shrinking based on the decreasing concentrations observed at monitoring well BF-108.

Potential Receptors

The only potential receptors to COCs in groundwater in AOI 3 are the ecological receptors within AOI 3 and the Schuylkill River. The majority of AOI 3 is covered with pavement, soil and gravel. Paved areas are primarily located in northern portion of AOI 3 as shown in Figure I-9. The soil and gravel-covered portions of AOI 3 are not likely to serve as a breeding area, migratory stopover, or primary habitat for wildlife. The Guard Basin and Four Pond area are permitted storm water retention features located along in the southern portion of AOI 3 and, based on their function as permitted (NPDES) storm water features, are not considered ecological receptors. Based on the observed hydraulic gradients, shallow unconfined groundwater generally flows away from the Schuylkill River in AOI 3. Based on this conceptual understanding, unconfined shallow groundwater impacts do not pose a significant risk to surface water quality in the Schuylkill River. Refer to the AOI 3 RIR for additional information.

Fate and Transport Assessment Summary

Based on the qualitative assessment of the fate and transport of dissolved COCs in groundwater in AOI 3, the following points summarize the findings:

- Groundwater recharge of the perched aquifer occurs at the potentiometric high centered on the area just east of the Guard Basin where fill deposits are thickest within AOI 3. From this point, perched groundwater flows radially outward.
- Perched groundwater is assumed to eventually recharge the unconfined aquifer by

vertical infiltration through areas of thin or more permeable Holocene Alluvium deposits.

- Groundwater recharge to the unconfined aquifer within AOI 3 appears to occur in the north where Holocene alluvium deposits are thin, and due to the overlying perched aquifer and storm water retention basins in the south.
- From these potentiometric high points, the potentiometric surface of the unconfined aquifer roughly follows the elevation of the top of the Middle Clay within AOI 3. Unconfined groundwater flow from the north and the south converges towards the center of AOI 3 where the elevation of the top of the Middle Clay is at its lowest and the clay unit eventually pinches out. Where the Middle Clay is absent, the unconfined aquifer recharges the lower aquifer.
- Historically, the following COCs have been detected in perched, unconfined and lower aquifer wells at concentrations exceeding their respective PADEP non-residential groundwater MSCs:
    - Perched Aquifer - EDB, benzene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,hi,)perylene, chrysene, lead, MTBE, and toluene.
    - Unconfined Aquifer - 1,2,4-TMB, EDB, benzene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,hi,)perylene, chrysene, lead, MTBE, naphthalene, and toluene.
    - Lower Aquifer - benzene, lead, and MTBE.
- Two general contaminant source areas have been identified based on COC exceedances of PADEP groundwater MSCs:
    - The Northern Plume begins at the northwestern portion of AOI 3 and extends down to monitoring well BF-106 near the center of the AOI. The Northern Plume has merged with groundwater impacts at monitoring well BF-106. Based on COC trends the Northern Plume is stable in the vicinity of monitoring well S-280. Groundwater impacts in the vicinity of monitoring wells S-382 and S-414 indicate the presence of a second more recent source area for the Northern Plume. Based on the well construction of S-382, it is unclear whether the impacts observed in this well are from perched groundwater or the unconfined aquifer. However, it is assumed that recent impacts would occur as a shallow or

surficial release and be present in the perched groundwater. The Northern Plume, appears to be extending down gradient as the plume migrates towards the center of the AOI. The increasing trends observed in monitoring well S-382, as well as the increasing concentrations down gradient, indicate the plume may be expanding.

  - The Southern Plumes consist of isolated benzene plumes in both the perched and unconfined aquifers, and a MTBE plume in the unconfined aquifer.
    - Based on the COC concentration trends of monitoring wells S-288 and S-16, the southern benzene plume in both the perched and unconfined aquifer, respectively, appear to the stable or shrinking.
    - The small plume in the perched aquifer at monitoring wells S-409 and S-410 is most likely related to middle distillate LNAPL identified in monitoring well S-410, however benzene detections are relatively low (7.1 and 10.5 µg/l).
    - Monitoring well S-20 is identified as the source area well for the MTBE plume. Based on the MTBE concentration trends at monitoring wells S-20, S-23 and S-16, the MTBE plume appears to stable or shrinking. The LNAPL observed in monitoring well S-19 may be a potential source for the MTBE plume.

- Increasing COC trends were observed in lower aquifer monitoring wells S-13, S-69D, and S-284D. Dissolved COC concentrations in the unconfined aquifer upgradient of this area may be contributing to concentrations in these lower aquifer wells. The potential source for the observed increase in COCs concentrations in both the unconfined (monitoring wells S-382 and S-414) and the lower aquifer will be evaluated during the Complex-wide Cleanup Plan activities and comprehensively modeled to estimate the future extent of groundwater concentrations.

- Based on the LNAPL fingerprinting analysis completed as part of the 2009 Current Conditions Report and the 2010 AOI 3 Site Characterization Report, all LNAPL samples were highly to severely weathered, indicating these LNAPL plumes have been undergoing degradation within the subsurface for a significant time period. In October 2015, LNAPL was identified during the installation of monitoring well S-410. Based on the minimal thickness observed (less than 1 foot) and the isolated extent of the LNAPL plume indicate LNAPL at S-410 is immobile. The lateral extent and observed thickness of the previously identified LNAPL plumes have remained fairly constant over several years of monitoring, indicating these plumes are immobile.

- The quantitative fate and transport modeling will use the Complex-wide groundwater model to assess the appropriate remedial approach for the areas where COC concentrations in groundwater are above the non-residential MSCs and exhibit increasing concentration trends.

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Table I-1
Groundwater Seepage Velocity and COC Retardation Estimates
AOI 3 Qualitative Fate and Transport Analysis
PES Refining Complex
Philadelphia, Pennsylvania

Constituent	Koc	Kd	R Unconfined Aquifer	Vc Unconfined Aquifer	Aerobic Conditions Lambda	Aerobic Conditions Half-life	
	L/kg		unitless	ft/d	yr-1	years	days
METALS							
Lead (Total)	na	900	15,060	9.4E-05	na		
VOCs							
1,2-Dichloroethane	38	0.076	2	0.63	0.07	9.9021	3,614
1,2,4-Trimethylbenzene	2,200	4.4	75	0.02	4.5	0.154	56
1,2-Dibromoethane (EDB)	54	0.108	3	0.51	2.11	0.3285	120
1,3,5-Trimethylbenzene[1]	660	1.32	23	0.06	4.5	0.154	56
Benzene	58	0.116	3	0.48	0.35	1.98	723
Cumene	2,800	5.6	95	0.01	15.81	0.04	16
Ethylbenzene	220	0.44	8	0.17	1.11	0.62	228
Methyl Tertiary Butyl Ether	12	0.024	1	1.01	0.69	1.00	367
Toluene	130	0.26	5	0.27	9.01	0.08	28
Xylene (Total)[2]	350	0.7	13	1.12E-01	0.69	1.00	367
SVOCs/ PAHs							
Anthracene	21,000	42	704	2.0E-03	0.28	2.48	904
Benzo(a)anthracene	350,000	700	11,714	1.2E-04	0.19	3.65	1,332
Benzo(a)pyrene	910,000	1820	30,454	4.7E-05	0.24	2.89	1,054
Benzo(b)fluoranthene	550,000	1100	18,407	7.7E-05	0.21	3.30	1,205
Benzo(g,h,i)perylene	2,800,000	5600	93,704	1.5E-05	0.19	3.65	1,332
Chrysene	490,000	980	16,399	8.7E-05	0.13	5.33	1,946
Fluorene	7,900	15.8	265	5.4E-03	2.11	0.33	120
Naphthalene	950	1.9	33	4.3E-02	0.98	0.71	258
Phenanthrene	38,000	76	1,273	1.1E-03	0.63	1.10	402
Pyrene	68,000	136	2,277	6.2E-04	0.07	9.90	3,614

Notes:

Aerobic half-lives from PA Code Chapter 250, Appendix A, Table 5A

[1] The aerobic half-life for 1,2,4-trimethylbenzene was used for 1,3,5-trimethylbenzene

[2] The low range value for aerobic half-life for o-Xylene reported the Handbook of Envrionmental Degradation Rates (Howard et. al., 1991) was used for Xylenes (total)

Koc = soil organic carbon-water partitioning coefficient
Kd = soil-water partitioning coefficient
R = retardation
Vc = retarded seepage velocity
L/kg = liters per kilogram
ft/d = feet per day
yr-1 = 1/year
gram/cc = grams per cubic centimeter
VOCs = volatile organic compounds
SVOCs = semi-volatile organic compounds
PAHs = polycyclic aromatic hydrocarbons
na = not applicable
COC = constituent of concern

porosity - surface soils	0.101	unitless
bulk density	1.69	gram/cc
fraction of organic carbon	0.002	unitless
seepage velocity	1.42	ft/d

Figure I-1 – Generalized Stratigraphic Section of the Coastal Plain in South Philadelphia, Pennsylvania
AOI 3 Remedial Investigation Report
PES Refining Complex
Philadelphia, Pennsylvania

<table>
<tr><th>SYSTEM</th><th>SERIES</th><th colspan="2">GEOLOGIC UNIT</th><th>HYDROGEOLOGIC UNIT</th></tr>
<tr><td rowspan="2">Quaternary</td><td>Holocene</td><td colspan="2">alluvium</td><td rowspan="4">water-table aquifer</td></tr>
<tr><td>Pleistocene</td><td colspan="2">“Trenton gravel”</td></tr>
<tr><td rowspan="6">Cretaceous</td><td rowspan="5">Upper Cretaceous</td><td rowspan="6">Potomac-Raritan-Magothy aquifer system</td><td>upper clay unit</td></tr>
<tr><td>upper sand unit</td></tr>
<tr><td>middle clay unit</td><td rowspan="4">confined aquifer</td></tr>
<tr><td>middle sand unit</td></tr>
<tr><td>lower clay unit</td></tr>
<tr><td>Lower Cretaceous</td><td>lower sand unit</td></tr>
<tr><td>pre-Cretaceous</td><td></td><td colspan="2">crystalline rocks</td><td></td></tr>
</table>

Notes:
1) Modified from Schreffler, 2001.
2) All geologic and hydrogeologic units are present at AOI 3.

Legend

S-21
9.84 ● Perched Aquifer Monitoring Well and Groundwater Elevation (ft. amsl)

● Well Abandoned/Destroyed/Unable to Locate

● Perched Aquifer Monitoring Well

● Unconfined Aquifer Monitoring Well

● Lower Aquifer Monitoring Well

● Unconfined Aquifer Recovery Well

—6— Perched Aquifer Groundwater Contours (ft. amsl)

- - -6- - - Inferred Perched Aquifer Groundwater Contours (ft. amsl)

🟨 AOI Boundary

Notes:
1. Aerial imagery provided by Nearmap.com, dated 7/29/2015.
2. Area of Interest boundaries referenced from 2011 ALTA/ACSM Land Title Survey, prepared for Sunoco Inc. (R&S).
3. Groundwater elevations were obtained from the June 2015 gauging event performed by Aquaterra Technologies, Incorporated.
4. ft. amsl = feet above mean sea level
5. Monitoring wells S-407 through S-414 were installed in October 2015; therefore, these wells are not displayed on this figure.

Figure I-2: Groundwater Elevations (June 2015)
Perched Aquifer Wells
AOI-3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, Pennsylvania

EVERGREEN

Philadelphia Refinery Operations
A Series of Evergreen Resources
Group, LLC.
2 Righter Parkway, Suite 200
Wilmington, DE 19803

0 75 150 300 Feet

SCALE: 1" = 150'
DATE: February 8, 2017
DRN. BY: MMK
CKD. BY: ED
JOB#: 2574601

Document Path: \\langan.com\data\DYL\data6\2574601\ArcGIS\MapDocuments\AOI 3 RIR 2016\Fate and Transport\Figure I-2 - Groundwater Elevations (June 2015) – Perched Aquifer Wells.m

Legend

S-21 7.84 ● Perched Aquifer Monitoring Well and Groundwater Elevation (ft. amsl)

● Well Abandoned/Destroyed/Unable to Locate

● Perched Aquifer Monitoring Well

● Unconfined Aquifer Monitoring Well

● Lower Aquifer Monitoring Well

▨ Unconfined Aquifer Recovery Well

—6— Perched Aquifer Groundwater Contours (ft. amsl)

- - -6- - - Inferred Perched Aquifer Groundwater Contours (ft. amsl)

🟨 AOI Boundary

S-410 9.09 ● Well Not Used in Contouring

Notes:
1. Aerial imagery provided by Nearmap.com, dated 7/29/2015.
2. Area of Interest boundaries referenced from 2011 ALTA/ACSM Land Title Survey, prepared for Sunoco Inc. (R&S).
3. Groundwater elevations were obtained from the December 2015 gauging event performed by Aquaterra Technologies, Incorporated.
4. ft. amsl = feet above mean sea level
5. Monitoring well S-410 was not used in contouring because it appears to be screened across both the perched and unconfined aquifers.

Figure I-3: Groundwater Elevations (December 2015) – Perched Aquifer Wells
AOI-3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, Pennsylvania

Philadelphia Refinery Operations
A Series of Evergreen Resources Group, LLC.
2 Righter Parkway, Suite 200
Wilmington, DE 19803

0 75 150 300 Feet

SCALE: 1" = 150'
DATE: February 8, 2017
DRN. BY: MMK
CKD. BY: KM
JOB#: 2574601

Document Path: \\langan.com\data\DYL\data6\2574601\ArcGIS\MapDocuments\AOI 3 RIR 2016\Fate and Transport\Figure I-3 - Groundwater Elevations (December 2015) – Perched Aquifer Wells.m

Legend

S-10 1.41 ◒	Unconfined Aquifer Monitoring Well and Groundwater Elevation (ft. amsl)
⊕	Well Abandoned/Destroyed/Unable to Locate
⊕	Perched Aquifer Monitoring Well
◒	Unconfined Aquifer Monitoring Well
◐	Lower Aquifer Monitoring Well
⊞	Unconfined Aquifer Recovery Well
—1—	Unconfined Aquifer Groundwater Contours (ft amsl)
- - -1- - -	Inferred Unconfined Aquifer Groundwater Contours (ft amsl)
🟨	AOI Boundary
S-66 -2.53 ◒	Well Not Used in Contouring

Notes:
1. Aerial imagery provided by Nearmap.com, dated 7/29/2015.
2. Area of Interest boundaries referenced from 2011 ALTA/ACSM Land Title Survey, prepared for Sunoco Inc. (R&S).
3. Groundwater elevations were obtained from the June 2015 gauging event performed by Aquaterra Technologies, Incorporated.
4. Groundwater elevation from S-59 and S-66 were omitted when generating the groundwater contours.
5. ft. amsl = feet above mean sea level
6. Groundwater elevation at BF-90D was not measured during the June 2015 gauging. Groundwater elevation shown and used for contouring at BF-90D is from May 12, 2015.
7. Monitoring well S-285 and S-290 were not used in contouring because they appear to be screened across both the perched and unconfined aquifers.
8. Monitoring wells S-407 through S-414 were installed in October 2015; therefore, these wells are not displayed on this figure.

Figure I-4: Groundwater Elevations (June 2015)
Unconfined Aquifer Wells
AOI-3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, Pennsylvania

Philadelphia Refinery Operations
A Series of Evergreen Resources Group, LLC.
2 Righter Parkway, Suite 200
Wilmington, DE 19803

0 75 150 300
Feet

SCALE: 1" = 150'
DATE: February 8, 2017
DRN. BY: MMK
CKD. BY: ED
JOB#: 2574601

Document Path: \\langan.com\data\DYL\data6\2574601\ArcGIS\MapDocuments\AOI 3 RIR 2016\Fate and Transport\Figure I-4 - Groundwater Elevations (June 2015) – Unconfined Aquifer Wells.mxd

Legend

S-23 0.64 ● Unconfined Aquifer Monitoring Well and Groundwater Elevation (ft. amsl)

⊕ Well Abandoned/Destroyed/Unable to Locate

⊕ Perched Aquifer Monitoring Well

⊕ Unconfined Aquifer Monitoring Well

⊕ Lower Aquifer Monitoring Well

⊞ Unconfined Aquifer Recovery Well

—1— Unconfined Aquifer Groundwater Contours (ft amsl)

- - - -1- - - Inferred Unconfined Aquifer Groundwater Contours (ft amsl)

▭ AOI Boundary

S-59 2.67 Well Not Used in Contouring

Notes:
1. Aerial imagery provided by Nearmap.com, dated 7/29/2015.
2. Area of Interest boundaries referenced from 2011 ALTA/ACSM Land Title Survey, prepared for Sunoco Inc. (R&S).
3. Groundwater elevations were obtained from the December 2015 gauging event performed by Aquaterra Technologies, Incorporated.
4. ft. amsl = feet above mean sea level
5. Monitoring well S-285 and S-290 was not used in contouring because they appear to be screened across both the perched and unconfined aquifers.
6. Groundwater elevation from S-59 was omitted when generating the groundwater contours.
7. NM = not measured

Figure I-5: Groundwater Elevations (December 2015) – Unconfined Aquifer Wells
AOI-3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, Pennsylvania

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2 Righter Parkway, Suite 200
Wilmington, DE 19803

0 75 150 300
Feet

SCALE: 1" = 150'
DATE: June 23, 2016
DRN. BY: AJC
CKD. BY: KM
JOB#: 2574601

Document Path: \\langan.com\data\DYL\data6\2574601\ArcGIS\MapDocuments\AOI 3 RIR 2016\Fate and Transport\Figure I-5 - Groundwater Elevations (December 2015) – Unconfined Aquifer Wells.mx

Legend

S-22 -0.35 ◐	Lower Aquifer Monitoring Well and Groundwater Elevation (ft. amsl)
⊕	Well Abandoned/Destroyed/Unable to Locate
⊕	Perched Aquifer Monitoring Well
⊕	Unconfined Aquifer Monitoring Well
◐	Lower Aquifer Monitoring Well
⊞	Unconfined Aquifer Recovery Well
—0.5—	Lower Aquifer Groundwater Contours (ft amsl)
- - -0.5- -	Inferred Lower Aquifer Groundwater Contours (ft amsl)
🟨	AOI Boundary
S-13 -0.608 ◐	Well Not Used in Contouring

Notes:
1. Aerial photography provided by Nearmap.com, dated 7/29/2015.
2. Area of Interest boundaries referenced from 2011 ALTA/ACSM Land Title Survey, prepared for Sunoco Inc. (R&S).
3. Groundwater elevations were obtained from the May 2015 gauging event performed by Aquaterra Technologies, Incorporated.
4. Groundwater elevation from S-13 was omitted when generating the groundwater contours.
5. ft. amsl = feet above mean sea level

Figure I-6: Groundwater Elevations (May 2015)
Lower Aquifer Wells
AOI-3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, Pennsylvania

EVERGREEN

Philadelphia Refinery Operations
A Series of Evergreen Resources
Group, LLC.
2 Righter Parkway, Suite 200
Wilmington, DE 19803

0 75 150 300 Feet

SCALE: 1" = 150'
DATE: February 8, 2017
DRN. BY: MMK
CKD. BY: ED
JOB#: 2574602

Path: \\langan.com\data\DYL\data6\2574601\ArcGIS\MapDocuments\AOI 3 RIR 2016\Fate and Transport\Figure I-6 - Groundwater Elevations (May 2015) – Lower Aquifer Wells.mxd Date: 2/16/2017 User: MMking Time: 12:06:03 PM

Legend

S-22 -1.01 ◐ Lower Aquifer Monitoring Well and Groundwater Elevation (ft. amsl)

⊕ Well Abandoned/Destroyed/Unable to Locate

⊕ Perched Aquifer Monitoring Well

⊕ Unconfined Aquifer Monitoring Well

◐ Lower Aquifer Monitoring Well

■ Unconfined Aquifer Recovery Well

—-1— Lower Aquifer Groundwater Contours (ft amsl)

- - -1- - - Inferred Lower Aquifer Groundwater Contours (ft amsl)

🟨 AOI Boundary

Notes:
1. Aerial photography provided by Nearmap.com, dated 7/29/2015.
2. Area of Interest boundaries referenced from 2011 ALTA/ACSM Land Title Survey, prepared for Sunoco Inc. (R&S).
3. Groundwater elevations were obtained from the December 2015 gauging event performed by Aquaterra Technologies, Incorporated.
4. ft. amsl = feet above mean sea level

Figure I-7: Groundwater Elevations (December 2015)
Lower Aquifer Wells
AOI-3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, Pennsylvania

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Group, LLC.
2 Righter Parkway, Suite 200
Wilmington, DE 19803

0 75 150 300 Feet

SCALE: 1" = 150'
DATE: February 8, 2017
DRN. BY: MMK
CKD. BY: ED
JOB#: 2574602

Path: \\langan.com\data\DYL\data6\2574601\ArcGIS\MapDocuments\AOI 3 RIR 2016\Fate and Transport\Figure I-7 - Groundwater Elevations (December 2015) – Lower Aquifer Wells.mxd Date: 2/16/2017 User: MMking Time: 12:06:14 PM

Legend

——— 2 Foot Topographic contours (ft amsl)

🟨 AOI Boundary

Notes:
1. Aerial photography provided by Nearmap.com, dated 10/19/2015.
2. Area of Interest boundaries referenced from 2011 ALTA/ACSM Land Title Survey, prepared for Sunoco Inc. (R&S).
3. Topographic contours developed from 2010 LiDAR data for the City of Philadelphia.
4. ft amsl = feet above mean sea level

Figure I-8: AOI-3 Topography
AOI-3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, Pennsylvania

Philadelphia Refinery Operations
A Series of Evergreen Resources Group, LLC.
2 Righter Parkway, Suite 200
Wilmington, DE 19803

0 75 150 300 Feet

SCALE: 1" = 150'
DATE: February 15, 2017
DRN. BY: MMK
CKD. BY: ED
JOB#: 2574602

Path: \\langan.com\data\DYL\data6\2574601\ArcGIS\MapDocuments\AOI 3 RIR 2016\Fate and Transport\Figure I-8 - AOI 3 Topography.mxd Date: 2/15/2017 User: MMking Time: 4:59:32 PM

Legend

▨ Impermeable Surfaces

☐ AOI Boundary

Notes:
1. Aerial photography provided by Nearmap.com, dated 10/19/2015.
2. Area of Interest boundaries referenced from 2011 ALTA/ACSM Land Title Survey, prepared for Sunoco Inc. (R&S).

Figure I-9: Impermeable Surface Locations
AOI-3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, Pennsylvania

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A Series of Evergreen Resources
Group, LLC.
2 Righter Parkway, Suite 200
Wilmington, DE 19803

0 75 150 300 Feet

SCALE: 1" = 150'
DATE: February 15, 2017
DRN. BY: MMK
CKD. BY: ED
JOB#: 2574602

Path: \\langan.com\data\DYL\data6\2574601\ArcGIS\MapDocuments\AOI 3 RIR 2016\Fate and Transport\Figure I-9 - Impermeable Surface Locations.mxd Date: 2/15/2017 User: MMking Time: 5:01:25 PM

"A Map of Philadelphia and Parts Adjacent, 1750 (circa)", Zebooker collection, Athenaeum of Philadelphia.

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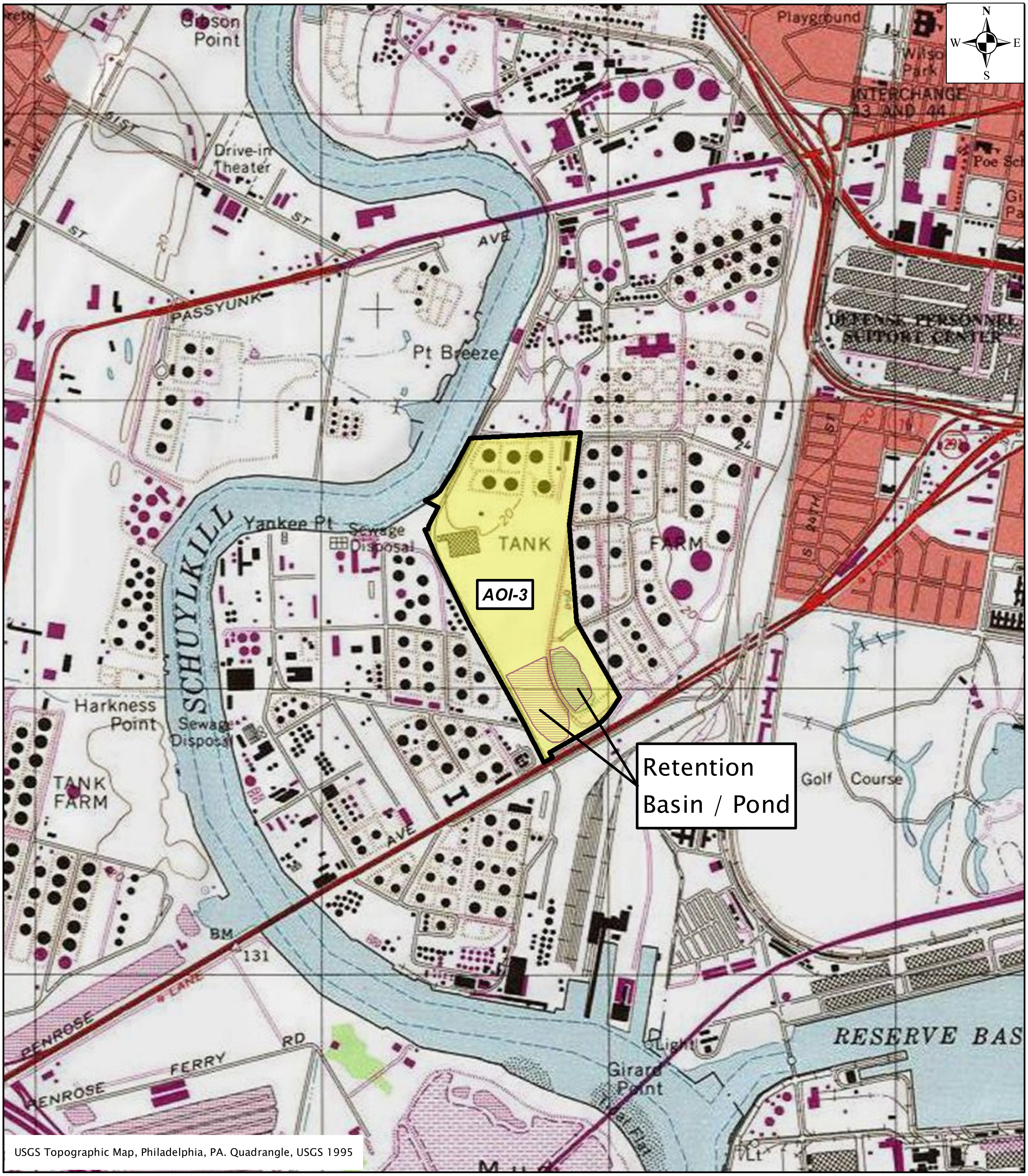
Wilmington, DE 19803

Figure I-10: Historical Surface Water Features AOI-3 Remedial Investigation Report PES Philadelphia Refining Complex

Philadelphia
Pennsylvania

Job Number	Scale: 1" = 1,500'	Date
2574602	0 750 1,500 Feet	February 15, 2017

Path: \\langan.com\data\DYL\data6\2574601\ArcGIS\MapDocuments\AOI 3 RIR 2016\Fate and Transport\Figure I-10 - Historical Surface Water Features.mxd



USGS Topographic Map, Philadelphia, PA. Quadrangle, USGS 1995

Philadelphia Refinery Operations
A Series of Evergreen Resources
Group, LLC.

2 Righter Parkway, Suite 200
Wilmington, DE 19803

Figure I-11: Current Surface Water Features
AOI-3 Remedial Investigation Report
PES Philadelphia Refining Complex

Philadelphia
Pennsylvania

Job Number	Scale: 1" = 1,500'	Date
2574602	0 750 1,500 Feet	February 15, 2017

Path: \\langan.com\data\DYL\data6\2574601\ArcGIS\MapDocuments\AOI 3 RIR 2016\Fate and Transport\Figure I-11 - Current Surface Water Features.mxd

Legend

🟦 Retention Basin/Pond

▨ Past Disposal Areas (PDAs)

🟨 AOI Boundary

Notes:

1. Aerial imagery provided by Nearmap.com, dated 7/29/2015.
2. Area of Interest boundaries referenced from 2011 ALTA/ACSM Land Title Survey, prepared for Sunoco Inc. (R&S).

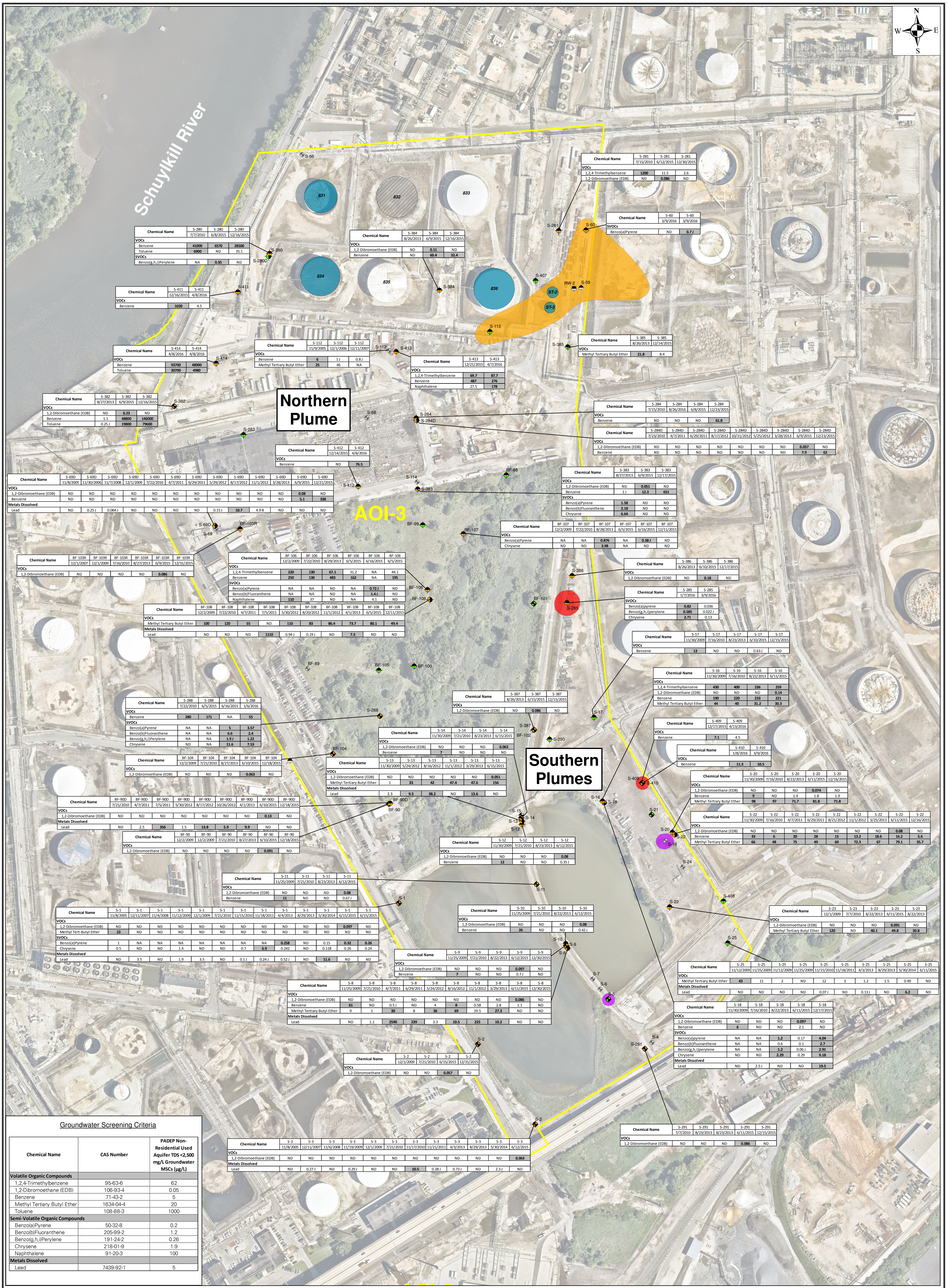
Figure I-12: Anthropogenic Site Features in AOI-3
AOI-3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, Pennsylvania

Philadelphia Refinery Operations
A Series of Evergreen Resources Group, LLC.
2 Righter Parkway, Suite 200
Wilmington, DE 19803

0 75 150 300 Feet

SCALE: 1" = 150'
DATE: February 15, 2017
DRN. BY: MMK
CKD. BY: ED
JOB#: 2574602

Path: \\langan.com\data\DYL\data6\2574601\ArcGIS\MapDocuments\AOI 3 RIR 2016\Fate and Transport\Figure I-12 - Anthropogenic Site Features.mxd Date: 2/21/2017 User: MMking Time: 11:20:01 AM



Chemical Name	S-280 7/7/2010	S-280 6/8/2015	S-280 12/16/2015
VOCs			
Benzene	**41000**	**6570**	**28500**
Toluene	**6900**	ND	35.1
SVOCs			
Benzo(g,h,i)Perylene	NA	**0.35**	ND

Chemical Name	S-384 8/26/2013	S-384 6/9/2015	S-384 12/16/2015
VOCs			
1,2-Dibromoethane (EDB)	ND	**0.11**	ND
Benzene	ND	**60.4**	**32.4**

Chemical Name	S-281 7/15/2010	S-281 6/12/2015	S-281 12/30/2015
VOCs			
1,2,4-Trimethylbenzene	**1200**	11.5	2.6
1,2-Dibromoethane (EDB)	ND	**0.086**	ND

Chemical Name	S-60 3/9/2016	S-60 3/9/2016
SVOCs		
Benzo(a)Pyrene	ND	**0.7 J**

Chemical Name	S-411 12/16/2015	S-411 4/8/2016
VOCs		
Benzene	**1020**	4.5

Chemical Name	S-414 4/8/2016	S-414 4/8/2016
VOCs		
Benzene	**93700**	**48900**
Toluene	**30700**	**4980**

Chemical Name	S-112 11/9/2005	S-112 12/1/2006	S-112 12/11/2007
VOCs			
Benzene	**6**	1 J	0.8 J
Methyl Tertiary Butyl Ether	**25**	46	NA

Chemical Name	S-413 12/21/2015	S-413 4/7/2016
VOCs		
1,2,4-Trimethylbenzene	**69.7**	**87.7**
Benzene	**487**	**276**
Naphthalene	27.5	**178**

Chemical Name	S-385 8/26/2013	S-385 12/14/2015
VOCs		
Methyl Tertiary Butyl Ether	**21.8**	8.4

Chemical Name	S-382 8/27/2013	S-382 6/9/2015	S-382 12/16/2015
VOCs			
1,2-Dibromoethane (EDB)	ND	**0.23**	ND
Benzene	1.1	**48800**	**146000**
Toluene	0.25 J	**19800**	**79600**

Chemical Name	S-284 7/15/2010	S-284 8/26/2016	S-284 6/8/2015	S-284 12/23/2015
VOCs				
Benzene	ND	ND	ND	**61.8**

Chemical Name	S-284D 7/23/2010	S-284D 4/7/2011	S-284D 6/29/2011	S-284D 8/17/2012	S-284D 10/31/2012	S-284D 5/25/2012	S-284D 3/28/2013	S-284D 6/9/2015	S-284D 12/23/2015
VOCs									
1,2-Dibromoethane (EDB)	ND	ND	ND	ND	ND	ND	ND	**0.057**	ND
Benzene	ND	ND	ND	ND	ND	ND	ND	**7.9**	**62**

Chemical Name	S-412 12/14/2015	S-412 4/8/2016
VOCs		
Benzene	ND	**76.5**

Chemical Name	S-69D 11/8/2005	S-69D 11/30/2006	S-69D 11/7/2008	S-69D 12/1/2009	S-69D 7/22/2010	S-69D 4/7/2011	S-69D 6/29/2011	S-69D 5/29/2012	S-69D 8/17/2012	S-69D 11/1/2012	S-69D 3/28/2013	S-69D 6/9/2015	S-69D 12/21/2015
VOCs													
1,2-Dibromoethane (EDB)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**0.08**	ND
Benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**5.1**	**338**
Metals Dissolved													
Lead	ND	0.25 J	0.064 J	ND	ND	ND	ND	0.15 J	**10.7**	4.9 B	ND	ND	ND

Chemical Name	S-383 8/27/2013	S-383 6/9/2015	S-383 12/17/2015
VOCs			
1,2-Dibromoethane (EDB)	ND	**0.051**	ND
Benzene	1 J	**12.3**	**651**
SVOCs			
Benzo(a)Pyrene	**1.58**	ND	ND
Benzo(b)Fluoranthene	**2.18**	ND	ND
Chrysene	**6.64**	ND	ND

Chemical Name	BF-107 12/2/2009	BF-107 7/22/2010	BF-107 8/28/2013	BF-107 6/5/2015	BF-107 6/16/2015	BF-107 12/11/2015
VOCs						
Benzo(a)Pyrene	NA	NA	**0.876**	NA	**0.38 J**	ND
Chrysene	ND	ND	**3.98**	NA	ND	ND

Chemical Name	BF-103R 12/1/2007	BF-103R 12/1/2009	BF-103R 7/16/2010	BF-103R 8/27/2013	BF-103R 6/9/2015	BF-103R 12/31/2015
VOCs						
1,2-Dibromoethane (EDB)	ND	ND	ND	ND	**0.086**	ND

Chemical Name	BF-106 12/2/2009	BF-106 7/22/2010	BF-106 8/29/2013	BF-106 6/5/2015	BF-106 6/16/2015	BF-106 6/5/2015
VOCs						
1,2,4-Trimethylbenzene	**220**	**130**	**67.1**	31.2	NA	44.1
Benzene	**250**	**130**	**483**	**162**	NA	**195**
SVOCs						
Benzo(a)Pyrene	NA	NA	ND	NA	**0.72 J**	ND
Benzo(b)Fluoranthene	NA	NA	ND	NA	**1.4 J**	ND
Naphthalene	**110**	37	ND	NA	4.1	ND

Chemical Name	S-386 8/26/2013	S-386 6/10/2015	S-386 12/17/2015
VOCs			
1,2-Dibromoethane (EDB)	ND	**0.18**	ND

Chemical Name	S-285 1/7/2016	S-285 3/9/2016
SVOCs		
Benzo(a)pyrene	**0.82**	0.036
Benzo(g,h,i)perylene	**0.585**	0.022 J
Chrysene	**2.71**	0.13

Chemical Name	BF-108 12/2/2009	BF-108 7/22/2010	BF-108 4/7/2011	BF-108 7/5/2011	BF-108 5/30/2012	BF-108 8/20/2012	BF-108 11/1/2012	BF-108 4/1/2013	BF-108 6/5/2015	BF-108 12/11/2015
VOCs										
Methyl Tertiary Butyl Ether	**100**	**120**	**55**	ND	**110**	**83**	**86.4**	**73.7**	**80.1**	**49.4**
Metals Dissolved										
Lead	ND	ND	ND	**1110**	0.94 J	0.19 J	ND	**7.5**	ND	ND

Chemical Name	S-17 11/30/2009	S-17 7/16/2010	S-17 8/23/2013	S-17 6/10/2015	S-17 12/15/2015
VOCs					
Benzene	**13**	ND	ND	0.63 J	ND

Chemical Name	S-16 11/30/2009	S-16 7/16/2010	S-16 8/22/2013	S-16 6/11/2015
VOCs				
1,2,4-Trimethylbenzene	**430**	**400**	**236**	**259**
1,2-Dibromoethane (EDB)	ND	ND	ND	**0.14**
Benzene	**190**	**220**	**233**	**221**
Methyl Tertiary Butyl Ether	**44**	**40**	**31.2**	**30.3**

Chemical Name	S-387 8/26/2013	S-387 6/15/2015	S-387 12/15/2015
VOCs			
1,2-Dibromoethane (EDB)	ND	**0.086**	ND

Chemical Name	S-288 7/22/2010	S-288 6/5/2015	S-288 6/16/2015	S-288 1/6/2016
VOCs				
Benzene	**280**	**171**	NA	**55**
SVOCs				
Benzo(a)Pyrene	NA	NA	**5**	**3.57**
Benzo(b)Fluoranthene	NA	NA	**6.6**	**2.4**
Benzo(g,h,i)Perylene	NA	NA	**1.9 J**	**1.22**
Chrysene	ND	NA	**11.6**	**7.53**

Chemical Name	S-14 11/30/2009	S-14 7/21/2010	S-14 8/23/2013	S-14 6/15/2015
VOCs				
1,2-Dibromoethane (EDB)	ND	ND	ND	**0.063**
Benzene	**7**	ND	ND	ND

Chemical Name	S-409 12/17/2015	S-409 4/13/2016
VOCs		
Benzene	**7.1**	4.5

Chemical Name	BF-104 12/2/2009	BF-104 7/21/2010	BF-104 8/27/2013	BF-104 6/10/2015	BF-104 12/18/2015
VOCs					
1,2-Dibromoethane (EDB)	ND	ND	ND	**0.063**	ND

Chemical Name	S-13 11/30/2009	S-13 5/24/2012	S-13 8/16/2012	S-13 11/1/2012	S-13 3/29/2013	S-13 6/15/2015
VOCs						
1,2-Dibromoethane (EDB)	ND	ND	ND	ND	ND	**0.051**
Methyl Tertiary Butyl Ether	1	**33**	**42**	**47.4**	**47.6**	**156**
Metals Dissolved						
Lead	2.3	**9.5**	**38.2**	ND	**13.6**	ND

Chemical Name	S-410 1/8/2016	S-410 3/9/2016
VOCs		
Benzene	**11.3**	**10.5**

Chemical Name	S-20 11/30/2009	S-20 7/16/2010	S-20 8/22/2013	S-20 6/11/2015	S-20 12/16/2015
VOCs					
1,2-Dibromoethane (EDB)	ND	ND	ND	**0.074**	ND
Benzene	**9**	ND	1.4	1.8	1.9
Methyl Tertiary Butyl Ether	**98**	**97**	**71.7**	**81.8**	**71.8**

Chemical Name	BF-90D 7/21/2010	BF-90D 4/7/2011	BF-90D 7/5/2011	BF-90D 5/30/2012	BF-90D 8/17/2012	BF-90D 10/26/2012	BF-90D 4/1/2013	BF-90D 6/10/2015	BF-90D 12/18/2015
VOCs									
1,2-Dibromoethane (EDB)	ND	ND	ND	ND	ND	ND	ND	**0.13**	ND
Metals Dissolved									
Lead	ND	2.5	**356**	1.5	**13.8**	**5.9**	**9.9**	ND	ND

Chemical Name	S-22 11/30/2009	S-22 7/16/2010	S-22 4/7/2011	S-22 6/29/2011	S-22 8/21/2012	S-22 11/1/2012	S-22 3/25/2013	S-22 6/11/2015	S-22 12/16/2015
VOCs									
1,2-Dibromoethane (EDB)	ND	ND	ND	ND	ND	ND	ND	**0.08**	ND
Benzene	**33**	**6**	**20**	**28**	**15**	**13.2**	**18.6**	**16.2**	**5.6**
Methyl Tertiary Butyl Ether	**66**	**48**	**75**	**49**	**60**	**72.3**	**67**	**79.1**	**35.7**

Chemical Name	BF-90 12/2/2009	BF-90 12/2/2009	BF-90 7/21/2010	BF-90 8/27/2013	BF-90 6/10/2015	BF-90 12/18/2015
VOCs						
1,2-Dibromoethane (EDB)	ND	ND	ND	ND	**0.091**	ND

Chemical Name	S-12 11/30/2009	S-12 7/21/2010	S-12 8/23/2013	S-12 6/12/2015
VOCs				
1,2-Dibromoethane (EDB)	ND	ND	ND	**0.08**
Benzene	**12**	ND	ND	0.35 J

Chemical Name	S-11 11/25/2009	S-11 7/21/2010	S-11 8/23/2013	S-11 6/12/2015
VOCs				
1,2-Dibromoethane (EDB)	ND	ND	ND	**0.08**
Benzene	**11**	ND	ND	0.67 J

Chemical Name	S-1 11/8/2005	S-1 12/11/2007	S-1 11/4/2008	S-1 11/12/2009	S-1 12/1/2009	S-1 7/21/2010	S-1 11/15/2010	S-1 11/18/2011	S-1 4/4/2013	S-1 8/29/2013	S-1 5/30/2014	S-1 6/15/2015	S-1 6/15/2015
VOCs													
1,2-Dibromoethane (EDB)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**0.097**	ND
Methyl Tert-Butyl Ether	**23**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SVOCs													
Benzo(a)Pyrene	1	NA	NA	NA	NA	NA	NA	NA	**0.258**	ND	0.15	**0.32**	**0.26**
Chrysene	0.5	ND	ND	1.4	ND	ND	0.7	**6.9**	0.242	ND	0.118	0.26	0.24
Metals Dissolved													
Lead	ND	3.5	ND	1.9	3.5	ND	0.1 J	0.24 J	0.52 J	ND	**11.6**	ND	ND

Chemical Name	S-10 11/25/2009	S-10 7/21/2010	S-10 8/22/2013	S-10 6/12/2015
VOCs				
1,2-Dibromoethane (EDB)	ND	ND	ND	**0.08**
Benzene	**26**	ND	ND	0.42 J

Chemical Name	S-23 12/1/2009	S-23 7/7/2010	S-23 8/22/2013	S-23 6/11/2015	S-23 8/22/2013
VOCs					
1,2-Dibromoethane (EDB)	ND	ND	ND	**0.091**	ND
Methyl Tertiary Butyl Ether	**120**	ND	**40.1**	**49.8**	**30.8**

Chemical Name	S-9 11/25/2009	S-9 7/21/2010	S-9 8/22/2013	S-9 6/12/2015	S-9 12/30/2015
VOCs					
1,2-Dibromoethane (EDB)	ND	ND	ND	**0.097**	ND
Benzene	**7**	ND	ND	0.7 J	ND

Chemical Name	S-25 11/12/2009	S-25 11/25/2009	S-25 11/12/2009	S-25 11/25/2009	S-25 11/15/2010	S-25 11/18/2011	S-25 4/3/2013	S-25 8/29/2013	S-25 5/30/2014	S-25 6/11/2015
VOCs										
Methyl Tertiary Butyl Ether	**43**	11	2	ND	12	3	1.2	1.5	0.49	ND
Metals Dissolved										
Lead	ND	ND	ND	ND	0.07 J	ND	0.13 J	ND	**6.2**	ND

Chemical Name	S-8 11/25/2009	S-8 7/21/2010	S-8 4/7/2011	S-8 6/29/2011	S-8 5/24/2012	S-8 8/16/2012	S-8 11/1/2012	S-8 3/29/2013	S-8 6/11/2015	S-8 12/30/2015
VOCs										
1,2-Dibromoethane (EDB)	ND	ND	ND	ND	ND	ND	ND	ND	**0.086**	ND
Benzene	**61**	ND	0.5 J	ND	4	**8**	0.58	2.8	1.1	ND
Methyl Tertiary Butyl Ether	9	1	**30**	8	**36**	**69**	19.5	**27.3**	ND	ND
Metals Dissolved										
Lead	ND	1.1	**2590**	**239**	3.3	**10.5**	**225**	**10.2**	ND	ND

Chemical Name	S-18 11/30/2009	S-18 7/16/2010	S-18 8/22/2013	S-18 6/11/2015	S-18 12/17/2015
VOCs					
1,2-Dibromoethane (EDB)	ND	ND	ND	**0.097**	ND
Benzene	**6**	ND	ND	2.1	ND
SVOCs					
Benzo(a)pyrene	NA	NA	**1.2**	0.17	**4.04**
Benzo(b)fluoranthene	NA	NA	0.6	0.1	**2.7**
Benzo(g,h,i)perylene	NA	NA	**1.2**	0.06 J	**2.91**
Chrysene	ND	ND	**2.29**	0.29	**9.18**
Metals Dissolved					
Lead	ND	2.5 J	ND	ND	**19.5**

Chemical Name	S-2 12/1/2009	S-2 7/21/2010	S-2 6/15/2015	S-2 12/31/2015
VOCs				
1,2-Dibromoethane (EDB)	ND	ND	**0.057**	ND

Chemical Name	S-291 7/7/2010	S-291 8/23/2013	S-291 8/23/2013	S-291 6/11/2015	S-291 12/15/2015
VOCs					
1,2-Dibromoethane (EDB)	ND	ND	ND	**0.086**	ND

Chemical Name	S-3 11/8/2005	S-3 12/11/2007	S-3 11/6/2008	S-3 11/19/2009	S-3 12/1/2009	S-3 7/21/2010	S-3 11/17/2010	S-3 11/21/2011	S-3 4/3/2013	S-3 8/29/2013	S-3 5/30/2014	S-3 6/12/2015
VOCs												
1,2-Dibromoethane (EDB)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**0.063**
Metals Dissolved												
Lead	ND	0.27 J	ND	0.29 J	ND	ND	**10.5**	0.28 J	0.73 J	ND	2.3 J	ND

Groundwater Screening Criteria

Chemical Name	CAS Number	PADEP Non-Residential Used Aquifer TDS <2,500 mg/L Groundwater MSCs (µg/L)
Volatile Organic Compounds		
1,2,4-Trimethylbenzene	95-63-6	62
1,2-Dibromoethane (EDB)	106-93-4	0.05
Benzene	71-43-2	5
Methyl Tertiary Butyl Ether	1634-04-4	20
Toluene	108-88-3	1000
Semi-Volatile Organic Compounds		
Benzo(a)Pyrene	50-32-8	0.2
Benzo(b)Fluoranthene	205-99-2	1.2
Benzo(g,h,i)Perylene	191-24-2	0.26
Chrysene	218-01-9	1.9
Naphthalene	91-20-3	100
Metals Dissolved		
Lead	7439-92-1	5

Legend

- Perched Aquifer Monitoring Well Groundwater Sample with Exceedance between 2015 - 2016
- Unconfined Aquifer Monitoring Well Groundwater Sample with Exceedance between 2015 - 2016
- Lower Aquifer Monitoring Well Groundwater Sample with Exceedance between 2015 - 2016
- Perched Aquifer Monitoring Well Groundwater Sample with No Exceedance between 2015 - 2016
- Unconfined Aquifer Monitoring Well Groundwater Sample with No Exceedance between 2015 - 2016
- Lower Aquifer Monitoring Well Groundwater Sample with No Exceedance between 2015 - 2016
- Well Abandoned/Destroyed/Unable to Locate
- Perched Aquifer Monitoring Well
- Unconfined Aquifer Monitoring Well
- Lower Aquifer Monitoring Well
- Unconfined Aquifer Recovery Well
- ▨ Tank Closed in Place
- ● Tank in Service

LNAPL Types

- 🟧 Mixes of Light/Middle Distillate
- 🟥 Middle Distillate
- 🟪 Heavy Distillate
- ☐ Area of Interest (AOI) Boundary
- **10** Result Exceeds PADEP Non-Residential Used Aquifer MSC TDS<2500 mg/L

Notes:
1. Aerial imagery provided by Nearmap.com as is dated 07/29/15.
2. Area of Interest boundaries referenced from 2011 ALTA/ACSM Land Title Survey, prepared for Sunoco Inc. (R&S).
3. LNAPL presence based on December 2015 groundwater gauging.
4. All groundwater results are displayed in micrograms per liter(µg/L).
5. mg/L = Milligrams per liter.
6. µg/L = Micrograms per liter.
7. ~~~
8. PADEP = Pennsylvania Department of Environmental Protection.
9. CAS Number = Chemical Abstract Service Number.
10. MSCs = Medium Specific Concentration.
11. TDS = Total Dissolved Solids.

Figure I-13:Summary of Groundwater Sample Exceedances
AOI-3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, Pennsylvania

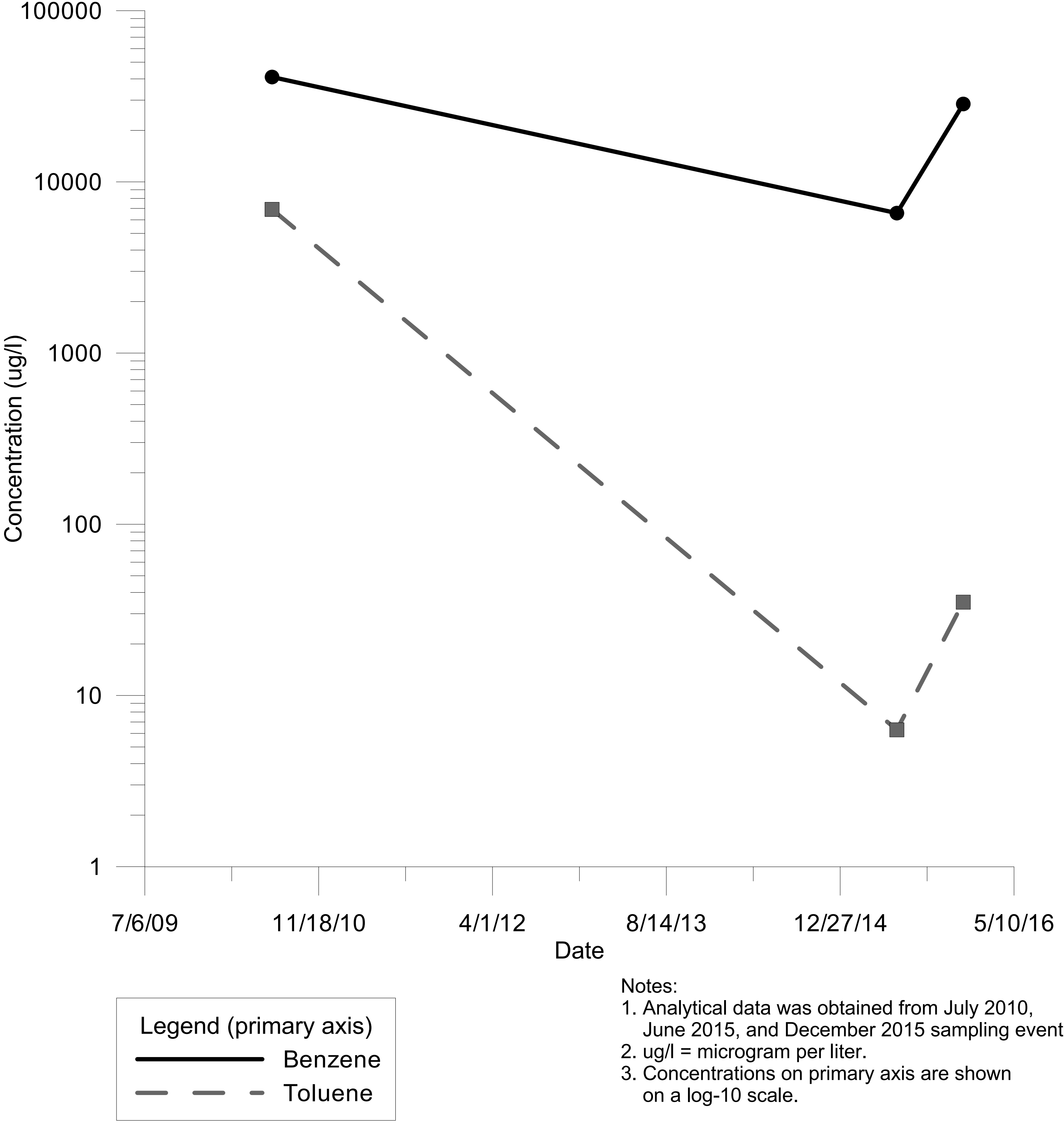
Philadelphia Refinery Operations
A Series of Evergreen Resources Group, LLC.
2 Righter Parkway, Suite 200
Wilmington, DE 19803

0 75 150 300 Feet

SCALE: 1" = 150'
DATE: February 17, 2017
DRN. BY: MMK
CKD. BY: ED
JOB#: 2574602

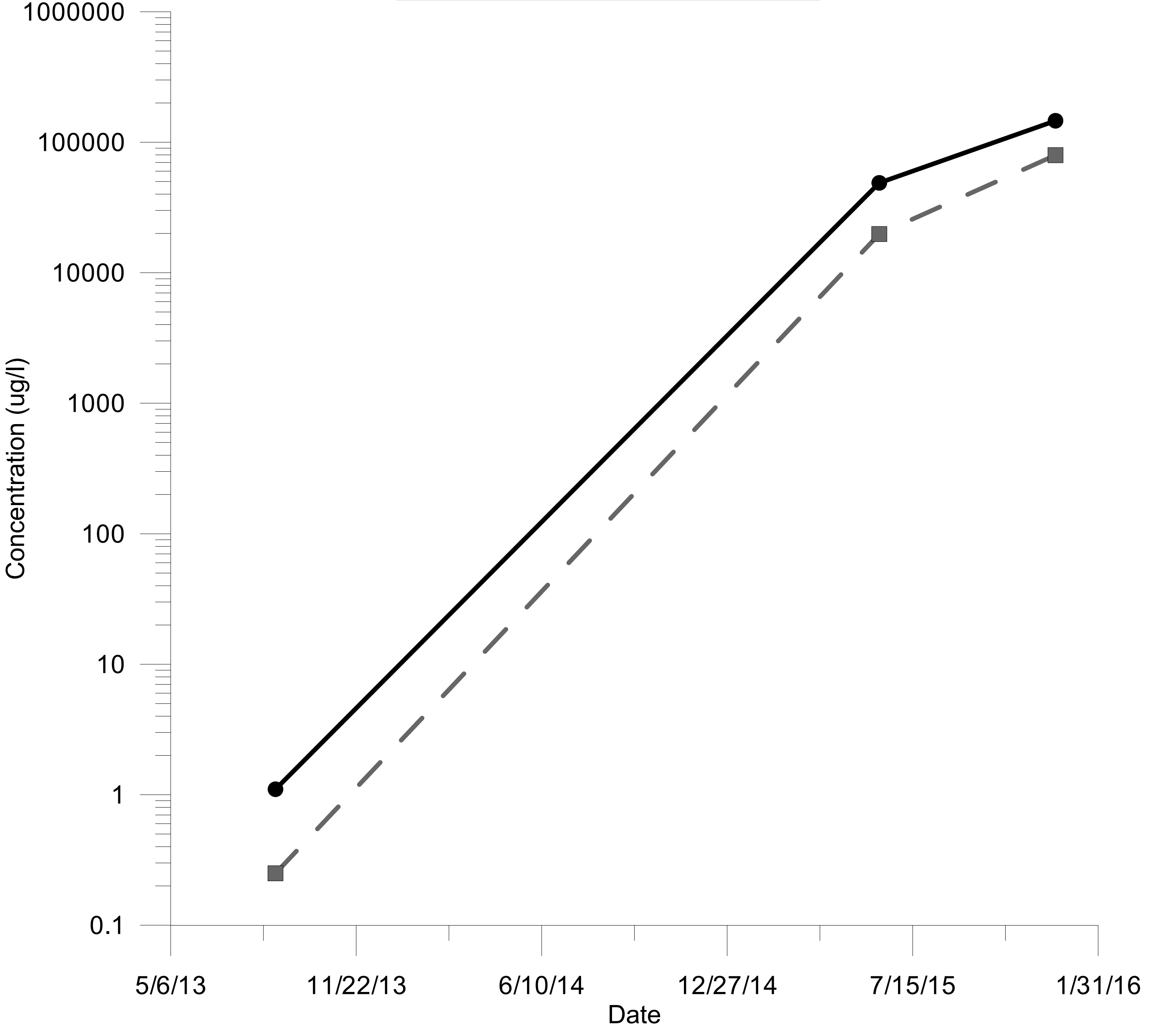
Document Path: \\Langan.com\data\DYL\data6\2574601\ArcGIS\MapDocuments\AOI 3 RIR 2016\Fate and Transport\Figure I-13 - Locations of Interpreted Groundwater Impact Source Areas.mxd

Figure I-14
Northern Plume Source Area
COC Concentration Trends at S-280
AOI 3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, PA



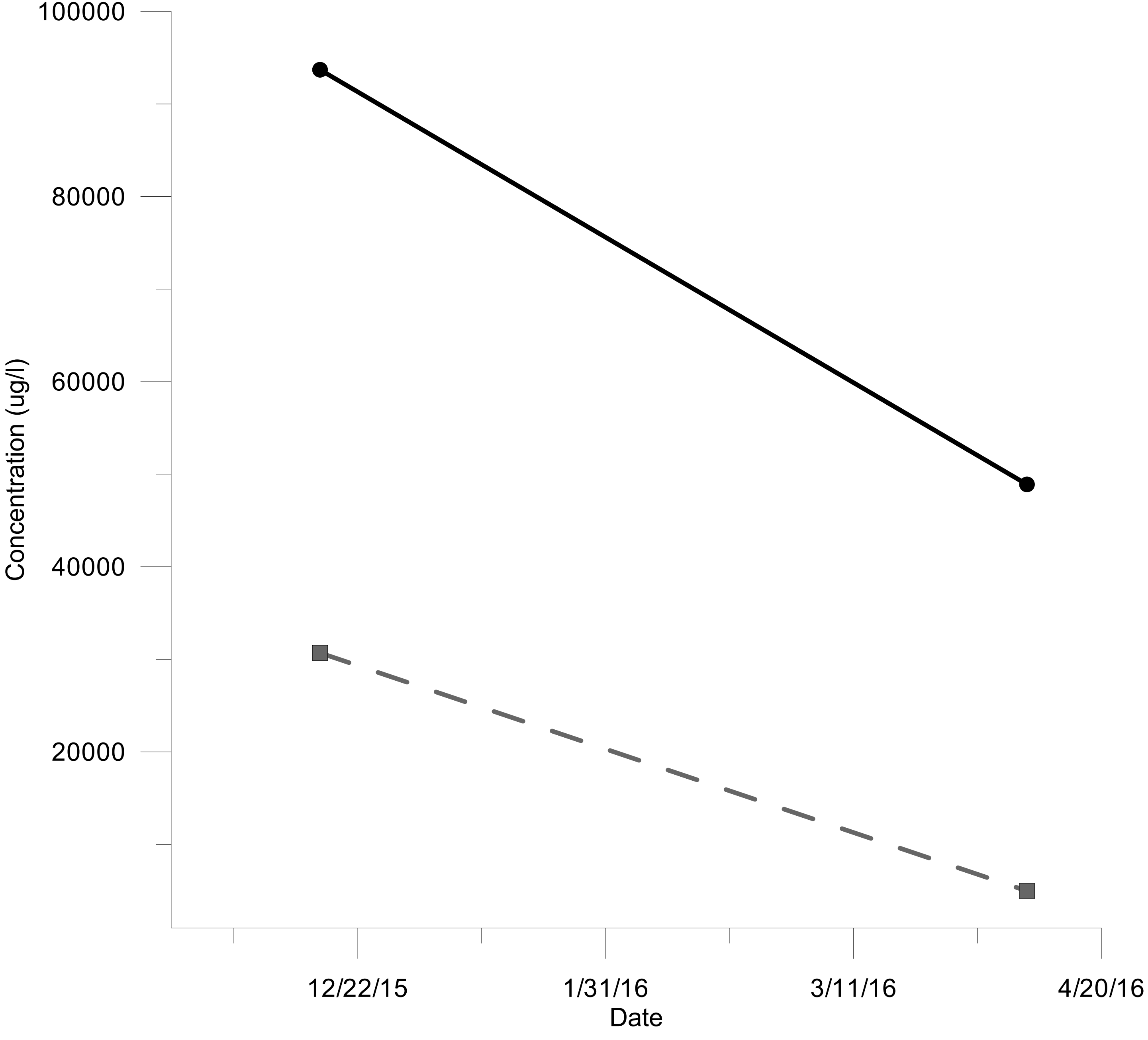
Notes:
1. Analytical data was obtained from July 2010, June 2015, and December 2015 sampling events.
2. ug/l = microgram per liter.
3. Concentrations on primary axis are shown on a log-10 scale.

Figure I-15
Northern Plume Source Area
COC Concentration Trends at S-382
AOI 3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, PA



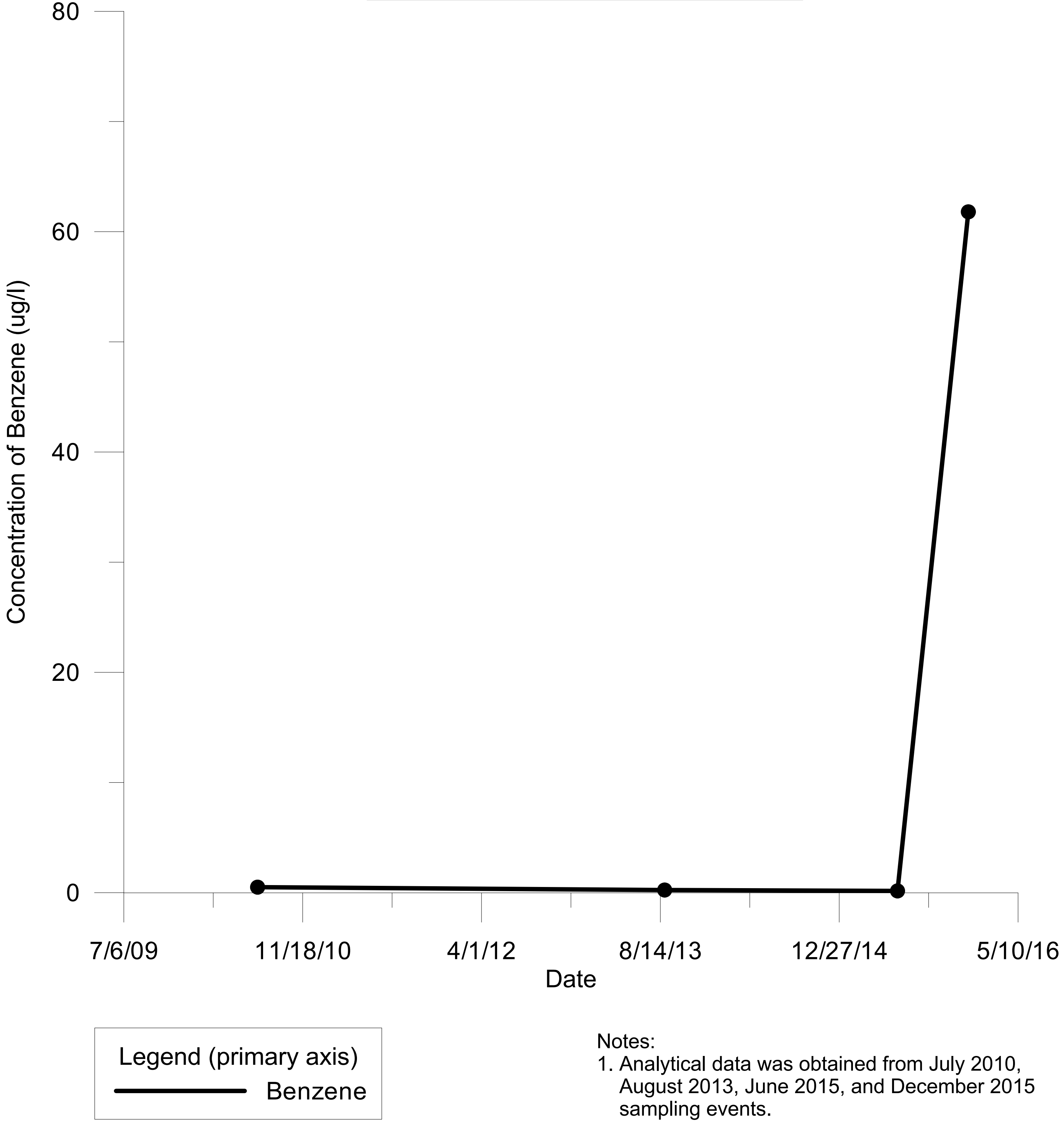
Notes:
1. Analytical data was obtained from August 2013, June 2015, and December 2015 sampling events.
2. ug/l = microgram per liter.
3. Concentrations on primary axis are shown on a log-10 scale.

Figure I-16
Northern Plume Source Area
COC Concentration Trends at S-414
AOI 3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, PA



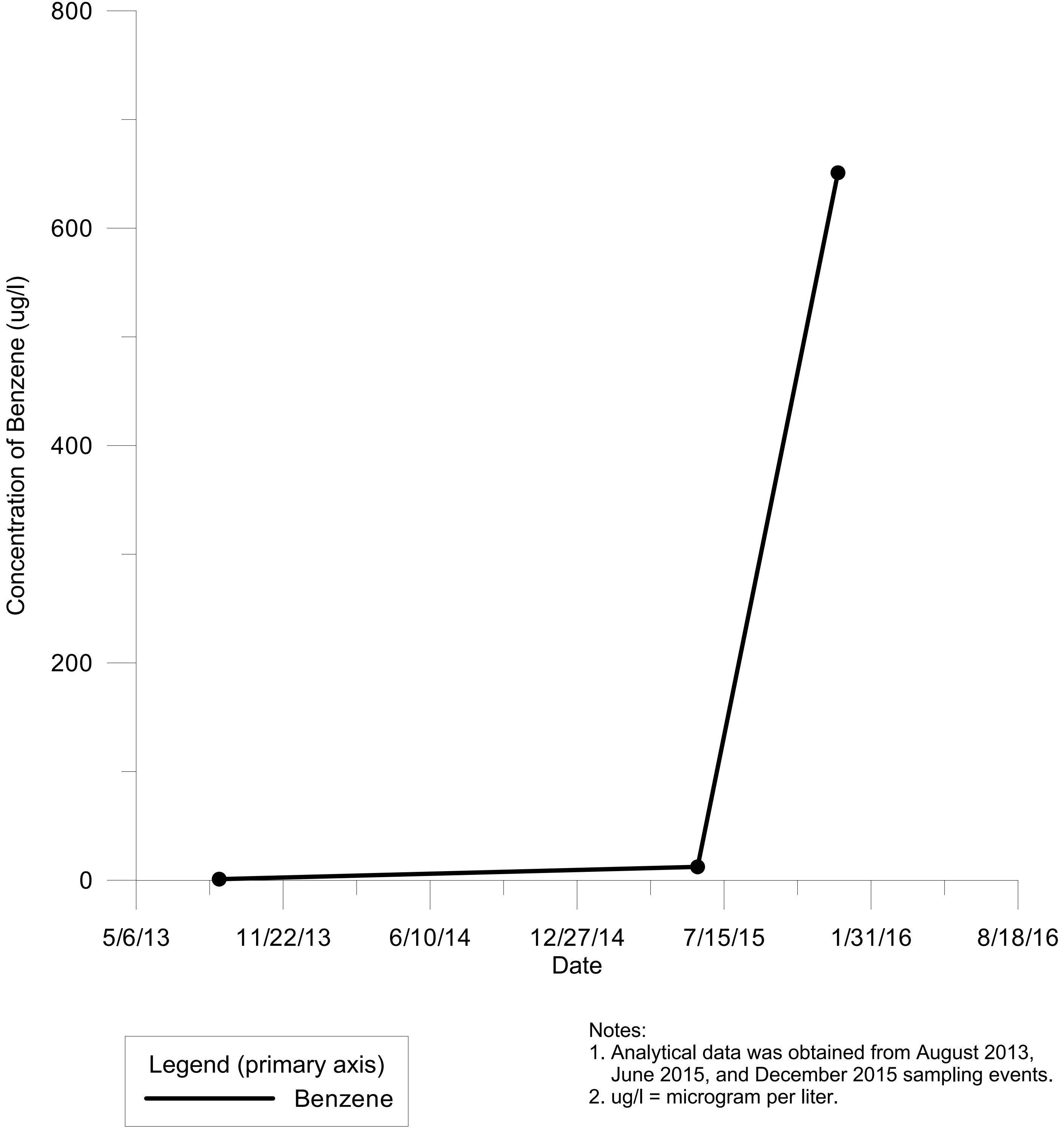
Notes:
1. Analytical data was obtained from December 2015 and April 2016 sampling events.
2. ug/l = microgram per liter.

Figure I-17
Northern Plume
Benzene Concentration Trend at S-284
AOI 3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, PA



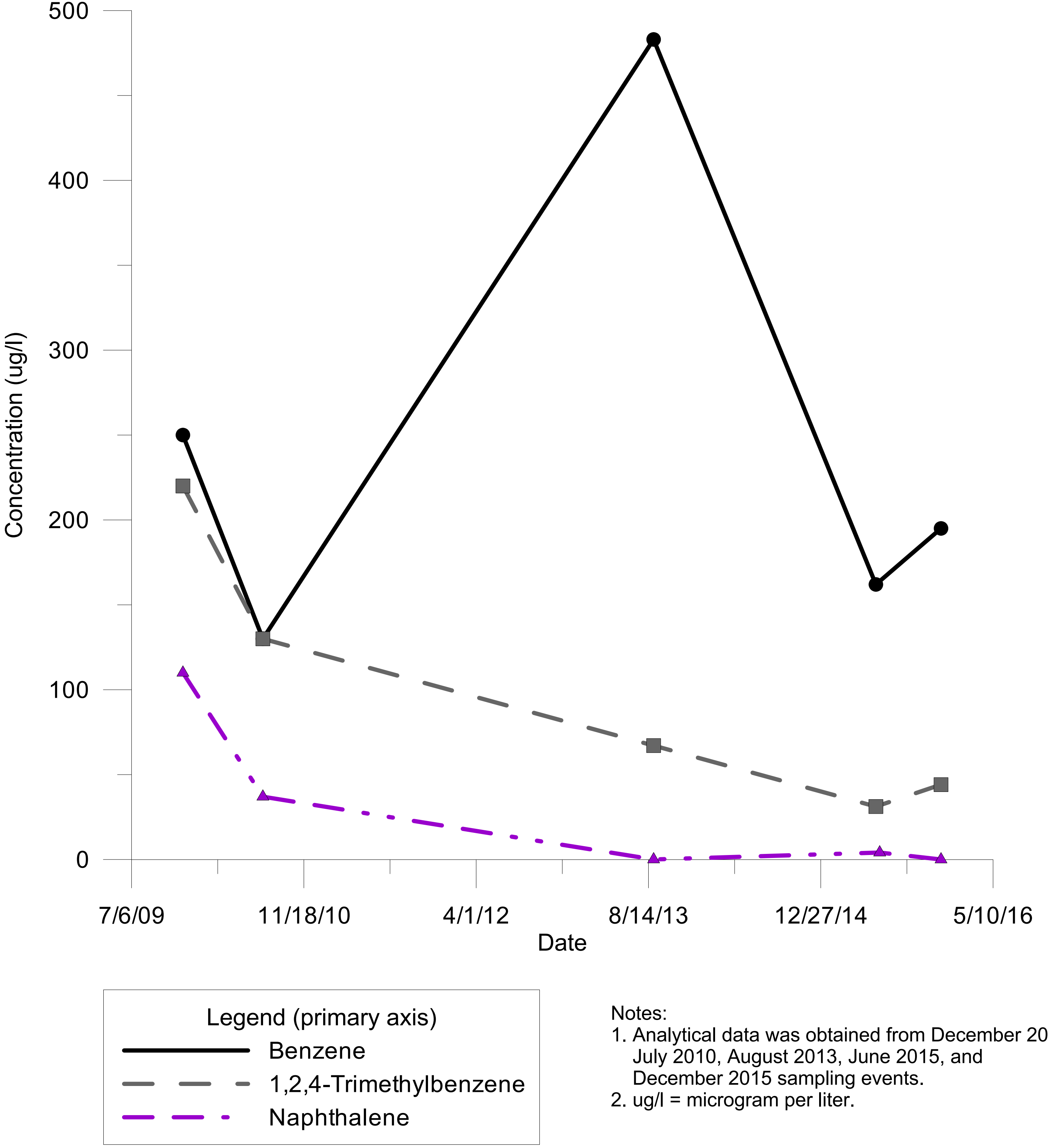
Notes:
1. Analytical data was obtained from July 2010, August 2013, June 2015, and December 2015 sampling events.
2. ug/l = microgram per liter.

Figure I-18
Northern Plume
Benzene Concentration Trend at S-383
AOI 3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, PA



Notes:
1. Analytical data was obtained from August 2013, June 2015, and December 2015 sampling events.
2. ug/l = microgram per liter.

Figure I-19
Northern Plume
COC Concentration Trends at BF-106
AOI 3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, PA



Notes:
1. Analytical data was obtained from December 2009, July 2010, August 2013, June 2015, and December 2015 sampling events.
2. ug/l = microgram per liter.

Legend

S-288 280 ⊕ Benzene Groundwater Results (July 2010) (µg/L)
⊕ Well Abandoned/Destroyed/Unable to Locate
⊕ Perched Aquifer Monitoring Well
⊕ Unconfined Aquifer Monitoring Well
⊕ Lower Aquifer Monitoring Well
⊕ Unconfined Aquifer Recovery Well

—100— Benzene Iso-Contours (µg/L)
··100·· Inferred Benzene Iso-Contours (µg/L)
—4— Perched Aquifer Groundwater Contours (ft. amsl)
---4--- Inferred Perched Aquifer Groundwater Contours (ft. amsl)

LNAPL Types

🟧 Mixes of Light/Middle Distillate
🟥 Middle Distillate
🟪 Heavy Distillate
🟨 AOI Boundary

Notes:

1. Aerial imagery provided by Nearmap.com, dated 7/29/2015.
2. Area of Interest boundaries referenced from 2011 ALTA/ACSM Land Title Survey, prepared for Sunoco Inc. (R&S).
3. Groundwater sampling completed in July 2010, by Aquaterra.
4. Groundwater contours were generated from the July 2010 gauging event.
5. All benzene concentrations are in micrograms per liter (µg/L).
6. LNAPL presence based on December 2015 groundwater gauging.
7. ND = Non-detect
8. ft amsl = Feet above mean sea level
9. Monitoring wells installed after July 2010 are not displayed on this figure.

Figure I-20: Perched Aquifer Benzene Concentrations July 2010
AOI-3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, Pennsylvania

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0 75 150 300 Feet

SCALE: 1" = 150'
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CKD. BY: ED
JOB#: 2574602

Path: \\langan.com\data\DYL\data6\2574601\ArcGIS\MapDocuments\AOI 3 RIR 2016\Fate and Transport\Figure I-20 - Perched Aquifer Benzene Concentrations July 2010_071417.mxd Date: 3/15/2017 User: acostello Time: 11:39:16 AM

Legend

S-288
55 ⊕ Benzene Groundwater Results (December 2015 and January 2016) (µg/L)

Well Abandoned/Destroyed/Unable to Locate

Perched Aquifer Monitoring Well

Unconfined Aquifer Monitoring Well

Lower Aquifer Monitoring Well

Unconfined Aquifer Recovery Well

10 Benzene Iso-Contours (µg/L)

10 Inferred Benzene Iso-Contours (µg/L)

2 Perched Aquifer Groundwater Contours (ft. amsl)

2 Inferred Perched Aquifer Groundwater Contours (ft. amsl)

LNAPL Types

🟧 Mixes of Light/Middle Distillate

🟥 Middle Distillate

🟪 Heavy Distillate

🟨 AOI Boundary

Notes:

1. Aerial imagery provided by Nearmap.com, dated 7/29/2015.
2. Area of Interest boundaries referenced from 2011 ALTA/ ACSM Land Title Survey, prepared for Sunoco Inc. (R&S).
3. Groundwater sampling completed in December 2015 and January 2016, by Aquaterra.
4. Groundwater contours were generated from the December 2015 gauging event.
5. All benzene concentrations are in micrograms per liter (µg/L).
6. LNAPL presence based on December 2015 groundwater gauging.
7. Sub-LNAPL groundwater samples were collected from S-5, S-60, S-113, S-285, and S-410 in January 2016 by Aquaterra.
8. ND = Non-detect
9. ft. amsl = Feet above mean sea level

Figure I-21: Perched Aquifer Benzene Concentrations December 2015 and January 2016
AOI-3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, Pennsylvania

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Wilmington, DE 19803

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CKD. BY: ED
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Path: \\langan.com\data\DYL\data6\2574601\ArcGIS\MapDocuments\AOI 3 RIR 2016\Fate and Transport\Figure I-21 - Perched Aquifer Benzene Concentrations Dec2015_Jan2016_071417.mxd Date: 3/15/2017 User: acostello Time: 11:30:13 AM

Legend

S-16
220 ⊕ Benzene Groundwater Results (July 2010) (µg/L)

⊕ Well Abandoned/Destroyed/Unable to Locate

⊕ Perched Aquifer Monitoring Well

⊕ Unconfined Aquifer Monitoring Well

⊕ Lower Aquifer Monitoring Well

⊕ Unconfined Aquifer Recovery Well

—100— Benzene Iso-Contours (µg/L)

··100·· Inferred Benzene Iso-Contours (µg/L)

—2— Unconfined Aquifer Groundwater Contours (ft. amsl)

---2--- Inferred Unconfined Aquifer Groundwater Contours (ft. amsl)

LNAPL Types

🟧 Mixes of Light/Middle Distillate

🟥 Middle Distillate

🟪 Heavy Distillate

🟨 AOI Boundary

Notes:
1. Aerial imagery provided by Nearmap.com, dated 7/29/2015.
2. Area of Interest boundaries referenced from 2011 ALTA/ACSM Land Title Survey, prepared for Sunoco Inc. (R&S).
3. Groundwater sampling completed in July 2010, by Aquaterra.
4. Groundwater contours were generated from the July 2010 gauging event.
5. All benzene concentrations are in micrograms per liter (µg/L).
6. LNAPL presence based on December 2015 groundwater gauging.
7. ND = Non-detect
8. ft amsl = Feet above mean sea level
9. Monitoring wells installed after July 2010 are not displayed on this figure.

Figure I-22: Unconfined Aquifer Benzene Concentrations July 2010
AOI-3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, Pennsylvania

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0 75 150 300 Feet

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Legend

S-16 ⌖ 278	Benzene Groundwater Results (December 2015 and January 2016) (µg/L)
⌖	Well Abandoned/Destroyed/Unable to Locate
⌖	Perched Aquifer Monitoring Well
⌖	Unconfined Aquifer Monitoring Well
⌖	Lower Aquifer Monitoring Well
⌖	Unconfined Aquifer Recovery Well
—100—	Benzene Iso-Contours (µg/L)
···100·	Inferred Benzene Iso-Contours (µg/L)
—2—	Unconfined Aquifer Groundwater Contours (ft amsl)
---2---	Inferred Unconfined Aquifer Groundwater Contours (ft amsl)

LNAPL Types

🟧	Mixes of Light/Middle Distillate
🟥	Middle Distillate
🟪	Heavy Distillate
🟨	AOI Boundary

Notes:
1. Aerial imagery provided by Nearmap.com, dated 7/29/2015.
2. Area of Interest boundaries referenced from 2011 ALTA/ACSM Land Title Survey, prepared for Sunoco Inc. (R&S).
3. Groundwater sampling completed in December 2015 and January 2016, by Aquaterra.
4. Groundwater contours were generated from the December 2015 gauging event.
5. All benzene concentrations are in micrograms per liter (µg/L).
6. LNAPL presence based on December 2015 groundwater gauging.
7. Sub-LNAPL groundwater samples were collected from S-5, S-60, S-113, S-285, and S-410 in January 2016 by Aquaterra.
8. ND = Non-detect
9. ft. amsl = Feet above mean sea level

Figure I-23: Unconfined Aquifer Benzene Concentrations December 2015 and January 2016
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PES Philadelphia Refining Complex
Philadelphia, Pennsylvania

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Legend

S-20 97 ⊕ MTBE Groundwater Results (July 2010) (µg/L)

⊕ Well Abandoned/Destroyed/Unable to Locate

⊕ Perched Aquifer Monitoring Well

⊕ Unconfined Aquifer Monitoring Well

⊕ Lower Aquifer Monitoring Well

⊕ Unconfined Aquifer Recovery Well

—60— MTBE Iso-Contours (µg/L)

···60··· Inferred MTBE Iso-Contours (µg/L)

—2— Unconfined Aquifer Groundwater Contours (ft amsl)

- - -2- - - Inferred Unconfined Aquifer Groundwater Contours (ft. amsl)

LNAPL Types

🟧 Mixes of Light/Middle Distillate

🟥 Middle Distillate

🟪 Heavy Distillate

🟨 AOI Boundary

Notes:
1. Aerial imagery provided by Nearmap.com, dated 7/29/2015.
2. Area of Interest boundaries referenced from 2011 ALTA/ACSM Land Title Survey, prepared for Sunoco Inc. (R&S).
3. Groundwater sampling completed in July 2010, by Aquaterra.
4. Groundwater contours were generated from the July 2010 gauging event.
5. All MTBE concentrations are in micrograms per liter (µg/L).
6. LNAPL presence based on December 2015 groundwater gauging.
7. ND = Non-detect.
8. ft amsl = Feet above mean sea level.
9. MTBE = Methyl tert-butyl ether.
10. Monitoring wells installed after July 2010 are not displayed on this figure.

Figure I-24: Unconfined Aquifer MTBE Concentrations July 2010
AOI-3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, Pennsylvania

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2 Righter Parkway, Suite 200
Wilmington, DE 19803

0 75 150 300 Feet

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Path: \\langan.com\data\DYL\data6\2574601\ArcGIS\MapDocuments\AOI 3 RIR 2016\Fate and Transport\Figure I-24 - Unconfined Aquifer MTBE Concentrations July 2010_021517.mxd Date: 3/15/2017 User: acostello Time: 11:29:50 AM

Legend

S-23 30.8 ⊕	MTBE Groundwater Results (December 2015 and January 2016) (µg/L)
⊕	Well Abandoned/Destroyed/Unable to
⊕	Perched Aquifer Monitoring Well
⊕	Unconfined Aquifer Monitoring Well
⊕	Lower Aquifer Monitoring Well
⊞	Unconfined Aquifer Recovery Well
—60—	Inferred MTBE Iso-Contours (µg/L)
···60···	MTBE Iso-Contours (µg/L)
—2—	Unconfined Aquifer Groundwater Contours (ft
---2---	Inferred Unconfined Aquifer Groundwater Contours (ft

LNAPL Types

🟧	Mixes of Light/Middle Distillate
🟥	Middle Distillate
🟪	Heavy Distillate
☐	AOI Boundary

Notes:
1. Aerial imagery provided by Nearmap.com, dated 7/29/2015.
2. Area of Interest boundaries referenced from 2011 ALTA/ACSM Land Title Survey, prepared for Sunoco Inc. (R&S).
3. Groundwater sampling completed in December 2015 and January 2016, by Aquaterra.
4. Groundwater contours were generated from the December 2015 gauging event.
5. MTBE concentrations are in micrograms per liter (µg/L).
6. LNAPL presence based on December 2015 groundwater gauging.
7. Sub-LNAPL groundwater samples were collected from S-5, S-60, S-113, S-285, and S-410 in January 2016 by Aquaterra.
8. ND = Non-detect
9. ft. amsl = Feet above mean sea level
10. MTBE = Methyl tert-butyl ether

Figure I-25: Unconfined Aquifer MTBE Concentrations
December 2015 and January 2016
AOI-3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, Pennsylvania

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0 75 150 300 Feet

SCALE: 1" = 150'
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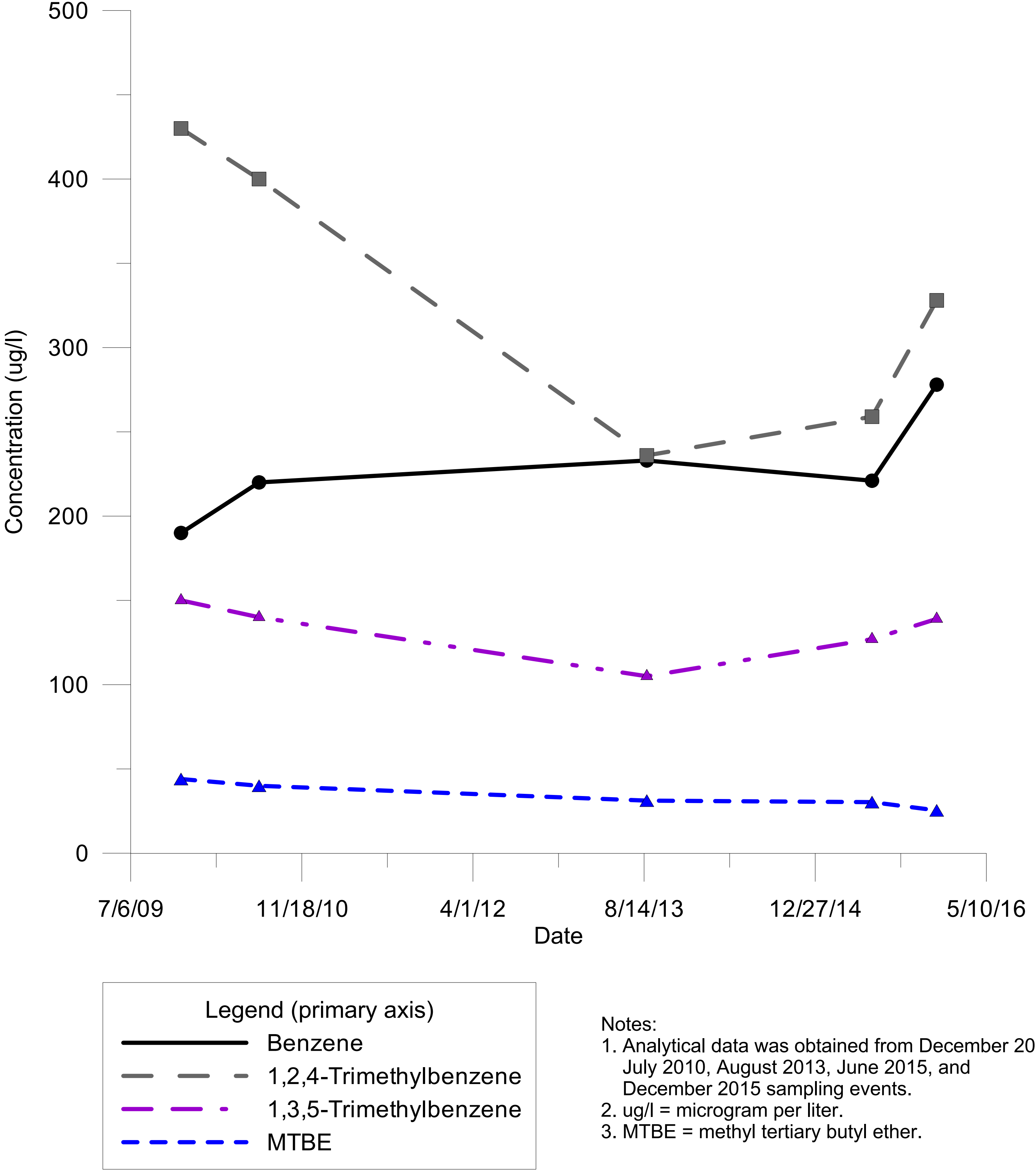
JOB#: 2574602

Path: \\langan.com\data\DYL\data6\2574601\ArcGIS\MapDocuments\AOI 3 RIR 2016\Fate and Transport\Figure I-25 - Unconfined Aquifer MTBE Concentrations Dec2015_Jan2016_021517.mxd Date: 3/15/2017 User: acostello Time: 11:38:44 AM

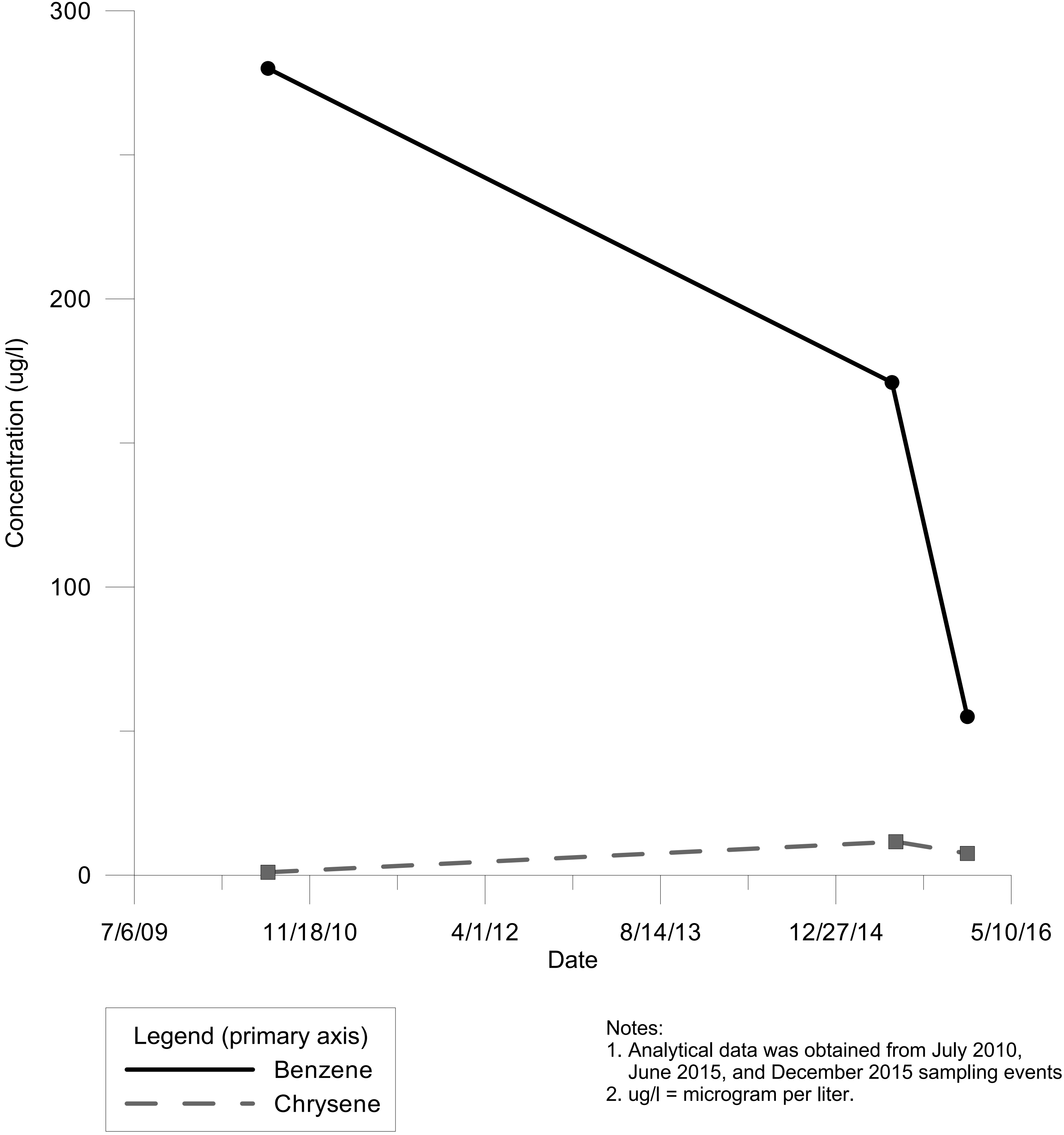
Figure I-26
Southern Plumes
COC Concentration Trends at S-16
AOI 3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, PA



Notes:

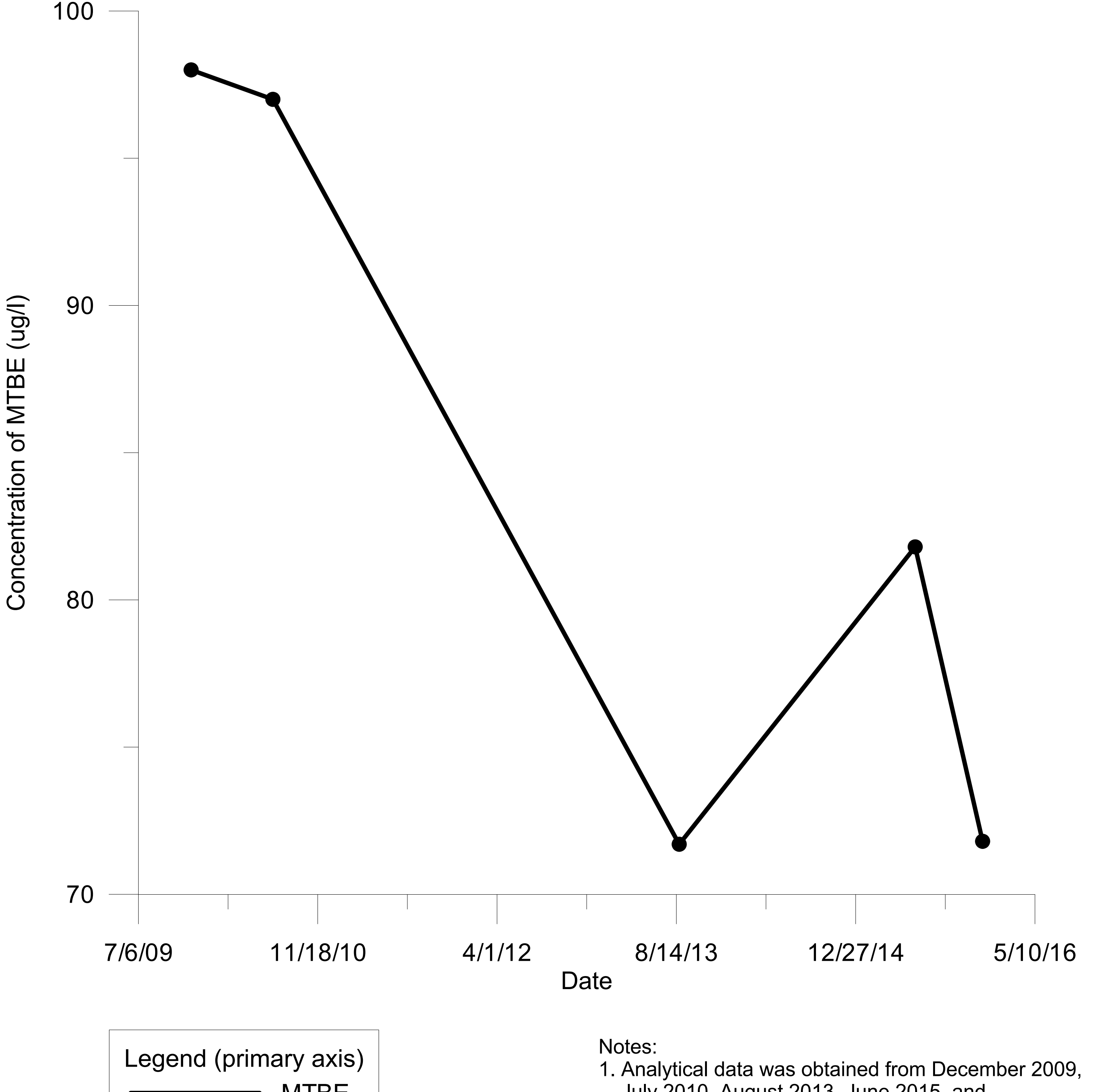
1. Analytical data was obtained from December 2009, July 2010, August 2013, June 2015, and December 2015 sampling events.
2. ug/l = microgram per liter.
3. MTBE = methyl tertiary butyl ether.

Figure I-27
Southern Plumes
COC Concentration Trends at S-288
AOI 3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, PA



Notes:
1. Analytical data was obtained from July 2010,
June 2015, and December 2015 sampling events.
2. ug/l = microgram per liter.

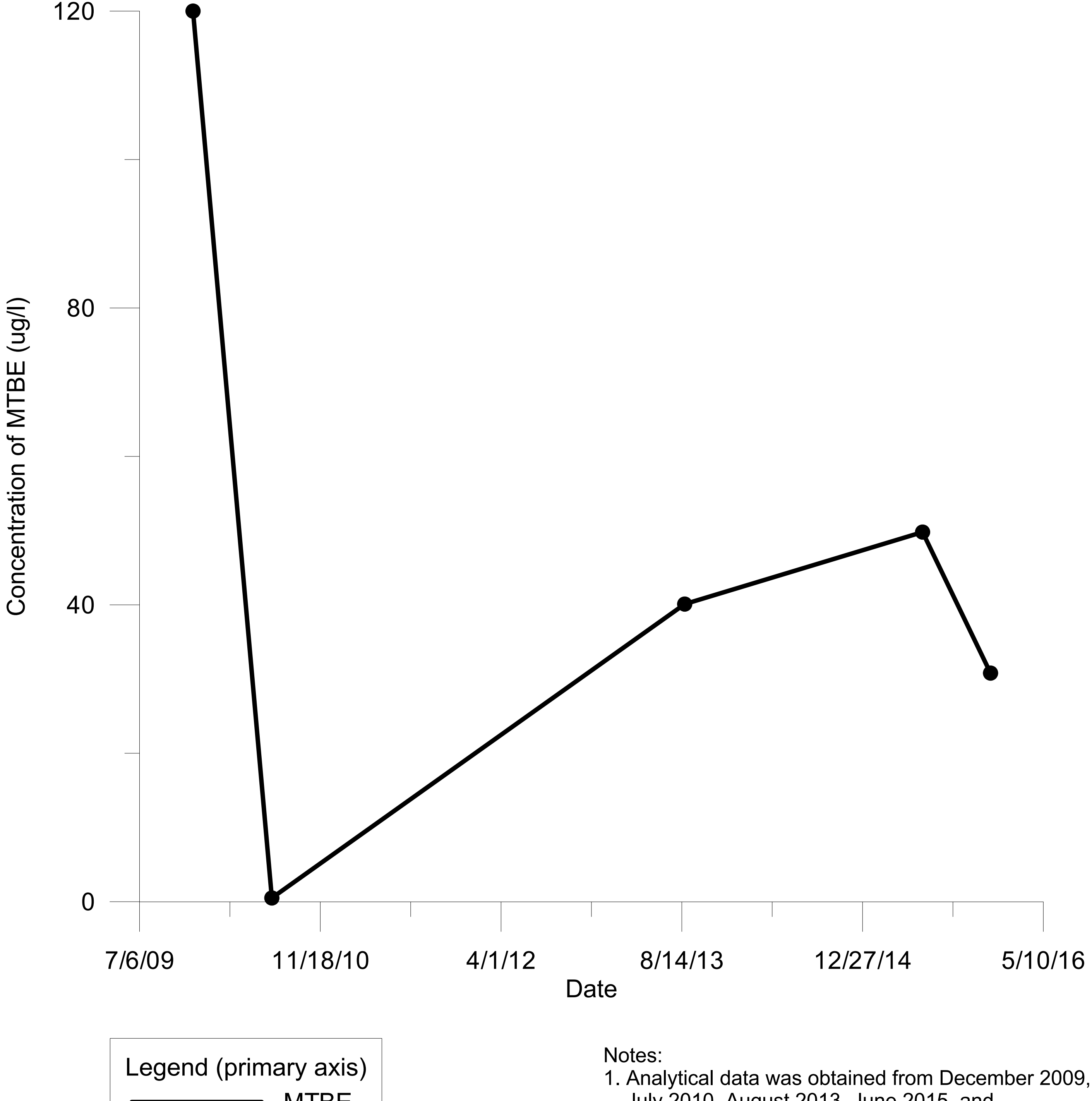
Figure I-28
Southern Plumes
MTBE Concentration Trend at S-20
AOI 3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, PA



Notes:

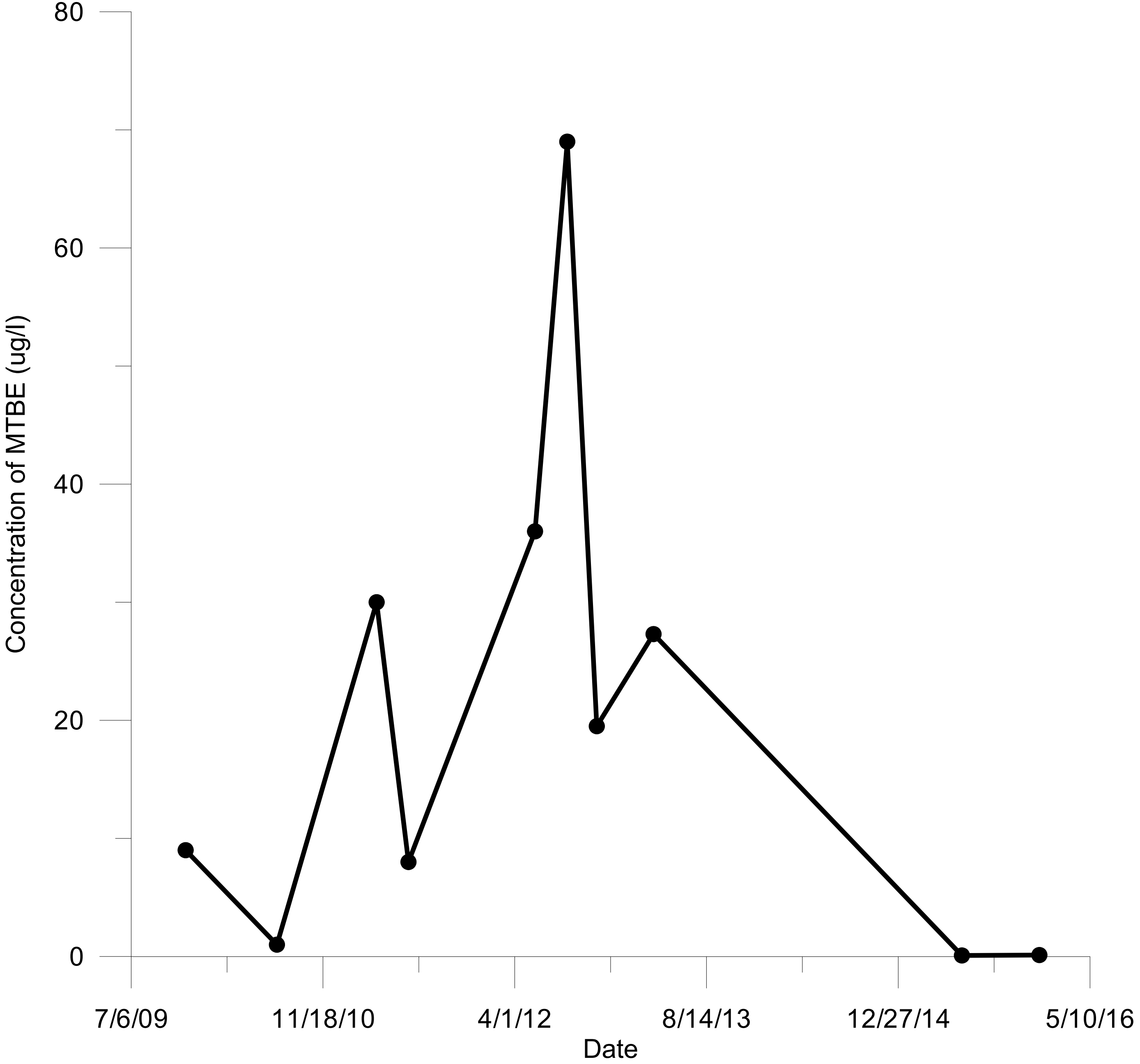
1. Analytical data was obtained from December 2009, July 2010, August 2013, June 2015, and December 2015 sampling events.
2. ug/l = microgram per liter.
3. MTBE = methyl tertiary butyl ether.

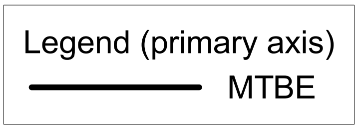
Figure I-29
Southern Plumes
MTBE Concentration Trend at S-23
AOI 3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, PA



Notes:
1. Analytical data was obtained from December 2009, July 2010, August 2013, June 2015, and December 2015 sampling events.
2. ug/l = microgram per liter.
3. MTBE = methyl tertiary butyl ether.

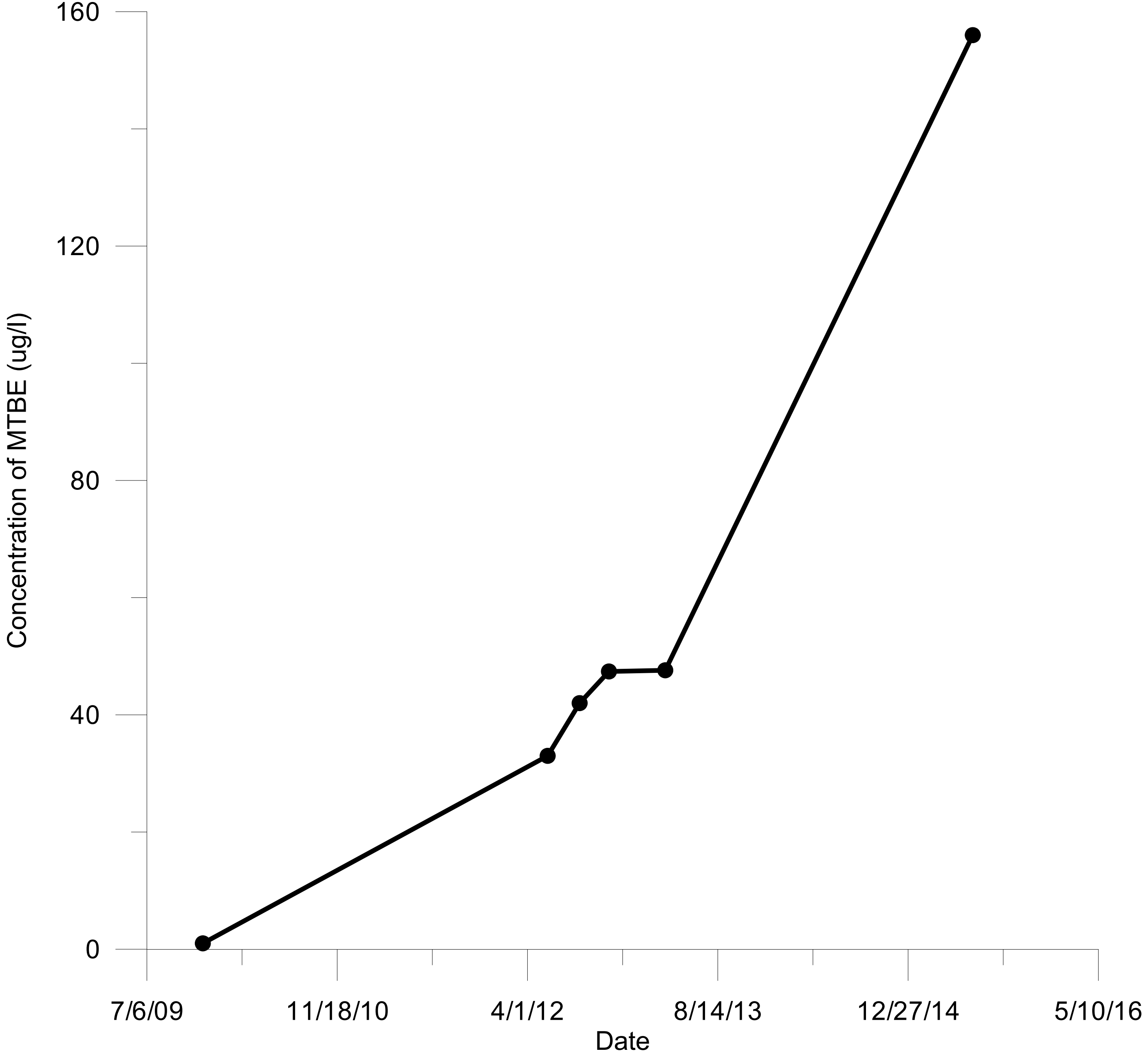
Figure I-30
Lower Aquifer COC Trends
MTBE Concentration Trend at S-8
AOI 3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, PA

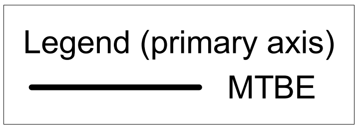




Notes:
1. Analytical data was obtained from December 2009 thru December 2015.
2. ug/l = microgram per liter.
3. MTBE = methyl tertiary butyl ether.

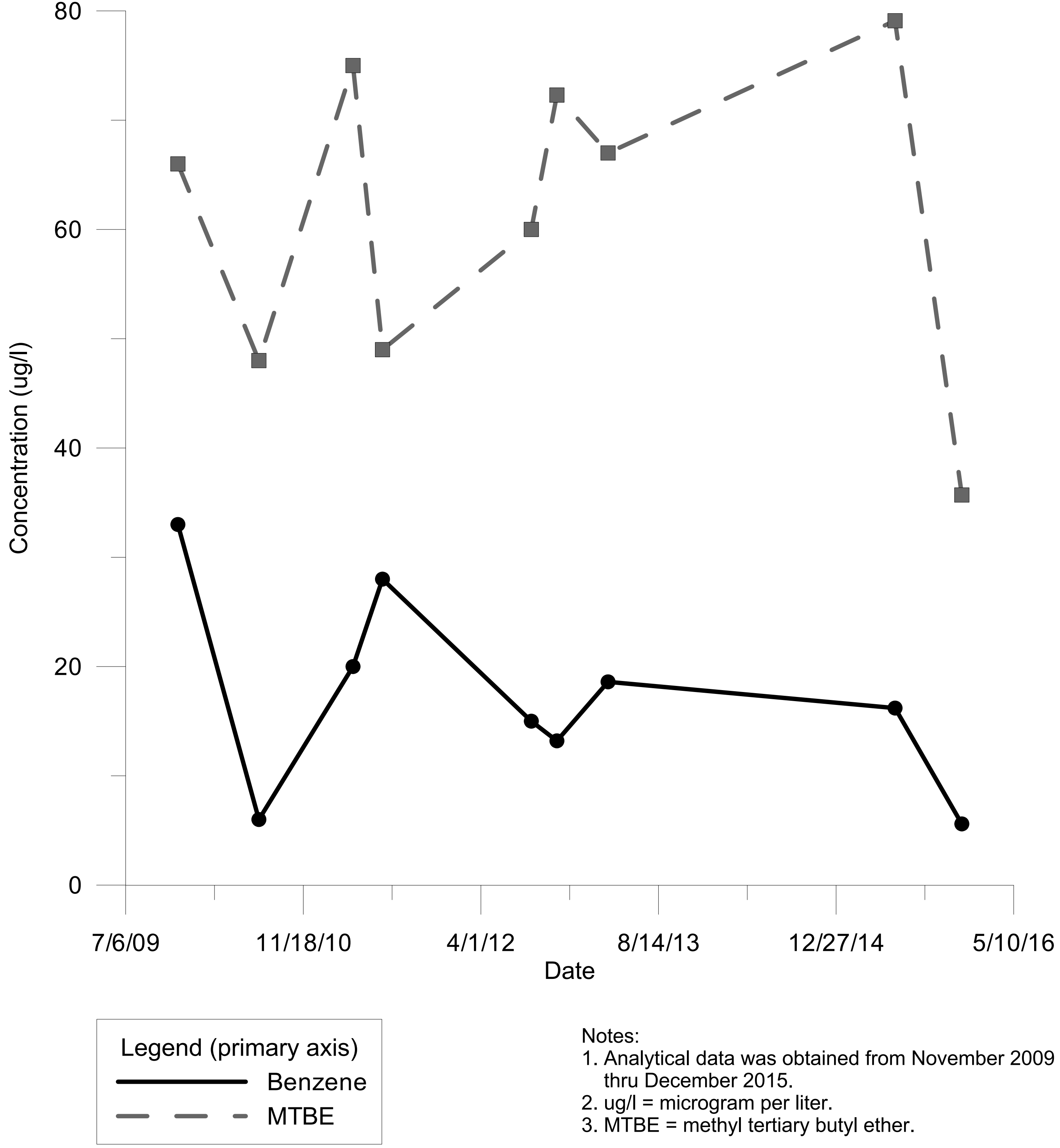
Figure I-31
Lower Aquifer COC Trends
MTBE Concentration Trend at S-13
AOI 3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, PA





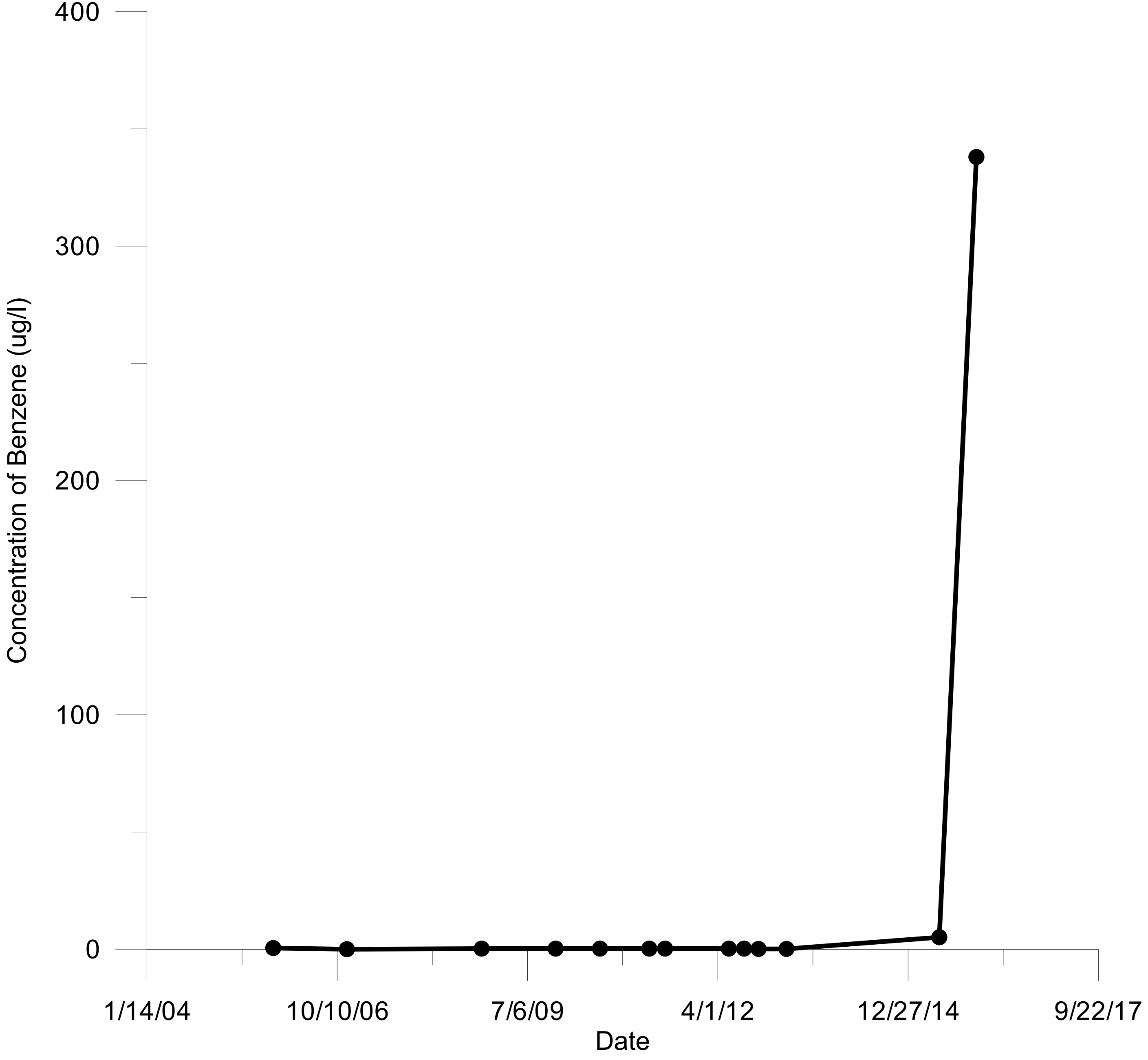
Notes:
1. Analytical data was obtained from November 2009 thru June 2015.
2. ug/l = microgram per liter.
3. MTBE = methyl tertiary butyl ether.

Figure I-32
Lower Aquifer COC Trends
COC Concentration Trend at S-22
AOI 3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, PA



Notes:
1. Analytical data was obtained from November 2009 thru December 2015.
2. ug/l = microgram per liter.
3. MTBE = methyl tertiary butyl ether.

Figure I-33
Lower Aquifer COC Trends
Benzene Concentration Trend at S-69D
AOI 3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, PA

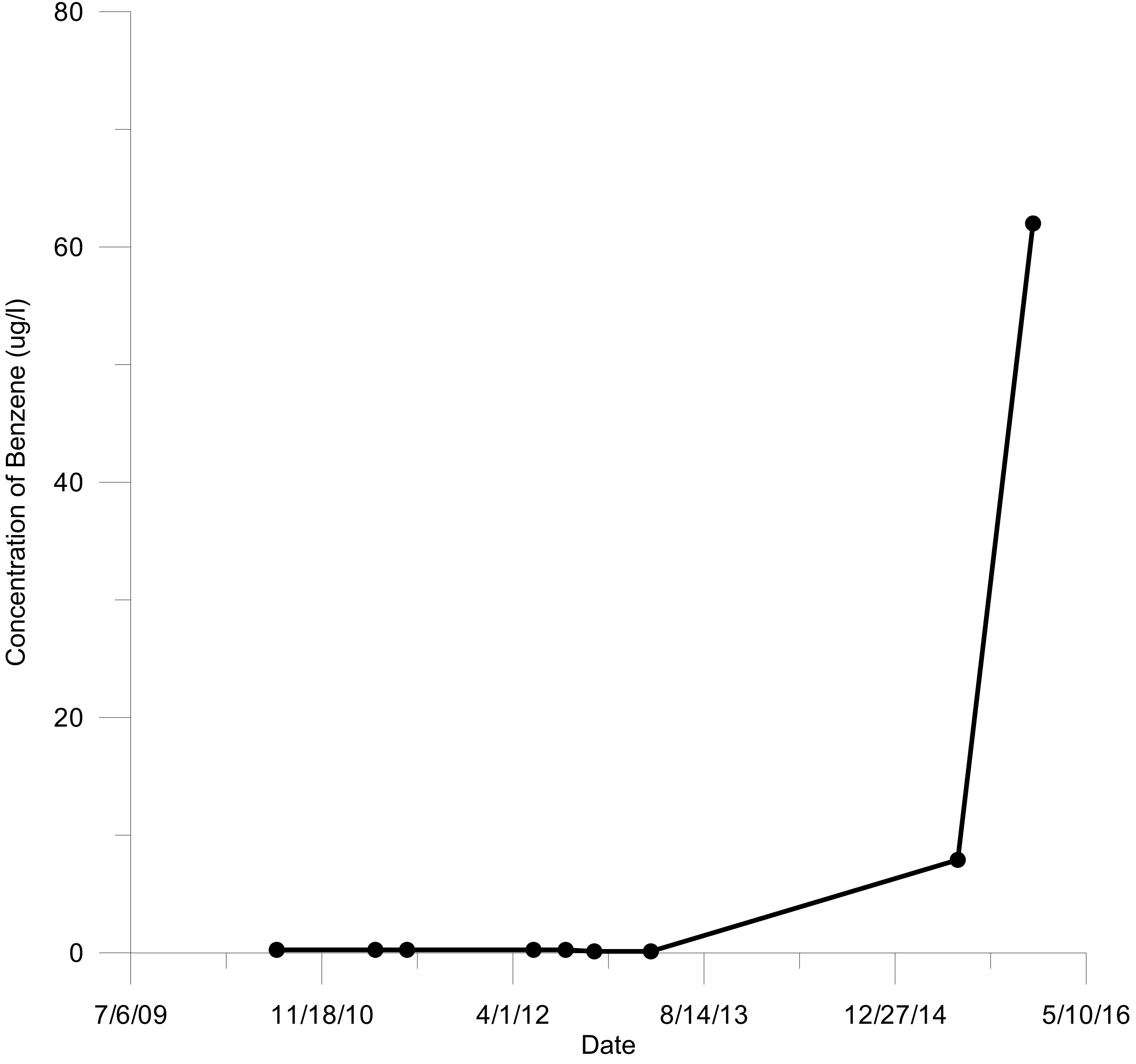


Legend (primary axis)
Benzene

Notes:
1. Analytical data was obtained from November 2005 thru December 2015.
2. ug/l = microgram per liter.

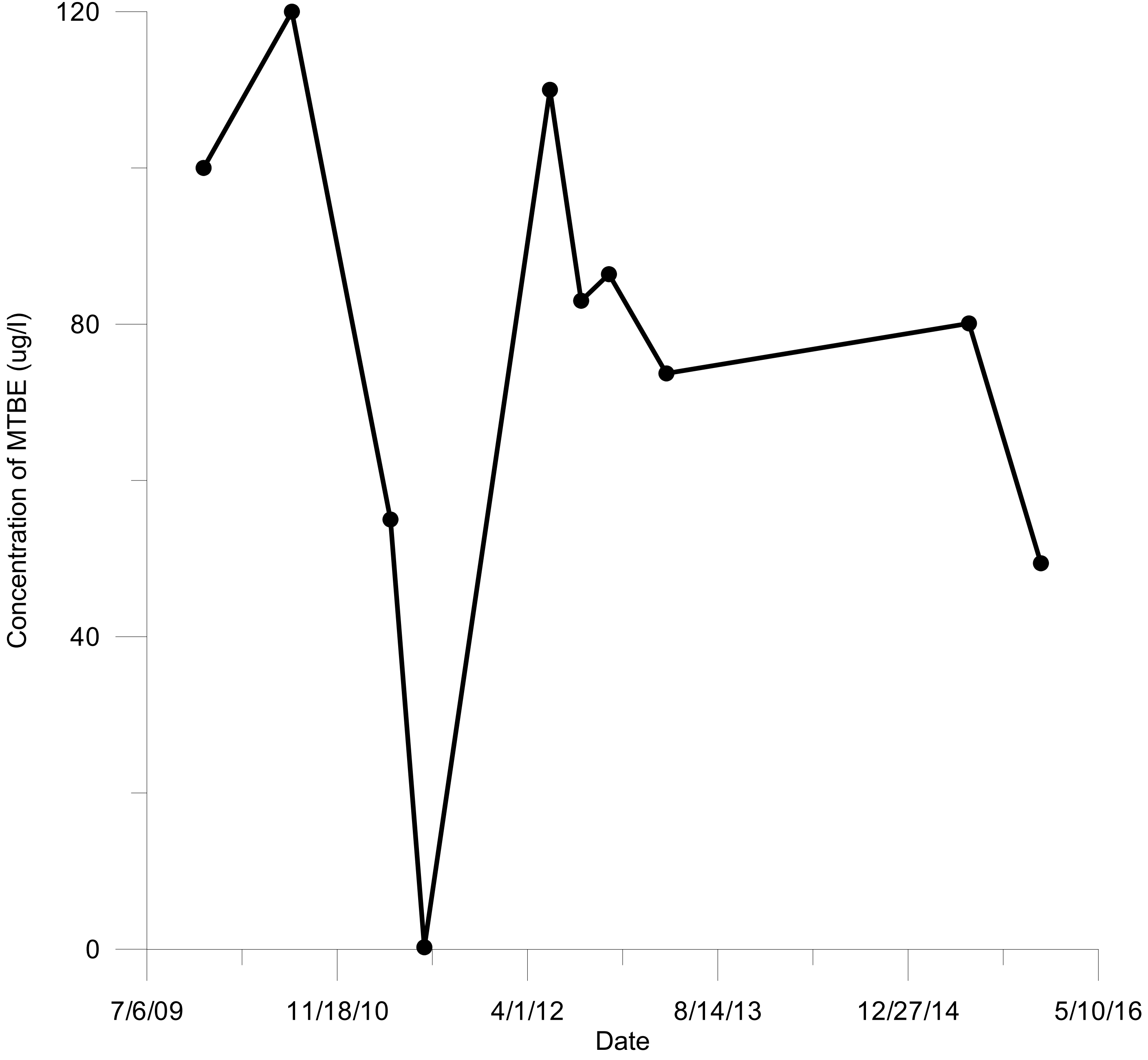
\\langan.com\DYL\data6\2574601\Office Data\Reports\Remedial Investigation Report\AOI 3\RIR\Appendices\Appendix H_Fate and Transport Modeling\Groundwater Trend Graphs

Figure I-34
Lower Aquifer COC Trends
Benzene Concentration Trend at S-284D
AOI 3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, PA



Notes:
1. Analytical data was obtained from July 2010 thru December 2015.
2. ug/l = microgram per liter.

Figure I-35
Lower Aquifer COC Trends
MTBE Concentration Trend at BF-108
AOI 3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, PA



Notes:
1. Analytical data was obtained from December 2009 thru December 2015.
2. ug/l = microgram per liter.
3. MTBE = methyl tertiary butyl ether.

Legend

S-23 30.8 ⊕	Benzene Groundwater Results (July 2010) (μg/L)
⊕	Well Abandoned/Destroyed/Unable to Locate
⊕	Perched Aquifer Monitoring Well
⊕	Unconfined Aquifer Monitoring Well
⊕	Lower Aquifer Monitoring Well
⊕	Unconfined Aquifer Recovery Well
—5—	Benzene Iso-Contours (μg/L)
···5···	Inferred Benzene Iso-Contours (μg/L)
—0—	Lower Aquifer Groundwater Contours (ft amsl)
---0---	Inferred Lower Aquifer Groundwater Contours (ft amsl)
☐	AOI Boundary

Notes:
1. Aerial photography provided by Nearmap.com, dated 7/29/2015.
2. Area of Interest boundaries referenced from 2011 ALTA/ACSM Land Title Survey, prepared for Sunoco Inc. (R&S).
3. Groundwater elevations were obtained from the July 2010 gauging event performed by Aquaterra Technologies, Incorporated.
4. Groundwater sampling completed in July 2010 by Aquaterra Technologies, Incorporated.
5. ft. amsl = feet above mean sea level.
6. All benzene concentrations are in micrograms per liter (μg/L).
7. Monitoring wells S-407 through S-414 were installed in October 2015; therefore, these wells are not displayed on this figure.
8. Monitoring wells installed after July 2010 are not displayed on this figure.

*Benzene concentration shown at S-13 is from November 2009. S-13 was not sampled during July 2010.

Figure I-36: Lower Aquifer Benzene Concentrations (July 2010)
AOI-3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, Pennsylvania

EVERGREEN

Philadelphia Refinery Operations
A Series of Evergreen Resources
Group, LLC.
2 Righter Parkway, Suite 200
Wilmington, DE 19803

0 75 150 300 Feet

SCALE: 1" = 150'
DATE: February 15, 2017
DRN. BY: MMK
CKD. BY: ED
JOB#: 2574602

Path: \\langan.com\data\DYL\data6\2574601\ArcGIS\MapDocuments\AOI 3 RIR 2016\Fate and Transport\Figure I-36 - Lower Aquifer Benzene Concentrations July 2010.mxd Date: 2/21/2017 User: MMking Time: 4:02:51 PM

Legend

S-22
5.6 ⊕ Benzene Groundwater Results (July 2010) (µg/L)

⊕ Well Abandoned/Destroyed/Unable to Locate

⊕ Perched Aquifer Monitoring Well

⊕ Unconfined Aquifer Monitoring Well

⊕ Lower Aquifer Monitoring Well

⊞ Unconfined Aquifer Recovery Well

—10— Benzene Iso-Contours (µg/L)

···10·· Inferred Benzene Iso-Contours (µg/L)

—2— Lower Aquifer Groundwater Contours (ft amsl)

---2--- Inferred Lower Aquifer Groundwater Contours (ft amsl)

▭ AOI Boundary

Notes:
1. Aerial photography provided by Nearmap.com, dated 7/29/2015.
2. Area of Interest boundaries referenced from 2011 ALTA/ACSM Land Title Survey, prepared for Sunoco Inc. (R&S).
3. Groundwater elevations were obtained from the December 2015 gauging event performed by Aquaterra Technologies, Incorporated.
4. Groundwater sampling completed in December 2015 by Aquaterra Technologies, Incorporated.
5. ft. amsl = feet above mean sea level.
6. All benzene concentrations are in micrograms per liter (µg/L).

*Benzene concentration shown at S-13 is from June 2015. S-13 was not sampled during December 2015.

Figure I-37: Lower Aquifer Benzene Concentrations
(December 2015)
AOI-3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, Pennsylvania

EVERGREEN

Philadelphia Refinery Operations
A Series of Evergreen Resources
Group, LLC.
2 Righter Parkway, Suite 200
Wilmington, DE 19803

0 75 150 300 Feet

SCALE: 1" = 150'
DATE: February 15, 2017
DRN. BY: MMK
CKD. BY: ED
JOB#: 2574602

Path: \\langan.com\data\DYL\data6\2574601\ArcGIS\MapDocuments\AOI 3 RIR 2016\Fate and Transport\Figure I-37 - Lower Aquifer Benzene Concentrations Dec2015.mxd Date: 2/21/2017 User: MMking Time: 4:03:23 PM

Legend

S-22 48 ⊕	MTBE Groundwater Results (July 2010) (µg/L)
⊕	Well Abandoned/Destroyed/Unable to Locate
⊕	Perched Aquifer Monitoring Well
⊕	Unconfined Aquifer Monitoring Well
⊕	Lower Aquifer Monitoring Well
⊕	Unconfined Aquifer Recovery Well
—20—	MTBE Iso-Contours (µg/L)
···20··	Inferred MTBE Iso-Contours (µg/L)
—0—	Lower Aquifer Groundwater Contours (ft amsl)
---0---	Inferred Lower Aquifer Groundwater Contours (ft amsl)
☐	AOI Boundary

Notes:
1. Aerial photography provided by Nearmap.com, dated 7/29/2015.
2. Area of Interest boundaries referenced from 2011 ALTA/ACSM Land Title Survey, prepared for Sunoco Inc. (R&S).
3. Groundwater elevations were obtained from the July 2010 gauging event performed by Aquaterra Technologies, Incorporated.
4. Groundwater sampling completed in July 2010 by Aquaterra Technologies, Incorporated.
5. ft. amsl = feet above mean sea level.
6. MTBE= Methyl tert-butyl ether.
7. All MTBE concentrations are in micrograms per liter (µg/L)
8. Monitoring wells installed after July 2010 are not displayed on this figure.

*MTBE concentration shown at S-13 is from November 2009. S-13 was not sampled during July 2010.

Figure I-38: Lower Aquifer MTBE Concentrations
(July 2010)
AOI-3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, Pennsylvania

EVERGREEN

Philadelphia Refinery Operations
A Series of Evergreen Resources
Group, LLC.
2 Righter Parkway, Suite 200
Wilmington, DE 19803

0 75 150 300 Feet

SCALE: 1" = 200'
DATE: February 15, 2017
DRN. BY: MMK
CKD. BY: ED
JOB#: 2574602

Path: \\langan.com\data\DYL\data6\2574601\ArcGIS\MapDocuments\AOI 3 RIR 2016\Fate and Transport\Figure I-38 - Lower Aquifer MTBE Concentrations July 2010.mxd Date: 2/21/2017 User: MMking Time: 4:03:43 PM

Legend

S-22 35.7 ⊕ MTBE Groundwater Results (December 2015) (µg/L)

⊕ Well Abandoned/Destroyed/Unable to Locate

⊕ Perched Aquifer Monitoring Well

⊕ Unconfined Aquifer Monitoring Well

⊕ Lower Aquifer Monitoring Well

⊞ Unconfined Aquifer Recovery Well

—20— MTBE Iso-Contours (µg/L)

··20··· Inferred MTBE Iso-Contours (µg/L)

0—— Lower Aquifer Groundwater Contours (ft amsl)

0------ Inferred Lower Aquifer Groundwater Contours (ft amsl)

▭ AOI Boundary

Notes:
1. Aerial photography provided by Nearmap.com, dated 7/29/2015.
2. Area of Interest boundaries referenced from 2011 ALTA/ACSM Land Title Survey, prepared for Sunoco Inc. (R&S).
3. Groundwater elevations were obtained from the December 2015 gauging event performed by Aquaterra Technologies, Incorporated.
4. Groundwater sampling completed in December 2015 by Aquaterra Technologies, Incorporated.
5. ft. amsl = feet above mean sea level.
6. MTBE= Methyl tert-butyl ether.
7. All MTBE concentrations are in micrograms per liter (µg/L).

*MTBE concentration shown at S-13 is from June 2015. S-13 was not sampled during December 2015.

Figure I-39: Lower Aquifer MTBE Concentrations (December 2015)
AOI-3 Remedial Investigation Report
PES Philadelphia Refining Complex
Philadelphia, Pennsylvania

EVERGREEN

Philadelphia Refinery Operations
A Series of Evergreen Resources Group, LLC.
2 Righter Parkway, Suite 200
Wilmington, DE 19803

0 75 150 300 Feet

SCALE: 1" = 150'
DATE: February 15, 2017
DRN. BY: MMK
CKD. BY: ED
JOB#: 2574602

Path: \\langan.com\data\DYL\data6\2574601\ArcGIS\MapDocuments\AOI 3 RIR 2016\Fate and Transport\Figure I-39 - Lower Aquifer MTBE Concentrations Dec2015.mxd Date: 2/21/2017 User: EDieck Time: 4:20:56 PM

APPENDIX J

AOI 3 HISTORIC REPORTS (on CD)