


MEMO

TO Ragesh R. Patel
Regional Manager
Environmental Cleanup and Brownfields

FROM Lisa Strobridge, P.G. 
Professional Geologist

THROUGH C. David Brown, P.G.
Professional Geologist Manager

DATE December 29, 2021

RE ECB – Land Recycling Program
Act 2 Technical Memo Summary
Remedial Investigation Report Addendum
Philadelphia Refinery AOI 4
eFACTS PF No. 770318
PESRM - Evergreen
3144 West Passyunk Avenue
City of Philadelphia
Philadelphia County

Property Owner:

Hilco Redevelopment Partners
99 Summer Street, Suite 1110, Boston, MA 02110

Remediator:

Evergreen Resources Management Operations
2 Righter Parkway, Suite 120
Wilmington, DE 19083

Site Address:

3144 West Passyunk Avenue
Philadelphia, PA 19145

Act 2 Standard(s) Sought: non-residential site-specific standard for soil and groundwater

Property Size: 105 acres

Project Site History: Petroleum refining began at the Philadelphia Refinery circa 1870. The facility consisted of two refineries, Point Breeze operated by Atlantic Petroleum Corporation (formerly ARCO) and Girard Point by Chevron (formerly Gulf). Sunoco purchased these two

refineries in 1988 and 1994 and consolidated them into a single facility. In 2012, Sunoco sold the refinery to the Carlyle Group and entered a joint venture to operate it as Philadelphia Energy Solutions (PES). Sunoco, Inc. is now a subsidiary of Energy Transfer Partners, L.P., and Evergreen is a Sunoco affiliate that is responsible for legacy environmental remediation. In 2020, PES was acquired by Hilco Redevelopment Partners (HRP).

The Philadelphia Refinery processed up to 330,000 barrels a day of crude oil. It produced gasoline, diesel, jet fuel, kerosene, home heating oil, and other petroleum liquids. The facility consisted of multiple process units, above-ground storage tanks, pipelines, as well as truck, railcar, and barge transfer equipment. The facility has been divided into eleven areas of interest (AOI 1–11) for purposes of characterizing contamination. The first ten are geographical areas of the facility, and AOI 11 represents the deep groundwater aquifer.

Area of Interest 4 of the Philadelphia Refinery complex (AOI 4) is known as the Point Breeze No. 4 Tank Farm Area. It is located in the southwest section of the Point Breeze South Yard. It is bordered by AOIs 1 and 2 to the north, AOI 3 to the west, Penrose Avenue to the southeast, and 26th Street to the east. (The nearest surface water body, the Schuylkill River, is ~1200' to the west.) Approximately 24 above-ground storage tanks have been located in AOI 4, as well as oil pipelines and pump stations.

Petroleum contamination exists in AOI 4 from historical operations, including releases from above ground storage tanks and pipelines. Evergreen (Sunoco) is participating in the Act 2 program to address contamination predating the transfer of the property to PES on September 8, 2012. Corrective action responsibilities under the Storage Tank and Spill Prevention Act are being addressed simultaneously. There were 11 open tank incidents associated with 11 regulated storage tanks in AOI 4 (51-19781). A combined site characterization report and remedial action completion report for these tanks was received on February 17, 2017 and was approved on May 11, 2017. All incidents were closed.

Site Findings:

Soil

- Unconsolidated materials extend to approximately 80-110 feet below grade and consist of fill (up to 15 ft), alluvium (silt, clay, and sand), the Trenton Gravel, and the Potomac-Raritan-Magothy (PRM) formations (sand and clay units). The Wissahickon Formation underlies the unconsolidated materials.
 - Fill is thickest in the vicinity of Penrose Avenue sewer and in low areas south of Penrose Avenue
 - Additional analysis was conducted to differentiate the alluvium and PRM middle clay continuity
- In 2005 and from 2013 through 2016, approximately 63 surface soil samples were collected

- From 2003-2007, numerous additional samples were collected for AST closure and delineation
- Soil samples were analyzed for: 10 VOCs, 10 SVOCs, and lead
 - Select samples were analyzed for 14 VOCs, 28 SVOCs, and five metals
 - VOCs include benzene, toluene, ethylbenzene, xylene (total), methyl tertiary butyl ether (MTBE), isopropylbenzene (cumene), 1,2-dichloroethane (EDC), ethylene dibromide (EDB), 1,2,4-trimethylbenzene (1,2,4-TMB), and 1,3,5-trimethylbenzene (1.3.5-TMB)
 - SVOCs include anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, chrysene, fluorene, naphthalene, phenanthrene, and pyrene.
- Soil sample results indicated numerous exceedances of soil to groundwater MSCs for benzene and lead
- Isolated exceedances of soil-to-groundwater MSCs were found for 1,2,4-trimethylbenzene, toluene, and naphthalene
- Benzene, 1,2,4-trimethylbenzene, toluene, and naphthalene were delineated to the soil to groundwater MSCs
- Lead exceeded the site-specific direct contact standard (2,240 mg/kg) in surface soil at four locations.
 - Lead concentrations that exceeded the direct contact standard ranged from 3,000 mg/kg to 26,000 mg/kg
 - There were no other direct contact MSC exceedances beside lead.
 - Lead was delineated to the established Site-Specific Standard of 2,240 mg/kg
- In May 2018, targeted soil excavations were conducted as part of tank re-activation of PB-848 in AOI 4 and impacted the tank berm for PB-848 and PB 252. A total of 53.5 tons of soil was excavated and transported offsite for disposal and 24 post excavation soil samples were collected from the three limited excavations. These activities were interim remedial measures, removed some lead mass at the site, and will still require the use of additional remedial strategies (future cap) in the area to eliminate the direct contact exposure pathway in the future.
- In January 2021, a soil boring was installed offsite at the downgradient former ARCO property
 - One soil sample was collected for forensic analysis
 - Elevated field screening, hydrocarbon staining, and sheen were noted in the borehole
- In April 2021, one additional shallow soil sample was collected to further delineate soil along the exterior property boundary in anticipation of the soil direct contact value for lead possibly changing from 2,240 mg/kg to 1,000 mg/kg
 - This additional sample delineates soil along the southern property boundary to the 1,000 mg/kg limit. The eastern property boundary was previously delineated to the 1,000 mg/kg limit.
 - The site is bordered by other AOI's to the north (AOI 1 and AOI 2) and west (AOI 3)

LNAPL

- LNAPL was detected offsite in two wells located near the PennDOT Right of Way (PennDOT ROW) and South 26th Street
 - Fingerprint results indicate the LNAPL in one was weathered and degraded gasoline
 - Gasoline was not historically stored in AOI 4
 - The two offsite wells containing LNAPL are located in close proximity to the former ARCO retail station
- LNAPL is observed in several areas within AOI 4: the north (near the 870 Unit across Hartranft St near S-104), south-central area around S-30 system), and southeast (around Penrose System), as well as in several isolated wells.
 - S-104 Area maximum LNAPL thickness 2016 through 2021 was 6.94 ft
 - LNAPL in S-104 identified as extremely weathered middle distillate in 2004
 - LNAPL analysis in 2019 identified a recent release post 2012
 - Transmissivity testing in A-104 area indicated that the LNAPL was not likely mobile
 - S-30 System Area maximum LNAPL thicknesses from 2016 through 2021 was approximately 8'
 - Active LNAPL recovery is being conducted
 - Penrose System Area maximum LNAPL thickness 2016 through 2021 was 3.49'
 - PESRM acknowledged a release associated with piping associated with tank PB 253 and resulted in increased LNAPL presence in wells in 2016
 - LNAPL maximum thickness from 2016 through 2021 at the southeast property boundary downgradient of the Penrose System is 0.87'
 - LNAPL is present offsite southeast of the Penrose System at a maximum thickness of 0.94' from 2016 through 2021
 - LNAPL is present south of the offsite Penrose Avenue Sewer at a maximum thickness of 0.02' from 2016 through 2021
 - Evergreen operated the total fluids system until 2018
 - Operation of this system created a capture zone that extended to the Penrose Avenue sewer, as evidenced by sucralose and chloride concentrations detected in recovery wells
 - In 2018, the installation of an in-situ Submerged Oxygen Curtain (iSOC) was initiated during the second half of 2018 with the purpose of creating an oxygen barrier to accelerate the natural degradation of petroleum hydrocarbons.
 - The iSOC system was turned off April 7, 2020
 - LNAPL recovery decreased over time
 - One well in the Penrose System area indicated recoverable LNAPL
 - DEP will contact Hilco to discuss LNAPL in the areas of S-30 and the former Penrose System

Groundwater

- Two aquifers are identified at AOI 4
 - An unconfined aquifer exists throughout the site in the alluvium, Trenton Gravel, and PRM Upper Sand
 - Groundwater generally flows south to southeast across AOI 4 in the unconfined aquifer
 - The lower aquifer occurs in the PRM Lower Sand Unit
 - Groundwater flow is inferred to the south-southwest under a shallow gradient
 - Water levels from co-located well pairs indicate the middle clay aquitard locally separates the unconfined and lower aquifer in this area
- 94 monitoring wells and 19 recovery wells are present in AOI 4
 - Seven of these are deep (70–90'), screened entirely in the Lower Sand of the PRM.
 - The shallow wells are typically 15-45' deep, and they are screened either in the Trenton Gravel or the top of the Upper Sand of the PRM.
 - 13 water table monitoring wells were installed offsite in the PennDOT Right of Way and along Penrose Avenue and South 26th Street
 - Two of the offsite shallow wells were installed south of the Penrose Sewer, adjacent to the Provco Property (a separate Act 2 site)
 - Provco former land use includes scrap metal shredding, railyard, and park
 - Historical gasoline and diesel releases from USTs were documented on Provco
 - Benzene is detected in groundwater at concentrations above SHS MSCs at Provco
 - Groundwater flow in 2019 on Provco property was reported to be north towards the Penrose Avenue sewer
 - One offsite lower aquifer well was installed offsite south of the Penrose Avenue sewer
 - Select wells were gauged 11 times from May 2017 through May 2021
 - Offsite gauging at the adjacent Defense Support Center Philadelphia (DSCP) site occurred during four of the events
 - Groundwater sampling was conducted on 14 occasions from 2017 through 2021
 - Samples were historically analyzed for 10 VOCs, 10 SVOCs, and lead
 - TBA was added to the analysis list in 2018 to evaluate degradation of MTBE
 - In 2021, general groundwater chemistry, sucralose, pesticides, and compound specific isotope analysis (CSIA) was added for select wells
 - Benzene, ethylbenzene, toluene, MTBE, 1,2,4-trimethylbenzene (1,2,4-TMB), 1,2-dibromomethane (EDB), and naphthalene was detected in

onsite wells at concentrations exceeding SHS MSCs from 2017 through 2021 in the unconfined aquifer

- Benzene, ethylbenzene, toluene, 1,2,4-TMB, EDB, and naphthalene were detected in offsite wells at concentrations exceeding SHS MSCs from 2017 through 2021 in the unconfined aquifer
- Dissolved lead and benzo(a)pyrene have been detected on one occasion in the unconfined aquifer at concentrations above the SHS MSCs
- In the lower aquifer, MTBE has been detected onsite at concentrations above the SHS MSC, and benzene and MTBE were detected at concentrations above the SHS MSC in offsite wells
- The area surrounding the offsite wells were further evaluated for the potential for offsite sources contributing to detections of COCs using multiple lines of evidence
 - Ground penetrating radar was utilized to look for underground storage tanks and none were found
 - Electrical resistivity imaging was conducted to both refine the conceptual site model, to identify potential preferential pathways, and to evaluate petroleum hydrocarbon distribution
 - Electrical resistivity results either confirmed the stratigraphy in targeted areas, or identified anomalies that guided placement of drilling locations
 - Electrical resistivity anomalies were present around the Penrose Avenue sewer indicating communication between groundwater and the sewer system
 - This connection is further supported by sucralose tracer testing, CSIA analysis, sulfate results, and microbial assays
 - Electrical resistivity anomalies identified preferential flow paths that connect the Penrose Avenue sewer to the former Penrose Remediation System
 - Sucralose tracer testing also confirmed this connection
 - Electrical resistivity anomalous zones were present in the vicinity of offsite well S-449 where offsite benzene and MTBE impacts were observed,
 - electrical resistivity anomalous zones were not present in the deeper zone at AOI 4 where onsite MTBE impacts were observed suggesting there is not a migration pathway present from AOI 4 to offsite locations
 - CSIA analysis indicates offsite sources for dissolved impacts in the southeastern area of the AOI 4
 - At least three sources of benzene were identified in the unconfined aquifer

- Two of the benzene sources were demonstrated to originate offsite
- The third source of offsite benzene is present in wells that are located on each side of the Penrose Avenue sewer and is a line of evidence to support the interpretation that dissolved impacts present around Penrose Avenue sewer are being transported by the sewer system
- Toluene, ethylbenzene, and xylenes CSIA data indicate correlation between COCs onsite and offsite wells in the unconfined aquifer
 - Toluene and ethylbenzene data also indicated biodegraded onsite isotopes from corresponding offsite source area wells
- CSIA analysis of key biomarker compounds (cyclohexane and methylcyclohexane) were conducted on wells in proximity to upgradient sewers that connect to the interceptor in the unconfined aquifer
 - Results indicate a single common source of impact
 - This line of evidence supports the concept of sewers acting as the source and migration pathway of offsite dissolved COCs
- Multivariant analysis of VOC range hydrocarbons indicate 5 groups of samples that share source fingerprint attributes in the unconfined aquifer
 - MVA Group 4 was notable as it contains the largest group of groundwater samples with a shared fingerprint
 - Weathered gasoline was the identified fuel type and gasoline was not a fuel stored historically in AOI 4
 - Onsite and offsite wells in the southeast portion of the site comprised this group supporting offsite migration of gasoline related compounds from offsite sources onto AOI 4
- Analysis of the technologies utilized to evaluate the source of offsite benzene and MTBE concentrations and migration flow paths indicate the sewers that are adjacent to AOI 4 are a primary source and transport mechanism for offsite COC impact in the unconfined aquifer
- CSIA analysis of the offsite lower aquifer indicates multiple petroleum sources and multiple fuel types, including gasoline
 - Sources in the lower aquifer could be from water table sources along Penrose Avenue, offsite sources, or a mixture of the two

- There is no clear source for MTBE in the lower aquifer demonstrated by the CSIA analysis, including no evidence of an onsite source
- Evergreen indicated additional lower aquifer wells will be installed on the offsite Conrail property at locations presumed to be hydraulically downgradient of the existing offsite lower aquifer well to further inform the fate and transport COCs and offsite sources

Vapor Intrusion

- Vapor intrusion was evaluated for offsite neighboring properties and determined that the offsite properties were outside of proximity distance for vapor intrusion for dissolved impacts attributed to AOI 4
- Proximity distances are not applicable for LNAPL due to the presence of shallow LNAPL.
 - Onsite future buildings will contain vapor mitigation systems as part of the redevelopment plan
 - Offsite buildings on the Provco property will also contain vapor mitigation and is documented as part of the Act 2 demonstration of attainment for SSS for that site
- One indoor air sample and one ambient air sample were collected in March 2017 from a refinery building that is not positively pressurized
 - The samples did not exceed occupational limits (such as OSHA PELs), or RSLs
- Utility corridors onsite could serve as a preferential pathway for vapor migration and will be assessed in future reports.

Ecological Evaluation

- A PNDI review was performed in September 2015, updated in 2018, and again in 2021.
 - Overall, the changes in species identified is similar to slightly improved
 - Two fewer plant species were identified in 2021 as compared to 2018
 - One fewer fish species was identified in 2021 as compared to 2018
- An Ecological Risk Assessment is being prepared by Evergreen for AOI 1 through AOI 9 and will be submitted following approval of the Remedial Investigation reports.
 - The potential impact to species will be evaluated in the June 2022 Ecological Risk Assessment (ERA), as required by the COA.
 - The Ecological Risk Assessment evaluates risk from site COCs to threatened species, endangered species, and species of concern identified by PNDI
 - Species evaluated in AOIs 1 through 9 include bird species (marsh wren, peregrine falcon, and least bittern), fish species (Atlantic sturgeon, shortnose sturgeon, and hickory shad), reptile species (eastern redbelly turtle) and plant species (waterhemp ragweed, eastern baccharis, Walter's barnyard-grass, multiflowered mudplantain, bugleweed, shrubby camphor-weed, and river bullrush).

Exposure Pathways

- Direct contact exposure to soil, groundwater, and/or LNAPL to the onsite worker is currently managed through HASP, PPE, and workplan/permitting protocols.
- Future direct contact exposure to soil impacts will be addressed in the Cleanup Plan.
- Soil and groundwater vapor receptors include occupants of onsite buildings.
 - Sewers are potential preferential pathways for vapors
 - The indoor air and ambient air sample results were below EPA RSLs
 - There are multiple lines of evidence presented that indicate the sewers are primary contaminant migration pathways as groundwater moves into and out of the sewers and migrated toward the Penrose Avenue recovery wells
- No active potable supply wells are located within a mile radius of AOI 4
- Evergreen will be required to address all potentially complete exposure pathways through the submission of a risk assessment report and/or a cleanup plan.

Site Cleanup History

An initial NIR was submitted October 16, 2006; it was revised with updated information on November 17, 2014 and December 14, 2016. The facility entered into a consent order and agreement with DEP's Clean Water Program in December 1993; the agreement was succeeded by another in December 2003 which terminated in December 2013. The facility is currently subject to a DEP buyer-seller agreement which became effective September 8, 2012 and was amended June 26, 2020. The site entered the One Cleanup Program with DEP and EPA on November 8, 2011.

The City of Philadelphia requested a public involvement plan in a letter dated November 3, 2006. Sunoco held an initial public meeting on September 19, 2007. Sunoco began submitting Act 2 remedial investigation reports in 2011; multiple Act 2 reports were submitted by Sunoco and Evergreen through 2017. In 2018, DEP determined that Evergreen had not fulfilled the public participation requirements of Act 2 for the reports that had been submitted and reviewed. In a meeting on November 27, 2018 with Evergreen, the City, and EPA, and in subsequent communications and meetings, DEP directed Evergreen to rectify the lack of public involvement for the 2011-2017 reports and ensure that public involvement requirements were satisfied for all future reporting. Since 2019, Evergreen has reinvigorated the public participation program for the project and submitted the public involvement remedial investigation report on March 31, 2021. DEP reviewed the report and issued a technical deficiency letter on June 29, 2021. Evergreen submitted an addendum document responding to the deficiencies which was submitted on August 28, 2021. DEP approved the Public Involvement Remedial Investigation Report, as amended on November 24, 2021. There were comments and responses related to AOI 4 that were presented in the PIP RI, as well as additional responses included in this remedial Investigation Report Addendum. The additional responses include references to text, figures, and tables in this report that supplement the response.

Petroleum impact is present in AOI 4 from historical operations, including releases from ASTs and pipelines. Evergreen is participating in the Act 2 program to address soil and groundwater contamination that predates the transfer of the property to PES on September 8, 2012. Corrective action responsibilities under the Storage Tank and Spill Prevention Act are being addressed simultaneously.

The 2017 AOI 4 Remedial Investigation Report was disapproved on June 21, 2017 due to:

- Incomplete groundwater delineation along the property boundary to determine the extent offsite. In addition, the fate and transport analysis used to estimate the dissolved plume offsite did not have groundwater elevation and contaminant concentrations from offsite locations to support the analysis.
 - Multiple lines of evidence approach were utilized to enhance the understanding of the extent, nature and transport of contamination beyond the eastern and southern property boundary of AOI 4 to inform future inputs into the fate and transport analysis
 - Collective data suggests that offsite impacts from the unconfined aquifer are from offsite sources that migrated onsite during groundwater pumping from the Penrose Remediation System
 - The offsite sources include both the adjacent sewers and offsite properties with historical releases
 - DEP recognizes the sewers may have been pathways for contamination migrating onto AOI 4 from elsewhere at the refinery
 - Offsite impacts of MTBE are attributed to an offsite source given the absence of MTBE containing fuel storage onsite and absence of subsurface migration pathway connecting AOI 4 to offsite locations
 - Further groundwater characterization of the area southeast of AOI 4 will be required for completion of the fate-and-transport analysis and submittal of the forthcoming fate-and-transport remedial investigation report
- DEP and EPA discussed the report and this memo incorporates EPA comments

Discussion of Public Involvement/Public Comments

- On November 29, 2021, DEP received Evergreen's Response to public comments for the present AOI 4 RIR.
 - Evergreen reported receipt of public comments from one member of the community and one set of comments from Clean Air Council.
- DEP received, reviewed, and took into consideration comments from two members of the community, as well as comments from two representatives from CAC as part of the review.
 - One message received from CAC included a petition with 54 names referenced.
- DEP identified the one public comment and one comment from CAC that was not included in Evergreen's November 29, 2021 Response to public comments. The content of the comments that were not reported by Evergreen were consistent with the language

of the comments that were reported by Evergreen and therefore Evergreen's responses remain applicable.

- DEP has requested that Evergreen investigate why these comments were not received and include them on their website.
- Evergreen acknowledged that concerns raised in the comment relating to the site-specific direct contact standard for lead, the groundwater fate-and-transport analysis, and the vapor intrusion pathway evaluation are the subject of ongoing work that will be addressed in future reports.
- DEP reviewed the responses to public comments and was satisfied with the responses.

DEP Final Action: The Remedial Investigation Report Addendum for AOI-4 is recommended for approval.

DEP Contact: Lisa Strobridge, P.G. **Phone:** 484-250-5796

Site Contact: Tiffani Doerr, P.G., Evergreen **Phone:** 302-477-1305

Site Consultant: Jennifer Menges, Stantec **Phone:** 610-840-2540

One Cleanup Program

EPA Contact: Kevin Bilash, USEPA Region III **Phone:** 215-814-2796