Final

Former Frankford Arsenal Area I Soils
DECISION DOCUMENT

June 2015

U.S. Army Corps of Engineers
Baltimore District
Baltimore, Maryland

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TABLE OF CONTENTS

PAGE **SECTION**

LIST OF TABLES

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

ALM	Adult Lead Model
AOC	Area of Concern
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COPC	**c**hemical of potential concern
EE/CA	Engineering Evaluation/ Cost Analysis
FFA	Former Frankford Arsenal
ft	foot (feet)
HHRA	Human Health Risk Assessment
HI	Hazard Index
µg/kg	microgram(s) per kilogram
mg/dL	milligrams per decaliter
mg/kg	milligram(s) per kilogram
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
PADEP	Pennsylvania Department of Environmental Protection
PCB	polychlorinated biphenyl
PWD	Philadelphia Water Department
RME	Reasonable Maximum Exposure
§	Section
SARA	Superfund Amendments and Reauthorization Act
SVOC	**s**emi-volatile organic compound
TCE	Trichloroethene
USACE	U.S. Army Corps of Engineers
USC	United States Code
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound

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I. DECLARATION

A. Site Name and Location

Former Frankford Arsenal, Area I
Philadelphia, Pennsylvania

B. Statement of Basis and Purpose

This decision document presents the selected remedial action for soils at the Former Frankford Arsenal (FFA) Area I (hereafter referred to as "Area I" or the "Site"). The selected remedial action was chosen in accordance with the requirements of the *Comprehensive Environmental Response, Compensation and Liability Act* (CERCLA) as amended by *Superfund Amendments and Reauthorization Act* (SARA), 42 United States Code (USC) Section (§) 9601-9675, and to the extent practicable, the *National Oil and Hazardous Substances Pollution Contingency Plan* (NCP), as amended, 40 Code of Federal Regulations (CFR) §300. The decision is based on information contained in the Administrative Record File for the FFA and has been made by the United States Army Corps of Engineers (USACE) in conjunction with the Pennsylvania Department of Environmental Protection (PADEP). No comments on the *Proposed Plan* for the FFA Area I soils were received during the public comment period. The PADEP has concurred with the Selected Remedy.

C. Description of Selected Remedy

USACE has determined that no further action is necessary to protect public health, welfare or the environment. Interim removal actions previously conducted for the FFA Area I soils have proved to be protective of human health and the environment and have eliminated the need to conduct additional remedial action. Therefore, USACE has selected No Further Action as the final remedy for the Area I soils. Soil contamination present below the water table will be addressed as part of a separate groundwater remedial investigation.

D. Statutory Determinations

Previous removal actions conducted for the FFA Area I soils have proved to be protective of human health and the environment, and have eliminated the need to conduct additional remedial action.

The selected remedy, as documented in this *Decision Document*, is protective of human health and the environment, and is cost-effective. Soil removal activities have resulted in the removal of contaminants from soil, with the exception of soils beneath the water table. As previously noted, the soils beneath the water table will be addressed under a separate groundwater remedial investigation. Because this selected remedy will result in hazardous substances, pollutants, or contaminants remaining at the Site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years of the date of this *Decision Document* to ensure that the remedy is protective of human health and the environment.

E. Authorizing Signatures

Joseph R. Jordan
Colonel, Corps of Engineers
Commanding

1 July 2015
Date

II. DECISION SUMMARY

This section presents a summary of USACE decisions regarding residual soils present at FFA Area I that are included in the determination of No Further Action.

A. Site Name, Location and Description

The Former Frankford Arsenal is a 109.4-acre facility located in northeast Philadelphia (Figure 1). The facility currently consists of 53 remaining buildings of various sizes, age, and condition. Area I, which is the focus of this *Decision Document*, consists of 46 acres planned for light industrial use. Area I occupies the eastern half of the Former Frankford Arsenal between Baird Street and Sanger Street. Separate investigations are being conducted for the western half of the FFA (designated as Area II), the land owned by the City of Philadelphia (former Pennsylvania Fish and Boat Commission property) and Dietz and Watson (designated as Area III), and groundwater at the FFA (designated as Area IV). The layout of the FFA showing Areas I, II, and III is depicted on Figure 2. This *Decision Document* addresses the soil media present above the water table at FFA Area I.

Between the time that the *Final Area I Soil Remedial Investigation/Risk Assessment Report* (Cabrera, 2014) was approved and the *Proposed Plan* (USACE, 2014) was developed, the ownership at the FFA had changed. This change in ownership did not alter any of the land use assumptions for the property, which are industrial/commercial. In 2014, Dietz and Watson expanded, taking a portion of Area I and the former Pennsylvania Fish and Boat Commission property. The remaining Pennsylvania Fish and Boat Commission boat launch property was purchased by the City of Philadelphia. The western portion of Area I was purchased by the Philadelphia Industrial Development Corp. The current property boundaries are displayed in Figure 3.

B. Site History and Enforcement Activities

B.1 Site History

The FFA was commissioned in 1816 for military use. Previously, the area consisted of farmland and undeveloped wetlands. Between 1816 and the decommissioning in 1977, the facility was used for a variety of military activities as its mission was adjusted to fit the military's changing needs. Activities at the FFA during its years of operation included military ordnance production, testing and storage, and munitions research. Figure 4 provides a historical timeline of site-related events for the period between 1816 and 2013.

In 1976, the FFA was declared excess by the U.S. Army. On 30 September 1977, the Arsenal was closed. Later, a number of cleanups were conducted at the Arsenal by the Army Toxic and Hazardous Materials Agency prior to transferring the property to the General Services Administration for subsequent disposition. Decontamination efforts were primarily focused on the removal of munitions and radiological wastes. Some chemical-waste cleanup was also conducted to allow for the commercial redevelopment.

B.2 Previous Removal Actions for Former Frankford Arsenal Area I Soils

Three historical site assessments and 15 separate environmental investigations were conducted in Area I and are summarized in Table 1. Additional details on these investigations are presented in the *Remedial Investigation/Risk Assessment* (Cabrera, 2014). During these investigations, various

hazardous materials were discovered and removed. Based on surveys conducted for radionuclides inside and outside of buildings and sewers, radionuclide contamination was removed from building surfaces and sewers and uranium-contaminated soil was excavated from several locations. Solid-shot cannon balls were discovered below the ground surface (bgs) and removed. Heavy-metal and explosives residues were removed from buildings and sewers. Above-ground storage tanks were removed, and underground storage tanks and associated contaminated soils were also removed. Lead batteries and transformers containing polychlorinated biphenyls (PCB) were removed in Area I.

An *Engineering Evaluation/Cost Analysis (EE/CA)* was conducted in 2009 to evaluate various removal action alternatives to address the contamination detected during the previous sampling in 2008 (Table 1) (Cabrera, 2009a). A baseline human health risk assessment conducted to support the *EE/CA* determined that chemical contamination present in the soil would pose an unacceptable risk to human health. Arsenic, copper and PCB-1260 were identified as the chemicals presenting the greatest potential risks to human health.

An *Action Memorandum* (Cabrera, 2009b) was prepared to document the selected interim removal action alternative chosen from those presented in the *EE/CA*. Excavation with Off-site Disposal was chosen as the Non Time Critical Removal Action for Area I. In addition, the *Action Memorandum* provided cleanup levels to be used during the removal action. These cleanup levels are presented in Table 2.

For the interim removal actions conducted during 2009, the arsenic cleanup levels of 53 milligrams per kilogram (mg/kg) in surface soil and 150 mg/kg in subsurface soil were used. After 2009, PADEP changed the arsenic cleanup level to 29 mg/kg for both surface and subsurface soil. For the interim removal actions conducted between 2012 and 2013, the arsenic cleanup level of 29 mg/kg was used.

Six Interim Removal Actions were conducted in Area I between September 2009 and August 2013. The purpose of the Interim Removal Actions was to remove certain soil contamination and underground storage tanks remaining from historical activities to allow for redevelopment of Area I. The results of these final soil removal activities have been used to determine current site conditions. Table 3 presents a summary of each area, associated buildings and site constituents, as well as the final status for each. Details on each Interim Removal Action are presented in both the *Remedial Investigation/Risk Assessment* (Cabrera, 2014), and the *Completion Report* (Cabrera, 2013). Summaries of each Interim Removal Action and final site conditions are presented below.

B.2.1 Area I Interim Removal Action, 2009-2010

As part of this removal action, contaminated soil was removed from 10 locations: Building 44/47 Tank Pit; Building 141 through 143; the Compound Area; Building 149; and Areas of Concern (AOCs) 3 through 8. The location and dimensions of the Compound Area and AOCs 3 through 8 are shown on Figure 5. Four underground storage tanks that had previously been closed in place were also removed and disposed of off-site.

Building 44/47 Tank Pit

After removal 296 cubic yards of soil at Building 44/47 Tank Pit, fifteen soil samples were collected from the excavation and analyzed for PCBs and metals. One floor sample (TP44-SO-11; 1,810 mg/kg) exceeded the cleanup level for lead of 450 mg/kg. Two floor samples (TP44-

SO-07; 5.5 mg/kg and TP44-SO-08; 7.6 mg/kg) exceeded the PCB cleanup level of 1.0 mg/kg. These metals and PCB samples were collected at a depth of 15 feet (ft) below the ground, which is below the water table. Therefore, no further excavation was possible. This contamination will be addressed in a separate Groundwater Remedial Investigation. The locations of the remaining metals and PCB contamination are presented in Figures 6 (metals) and 7 (PCBs).

Building 141 through 143

For Building 141 through 143 AOC 11, a total of 399 cubic yards of soil was excavated and disposed of offsite. Fifteen soil samples were collected from 1.0 foot bgs for metals analysis. All metals concentrations were below the cleanup levels.

Compound Area

After removal of the contaminated soil at the Compound Area excavation, 16 soil samples collected at 1.5 ft bgs were analyzed for metals. All metals concentrations were below the cleanup levels. A total of eight cubic yards of soil was excavated and disposed of offsite.

Building 149

For the Building 149 (AOC 7) excavation, a total of 49 cubic yards of soil was excavated and disposed of offsite. Eight soil samples were collected at 1.5 ft below the ground and analyzed for metals. All metals concentrations were below the cleanup levels.

AOCs 3 through 8

After removal of the soil in AOC 3, 12 samples were collected at depths between six and 12 ft bgs. These samples were analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOC) and metals. All chemical concentrations were below their respective cleanup levels. A total of 1,095 cubic yards of soil was excavated and disposed of offsite.

A total of 96 cubic yards of soil was excavated from AOC 4 and disposed of offsite. Eight samples were collected for PCBs and metals analysis at depth of two ft bgs. All chemical concentrations were below their respective cleanup levels. For AOC 5, a total of 153 cubic yards of soil was excavated and disposed of offsite. Due to the risk of making the building foundation unstable, the remaining soil contamination next to the foundation was not removed. As shown on Figure 6, metals concentrations for two floor samples in AOC 5 exceeded the cleanup level for lead (450 mg/kg), mercury (10 mg/kg) and chromium (190 mg/kg). Sample AOC5-SO-03 (4 feet below the ground) contained lead at a concentration of 770 mg/kg and mercury at a concentration of 18.7 mg/kg. Chromium (235 mg/kg) was detected at a depth of six ft bgs in sample AOC5-SO-07. After removal of the soil from AOC 6, eight samples were collected for PCBs and metals analysis at depths between two and eight ft bgs. All chemical concentrations were below their respective cleanup levels. A total of 99 cubic yards of soil was excavated and disposed of offsite.

For AOC 7, a total of 97 cubic yards of soil was excavated and disposed of offsite. Eight samples were collected for VOC, SVOC and metals analysis at a depth of two ft below the ground. All chemical concentrations were below their respective cleanup levels.

After removal of the soil from AOC 8, seven samples were collected for PCBs and metals analysis at depths between two and four ft below the ground. Two sample locations (AOC8-SO-02; 609 mg/kg and AOC8-SO-03c; 518 mg/kg) exceeded the cleanup level for lead at a depth of 3.0 ft below the ground, as shown on Figure 6. All the other chemical concentrations were below

the cleanup levels. Due to the risk of making the building foundation unstable, the remaining soil contamination next to the foundation could not be removed and was left in place. A total of 81 cubic yards of soil was excavated and disposed of offsite.

Following the soil sampling, the excavations for each area were filled in with clean soil obtained from off-site. In total, 726 cubic yards of PCB-contaminated soil and 1,648 cubic yards of hazardous and non-hazardous waste soil were excavated and transported to licensed landfills

B.2.2 Area I Interim Removal Action, May-June 2012

The Interim Removal Action conducted between May 2012 and June 2012 addressed soil contamination beneath former Buildings 47, 58, 231, and 128. This soil contamination was not accessible at the time the 2009 Interim Removal Action was conducted.

Building 47

After removal of the soil from Building 47 AOCs 1 and 2, 114 floor soil samples were collected for VOC analysis. As shown on Figure 8, eight of the soil samples exceeded the cleanup level for VOCs (500 mg/kg) at depths of 1.0 to 4.0 ft below the ground. These contaminated soil areas were addressed later during the Interim Removal Action that began in October 2012. The remaining 106 soil samples were below the cleanup level. A total of 1,323 cubic yards of soil was removed and disposed of offsite.

Building 58

A total of 90 cubic yards of soil was excavated from Building 58 (AOC 14) and disposed of offsite. After removal of the soil, thirty-four soil samples were collected from the floor of the (AOC 14 excavation and analyzed for PCBs, metals and/or VOCs. The 10 VOC samples were collected from a depth of 5-10 ft below the ground. The six metals samples were collected from a depth of 3 ft bgs and the 18 PCB samples were collected from a depth of 1.0 foot bgs.

The concentrations of VOCs and metals were below their respective cleanup levels. Five PCB samples were above the cleanup level. The locations of these samples were addressed later during the Interim Removal Action that began in October 2012. These sample locations are shown on Figure 7.

Building 128 Transformer Pad

After removal of the soil from the Building 128 Transformer Pad, four soil samples were collected from a depth of 1.0 foot bgs and analyzed for PCBs. All PCB concentrations were below the cleanup level. A total of 14 cubic yards of soil was excavated and disposed of offsite.

Building 231

For Building 231 (AOC 12), a total of 57 cubic yards of soil was excavated and disposed of offsite. After removal of the soil, eight soil samples were collected between three and five ft bgs and analyzed for VOCs, PCBs and metals. All VOCs and SVOCs were either reported as not detected or at concentrations below the cleanup level. No PCBs were detected in the samples. Four samples contained antimony, lead, and/or mercury at concentrations above the cleanup levels. These contaminated soil areas were later addressed during the Interim Removal Action that began in October 2012.

In total, 1,484 cubic yards of hazardous and non-hazardous waste soil was excavated and transported to licensed landfills during the May-June 2012 Interim Removal Action.

B.2.3 Area I Interim Removal Action, October 2012 - January 2013

The Interim Removal Action conducted between October 2012 and January 2013 addressed the soil contamination that remained in place within the footprint of Building 47, Building 58, and Building 231 after completion of the May to June 2012 Interim Removal Action. In addition to addressing this soil contamination, an oil-water separator adjacent to Building 47 was removed and contaminated soil beneath the structure was excavated. Three underground storage tanks at Building 48 were also removed.

Building 47

After removal of the soil, 17 soil samples were collected from the excavation at depths of three to six ft bgs. The samples were analyzed for VOCs. All VOC concentrations were below the cleanup level. A total of 93 cubic yards of soil was excavated and disposed of offsite.

Building 47 Oil-Water Separator

Once the oil-water separator structure and surrounding soils were removed, soil sampling was conducted for each wall and the floor of the excavation. Forty soil samples were collected and analyzed for VOCs and PCBs. No VOCs or PCBs were detected in the samples. A total of 1,051 cubic yards of soil and debris was excavated and disposed of offsite.

Building 58

A total of 248 cubic yards of soil was excavated and disposed of offsite. After removal of the soil, 13 soil samples were collected from the excavation at seven to eight ft bgs. The samples were analyzed for PCBs and metals. One sample exceeded the cleanup level for arsenic (58-CS-48-P-8; 32.8 mg/kg). Two samples (58-CS-47-P-8; 4-4 mg/kg and 58-CS-38-P-8; 1.4 mg/kg) exceeded the PCB cleanup level (Figures 6 and 7). These PCB and arsenic sample locations were 8ft bgs, which is below the water table and no further excavation was possible. This contamination will be addressed in a separate groundwater remedial investigation. The remaining soil sample locations did not exceed the cleanup levels.

Building 231

After removal of the soil, 24 soil samples were collected from the Building 231 excavation at 7.0 ft bgs. All samples were located 7 ft bgs, which is below the water table. Seven of the samples exceeded the cleanup level for either lead or mercury. Lead concentrations ranged from 887 mg/kg to 1,060 mg/kg, while mercury concentrations ranged from 11.1 mg/kg to 34.9 mg/kg (Figure 6). Because the lead and mercury contamination is below the water table, no further excavation was performed. This contamination will be addressed in a separate groundwater remedial investigation. A total of 503 cubic yards of soil was excavated and disposed of offsite.

Building 48 Underground Storage Tanks

Three underground storage tanks were removed from the Building 48 area and disposed of off-site. Liquids remaining in the underground storage tanks were removed before the underground storage tank was taken out of the ground.

After removal of the tanks, six soil samples were collected from each excavation at a depth of one foot bgs for a total of 18 samples. All soil samples were below the cleanup levels for VOCs and SVOCs. A total of 245 cubic yards of soil was excavated and disposed of offsite.

During removal of the Building 48 underground storage tanks, an unknown underground storage tank was discovered. Because no contamination was found in the tank, further responsibility for the tank was transferred to the property owner.

In total, 88 cubic yards of PCB-contaminated soil and 2,051 cubic yards of hazardous and non-hazardous waste soil were excavated and transported to licensed landfills during the October 2012-January 2013 Interim Removal Action.

B.2.4 Area I Interim Removal Action, February 2013

The Interim Removal Action conducted in February 2013 included the removal of a leaking sump discovered in the Building 58 area. After removal of the sump and the excavation of contaminated soil; 18 soil samples were collected. Fifteen of the 18 samples exceeded the cleanup level for trichloroethene (TCE) while 10 samples exceeded the PCB cleanup level. This remaining contamination was later addressed during the Interim Removal Action that began in May 2013. The remaining three wall samples were below the cleanup level.

B.2.5 Area I Interim Removal Action, May-June 2013

The Interim Removal Action conducted between May and June 2013 addressed the TCE and PCB soil contamination remaining at Building 58 after the February 2013 Interim Removal Action. This contamination had been caused by the leaking sump. After excavating the contaminated soil, soil samples were collected from the walls and floor of the excavation. Seven of 29 floor samples exceeded the cleanup level for PCBs, VOCs, and SVOCs (Figures 7 and 8, respectively). PCB concentrations ranged from 1.1 mg/kg to 3.9 mg/kg while TCE concentrations ranged from 4,400 micrograms per kilogram (µg/kg) to 145,000 µg/kg. Sample location 58EM-CS-17-P12 also contained perchloroethyene **(**PCE) at a concentration of 805 µg/kg and methylene chloride at a concentration of 1,390 µg/kg.

No further excavation was performed because all sample locations were 12 ft bgs, which is beneath the water table. Two of the 26 wall locations exceeded the cleanup level for TCE (west wall) and PCBs (east wall). This TCE and PCB contamination will be addressed in a separate groundwater remedial investigation. The west wall TCE contamination was later addressed during the Interim Removal Action that began in August 2013. In total, 1,188 cubic yards of contaminated soil were excavated and transported to licensed landfills during the May and June 2013 Interim Removal Action.

B.2.6 Area I Interim Removal Action, August 2013

The August 2013 removal action was a continuation of the May/June 2013 excavation activities at Building 58 because the June 2013 samples showed TCE and PCB concentrations above cleanup levels. The area where the May/June 2013 samples exceeded the TCE cleanup level was excavated. Contaminated soil west of this area was also excavated. Ten soil samples were collected. The soil samples from the floor of the excavation were collected from 12 ft bgs, which is below the water table. All the soil samples were below the respective cleanup levels for VOCs, SVOCs and PCBs. A total of 136 cubic yards of contaminated soil was removed and transported off-site.

C. Community Participation

Community participation activities provide the public with an opportunity to express its views on the preferred remedial action. USACE, in consultation with PADEP, considered public input from the community participation activities conducted during the remedial investigation phase for Area I soil remediation.

The *Proposed Plan* for FFA Area I Soils was released to the public on January 30, 2015. The document was made available to the public in the *Administrative Record* maintained at the Tacony Branch of the Free Library of Philadelphia, 6742 Torresdale Avenue, Philadelphia, Pennsylvania. The notice of availability was published in local newspapers. A public comment period was held from February 5, 2015 through March 9, 2015. In addition, a public meeting was held on February 18, 2015. At this meeting, USACE representatives provided information regarding soil contamination at the FFA Area I. No verbal or written comments were received during the comment period. No transcript of the public meeting was generated as no comments were received.

A community relations plan has been implemented in accordance with the guidance in *Final Guidance of Administrative Records for Selecting CERCLA Response Actions* (USEPA, 1990a) to keep the public informed of site activities and to invite community input. As part of the plan, USACE has produced progress update fact sheets, developed a public website, maintained the *Administrative Record* files, published press releases and legal notices, and maintained a project mailing list.

D. Scope and Role of Remedial Action

To manage the Site cleanup efficiently, USACE divided the FFA property into four areas:

- Area I (eastern half of FFA) Soils - USACE completed a remedial investigation, as well as a series of removal actions, between 2009 and 2013. The removal actions addressed the excavation of soils above the water table which were contaminated with metals, PCBs, SVOCs and VOC constituents. The removal actions were performed to achieve protectiveness based on an industrial/commercial worker scenario. This Decision Document describes the No Further Action determination that is intended to be the final remedy for Area I soils above the water table. Contaminated soils remaining beneath the water table will be addressed under Area IV (groundwater at the FFA).
- Area II (western half of FFA) Soils – The RI Report is final, and a draft FS has been prepared to address contaminated soils within six AOCs at Area II. The Final Decision Document for Area II Soils is expected in fall 2015, with any necessary remedial actions to begin in 2016.
- Area III (land owned by the City of Philadelphia and Dietz and Watson - The RI Report is currently under development. Preliminary conclusions indicate that an FS will be required to address soils contaminated with metals and SVOCs within one AOC. Approval of the RI is expected in August 2015. A Feasibility Study will then be conducted, followed by the Proposed Plan and Decision Document (scheduled for finalization in FY17).
- Area IV (groundwater at the FFA) – Groundwater for all of Frankford Arsenal is being addressed under the site-wide groundwater project. Soil removal and remedial actions within Areas I, II, and III either have or will consider potential impacts to groundwater from contamination in soils above the water table. A draft RI report is currently under development, to be followed by a Feasibility Study/Proposed Plan/ Decision Document. The final Decision Document for site wide Groundwater is expected to be completed in FY17. .

The removal actions and the No Further Action decision for Area I, combined with the ongoing investigations and future actions to be completed at Areas II, III, and IV, provide the overall remediation strategy in support of future industrial/commercial and recreational use of the FFA.

E. Site Characteristics

E.1 Conceptual Site Model

USACE developed the Conceptual Site Model to determine the complete exposure pathways for each receptor scenario, based upon sources of contamination, contaminated media and the pathways of migration as shown in Figure 9. Based upon the Conceptual Site Model, three exposure pathways – soil ingestion, dermal contact, and inhalation of VOCs – were considered for each scenario. It was assumed that all receptors may be exposed to both surface soil and subsurface soil.

E.2 Surface and Subsurface Features

The surface deposits are fill materials consisting of reworked native soil mixed with bricks, wood, coal, concrete, gravel, slag, and ash. This fill material was encountered from land surface to a depth of nine ft bgs. Demolition debris was encountered at specific and localized areas, at depths of up to 20 ft bgs. Organic silts and peat, matching published descriptions of Holocene alluvium and swamp deposits, were present in several borings across the Site. Below the surface deposits, the Site is underlain by unconsolidated sediments of the Coastal Plain province. These unconsolidated materials overlie older crystalline rocks of the Piedmont province. The FFA is located about one-half mile southeast of the fall line between the Coastal Plain and the Piedmont provinces. The Site is underlain by the Trenton gravel, a Pleistocene unit of Wisconsin-age, described as a pale or reddish-brown, gravelly sand with a wide range of grain sizes, inter-bedded with cross-bedded sands and clayey-silt layers (USGS, 1991). Locally, this gravel layer has areas of Holocene alluvium and swamp deposits with small amounts of clay. The average thickness of this unit is about 40 ft, but can be as great as 80 ft (Langan, 2005).

The basement beneath the unconsolidated deposits is made up of crystalline rocks of the Wissahickon Formation, believed to be of early Paleozoic-age, and is mapped in the Philadelphia area as metamorphic schists and gneisses. The Trenton gravel and the bedrock are both used as aquifers in the Philadelphia area (USGS, 1991).

There are no wetlands, streams, or other surface watercourses located on the FFA property. Historically, a surface water feature named Hellfire Creek existed in the area of Baird Street until sometime in the 1800s. The creek drained to a marsh that existed along the Delaware River. This low-lying area has since been filled in during the expansion of the Arsenal (USA Environmental, 2004). Regional drainage surrounding the FFA is controlled by Frankford Creek and the Delaware River, which border the Site to the south/southeast. Both the frontage on Frankford Creek and the Delaware River are entirely bounded by sea walls.

Surface drainage is controlled by a system of catch basins and storm water pipes. The storm water is conveyed by this system to a pumping or “lift station” located adjacent to Frankford Creek. The storm water is discharged to Frankford Creek at this point. Frankford Creek flows in a southeasterly direction towards its confluence with the Delaware River (Langan, 2005).

Groundwater occurs under unconfined conditions in the unconsolidated overburden and is encountered at depths ranging from approximately 4 to 13 ft bgs. Groundwater flow is generally from northwest to south-southeast toward the Delaware River, or locally toward Frankford Creek.

E.3 Nature and Extent of Contamination

Soil contamination remaining in Area I is located beneath the water table. Arsenic contamination is present in surface soil at the Compound Area, Building 238 and AOCs 6 and 9. This contamination is present because, when contaminated soil was removed in 2009, the arsenic cleanup level was 53 mg/kg. The arsenic cleanup level was updated after 2009 and is currently 29 mg/kg. As presented in Section G, remaining arsenic concentrations above 29 mg/kg in shallow soil do not pose unacceptable risks to human health or the environment. In addition, current and future site physical features reduce the potential for humans and animals to be exposed to arsenic in the shallow soil. The current land use for Area I is commercial/industrial and is expected to remain as such in the future. Most all of the areas with arsenic concentrations above 29 mg/kg are planned to be parking lots, paved areas, and maintained landscaping.

This *Decision Document* addresses soil above the water table. Soil contamination remains below the water table in several areas, as noted below:

- AOC 10; two to seven ft bgs (arsenic, TCE, benzene*)*
- AOC 13; 9.5 to 10 ft bgs (arsenic)
- AOI 15; 6 ft bgs (TCE)
- AOC 16; two to nine ft bgs (TCE)
- Building 44/47 Tank Pit Area; 14-15 ft bgs (lead)
- Building 58 footprint AOC 14; eight ft bgs (arsenic, PCBs)
- Building 58 leaking sump; 12 ft bgs (TCE, PCBs)
- Building 231 footprint AOC 12; seven ft bgs (lead/mercury)

The deeper soil contamination listed above will be addressed during a separate groundwater remedial investigation.

F. Current and Potential Future Land and Water Uses

F.1 Current Land Use

The FFA is situated in an urban area consisting of both commercial/industrial and recreational properties. The current land use for Area I is commercial/industrial. Dietz and Watson is currently building warehouse facilities on a portion of Area I. Philadelphia Industrial Development Corporation owns the other portion of Area I, and plans to develop the property for industrial or commercial use.

F.2 Future Land Use

The most probable future land use for FFA Area I is considered to be commercial/industrial. Area I is currently zoned by the City of Philadelphia for Industrial Use and the existing/planned land usage by current owners are industrial and commercial in nature.

F.3 Groundwater and Surface Water Uses

Groundwater beneath the Site is not currently utilized as a potable water source. There are no wetlands, streams, or other surface watercourses located within Area I. Surface water at the FFA is controlled by a system of catch basins and storm water drains. The storm water in Area I is conveyed to the City of Philadelphia storm water drainage system.

The USACE conducted a search of federal, state, and municipal records to determine if there were any supply wells or surface water intakes within 0.5 miles of FFA. Records from the Pennsylvania Geological Survey, the Pennsylvania Groundwater Information System, the Delaware River Basin Commission, the Philadelphia Department of Public Works and the Philadelphia Water Department (PWD) were reviewed for information about water wells and intakes within 0.5 miles of the Site. Thirty-seven wells were identified, 23 of which were labeled as destroyed or no longer in use. Twelve wells, belonging to Rohm & Hass, are monitoring wells. One well is owned by Allied Chemicals and is used for industrial purposes. Another, owned by Krometal Manufacturing, Inc. located at 5825 Tacony Street, approximately 2,000 ft northeast and hydraulically cross gradient of the Site, is used for industrial processes. PWD confirmed that there were no surface or groundwater intakes within 0.5 miles of the Site.

G. Summary of Site Risks

The baseline risk assessment estimates potential risks posed by the Site if no actions were taken. It provides the basis for taking action and identifies contaminants and exposure pathways that need to be addressed by the remedial action. This section summarizes the results of the baseline risk assessment for the FFA Area I soil.

G.1 Human Health Risk Assessment

The Human Health Risk Assessment (HHRA) evaluated potential exposure to Area I soils for four reasonable maximum exposure (RME) receptors:

- Industrial/commercial worker,
- Construction worker,

- Utility worker, and
- Maintenance worker

It was assumed that all receptors may be exposed to both surface soil and subsurface soil. The industrial/commercial worker scenario was considered the likely potential future RME scenario for the FFA. The intent of the RME scenario was to focus the assessment on a conservative exposure that represents the maximum exposure that is reasonably expected to occur (USEPA, 1989a, b).

Three exposure pathways – soil ingestion, dermal contact, and inhalation of VOCs – were considered for each RME scenario. It was assumed that all receptors may be exposed to both surface soil and subsurface soil.

G.1.1 Identification of Contaminants of Concern

The primary soil contaminants of concern identified in the HHRA are metals, VOCs, SVOCs and PCBs. The individual soil contaminants of potential concern (COPCs) identified for the Area I soil above the water table are presented in Table 4.

G.1.2 Exposure Assessment

The HHRA identified and quantified three potential industrial/commercial exposure pathways:

- Incidental ingestion of surface and subsurface soil;
- Inhalation of airborne contaminated dust or volatile emissions from surface and subsurface soil; and
- Dermal exposure to chemicals in surface and subsurface soil.

Humans routinely ingest small amounts of soil or soil-like materials each day primarily as a result of hand-to-mouth activity. Soil ingestion is frequently an important pathway of exposure. Dermal contact is also a likely route of exposure to chemicals in environmental media. Dermal contact with soils could result in the absorption of chemicals through the skin.

Inhalation exposure may result from inhaling chemicals that have volatilized or dust that has become airborne. Fugitive dust emissions of inorganic particulates could be generated by soils that are not paved over or covered with vegetation. Because the soil surface at Area I is predominantly paved, the potential for contaminants in surface soil to be released to air via fugitive dust emission is minimal. However, as particles can be emitted into the air either by wind erosion or as a result of mechanical disturbance, inhalation exposure to chemicals in soil was evaluated.

The inhalation of chemical constituents present in subsurface soil and groundwater to indoor air pathways was not evaluated during the soil remedial investigation, as the remaining subsurface contamination is below the groundwater table. This pathway will be evaluated during the groundwater remedial investigation.

The groundwater exposure pathway was considered for evaluation; however, groundwater beneath the Site is not currently utilized as a potable water source. Furthermore, it is unlikely that future receptors will be utilizing the groundwater for such purposes. Therefore, it was not incorporated into the evaluation. As noted previously, there will be a subsequent

groundwater remedial investigation to evaluate the nature and extent of groundwater contamination and to conduct a groundwater risk assessment for the groundwater to indoor air pathway.

G.1.3 Risk Characterization

The risk assessment considers two types of risk: cancer risk and non-cancer risk. Typically, remedial action is considered at a CERCLA site when cumulative excess cancer risks exceed the United States Environmental Protection Agency (USEPA) risk range of $1x10^{-6}$ to $1x10^{-4}$ (i.e., one in one million to one in ten thousand) (USEPA, 1990b). For non-cancer effects, a hazard index (HI) is calculated which sums the non-cancer effects due to exposure to multiple COPCs for an exposure pathway. An HI greater than 1 indicates potential adverse non-cancer health effects.

The exposure scenarios and associated total risks evaluated under the HHRA are discussed below. Risks identified for each exposure scenario pathway, along with the chemical constituents driving such risk, are presented in Table 5.

Adult Industrial Commercial Worker

This exposure scenario assumes that the industrial/commercial worker may be exposed to residual soil contamination that may be present in soil. The worker is modeled as a typical site worker who spends most of the time indoors.

Excess cumulative risk for the adult industrial/commercial worker was identified as $1.1x10^{-5}$, well within USEPA's acceptable risk range of $1x10^{-6}$ to $1x\ 10^{-4}$. All risks were associated with potential exposure to both surface and subsurface soils via ingestion and the dermal pathway. The hazard index was less than 1.

The carcinogenic risk drivers for this exposure scenario are arsenic, chromium and benzo (a) pyrene.

Construction Worker

Under this scenario, construction workers are presumed to be exposed to residual contamination present in both surface and subsurface soil during construction activities. During a typical working day, the construction worker is assumed to spend eight hours outdoors.

Total cumulative risk for the adult construction worker is shown to be $3x10^{-6}$, within USEPA's acceptable risk range of $1x10^{-6}$ to $1x10^{-4}$. All of the risks are from potential exposure to both surface and subsurface soils via ingestion. The hazard index was less than 1.

The carcinogenic risk drivers for this exposure scenario are arsenic and chromium.

Utility Worker

The utility worker may participate in utility work or other intrusive outdoor activities at the Site. Like the construction worker, the utility worker is assumed to work outdoors eight hours a day.

Total cumulative risk for the adult utility worker is shown to be $2x10^{-7}$. This level of risk is slightly less than the lower end of the acceptable risk range ($1x10^{-6}$). The hazard index was less than 1.

Maintenance Worker

This receptor is responsible for caretaker activities such as mowing the grass, clearing brush, and general site maintenance. The maintenance worker is assumed to spend four hours per day indoors and four hours per day outdoors.

Total cumulative risk for the adult maintenance worker is shown to be $3x10^{-6,}$ well within the USEPA's acceptable risk range of $1x10^{-6}$ to $1x10^{-4}$. All of the risk is from potential exposure to both surface and subsurface soils via ingestion. The hazard index was less than 1.

There are no individual carcinogenic risk drivers for this scenario. The carcinogenic risk for each COPC was less than $1x10^{-6}$.

G.1.4 Lead Risk Assessment

The USEPA Adult Lead Model (ALM) was utilized to perform the risk characterization for exposures to lead in soil. The ALM model predicts the blood lead concentrations in women of child-bearing age, as well as for the most sensitive potential receptor - the fetus of a pregnant adult worker. The model results predicted estimated blood lead concentrations of up to 1.7 micrograms per decaliter (μg/dL) in an adult site industrial/commercial worker and 5.1 μg/dL in the fetus of a pregnant adult site industrial/commercial worker (Table 6). For both cases, the predicted fetal blood lead concentration is less than the USEPA threshold level of 10 μg/dL; thus, the risks are considered to be acceptable.

The ALM results also indicated that the highest probability that the blood lead concentration in the fetus of a pregnant adult industrial/commercial worker would exceed 10 μg/dL was 0.6%, which is less than the 5% benchmark established by USEPA. Thus, the results of the ALM model indicate that no potential adverse human health impacts are likely to occur as a result of exposure to lead at the Site.

G.1.5 Uncertainties in Risk Estimates

There are a variety of factors that contribute to the uncertainty in risk estimates presented in this risk assessment. The use of site-specific factors can decrease uncertainty, but it persists in even the most site-specific risk assessments. This inherent uncertainty affects the level of confidence which can be placed in the final results. However, because the assumptions used in the exposure and toxicity assessments tend to be health-protective and conservative in nature, the risks estimated in this human health risk assessment are likely to exceed the most probable risk posed to potential receptors at the Site.

The use of site-specific factors can decrease uncertainty, but it persists in even the most site-specific risk assessments. Therefore, risk assessment of contaminated sites must not be viewed as yielding single value, invariant results. Rather, the results of risk assessment are estimates that span a range of possible values, and must be understood only in light of the assumptions and methods used in the evaluation.

G.2 Ecological Risk Assessment

An ecological risk evaluation was performed for Area I to evaluate whether releases of chemicals to onsite soils may adversely affect ecological receptors. The scope of the ecological evaluation was exclusively Area I onsite soils. Evaluation of potential ecological

risks due to surface water, sediments or groundwater pathways associated with Area I will be conducted at a later time as part of a future groundwater remedial investigation.

There are no threatened or endangered species in Area I nor freshwater wetlands on or in the vicinity of Area I. Based on visual observations of ecological receptors around Area I, it was concluded that wildlife in Area I would be mainly industrial-tolerant animals such as cottontail rabbits, skunks, rats, and pigeons.

The current and probable future land use for Area I is commercial/industrial. The Site currently has and is expected in the future to continue to have physical features that would severely reduce potential exposure to Area I soil, such as parking lots, paved areas, and maintained landscaping. As a result, no ecological habitats and associated receptors are known to be associated with the current and future land use for Area I. Since the soil exposure pathway, and ecological habitats and associated receptors are not present, no additional ecological evaluation is necessary for soils at Area I.

G.3 Baseline Risk Assessment Summary

The results of the carcinogenic chemical risk assessments for both current and future receptor scenarios showed that the carcinogenic risks for the industrial/commercial worker, construction worker, and maintenance worker were within the CERCLA acceptable cancer risk range of $1x10^{-6}$ to $1x10^{-4}$. Noncancer hazard indices did not exceed the CERCLA limit of one for any receptor.

The results of the ALM model indicate that no potential adverse human health impacts are likely to occur as a result of exposure to lead at FFA.

III. RESPONSIVENESS SUMMARY

The public comment period for the FFA Area I Soils *Proposed Plan* extended from February 5, 2015 to March 9, 2015. No verbal or written comments were received during the public comment period. No comments were received (verbal or written) from PADEP or from property owners.

IV. REFERENCES

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TABLES

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Table 1: Former Frankford Arsenal Area I Previous Investigations Summary

Site Investigation	Date	Results
Inventory and Hazmat Removal, U.S. Army	1973 to 1976	The Army inventoried and removed hazardous materials from the FFA, including commercial quantities of acids, bases, solvents, paints, and laboratory reagents. Approximately one ton of mercury and six tons of depleted uranium were removed, as well as other radionuclides in smaller quantities.
Installation Assessment, USATHAMA,	1977	A records and historical data search was conducted to assess possible contamination and contaminant migration beyond the installation boundaries. Several areas on the installation were determined to be potentially contaminated with explosives, pyrotechnics, propellants or propellant wastes and unexploded ordnance. There were two disposal areas at FFA: a sanitary disposal area operated during the civil war period, and a demolition debris disposal area in the southeast portion of Area I.
Detailed Survey and Alternatives Assessment for FFA, Battelle	1978	A survey was conducted that included the property, buildings, vents, sewers, sumps, surface water, sediments, groundwater, soil, ambient air and biota. The results confirmed low levels of heavy metal residues, explosive residues, and radiological contamination. The survey results constituted the basis for the facility decontamination conducted by Rockwell for USATHAMA in 1980/1981.
Historic and Archeological Survey, John Milner Associates, Inc.	1979	The 1978 Battelle survey assessed the future use of site buildings and other facilities to determine whether future plans could be combined with national preservation objectives. In addition to documenting the historic evolution of the facility, the report discusses the archeological, architectural, and industrial significance of the installation, and the preservation guidelines to be used in future planning and development.
Frankford Arsenal Decontamination/Cleanup Report, Rockwell	1981	The survey concluded that numerous buildings and sumps, sewers, and vents were contaminated with low levels of heavy metal, explosive, and radiological residues and required cleanup. The FFA decontamination was conducted using Army-approved standard operating procedures; and post-cleanup data indicated that the approved release criteria for the identified contaminants were satisfied.

Table 1: Former Frankford Arsenal Area I Previous Investigations Summary (Continued)

Site Investigation	Date	Results
Remedial Action Decision Document, USATHAMA	1988	A Decision Document was prepared providing a description of the selected remedy based upon the decontamination/cleanup work documented in the Battelle and Rockwell reports.
Phase 1 Site Assessment, Property Solutions, Inc.	1996	Information reviewed included historical ownership records, aerial photographs, and USGS topographic maps. The review was supplemented by a historical records search, site visit, and interviews of current and former employees. PSI concluded that there were 15 areas of potential environmental concern including spray painting areas, ASTs, USTs, PCB-containing equipment, asbestos-containing materials, potential lead-based paints in many buildings, bulk storage of chemicals, hazardous materials and other raw materials storage, visual staining of floors and drains in buildings, and waste piles of demolition debris and other wastes.
Site Inspection and Evaluation, USEPA	1996	General environmental conditions at the FFA were evaluated, and potential issues of non-compliance at the facility were identified. The inspection identified non-compliance issues related to the discharge of wastewater to the sewers from Buildings 124 and 238. Some drains from these buildings discharge to Frankford Creek. One of the drains was diverted to the sanitary sewer system to correct the problem. Compliance issues were also related to potential PCB contamination, including storage drums containing PCBs and a PCB cleanup effort that was conducted at Buildings 128, 149, 150 and 250 by the property owner.
Phase 1 Environmental Site Assessment (ESA), Langan Environmental & Engineering Services	1999	The ESA consisted of groundwater-monitoring well installation, groundwater sampling, surface soil sampling, subsurface soil investigation (soil borings/test pits), sump, pit, and drain sampling in existing buildings. The soil investigation included collection of 42 soil samples from 48 soil borings; 17 soil samples from 42 test pits; and 48 surface soil samples. The results showed the presence of inorganic and organic contamination in soil and groundwater at the Site exceeding the PADEP non-residential cleanup standards for soil and groundwater; arsenic and lead, VOCs (TCE and carbon tetrachloride), SVOCs (naphthalene), and PCBs.

Table 1: Former Frankford Arsenal Area I Previous Investigations Summary (Continued)

Site Investigation	Date	Results
Radiological Historical Site Assessment, Cabrera Services	2001	106 buildings were evaluated to determine if they were potentially affected by radiological operations. Fifty-six of the buildings were determined to be impacted, indicating that radiological surveys would have been necessary to ensure that the buildings had been properly released. Of the 56 buildings, 14 had survey documentation showing verification and release granted by the NRC. Verification of final release surveys could not be located for the remaining 42 buildings as 19 of these buildings had been demolished and 23 remained. The radionuclide COPCs were identified as depleted uranium, radium, tritium, cesium-137 and cobalt-60.
Radiological Scoping Survey, Cabrera Services	2003	A radiological scoping survey was performed to determine if residual concentrations of the radionuclide COPCs in buildings and land areas supported the prior license termination action to release the Site for unrestricted use. Eight areas of "High Priority," four areas of "Medium Priority," and 29 areas of "Low Priority" were identified. The survey determined that there were no radionuclide COPCs present above the screening level and concluded that there was no residual radioactive contamination at concentrations of concern. NRC concurred and released FFA for unrestricted use (with respect to radioactivity) in 2003.
Engineering Evaluation/Cost Analysis for MEC, USA Environmental	2005	DoD commissioned an EE/CA to investigate and characterize the presence of MEC, evaluate associated risk, if any, and develop appropriate measures to mitigate such risk. The EE/CA concluded that buried munitions were a potential hazard; however, their presence was considered to be unlikely. The report recommended institutional controls to protect workers during future intrusive investigations and/or development activities.
Draft Act 2 Remedial Investigation Report, Langan Environmental & Engineering Services	2005	The RI involved the installation/sampling of soil borings and groundwater monitoring wells. The presence of PCBs adjacent to Building 128 was confirmed. The RI incorporated results of the 1999 Phase 1 ESA. The combined data evaluation identified several areas of soil contaminated with heavy metals, VOCs, SVOCs, PCBs, and radionuclides. The report identified limited areas of groundwater contamination and concluded that groundwater contamination was contained onsite.

Table 1: Former Frankford Arsenal Area I Previous Investigations Summary (Continued)

Site Investigation	Date	Results
Supplemental Site Investigation, Cabrera Services	2007	An SSI was performed to verify the nature and extent of contamination within Area I at locations identified during previous investigations. Thirty-five soil borings, 24 temporary and 14 permanent groundwater monitoring wells were installed, and eight test pits were excavated. Constituents that exceeded the screening values included lead and VOCs (benzene; carbon tetrachloride; PCE; and TCE). No concentrations of SVOCs, PCBs, or explosives exceeded the screening limits. Based on the results evaluated from the 1995 through 2007 investigations, 16 AOIs were identified as potential source areas of soil and groundwater contamination. These AOIs were further investigated in the 2008 Area I Data Gap Investigation.
Area I Data Gap Investigation, Cabrera Services	2008	The objective was to determine the lateral and vertical extent of soil contamination at the 16 AOIs. Thirtysoil borings were advanced and approximately 90 soil samples were collected for metals, VOCs, SVOCs, PCBs, and radionuclides. Based on the results, 11 AOIs were designated Areas of Concern (AOCs) as source areas for soil contamination.
Project Close-Out Report, EA Engineering	2008	EA Engineering, Technology, and Science performed the removal of USTs and batteries, as well as the abandonment of groundwater monitoring wells. Additionally, EA focused on the determination of the presence or absence of soil and groundwater contamination associated surrounding the removal areas. Of 10 USTs investigated; seven were found at four locations: Building 128, Buildings 44/47, Building 48, and Buildings 55/58. Sixteen groundwater monitoring wells were scheduled for abandonment; however, only eight wells could be located. Each well was tremie grouted and the surface casing cut to the ground surface
Area I Groundwater Monitoring and Sampling	2007–2009	Five groundwater-monitoring events were conducted at Area I between 2007 and 2009. Twenty-six 26 monitoring wells and seven piezometers were sampled for VOCs, SVOCs, metals, PCBs, explosives and radiological parameters. Sample results were compared to the PA Act 2 MSCs. VOCs, SVOCs, antimony, lead, thallium, and zinc were reported to exceed their respective MSCs.

Table 1: Former Frankford Arsenal Area I Previous Investigations Summary (Continued)

Site Investigation	Date	Results
Area I Interim Removal Actions	2009-2013	Six soil removal actions were implemented to address contaminated areas identified during the Data Gap (2008) sampling. Fifteen locations were remediated and 3 USTS removed. A total of 7,327 cubic yards of contaminated soil was excavated and disposed of offsite.

Table 2: Cleanup Levels for Former Frankford Arsenal Area I Soils

Analytes	Surface Soil Cleanup Levels	Subsurface Soil Cleanup Levels
Metal (mg/kg)		
Arsenic, Total	29	29
Chromium, Total (Cr VI)	190	190
Copper, Total	43000	43000
Lead, Total	450	450
Mercury, Total	10	10
VOCs (ug/kg)		
Benzene	500	500
Carbon Tetrachloride	500	500
Methylene Chloride	500	500
Tetrachloroethene	500	500
Trichloroethene	500	500
SVOCs (ug/kg)		
2,4-Dinitrotoluene	840	840
PCBs (mg/kg)		
Aroclor 1016	1.0	1.0
Aroclor 1221	1.0	1.0
Aroclor 1232	1.0	1.0
Aroclor 1242	1.0	1.0
Aroclor 1248	1.0	1.0
Aroclor 1254	1.0	1.0
Aroclor 1260	1.0	1.0
Aroclor 1262	1.0	1.0
Aroclor 1268	1.0	1.0

Table 3: Area of Concern Summary

AOC	Former Frankford Arsenal Building	Site Constituents	Final Status
1/1	47	VOCs	2009-2013 Interim Removal No remaining exceedances
2/2	47	VOCs	2009-2013 Interim Removal No remaining exceedances
3/3	47/48	VOCs	2009-2013 Interim Removal No remaining exceedances
4/4	64	PCBs	2009-2013 Interim Removal No remaining exceedances
5/5	127-128	Arsenic, chromium, lead, mercury	2009-2013 Interim Removal Remaining exceedances due to arsenic MSC*
6/6	128	Arsenic	2009-2013 Interim Removal Remaining due to arsenic
7/7	149-150	VOCs, SVOCs, arsenic	2009-2013 Interim Removal Remaining exceedances due to arsenic
8/8	237	PCBs	2009-2013 Interim Removal Remaining exceedances due to existing foundations or arsenic
9/9	301	Arsenic, PCBs	Urban fill, depth 1-2 feet, acceptable risk**
10/10	Landfill (MW-3)	Arsenic, chromium, lead, VOCs	Contamination below groundwater table; address in Area IV (Groundwater) RI
11/11	141-143/ Compound Area	Arsenic	2009-2013 Interim Removal Remaining exceedances due to arsenic
12/12	231	Lead, mercury	2009-2013 Interim Removal Remaining exceedances below groundwater table; address in Area IV RI

Table 3: Area of Concern Summary (Continued)

AOC	Former Frankford Arsenal Building	Site Constituents	Final Status
13/13	125-126	PCE	Remaining exceedances below groundwater table; address under Area IV RI
14/14	55-58	Arsenic, PCBs, VOCs	Remaining exceedances below groundwater table; address under Area IV RI
15/15	324	Arsenic, chromium, lead	Remaining exceedances below groundwater table; address under Area IV RI
16/16	46	TCE	Remaining exceedances below groundwater table; address under Area IV RI
58 Leaking Sump (discovered during building demolition)		PCBs, SVOCs, VOCs	2009-2013 Interim Removal Remaining exceedances below groundwater table; address under Area IV RI
Building 47 Oil/Water Separator (discovered during building demolition)		PCBs, VOCs	2009-2013 Interim Removal No remaining exceedances
Building 48 USTs (discovered during building demolition)		SVOCs, VOCs	2009-2013 Interim Removal No remaining exceedances

Table 3: Area of Concern Summary (Continued)

AOC	Former Frankford Arsenal Building	Site Constituents	Final Status
Building 44/47 Tank Pit (2008 CON/HTRW UST removal)		Lead, PCBs	2009-2013 Interim Removal Remaining exceedances below groundwater table; address in Area IV RI
Building 128 transformer pad		PCBs	2009-2013 Interim Removal No remaining exceedances

* In 2011, the PADEP MSC for arsenic was reduced to 29 mg/kg surface/subsurface from 53mg/kg surface/150 mg/kg subsurface.

**Based upon initial risk assessment performed with 2008 Data Gap samples.

Table 4: Summary of Constituents of Potential Concern

COPC	Total Soils
METAL COPCs	
ALUMINUM	√
ANTIMONY	√
ARSENIC	√
CHROMIUM	√
COBALT	√
COPPER	√
LEAD	√
MANGANESE	√
MERCURY	√
VANADIUM	√
VOC COPCs	
BENZENE	√
CARBON TETRACHLORIDE	√
CHLOROFORM	√
TETRACHLOROETHENE	√
TRICHLOROETHENE	√
SVOC COPCs	
BENZO(A)ANTHRACENE	√
BENZO(A)PYRENE	√
BENZO(B)FLUORANTHENE	√
BENZO(K)FLUORANTHENE	√
CHRYSENE	√
DIBENZO(A,H)ANTHRACENE	√
INDENO(1,2,3-CD)PYRENE	√
NAPHTHALENE	√
PCB COPCs	
AROCLOR 1254	√
AROCLOR 1260	√

Table 5: Results of Chemical Risk Assessments

Receptor	Medium	Exposure Pathway	Carcinogenic Risk	Hazard Indices
Industrial Worker	Surface and Subsurface Soil	Ingestion	1E-05	0.07
		Inhalation	2E-07	0.002
		Dermal Contact	4E-06	0.009
		Total	**1E-05**	**0.08**
Construction Worker	Surface and Subsurface Soil	Ingestion	3E-06	0.5
		Inhalation	6E-09	0.008
		Dermal Contact	4E-07	0.03
		Total	**3E-06**	**0.5**
Maintenance Worker	Surface and Subsurface Soil	Ingestion	2E-06	0.01
		Inhalation	2E-08	0.0002
		Dermal Contact	7E-07	0.002
		Total	**3E-06**	**0.02**
Utility Worker	Surface and Subsurface Soil	Ingestion	1E-07	0.02
		Inhalation	2E-10	0.00007
		Dermal Contact	5E-08	0.003
		Total	**2E-07**	**0.02**

Table 6. Summary of Estimated Blood Lead Concentrations

Receptor Scenarios	Blood Lead Concentration (µg/dl)			Probability of Fetal PbB Target Exceedance (%)[3]	
	Adult[1]	Fetus of Adult Worker[2]	Target Level (µg/dl)	Population Risk Level	Target Level (%)
Industrial/Commercial Worker	1.7	5.1	10	0.6	5
Construction Worker	1.9	5.7		0.8	
Maintenance Worker	1.5	4.7		0.4	
Maintenance Worker (TWA)	1.6	4.8		0.4	
Utility Worker	1.5	4.7		0.4	
Utility Worker (TWA)	1.8	5.4		0.6	

µg/dL = microgram per deciliter

[1] Blood lead concentration of adult worker is based on geometric mean

[2] Fetal PbB based on 95th percentile

[3] Probability that fetal PbB will exceed the target level, assuming lognormal distribution

FIGURES

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Pennsylvania

Philadelphia

Wilmington

Maryland

New Jersey

Delaware

Former Frankford Arsenal

Delaware River

95

N

Highway

Philadelphia City Limits

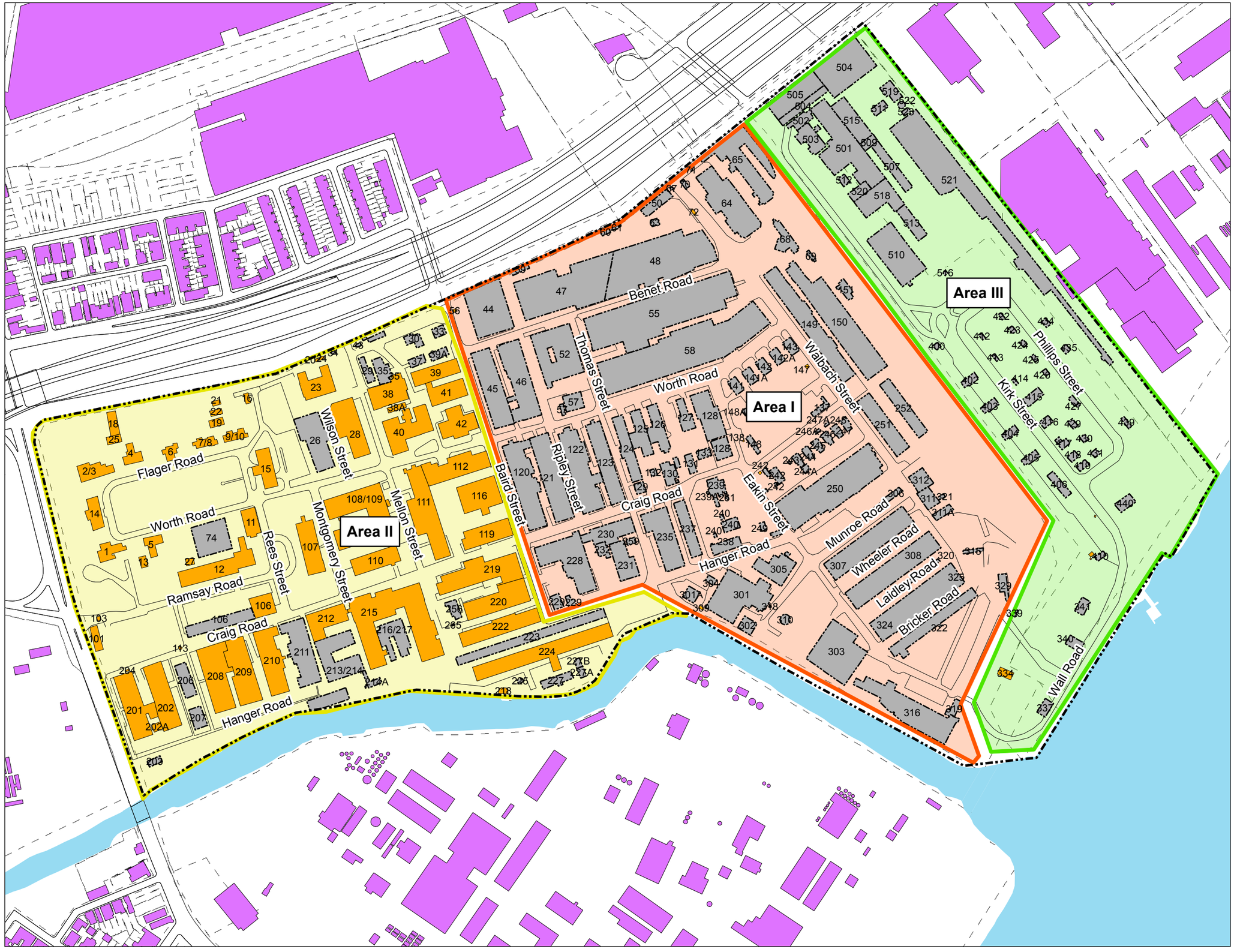
FORMER FRANKFORD ARSENAL
SITE LOCATION MAP

DECISION DOCUMENT
FORMER FRANKFORD ARSENAL
PHILADELPHIA, PENNSYLVANIA

1/2015	CABRERA Project No. 08-3103.00	FIGURE 1

Cabrera Services
1106 N. Charles St
Suite 300
Baltimore, MD 21202

U.S. Army Corps of Engineers, Baltimore District



Legend

- Original Frankford Arsenal Boundary
- Waterbodies

Buildings

- Existing FFA Building
- Demolished FFA Building
- Outside FFA Area

Phase Area Designations

- Area I (FFA Hankin)
- Area II (FFA Hankin)
- Area III
- Other Property Boundaries

0 300 600

Scale (feet)

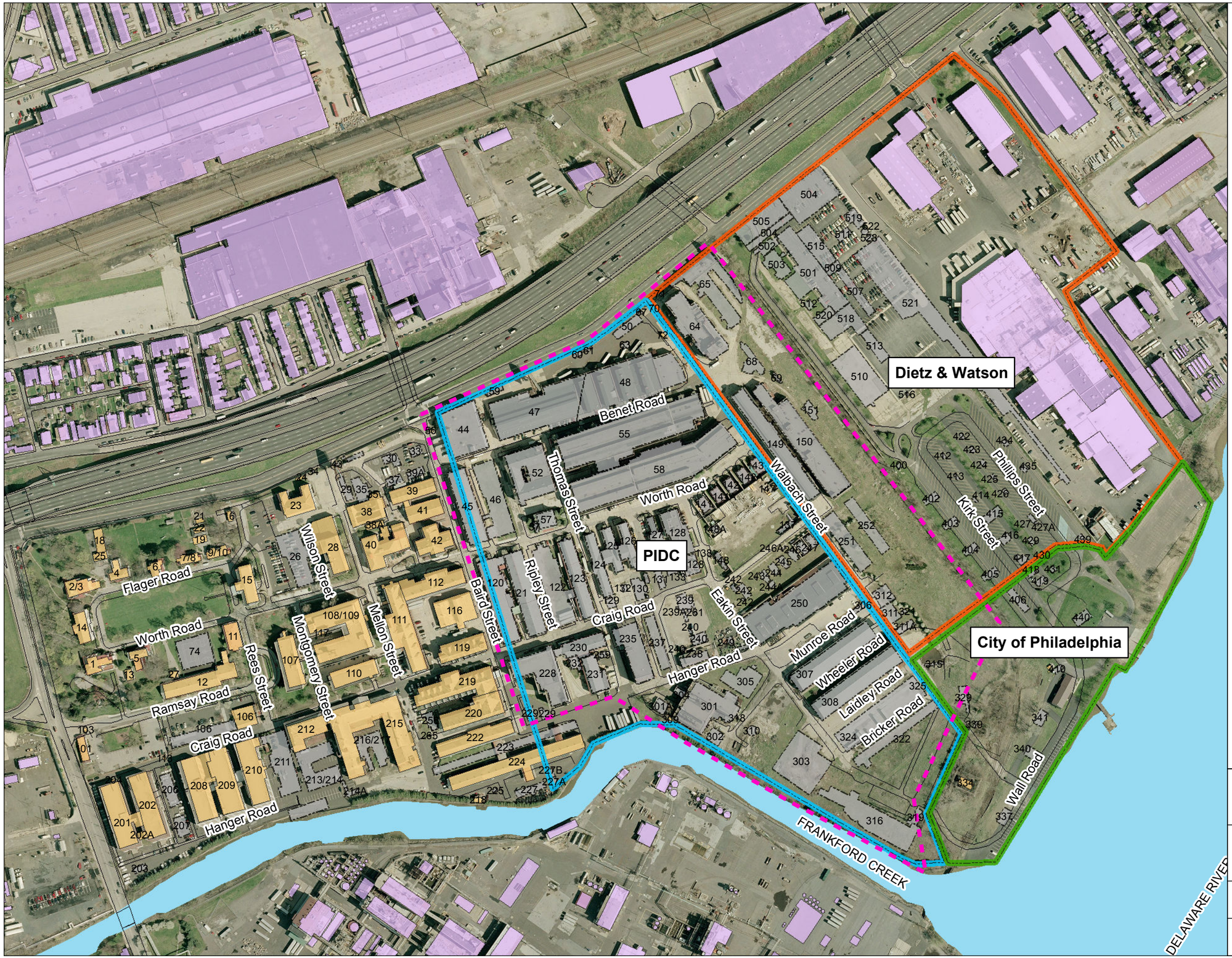
FORMER FRANKFORD ARSENAL
LAYOUT MAP

DECISION DOCUMENT
FORMER FRANKFORD ARSENAL
PHILADELPHIA, PENNSYLVANIA

1/2015	CABRERA Project No. 08-3103.00	FIGURE 2

Cabrera Services
1106 N Charles St
Suite 300
Baltimore, MD 21201

U.S. Army Corps of Engineers, Baltimore District



N

Area I Boundary

Property Boundary

City of Philadelphia

Dietz & Watson

PIDC

Buildings

Existing FFA Building

Demolished FFA Building

Outside FFA Area

Waterbodies

0 400 800

Scale (feet)

FORMER FRANKFORD ARSENAL
AREA I AND AREA III PROPERTY CHANGES

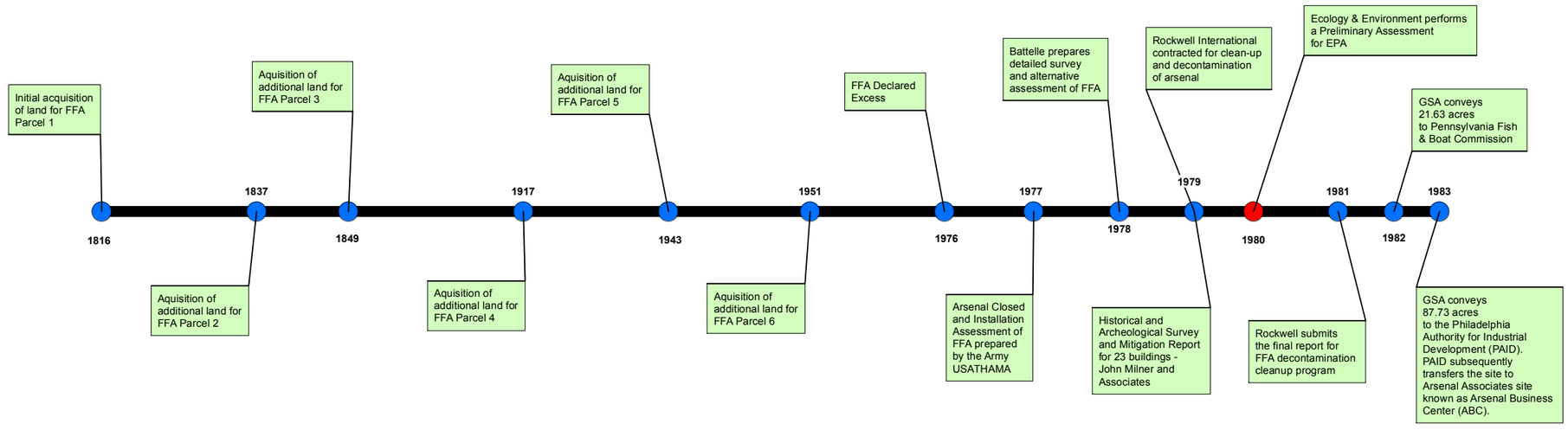
DECISION DOCUMENT
FORMER FRANKFORD ARSENAL
PHILADELPHIA, PENNSYLVANIA

12/2014	CABRERA Project No. 08-3103.00	FIGURE 3

Cabrera Services
1106 N Charles St
Suite 300
Baltimore, MD 21201

U.S. Army Corps of Engineers, Baltimore District

HISTORICAL TIMELINE OF EVENTS
1816 - 1983

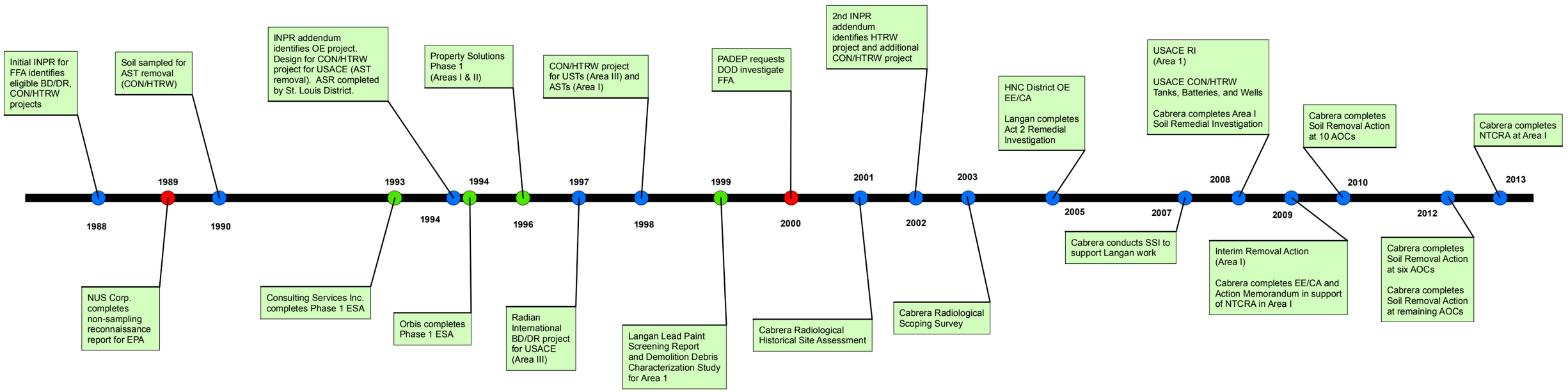


Legend

- Actions performed by DOD/Government
- Actions performed by PADEP/EPA
- Actions performed by Owner

HISTORICAL TIMELINE (1816 - 1983)		
DECISION DOCUMENT FORMER FRANKFORD ARSENAL PHILADELPHIA, PENNSYLVANIA		
1/2015	CABRERA Project No. 08-3103.00	FIGURE 4
Cabrera Services 103 E. Mount Royal Ave. Baltimore, MD 21202		U.S. Army Corps of Engineers, Baltimore District

HISTORICAL TIMELINE OF EVENTS
1984 - 2013



Legend

- Actions performed by DOD/Government
- Actions performed by PADEP/EPA
- Actions performed by Owner

HISTORICAL TIMELINE
(1984 - 2013)

DECISION DOCUMENT
FORMER FRANKFORD ARSENAL
PHILADELPHIA, PENNSYLVANIA

1/2015	CABRERA Project No. 08-3103.00	FIGURE 4

Cabrera Services
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Baltimore, MD 21202

U.S. Army Corps of Engineers,
Baltimore District

Legend

- Area of Concern (AOC)

Phase Area Designations

- Area I
- Area II
- Area III

Buildings

- Existing FFA Building
- Demolished FFA Building
- Outside FFA Area
- Waterbodies

0 400 800

Scale (feet)

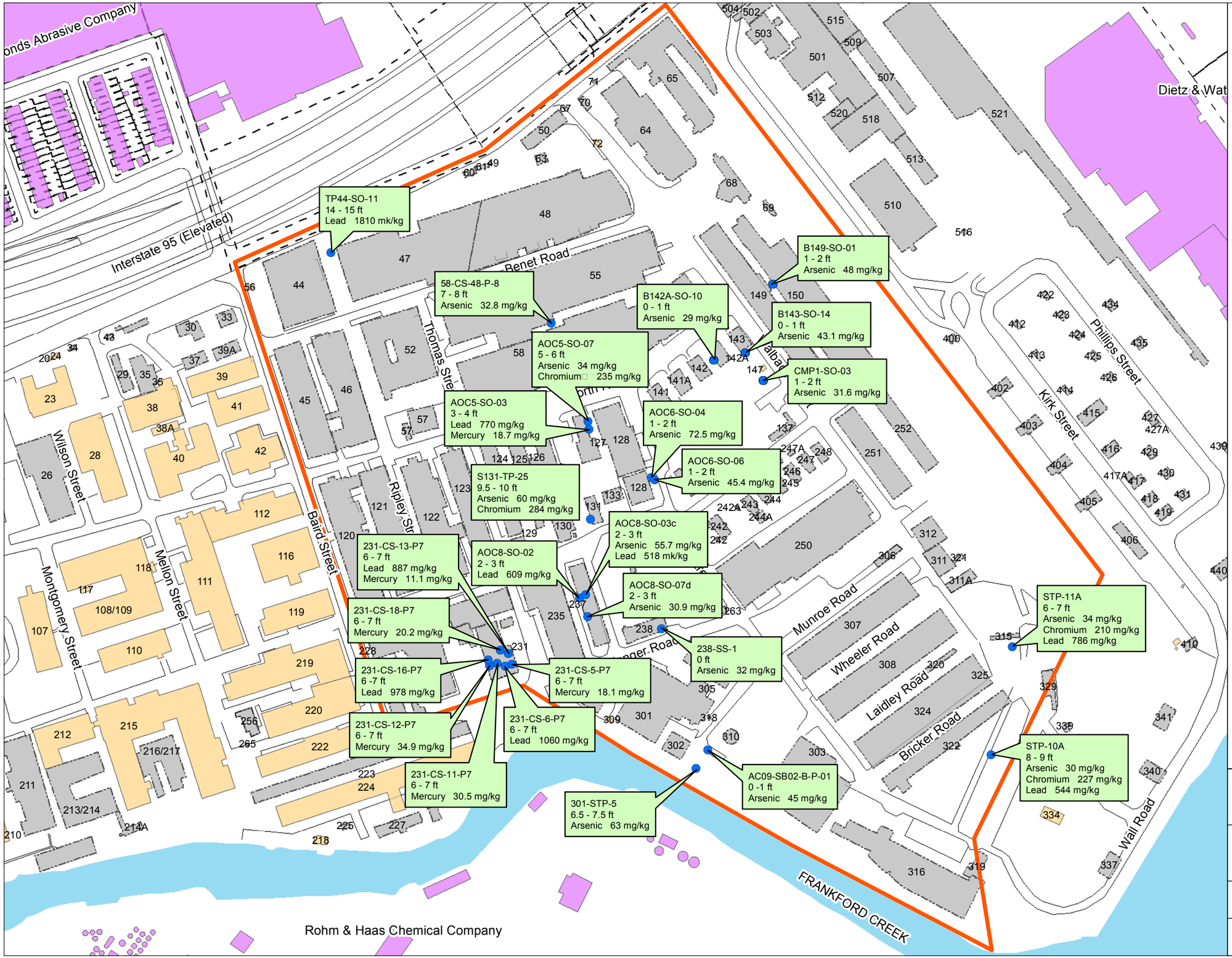
LOCATION AND DIMENSIONS OF COMPOUND AREA AND AOCs 3-8

DECISION DOCUMENT
FORMER FRANKFORD ARSENAL
PHILADELPHIA, PENNSYLVANIA

12/2014	CABRERA Project No. 08-3103.00	FIGURE 5

Cabrera Services
1106 N Charles St
Suite 300
Baltimore, MD 21201

U.S. Army Corps of Engineers, Baltimore District



Legend

- Soil Sample (Exceeds Cleanup)
- Area I Boundary

Buildings

- Existing FFA Building
- Demolished FFA Building
- Outside FFA Area
- Waterbodies

Sample ID
Depth Interval (Feet)
Soil Concentration (mg/kg)

mg/kg = milligrams per kilogram

0 200 400

Scale (feet)

METALS SOIL CONCENTRATION EXCEEDING CLEANUP LEVELS, 2013

DECISION DOCUMENT
FORMER FRANKFORD ARSENAL
PHILADELPHIA, PENNSYLVANIA

12/2014	CABRERA Project No. 08-3103.00	FIGURE 6

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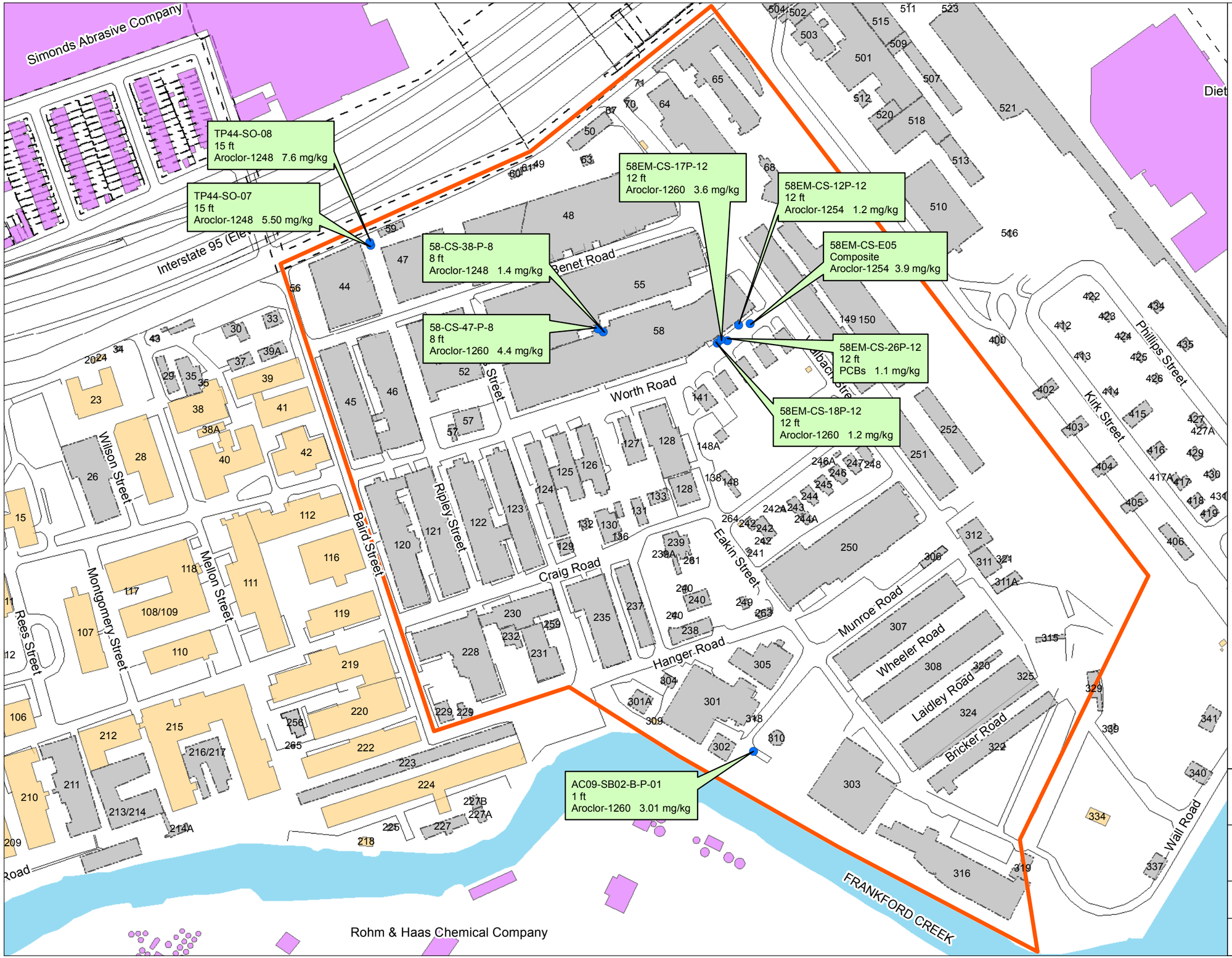

Legend

- Soil Sample (Exceeds Cleanup)
- Area I Boundary

Buildings

- Existing FFA Building
- Demolished FFA Building
- Outside FFA Area
- Waterbodies

Sample ID
Depth Interval (Feet)
Soil Concentration (mg/kg)

mg/kg = milligrams per kilogram

0 200 400
Scale (feet)

PCB SOIL CONCENTRATION EXCEEDING CLEANUP LEVELS, 2013

**DECISION DOCUMENT
FORMER FRANKFORD ARSENAL
PHILADELPHIA, PENNSYLVANIA**

12/2014	CABRERA Project No. 08-3103.00	FIGURE 7

Cabrera Services
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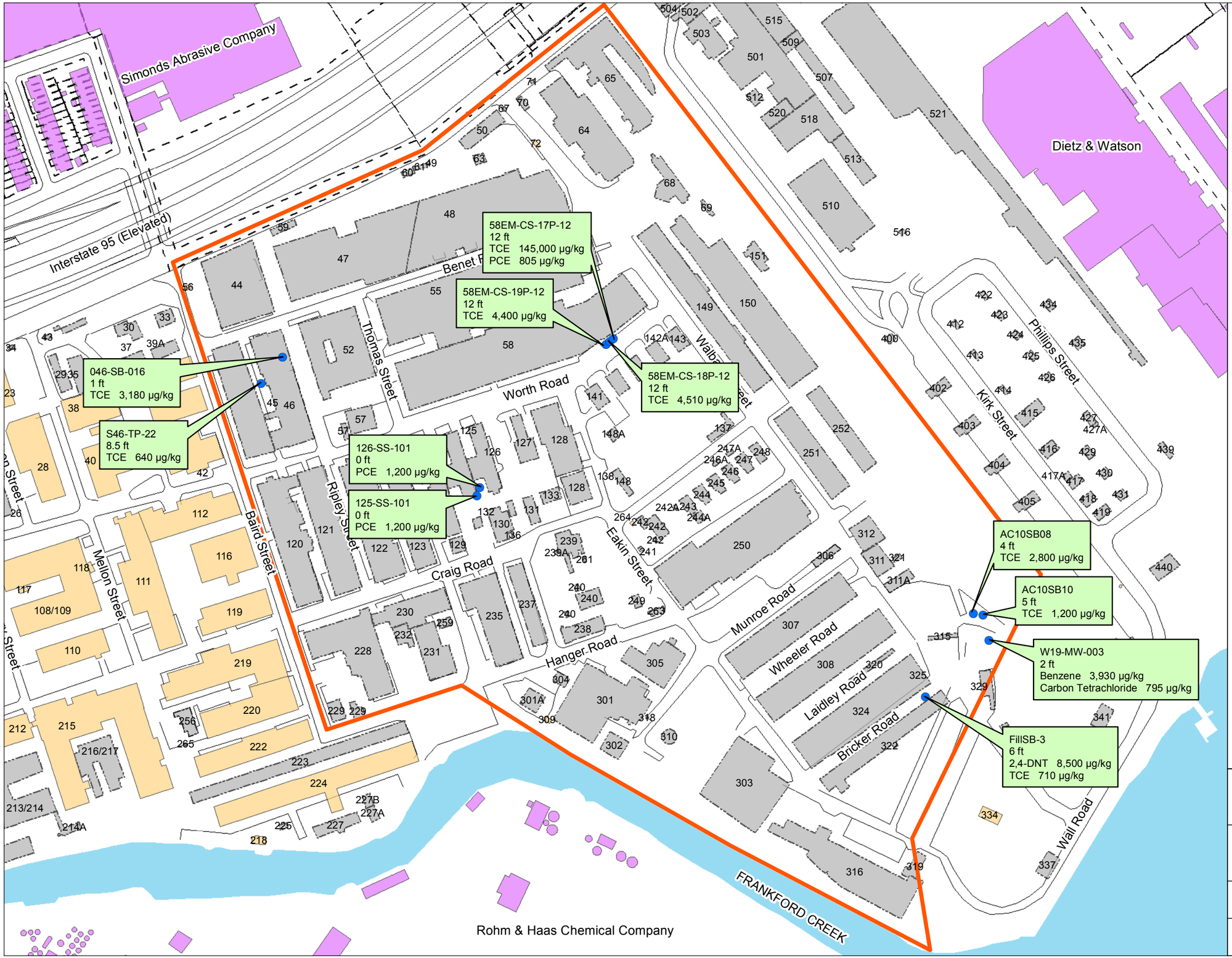

Legend

- Soil Sample (Exceeds Cleanup)
- Area I Boundary

Buildings

- Existing FFA Building
- Demolished FFA Building
- Outside FFA Area
- Waterbodies

Sample ID
Depth Interval (Feet)
Soil Concentration (ug/kg)

ug/kg = micrograms per kilogram

0 200 400
Scale (feet)

SVOC/VOC SOIL CONCENTRATION EXCEEDING CLEANUP LEVELS, 2013

DECISION DOCUMENT
FORMER FRANKFORD ARSENAL
PHILADELPHIA, PENNSYLVANIA

12/2014	CABRERA Project No. 08-3103.00	FIGURE 8

Cabrera Services
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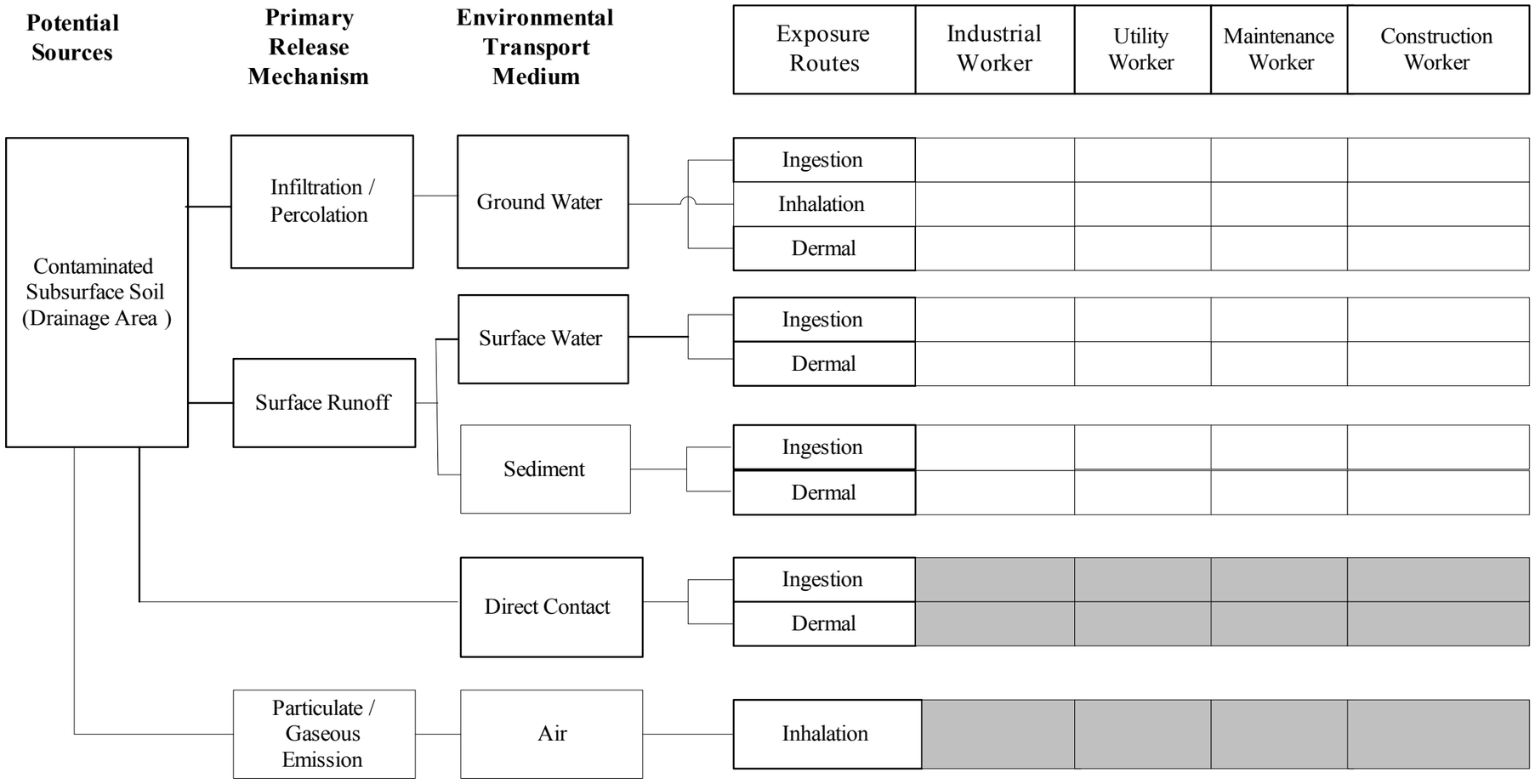
U.S. Army Corps of Engineers, Baltimore District



CONCEPTUAL SITE MODEL

DECISION DOCUMENT
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1/2015	CABRERA Project No. 08-3103.00	FIGURE 9

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