FINAL
FEASIBILITY STUDY REPORT
FRANKLIN SLAG PILE

PHILADELPHIA, PENNSYLVANIA

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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EA Engineering, Science,
and Technology, Inc., PBC

FINAL FEASIBILITY STUDY REPORT
FRANKLIN SLAG PILE
PHILADELPHIA, PENNSYLVANIA

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LIST OF ACRONYMS AND ABBREVIATIONS

µg/L	Microgram(s) per liter
µg/dL	Microgram(s) per deciliter
ARAR	Applicable or Relevant and Appropriate Requirements
ATSDR	Agency for Toxic Substances and Disease Registry
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	Contaminant of concern
COPC	Chemical of potential concern
EA	EA Engineering, Science, and Technology, Inc., PBC
EPA	United States Environmental Protection Agency
EPC	Exposure point concentration
ERA	Ecological risk assessment
FS	Feasibility study
FSRC	Franklin Smelting and Refining Corporation
ft	Feet/foot
G	Groundwater
GRA	General response action
HDPE	High-density polyethylene
HHRA	Human health risk assessment
HI	Hazard index
LLDPE	linear low-density polyethylene
MCL	Maximum contaminant level
MDC	MDC Industries
mg/kg	Milligrams per kilogram
MSC	Medium specific concentration
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
O&M	Operations and maintenance
OSHA	Occupational Safety and Health Administration
OU	Operable unit
PADEP	Pennsylvania Department of Environmental Protection
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl

PGW	Philadelphia Gas Works
PPE	Personal protective equipment
PRB	Permeable reactive barrier
PRG	Preliminary remediation goal
PRM	Potomac-Raritan-Magothy
PWD	Philadelphia Water Department
RAO	Remedial action objective
RCRA	Resource Conservation and Recovery Act
RI	Remedial investigation
ROD	Record of Decision
RSL	Regional screening level
S	Slag/soil
SARA	Superfund Amendments and Reauthorization Act of 1986
Site	Franklin Slag Pile Superfund Site
SSL	Soil screening level
SLERA	Screening-level ecological risk assessment
SVOC	Semivolatile organic compound
TAL	Target analyte list
TBC	To be considered
TCL	Target compound list
TCLP	Toxicity Characteristic Leaching Procedure
TtNUS	Tetra Tech NUS, Incorporated
VOC	Volatile organic compound

EXECUTIVE SUMMARY

EA Engineering, Science, and Technology, Inc., PBC (EA) has prepared this Feasibility Study (FS) for the Franklin Slag Pile Superfund Site (the Site), located in Philadelphia, Pennsylvania. This work was performed under U.S. Environmental Protection Agency (EPA) Remedial Action Contract Number EP-S3-07-07: Work Assignment 024 for EPA Region 3. This FS has been completed in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 and the National Oil and Hazardous Substances Pollution Contingency Plan (40 Code of Federal Regulations Part 300). The interim final Guidance for Conducting Remedial Investigations (RIs) and FSs under CERCLA (EPA 1988) was used to establish the framework for this FS.

The Site is located in the Port Richmond section of Philadelphia, Pennsylvania and consists of a large pile of slag generated from the secondary copper smelting process at the neighboring Franklin Smelting and Refining Corporation (FSRC). The slag pile occupies an approximately 4-acre lot and is covered with a 60-mil-thick high-density polyethylene (HDPE) geomembrane that was anchored in a 3-foot deep trench around the slag pile. Slag was piled on the ground surface and is not present below grade. MDC Industries (MDC) crushed, dried, and sized copper smelter slag from FSRC. The slag was sold as sand-blasting grit and for use as grit in asphalt roofing shingles. MDC operated from the 1950s until 1999; FSRC ceased operations in 1997.

The Site has been divided into two operable units (OUs): OU-1, which addresses the slag pile and associated soil, and OU-2, which addresses groundwater. The RI for OU-1 was completed in 2007 and did not assess impacts to groundwater at the Site. The RI for OU-2, which assessed potential impacts to groundwater from the slag pile, was finalized in 2018.

The RI for OU-1 (slag/soil) concluded that unacceptable exposures to the slag in the pile would be expected if the integrity of the HDPE cover were compromised in the future. The RI recommended that an FS be conducted to evaluate permanent remedies for the slag pile and any residual contaminated soils adjacent to the pile. Metals (including aluminum, beryllium, chromium, cobalt, copper, iron, lead, and manganese) were identified as contaminants of concern in slag and any underlying contaminated soil associated with the slag pile. Based on the findings of the RI and previous FS (completed in 2007), EPA issued a proposed plan proposing partial excavation and offsite disposal of slag, followed by regrading of the remaining slag and installation of a permanent multi-layered cap over the slag pile. However, EPA did not issue a Record of Decision (ROD) for OU-1 and embarked on further study and development of other alternatives for OU-1.

The RI for OU-2 (groundwater) identified arsenic, iron, manganese, cyanide, and polycyclic aromatic hydrocarbons (PAHs) as chemicals of potential concern (COPCs) for groundwater. However, the RI concluded that none of the groundwater COPCs are likely derived primarily from the Site.

The primary objective of this FS is to develop and evaluate remedial alternatives for OU-1 (slag/soil) and OU-2 (groundwater). A future response action is necessary to address potential risks associated with elevated concentrations of contaminants associated with the Site. The evaluation of response actions for the slag pile and associated soil in this FS is based on the findings of the Final RI Report for the Franklin Slag Pile Site, dated June 2007. The evaluation of response actions for groundwater is based on the findings of the Final RI Report, Franklin Slag Pile OU-2 Groundwater, Revision 4, dated April 2018.

This FS identifies the remedial action objectives and evaluates the effectiveness, implementability, and cost of various alternatives that may satisfy these objectives.

For OU-1 (slag/soil), five alternatives were evaluated using the nine criteria established by EPA:

- Alternative S1: No Action
- Alternative S2: Complete Removal and Offsite Disposal
- Alternative S3: Resource Conservation and Recovery Act (RCRA) Cap, Regrading, and Partial Offsite Disposal
- Alternative S4: Complete Removal, Onsite Treatment, and Offsite Disposal
- Alternative S5: Complete Removal, Offsite Treatment and Disposal.

A brief summary of the evaluation criteria and comparative analyses of these alternatives is presented in Table E-1.

For OU-2 (groundwater), one alternative was evaluated:

- Alternative G1: No Action.

Only this alternative was assessed, at the direction of EPA Region 3, because none of the groundwater COPCs are likely derived primarily from the Site.

Table E-1. Summary of Alternatives Evaluated for OU-1

Criteria	Alternative S1: No Action	Alternative S2: Removal and Offsite Disposal	Alternative S3: RCRA Capping and Partial Offsite Disposal	Alternative S4: Removal, Onsite Treatment, Offsite Disposal	Alternative S5: Removal, Offsite Treatment and Disposal
1. Protection of Human Health and the Environment	No	Yes	Yes	Yes	Yes
2. Compliance with Applicable or Relevant and Appropriate Requirements	No	Yes	Yes	Yes	Yes
3. Long-Term Effectiveness and Permanence	Worse	Better	Average	Better	Better
4. Reduction of Toxicity, Mobility, and/or Volume Through Treatment	Worse	Average	Average	Better	Better
5. Short-Term Effectiveness	Not Applicable	Average	Average	Average	Average
6. Implementability	Better	Better	Better	Average	Better
7. Cost	$82,574	$33,888,709	$6,923,236	$21,638,104	$28,470,064
8. Commonwealth Acceptance	Worse	Better	Worse	Better	Better
9. Community Acceptance	Worse	Average	Worse	Better	Better

NOTES: RCRA = Resource Conservation and Recovery Act.

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1. INTRODUCTION

EA Engineering, Science, and Technology, Inc., PBC (EA) has been contracted to conduct a Feasibility Study (FS) at the Franklin Slag Pile Superfund Site (the Site). The Site has been divided into two Operable Units (OU): OU-1 addresses the slag pile and associated soil and OU-2 addresses the groundwater. This FS was prepared by EA under U.S. Environmental Protection Agency (EPA) Remedial Action Contract Number EP-S3-07-07: Work Assignment 024 for EPA Region 3. The FS was prepared in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 Code of Federal Regulations [CFR] Part 300). The interim final guidance for conducting remedial investigations (RIs) and FSs under CERCLA was used to establish the framework for this FS (EPA 1988).

1.1 PURPOSE AND REPORT ORGANIZATION

The purpose of this FS is to develop and evaluate potential remedial alternatives for OU-1 (slag/soil) and OU-2 (groundwater). Following this FS, EPA Region 3 will select the remedial alternative for the Franklin Slag Pile Superfund Site in a Record of Decision (ROD).

This FS is based on the findings of the Final RI Report for the slag pile (Tetra Tech NUS, Incorporated [TtNUS] 2007a) and the Final RI Report for OU-2 Groundwater, Revision 4 (EA 2018).

Site characterization efforts during the RIs were used to develop remedial action objectives (RAOs) for OU-1. Additionally, remedial technologies were screened to identify those technologies and process options that warrant further consideration based on the applicability of the technology for the site-specific conditions. Technologies that were retained through the screening step were further developed into remedial alternatives. A detailed evaluation of the retained alternatives was then conducted.

Remedial alternatives described in this report were developed and screened based on federal, state, and local applicable or relevant and appropriate requirements (ARARs), To Be Considered (TBC) regulatory guidelines, and the findings of previous investigations. The remedial alternatives presented in this FS represent an assemblage of technologies best suited for the physical and logistical conditions at the Site and remedial timeframes.

This report is divided into the following chapters:

- ***Chapter 1, Introduction***—Outlines the purpose and organization of the report; presents background information and physical characteristics of the Site; summarizes the nature and extent of contamination, potential contaminant fate and transport, and the results of the baseline risk assessments (human health risk assessment [HHRA] and screening-level ecological risk assessment [SLERA]).

- ***Chapter 2, Identification and Screening of Technologies*—**Defines the RAOs; identifies contaminants of concern (COC), chemicals of potential concern (COPCs), and the chemical-, location-, and action-specific ARARs; develops Preliminary Remediation Goals (PRGs); identifies General Response Actions (GRAs) for the media of concern; and identifies and screens/evaluates applicable technologies based on the site-specific conditions and the COCs and COPCs identified.

- ***Chapter 3, Development of Remedial Action Alternatives and Evaluation Criteria***—Identifies the remedial action alternatives for each OU that were developed for detailed evaluation and describes the evaluation criteria used in Chapters 4 and 5.

- ***Chapters 4 and 5, Detailed Analysis of Alternatives***—Present descriptions and detailed evaluations of each alternative for each OU, as well as comparative analyses of the alternatives for OU-1.

- ***Chapter 6, References***—Includes references used in preparation of this FS.

The following appendix contains supporting documentation:

- ***Appendix A***—Evaluation of Preliminary Remediation Goals for Operable Unit 1, Franklin Slag Pile.

1.2 SITE BACKGROUND

1.2.1 Site Description and Setting

The Site is located at the intersection of Castor and Delaware Avenues in the Port Richmond section of Philadelphia, Pennsylvania (Figure 1-1). The Site consists of a large pile of slag generated from the secondary copper smelting process at the neighboring Franklin Smelting and Refining Corporation (FSRC). The slag pile occupies an approximately 4-acre lot and is covered with a 60-mil-thick high-density polyethylene (HDPE) geomembrane that was anchored in a 3-foot (ft)-deep trench around the slag pile (TtNUS 2007a). No soil is present on the cover. The slag pile is approximately 220 ft wide by 445 ft long and varies in height from grade to 40 ft. Slag was piled on the ground surface and is not present below grade. An unknown quantity of oversized material is thought to be present within the slag pile.

No structures or significant vegetation are present at the Site. The Delaware River is located 0.25 miles to the southeast (Figure 1-1). The Site is bordered by Delaware Avenue and the Tioga Marine Terminal to the southeast, Castor Avenue and the Philadelphia Gas Works (PGW) to the southwest, the former FSRC facility to the northwest, and the Philadelphia Water Department (PWD) Northeast Water Treatment Plant lagoons to the northeast. The closest residences are approximately one quarter mile northeast of the Site (EPA 2000). The residential neighborhood is a densely populated urban area located north-northeast of I-95; the Site and surrounding industrial area are located south-southwest of I-95.

1.2.2 Site History

FSRC made products including blister and black copper, mineral grit, converter slag, zinc oxides, and ammonium sulfate from the 1930s until 1997. FSRC deposited a mineral grit or by-product (slag) of the smelting process in a pile at the present Site. From the 1950s until 1999, MDC Industries (MDC) crushed, dried, and sized copper smelter slag from FSRC. The slag was sold as sand-blasting grit and for use as grit in asphalt roofing shingles (Agency for Toxic Substances and Disease Registry [ATSDR] 2005). MDC accumulated slag in a pile on the ground surface at their property (the Site). At times, the slag pile spilled beyond the property boundary (ATSDR 2005), and slag was observed being blown off of the property in clouds by wind. In addition to the slag pile, trailers, process buildings, and process equipment were also present at the Site.

1.2.2.1 Initial Sampling Results

Air sampling conducted between 1997 and 1999 by the Philadelphia Air Management Services reported high ambient lead levels at sampling locations surrounding the MDC property (ATSDR 2005). In addition, samples of various environmental media were collected from the Site by the EPA and Pennsylvania Department of Environmental Protection (PADEP) between 1988 and 2003 (ATSDR 2005). These samples were analyzed primarily for Toxicity Characteristic Leaching Procedure (TCLP) metals and total metals. It was found that samples of slag and adjacent surface soil contained elevated concentrations of lead and other metals (including aluminum, copper, and zinc). Total lead concentrations in slag ranged from approximately 4,000 milligrams per kilogram (mg/kg) to 22,100 mg/kg, and TCLP lead concentrations in slag samples were greater than the regulatory limit (cadmium was also reported in one sample collected in 1988 at a TCLP concentration greater than its regulatory limit) (TtNUS 2007a). Based on this, the slag is a hazardous waste by characteristic (i.e., toxicity). In addition, storm water runoff from the Site contained high concentrations of copper, lead, and zinc. Storm water runoff was found to flow to storm water drains that discharge directly to the Delaware River (ATSDR 2005).

1.2.2.2 Violation and Order for Compliance and EPA Emergency Response Action

In September 1999, the EPA Region 3 Water Protection Division issued a Findings of Violations and Order for Compliance to MDC as a result of high levels of copper, lead, zinc, and total suspended solids detected in storm water runoff (ATSDR 2005). In January 2000, MDC indicated that they did not intend to take action to control or stabilize the slag pile or address the potential threat posed by lead in the pile.

Therefore, EPA initiated an emergency response action to stabilize the pile in 1999-2000. The office trailer, all process buildings, two baghouses, and four storage silos were demolished and recycled and/or disposed of offsite, and the slag pile was reshaped and covered with a 60-mil HDPE cover. EPA also removed slag that had migrated offsite, removed contaminated soil along the railroad bed and slag pile, removed soil and slag from between the Site and Delaware Avenue and backfilled with gravel/stone, cleaned slag and soil from vicinity storm drains, and completed other slag removal activities (ATSDR 2005). A permanent steel fence was erected around the perimeter of the property to prevent humans and animals from accessing the pile and/or its cover. Locked gates were installed in the fence along Delaware Avenue (one gate) and Castor Avenue (two gates). The response action was completed in October 2000. The Site was listed as a National Priorities List Site in September 2002 as a result of the documented contamination originating from the Site.

1.2.2.3 Public Health Assessment

As a result of the Site's inclusion on the National Priorities List, the EPA and ATSDR completed a public health assessment for the Site (ATSDR 2005). The public health assessment found that the community would not be exposed to contaminants via groundwater because all residents and businesses in the area receive public water. However, the community could have been exposed (prior to placement of the HDPE cover) to contaminants in soil/slag, storm water runoff, and air. It was concluded that no adverse health effects were expected from current or future onsite exposures (unless future Site use or Site conditions change) because the slag pile had been covered and access was restricted. The potential for adverse health effects to past, current, and future offsite receptors from exposure to offsite contaminated media (i.e., soil and ambient air) was deemed uncertain due to a lack of offsite data. Therefore, ATSDR classified past, current, and future offsite exposures as posing an indeterminate public health hazard. The public health assessment identified metals as COPCs at the Site. This public health assessment noted that the slag pile was not necessarily the only area contributor to elevated levels of lead and that two former smelters in the Port Richmond area could also have contributed to elevated lead concentrations in the air and soil.

1.2.2.4 Operable Unit 1 Remedial Investigation

In 2003, TtNUS initiated an RI for OU-1 (slag/soil) (TtNUS 2007a), which included collection and analysis of offsite surface soil samples adjacent to the slag pile (Figure 1-2), to evaluate current and future risks from residual contamination. The RI provided a summary of elevated metals concentrations in offsite surface soil south and east of the slag pile, outside the fence marking the Site boundary. Soils samples were collected from locations adjacent to the slag pile where native soil remained in limited quantities following the previous excavation of soils around the slag pile and backfilling with gravel/stone. The RI surface soil results showed contaminants similar to those observed in the slag samples. Samples from two small accessible surface soil areas along the Delaware Avenue fence line adjacent to the pile showed elevated levels of aluminum (15,200-18,100 mg/kg), copper (852-1,600 mg/kg), lead (699-1,690 mg/kg), manganese (698-737 mg/kg), and zinc (5,630-20,000 mg/kg). A sample from adjacent to the PWD lagoons near the north-northeastern side of the slag pile showed the lowest levels of these contaminants (2,849 mg/kg aluminum, 413 mg/kg copper, 117 mg/kg lead, 604 mg/kg manganese, and 1,665 mg/kg zinc). Samples collected adjacent to the PWD lagoons at distances greater than 100 ft from the slag pile also showed elevated levels of aluminum (12,800-28,800 mg/kg), copper (2,550-6,860 mg/kg), lead (773-2,090 mg/kg), manganese (651-1,580 mg/kg), and zinc (5,670-19,300 mg/kg). One surface soil sample contained polycyclic aromatic hydrocarbons (PAHs) at a concentration exceeding residential screening levels (TtNUS 2007a).

Results of the baseline HHRA conducted as part of the RI (TtNUS 2007a) are summarized in Section 1.2.6. The HHRA indicated that current or future construction workers could experience unacceptable exposures to contaminants in offsite surface soils adjacent to the slag pile, and also that potential unacceptable exposures to the slag in the pile would be expected if the integrity of the cover were compromised. Based on the results, the RI for OU-1 recommended that an FS be conducted to evaluate permanent remedies for the slag pile and any residual contaminated soils adjacent to the pile. Although the RI for OU-1 did not include groundwater sampling, it did indicate that there was the potential for leaching of contaminants into groundwater underlying the Site, especially prior to placement of the cover (TtNUS 2007a).

1.2.2.5 Previous Operable Unit 1 Feasibility Study and Proposed Plan

Based on the findings of the OU-1 RI (TtNUS 2007a), an FS for this OU was completed by TtNUS (TtNUS 2007b). EPA issued a proposed plan in July 2007 to identify the preferred alternative for the permanent remedy for the slag pile (EPA 2007). The preferred alternative was to cover the slag pile with a Resource Conservation and Recovery Act (RCRA) multi-layer cap topped with soil and vegetative seeding. This alternative also included partial excavation and offsite disposal of slag, re-grading the remaining slag pile, security fencing, long-term maintenance and monitoring, and 5-year reviews. However, in light of public comment on the proposed plan, which indicated concerns regarding long-term maintenance of the slag pile at the Site, EPA did not issue a ROD for OU-1 and began to further study the Site and develop other alternatives for OU-1. This FS report replaces the previous 2007 FS report and will be the basis of a new proposed plan and ROD.

1.2.2.6 Operable Unit 2 Remedial Investigation

An RI for OU-2 (groundwater) was performed, beginning in 2012, to assess potential impacts to groundwater from the slag pile (EA 2018). The RI field investigation consisted of the collection of three rounds of groundwater samples from four onsite monitoring wells, one round of offsite groundwater samples from five area monitoring wells, subsurface soil samples from the water table interface, and three samples of slag material.

In support of the RI, four monitoring wells were installed (MW-1 through MW-4), one along each side of the Site (Figure 1-3). Three groundwater sampling events were conducted for the RI, in December 2012, April 2013, and December 2013. Samples were collected from each of the four monitoring wells during each event. The December 2013 event also included the collection of groundwater samples from five monitoring wells located on the adjacent PWD property, which is northeast of the Site (MW-BS, MW-BD, MW-CD, MW-CS, and MW-5) (Figure 1-3). The offsite wells were sampled to provide information on area-wide concentrations of COPCs. All groundwater samples were analyzed for target compound list (TCL) volatile organic compounds (VOCs), TCL semivolatile organic compounds (SVOCs), target analyte list

(TAL) metals plus mercury (total and dissolved fractions), cyanide, pesticides, and polychlorinated biphenyls (PCBs).

Metals, cyanide, pesticides, SVOCs, and VOCs were detected in the groundwater samples collected as part of the RI (EA 2018); PCBs were not detected in any samples. No specific organic compounds were consistently detected at concentrations greater than screening values, and neither an organic compound contamination plume nor a source of organics to groundwater was identified at the Site. However, a few PAHs were detected at elevated concentrations in groundwater. Arsenic, iron, manganese, and cyanide were consistently detected at concentrations greater than screening values in Site groundwater. Although these inorganic constituents are present in the slag material, they were also reported at elevated concentrations in offsite groundwater and are also associated with historical activities conducted at properties adjacent to the Site. Additionally, TCLP data collected in 1988 (see Section 1.2.2.1) indicated that arsenic would not leach out of the slag at hazardous concentrations, indicating that the slag material was an unlikely source of arsenic in groundwater.

To characterize potential risks associated with ambient groundwater conditions and to further assess groundwater impacts potentially attributable to the Site, groundwater data collected from 2012 to 2017 at the adjacent PGW property (southwest of the Site) were evaluated in a supplemental human health evaluation. This evaluation, which is discussed further in Section 1.2.7, provided evidence that while arsenic, iron, manganese, cyanide, and PAHs were identified as COPCs, the slag pile is not considered a source of PAHs or a primary source of arsenic, iron, manganese, and cyanide (EA 2018). A brief summary of the RI data for the COPCs in groundwater is provided in the following paragraphs.

- Arsenic

  - Unfiltered arsenic concentrations in groundwater ranged from 3 to 19.6 micrograms per liter (µg/L); filtered arsenic concentrations ranged from 3 to 18.8 µg/L. All detected concentrations were greater than the tap water regional screening level (RSL) of 0.052 µg/L, and the PADEP medium specific concentration (MSC) and EPA maximum contaminant level (MCL) of 10 µg/L were also exceeded. The highest concentrations of arsenic were consistently found in samples from MW-3 and MW-4.

  - The maximum filtered and unfiltered arsenic concentrations in groundwater onsite were approximately 1.4 times greater than the maximum concentrations detected in upgradient samples from the PWD property and approximately 2.8 times greater than the maximum concentration detected in crossgradient wells.

- Iron

  - Unfiltered iron concentrations in groundwater ranged from 6,780 to 86,900 µg/L; filtered iron concentrations ranged from 6,750 to 91,200 µg/L. All detected concentrations were greater than the tap water RSL of 1,400 µg/L; no other criteria were available for iron. The highest concentrations of iron were consistently found in samples from MW-4.

- The maximum filtered and unfiltered iron concentrations in groundwater onsite were approximately 1.5 times greater than the maximum concentrations reported in upgradient and downgradient samples from the PWD property and were approximately 5-6 times greater than concentrations reported in crossgradient samples.

- Statistical analysis comparing iron concentrations in onsite samples to concentrations in wells located on the PGW property indicated that the concentrations of iron in the onsite samples were statistically higher than the concentrations detected in the PGW samples.

- Manganese

  - Unfiltered manganese concentrations ranged from 1,040 to 7,660 µg/L; filtered manganese concentrations ranged from 1,120 to 7,780 µg/L. All detected concentrations were greater than the tap water RSL of 43 µg/L and the PADEP MSC of 300 µg/L. The highest concentrations were consistently detected in wells MW-3 and MW-4 (Figure 1-3).

  - The maximum filtered and unfiltered manganese concentrations onsite were approximately 1.5 times greater than the concentrations reported in upgradient and downgradient samples from the PWD property and were approximately 6 times greater than concentrations reported in crossgradient samples.

  - Statistical analysis comparing manganese concentrations in onsite samples to concentrations in wells located on the PGW property indicated that the concentrations of manganese in the onsite samples were statistically higher than the concentrations detected in the PGW samples.

- Cyanide

  - Cyanide was detected at concentrations ranging from 78.4 to 788 µg/L. All detected concentrations were greater than the tap water RSL of 0.15 µg/L and a majority of the samples had concentrations greater than the PADEP MSC and MCL of 200 µg/L. The highest concentrations were consistently detected in well MW-2 while the lowest concentrations were consistently detected in well MW-4.

  - Cyanide concentrations onsite were greater than the concentrations reported in samples from the PWD property. All but one of the concentrations reported in onsite samples (across all sampling events) from wells MW-1, MW-2, and MW-3 were greater than the maximum concentration reported from the PWD property (205 µg/L).

- Statistical analysis comparing cyanide concentrations in onsite samples to concentrations in wells located on the PGW property indicated that the concentrations of cyanide in the onsite samples were statistically higher than the concentrations detected in the PGW samples. However, historical groundwater data from nearby sites have indicated the presence of cyanide at maximum concentrations higher than what was observed onsite.

- PAHs
  - Nine PAHs were detected at concentrations greater than screening criteria. The elevated concentrations of PAHs were only detected in samples collected during a high, or incoming, tide. The impact of the Site's cyclical hydrogeology and the flooding conditions present during the December 2012 RI sampling event appear to be most apparent in the PAH analytical results.
  - The concentrations of PAHs detected in groundwater samples from the PGW property are notably higher than the concentrations detected in groundwater from the Site. The ratios of the primary PAHs in samples from the Site are also indicative of petrogenic sources (e.g. coal), which indicates that they likely originated from an offsite source.
  - PAHs present in the slag material were detected infrequently in groundwater or were not detected in groundwater (e.g., benzo[g,h,i]perylene, acenaphthylene, and dibenzo[a,h]anthracene), suggesting a lack of correlation between groundwater data and slag material data.

Subsurface soil samples were collected at the water table interface to determine the nature of any soil contamination that could potentially affect groundwater conditions. The soil data suggest that organic compounds are not present in Site subsurface soil at concentrations that would adversely affect groundwater quality. Arsenic, cobalt, and manganese were found the most consistently at elevated concentrations relative to more than one comparison criteria, and iron was consistently detected at concentrations notably greater than its comparison criterion. Maximum onsite subsurface soil concentrations of iron and manganese were less than offsite subsurface soil concentrations. The RI for OU-2 (EA 2018) concluded that metal contamination is not limited to the Site and that the Site soil is not a preferential source of these metals to groundwater.

Samples were collected from five monitoring wells located on the adjacent PWD property to provide additional information on offsite concentrations of COPCs. The maximum concentrations of arsenic, cyanide, iron, and manganese detected onsite were higher than the maximum concentrations detected in offsite wells located on the PWD property. However, groundwater data generated during previous investigations and monitoring at the PGW property indicated the presence of arsenic, cyanide, iron, and manganese at maximum concentrations higher than what was observed onsite.

Two composite samples (and one duplicate) of the slag material were collected from the northwest corner of the slag pile to determine the nature of potential metal, PAH, and cyanide contamination in the slag, for which historical data were limited. All of the TAL metals except thallium were detected in all samples. Cyanide was detected in two of the three slag samples. Screening values are not available for this type of media; however, it is notable that the reported concentrations of cyanide were less than the EPA soil screening level (SSL) for protection of groundwater, which is based on the MCL, and the PADEP Soil to Groundwater non-residential MSC. PAHs were detected in each of the slag material samples. All of the detected concentrations were orders of magnitude lower than the PADEP Soil to Groundwater non-residential MSCs; however, numerous concentrations were greater than the risk-based SSLs. The data suggest that there is not a correlation between the detections and concentrations of PAHs in the slag material and the groundwater. This, in addition to the ratios of the PAHs reported in the slag samples and the fact that PAH concentrations in groundwater were notably affected by varying hydrogeologic conditions, suggest that there may be other sources of PAHs to groundwater in the vicinity of the Site, such as atmospheric deposition.

1.2.3 Geology and Hydrogeology

The Site is located within the Atlantic Coastal Plain physiographic province, which is generally underlain by unconsolidated deposits of gravel, clay, silt, and sand. The Site area is mapped as underlain by the Quaternary-age Trenton Gravel, which is generally a gray to reddish-brown, medium- to coarse-grained gravelly sand with interbedded layers of clay and silt. The thickness of the Trenton Gravel beneath the Site is not known. A dark, organic clay layer (tidal marsh/swamp deposits) extends from the surface to depths ranging from approximately 15 to approximately 30 ft below ground surface across the Site and is underlain by fine to coarse sand and quartz gravel with some silt. Regionally, the Trenton Gravel forms part of the uppermost, unconfined groundwater aquifer system. The groundwater quality of this aquifer has been severely degraded in Philadelphia County by the impacts of urbanization and industrial development. The Trenton Gravel is underlain regionally by a sequence of Cretaceous-age sediments referred to collectively as the Potomac-Raritan-Magothy (PRM) system. The PRM system consists of alternating sequences of coarse-grained sands and gravels that form aquifers and finer-grained silts and clays that form aquitards or confining layers. The PRM is an important regional aquifer in neighboring New Jersey. The uppermost unit of the PRM is a clay unit of limited areal extent that, where present, forms an effective aquitard that hydraulically isolates the PRM from the overlying Trenton Gravel. Where the clay unit is absent, the Trenton Gravel and the underlying upper sand unit of the PRM form a common, interconnected aquifer.

Depth to groundwater at the Site is approximately 6-12.5 ft below ground surface (within the dark, organic clay layer). As documented in the OU-2 RI, tidal influences are present in groundwater in all four monitoring wells at the Site. During an investigation conducted on the adjacent PWD property, groundwater elevations in the Lower Sand Unit of the PRM were observed to respond to tidal fluctuations of the Delaware River. The prominent hydraulic response observed was interpreted as indicating a direct hydraulic connection between the Delaware River and the Lower Sand Unit of the PRM, which was attributed to highly permeable riverbed sediments in the area, the aquifer stratigraphy, and historical dredging activities in the River (Rettew Associates, Inc. 2002). The tidal influences in the Lower Sand Unit of the PRM result in groundwater flow away from the river during high tide and towards the river during low tide. Based on the amplitudes of the tidal groundwater fluctuations observed at the four onsite monitoring wells, the tidal influences are also thought to extend for an unknown distance inland from the Site. However, as observed during the 2007 aquifer testing, the overall movement of groundwater is limited due to the limited storage in this semiconfined aquifer observed during aquifer testing. Aquifer testing further indicated that flow in the unconfined Trenton Gravel deposits is south/southwest towards the Delaware River. Aquifer testing also showed a relatively high conductivity for groundwater flow in the Lower Sand Unit.

1.2.4 Nature and Extent of Contamination

1.2.4.1 Operable Unit 1 (Slag/Soil)

Surface soil samples were analyzed for metals as part of the RI for OU-1 (TtNUS 2007a) to evaluate levels of contamination in offsite surface soils adjacent to and near the covered slag pile. As stated in Section 1.2.2.2, soil removal was performed in select areas as part of the removal action in 2000; the extent to which contaminated soil remains onsite is not well documented. The metals detected in offsite surface soil samples were, in many cases, also observed in the slag samples, although concentrations in soil were lower than concentrations reported in the slag. Offsite surface soil samples from adjacent to the PWD lagoons and along the Delaware Avenue fence line adjacent to the pile showed elevated levels of aluminum, copper, lead, manganese, and zinc. The sample farthest from the slag pile had the highest levels of aluminum, copper, and lead detected during the RI for OU-1 (TtNUS 2007a). These results suggest deposition from airborne contaminants during the smelter’s operation or other offsite sources may have impacted these areas rather than direct disposal of slag. The Site is located in an industrialized area historically used for electrical generation (fossil fuel combustion), municipal waste incineration, and with heavy vehicular traffic (TtNUS 2007a).

1.2.4.2 Operable Unit 2 (Groundwater)

Groundwater sample data indicate that the greatest adverse impacts to groundwater at the Site are from arsenic, cyanide, iron, and manganese, which were consistently detected at concentrations greater than the highest comparison criteria available. However, based on a comparison of onsite and offsite soil and groundwater data, metals contamination is not limited to the Site.

Analysis of groundwater from adjacent sites (EA 2018) indicated that maximum concentrations of arsenic, cyanide, iron, and manganese on the PGW property (located to the southwest) were higher than onsite concentrations, while maximum concentrations on the PWD property (located to the northeast) were less than onsite concentrations.

1.2.5 Contaminant Fate and Transport

The OU-1 RI (TtNUS 2007a) evaluated fate and transport characteristics of the COPC metals. Metals typically adsorb to soil or sediment particles; therefore, contaminant transport is expected to be dependent on the migration and transport of solid particles. This is consistent with the observed transport of material from the slag pile beyond the property, either through spillage from the slag pile or via wind-driven transport. Such physical transport is likely the primary cause of observed impacts to surface soils in the vicinity of the slag pile. TCLP analysis conducted prior to the RI indicated that only lead (and cadmium, in the case of one sample) leached from the slag at a concentration greater than its regulatory limit. However, concentrations of other metals detected in the slag were also greater than the EPA's SSLs for the protection of groundwater, suggesting a potential for contaminants present in the slag to leach into groundwater underlying the Site at concentrations of concern. The OU-1 RI concluded that the potential for migration of contaminants from the Site was likely significant prior to placement of the HDPE cover, but the potential for contaminant migration had been significantly reduced since its installation. The HDPE cover should effectively reduce leaching because the slag was piled on the ground surface and is not present below grade. However, during the OU-2 RI, arsenic, iron, and manganese were detected at concentrations greater than soil to groundwater comparison criteria in subsurface soil samples collected from the water table interface at the Site (approximately 30-40 ft below ground surface in the boreholes).

Based on the results of the OU-2 RI (EA 2018), the COPCs for groundwater include arsenic, iron, manganese, cyanide, and PAHs. These analytes are persistent in the environment and, except for cyanide, are expected to be associated with aquifer solids. This reduces their mobility and migration potential. Cyanide complexes are less likely to adsorb and will persist in and migrate with groundwater.

Cyanide was detected in slag but not in soil samples, possibly due to its high solubility, which may prevent cyanide that is leached from the slag pile from being adsorbed to the soil. Two facilities adjacent to the Site (i.e., the closed in place water treatment plant lagoons and the PGW) conduct(ed) activities known to be associated with cyanide releases, and the wells with the highest concentrations of cyanide were located immediately adjacent to these facilities. In addition, groundwater monitoring data from 1989-1990 at the PGW property reported cyanide concentrations higher than those reported at the Site. This suggests that if the slag pile has contributed cyanide contamination to area groundwater, it may not be the only source.

The local hydrogeology is such that groundwater flow direction changes with changing tides. These tidal influences extend from the Delaware River at the Site and continue for an unknown distance away from the River. The periodic and repetitive changes in groundwater flow result in a homogenization and averaging of offsite and onsite groundwater contamination, which complicates efforts to associate contamination with specific sources. The issue of contaminant migration is also complicated by the fact that flooding conditions can result in a sustained reversal of groundwater flow and seemingly upgradient migration of contamination. Given the level of potential impacts from historical sources surrounding the Site and the similarity of contaminants potentially migrating from these sources, it is difficult to distinguish Site-related impacts from non Site-related impacts. Regardless, the net groundwater flow regime is such that groundwater discharges to the Delaware River. Therefore, contaminants being transported in groundwater would be expected to eventually reach the River.

As discussed above, the slag pile is not considered a source of PAHs or a primary source of arsenic, iron, manganese, and cyanide to groundwater (EA 2018). Elevated concentrations of arsenic, iron, manganese, and cyanide were reported in offsite (upgradient/crossgradient) groundwater and are likely associated with historical activities at properties adjacent to the Site. There does not appear to be a relationship between the PAHs detected in groundwater and those detected in the slag material. PAHs are associated with historical activities that occurred at the PGW and have been detected at highly elevated concentrations in groundwater underlying the PGW property. The onsite groundwater detections are associated with samples collected during high or incoming tides and are thought to be the result of offsite sources and the direction of groundwater flow.

1.2.6 Baseline Risk Assessment for Operable Unit 1 (Slag Pile and Associated Soil)

A site-specific HHRA and SLERA were completed for the Site during the RI for OU-1 (groundwater) (TtNUS 2007a). Summaries of the HHRA and SLERA are presented in the following subsections.

1.2.6.1 Human Health Risk Assessment for Operable Unit 1

The baseline HHRA for OU-1 (TtNUS 2007a) was performed in 2003-2007, after the slag pile was covered with HDPE in 2000, to characterize the potential risks to likely human receptors under current and potential future land use. The HHRA was based on analysis of slag collected in January 2000 and analysis of offsite soil collected adjacent to the covered slag pile in 2003, as part of the OU-1 RI. Details of the methodologies and techniques used in the HHRA can be found in the RI Report (TtNUS 2007a). Potential receptors identified and retained in the HHRA for quantitative evaluation included construction workers exposed to slag and adjacent offsite surface soil, child and adult recreational users exposed to adjacent offsite surface soil, and adolescent trespassers exposed to slag. Current exposures would be limited to recreational users exposed to offsite soils. Future construction workers could also be potentially exposed if earth moving activities were to occur in this area. The adjacent soils sampled are located along the railroad tracks, Delaware Avenue, and the PWD lagoons and would be expected to be only minimally visited by recreational receptors for limited durations. Construction activities would also be expected to be limited due to the proximity of the PWD lagoons and railroad. The trespasser scenario was evaluated for onsite exposure should a trespasser enter the Site and remove a portion of the cover, thereby creating a pathway for exposure to the slag material.

The HHRA identified the following COPCs for direct contact exposures. COPCs are those compounds detected at levels above risk-based screening levels and are subject to further evaluation in the risk assessment.

- Slag: Aluminum, antimony, arsenic, barium, beryllium, chromium, cobalt, copper, iron, lead, manganese, nickel, vanadium, and zinc.

- Offsite surface soil: Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, aluminum, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, thallium, vanadium, and zinc.

The COPCs for migration from soil to groundwater included:

- Slag: Antimony, arsenic, barium, beryllium, cadmium, chromium, copper, manganese, selenium, vanadium, and zinc.

- Offsite Surface Soil: 2-methylnapthalene, 4-choroaniline, acenaphthene, acetophenone, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, carbazole, chrysene, dibenzo(a,h)anthracene, dibenzofuran, fluoranthene, fluoranthene, fluorene, indeno(1,2,4-cd)pyrene, naphthalene, pyrene, Aroclor-1260, beta-BHC, arsenic, barium, beryllium, cadmium, chromium, copper, manganese, selenium, silver, thallium, vanadium, and zinc.

Although the levels of metals in the slag exceed EPA's SSLs, which indicate a potential for migration to groundwater, the presence of the 60-mil HDPE cover was determined to preclude surface water infiltration through the slag pile and leaching of contaminants into groundwater. Prior to placement of the cover, the high levels of leachable metals present in the slag pile were potentially available for transfer to groundwater.

Quantitative risk estimates for potential human receptors were developed for those chemicals identified as COPCs. Potential cancer risks and hazard indices (HIs) were calculated only for those receptors (construction workers, adolescent trespassers, and child, adult, and lifelong residents) and exposure pathways that were retained for quantitative evaluation in the HHRA.

To interpret the quantitative risks and to aid risk managers in determining the need for remediation at a site, quantitative risk estimates are compared to typical benchmarks. EPA has defined the range of $1x10^{-4}$ to $1x10^{-6}$ as the "target range" for excess lifetime cancer risk at most hazardous waste facilities addressed under CERCLA. Carcinogenic risks greater than $1x10^{-4}$ generally indicate that some degree of remediation is required whereas risks less than $1x10^{-6}$ normally do not result in remedial efforts. An HI greater than 1 indicates that there may be potential noncarcinogenic health hazards associated with exposure. If an HI exceeds 1.0, target organ effects from individual COPCs contributing to the hazard are considered. COPCs contributing to cancer risk exceeding the target range or contributing to a target organ cumulative non-carcinogenic hazard greater than 1.0 are considered to be COCs.

Calculated cancer risks for the following receptors were within EPA's target risk range of $1x10^{-4}$ to $1x10^{-6}$, with the exception of one location (SS-4) where PAHs were associated with higher risk (approximately 3.0×10^{-4}): construction workers exposed to slag and offsite surface soil;

adolescent trespassers exposed to slag; and child, adult, and lifelong residents exposed to offsite surface soil. It is not believed that PAHs are site-related compounds, as slag samples have not shown the presence of PAHs and the location with elevated PAHs is near the intersection of Delaware and Castor Avenues indicating a potential association with these roadways.

With one exception, HIs for adolescent trespassers exposed to slag, and child and adult recreational users exposed to offsite surface soil were less than 1, indicating that adverse non-carcinogenic effects are not anticipated for these receptors under the defined exposure conditions. For the child recreational receptor exposed to soil at one location (SS-6), an HI of 2 was calculated. Iron was the major contributor to this hazard.

HIs for construction workers exposed to slag and offsite surface soil exceeded 1. Inhalation of fugitive dust was the predominant exposure pathway. Manganese, cobalt, aluminum, beryllium, chromium, copper, and iron were the major contributors to the HI for exposure to slag. Aluminum and manganese were the major contributors to the HI for exposures to offsite surface soil, with cobalt, chromium, copper, and iron also contributing to the hazard at one location.

For construction workers exposed to slag, blood-lead modeling indicated that a lead concentration of 5,890 mg/kg would result in 78 percent having a blood lead level greater than 10 micrograms per deciliter (µg/dL). For construction workers exposed to offsite surface soil, exposure to the average concentration of lead (1,070 mg/kg) would result in 12.8 percent having a blood lead level great than 10.0 µg/dL. Based on this, more than 5 percent of the fetuses born to construction workers would be predicted to have blood lead levels greater than 10 µg/dL. Although short-duration exposures to lead in offsite surface soil by a child recreational user will contribute to the child's total daily lead exposure, the child's total daily lead exposure depends mainly on the child's soil yard exposure, which is unknown at this site.

Based on the findings of the HHRA, the following metals were identified as COCs in slag and associated soil: aluminum, beryllium, chromium, cobalt, copper, iron, lead, and manganese (see Table 6-19 in the OU-1 RI).

1.2.6.2 Screening-Level Ecological Risk Assessment for Operable Unit 1

The SLERA for OU-1 (TtNUS 2007a) was performed in accordance with Steps 1 and 2 of the 8-step ecological risk assessment (ERA) process (EPA 1997). A SLERA uses limited site-specific information and conservative assumptions to assess whether a conclusion can be drawn that risks to ecological receptors are negligible. Otherwise, the SLERA recommends that the ERA process proceed to a more thorough analysis based on more site-specific information. This more detailed analysis is termed a baseline ERA.

The lead concentrations measured in the slag greatly exceed the soil-based ecological screening level of 2 mg/kg established by EPA Region 3 as the maximum concentration protective of floral ecological receptors and the level of 0.01 mg/kg established by EPA Region 3 as the maximum concentration protective of faunal receptors. This indicates potential risk to both floral and faunal ecological receptors. However, the SLERA concluded that any ecological risks posed by the Site in its present condition are negligible. This conclusion is supported by the fact that the source of chemical contamination at the Site, the slag pile, was covered with an HDPE cover as part of the EPA removal action completed in 2000 to protect human and ecological receptors. It is further supported by the lack of natural habitat on the Site or in the vicinity of the Site, which is a densely developed urban industrial, commercial, and residential landscape. However, because the polymer cover is temporary and future deterioration of the cover could result in future exposure of ecological receptors to harmful concentrations of metals, implementation of a permanent remedy is necessary to ensure long-term protection of the environment.

1.2.7 Baseline Risk Assessment for Operable Unit 2 (Groundwater)

A site-specific HHRA and SLERA were completed for the Site during the RI for OU-2 (groundwater) (EA 2018). Summaries of the HHRA and SLERA for exposure to groundwater are presented in the following subsections.

1.2.7.1 Human Health Risk Assessment for Operable Unit 2

The HHRA for OU-2 (EA 2018) was completed in accordance with EPA guidance and evaluated the reasonable maximum exposure that has the potential to occur at the Site under both current and potential future conditions. Details of the methodologies and techniques used in the HHRA can be found in Section 6.0 of the RI Report (EA 2018). The following exposure pathways were identified as potentially complete and were evaluated in the assessment:

- Construction worker incidental ingestion of and dermal contact with groundwater
- Construction worker inhalation of VOCs in a trench
- Offsite resident ingestion of and dermal contact with groundwater
- Offsite resident inhalation of VOCs while showering and conducting other household activities.

The numerical estimate of excess lifetime cancer risk was calculated in accordance with EPA guidance. The following table presents a summary of the HHRA results. Analytes were identified as chemicals contributing significantly to results if their carcinogenic risks were greater than 1×10^{-6} and the cumulative carcinogenic risks were greater than 1×10^{-4} or the analyte's non-cancer hazards were greater than 0.1 and were contributing to a target organ cumulative non-carcinogenic hazard greater than 1.0.

Many of the chemicals that were significant contributors to risk had a low number of detects (e.g., PAHs and pesticides). The maximum detected concentrations of many of these chemicals were used as the exposure point concentration (EPC) for estimating risks and hazards because of their low number of detects. Additionally, many of these chemicals were not detected consistently in monitoring wells during the sampling events (e.g., PAHs and naphthalene). The use of the maximum concentration as the EPC and the inconsistent detections of these chemicals most likely overestimates risks when evaluating long term, chronic exposures.

Receptor	Media	Carcinogenic Risks[a]	Non-Carcinogenic Hazards	Chemicals Contributing Significantly to Results
Child Resident[a]	Groundwater	2×10^{-2}	56	Arsenic, cobalt, hexavalent chromium, iron, manganese, cyanide, PAHs, aldrin, beta-BHC, dieldrin, heptachlor epoxide, vinyl chloride
Adult Resident[a]	Groundwater	2×10^{-2}	49	Arsenic, cobalt, hexavalent chromium, iron, manganese, cyanide, PAHs, aldrin, beta-BHC, dieldrin, heptachlor epoxide, vinyl chloride
Construction Worker	Groundwater	2×10^{-5}	3	Hexavalent chromium, benzo(a)pyrene, naphthalene

a. Cancer risk for the resident adult and child is presented as a total lifetime cumulative cancer risk.

In an effort to characterize ambient groundwater conditions (and levels of risk) and assist in reaching conclusions in the RI about groundwater impacts attributable to the Site, groundwater data from the adjacent PGW property were evaluated in a supplemental human health evaluation (EA 2018). The supplemental risk evaluation found that unacceptable non-carcinogenic hazards and carcinogenic risks within or above the acceptable risk range were determined for the offsite resident for all COPCs except hexavalent chromium and vinyl chloride for both the Site and PGW. This indicates that there are area-wide risk concerns for exposure to COPCs in groundwater. In addition to area-wide concerns associated with groundwater concentrations of iron, manganese, and cyanide (and the other COPCs), blood-lead modeling revealed potential health concerns for exposure to soil and groundwater in both the Site and the PGW property (EA 2018).

1.2.7.2 Screening-Level Ecological Risk Assessment for Operable Unit 2

The SLERA for OU-2 (EA 2018) was performed in accordance with the EPA's Guidance for Superfund and consisted of Steps 1 and 2 of the 8-step ERA process (EPA 1997). In response to a request by the EPA, the SLERA evaluated the Site groundwater data with respect to the potential for impacts to surface water receptors when the groundwater is discharged. Typically, groundwater is not a medium of concern for biota because of the lack of complete exposure pathways. However, because of the potential for groundwater to discharge into the Delaware River, groundwater was identified as the medium of concern and the Delaware River was identified as the habitat of concern. The exposure pathway from ground/surface water is potentially complete for aquatic organisms in the Delaware River. Consequently, potential receptors evaluated in the SLERA were aquatic organisms (i.e., aquatic plants, fish, and invertebrates).

COPCs were first selected by comparison of maximum concentrations found in groundwater to EPA Region 3 ecological risk screening values. Analytes with no screening values were retained as COPCs. The SLERA identified 6 metals, cyanide, 10 PAHs, 5 pesticides, and dibenzofuran as COPCs for exposures to groundwater. In addition, 6 PAHs, 2 pesticides, 3 SVOCs, and 5 VOCs were retained for further evaluation because no EPA Region 3 screening level benchmarks were available.

A refined assessment of risks was then performed to provide a more site-specific and realistic risk characterization for the Site. The refined measurement endpoints included comparison of maximum and refined EPCs to chronic and acute toxicity reference values. The refined risk characterization also used a qualitative weight of evidence approach in which results for each measurement endpoint were considered as lines of evidence.

The refinement of risk estimates and weight-of-evidence evaluation built upon the results of the SLERA to conclude that cyanide, iron, and PAHs in groundwater may have the potential to pose risk to aquatic life in the Delaware River. However, if iron and cyanide bond with each other they become non-bioavailable, which may be expected to occur prior to potential discharge to the Delaware River. In addition, it was expected that measured PAHs in monitoring wells adjacent to the Site were associated with particulate matter and were not dissolved; consequently, PAHs were not expected to be easily transported to the river. It should also be noted that the RI results suggest that the slag pile is not a source of PAHs.

The SLERA stated that groundwater concentrations of analytes would be expected to decrease over time, as the HDPE cover prevents infiltration and reduces potential leaching, and that any risks would therefore be reduced. In addition, the SLERA identified uncertainty associated with comparing groundwater concentrations to surface water criteria. In the event that the groundwater is discharged into the Delaware River, it would be mixed with the surface water and receptors would likely not be exposed to concentrations detected in groundwater; however, no mixing zone calculations were performed in support of the SLERA. The SLERA stated that this uncertainty should be considered carefully during risk management.

1.2.7.3 Operable Unit 2 Remedial Investigation Conclusions

Based on the results of the RI, the HHRA, supplemental HHRA evaluation, and SLERA for OU-2, arsenic, iron, manganese, cyanide, and PAHs were identified as groundwater COPCs. However, the slag pile was not considered a source of PAHs or a primary source of arsenic, iron, manganese, and cyanide (EA 2018). There are multiple other potential sources of these constituents in the immediate vicinity of the Site. The lines of evidence evaluated in the RI support the conclusion that the slag pile may have contributed to area-wide contamination (particularly of metals) prior to placement of the HDPE cover, but that the slag pile was not a significant contributor above and beyond other area sources. The RI concluded that, given the variable groundwater flow regime present at the Site that results in horizontal mixing of constituents in the aquifer, remedial actions to address groundwater contamination would need to take a broad, area-wide approach, and would address contamination that is not site-related.

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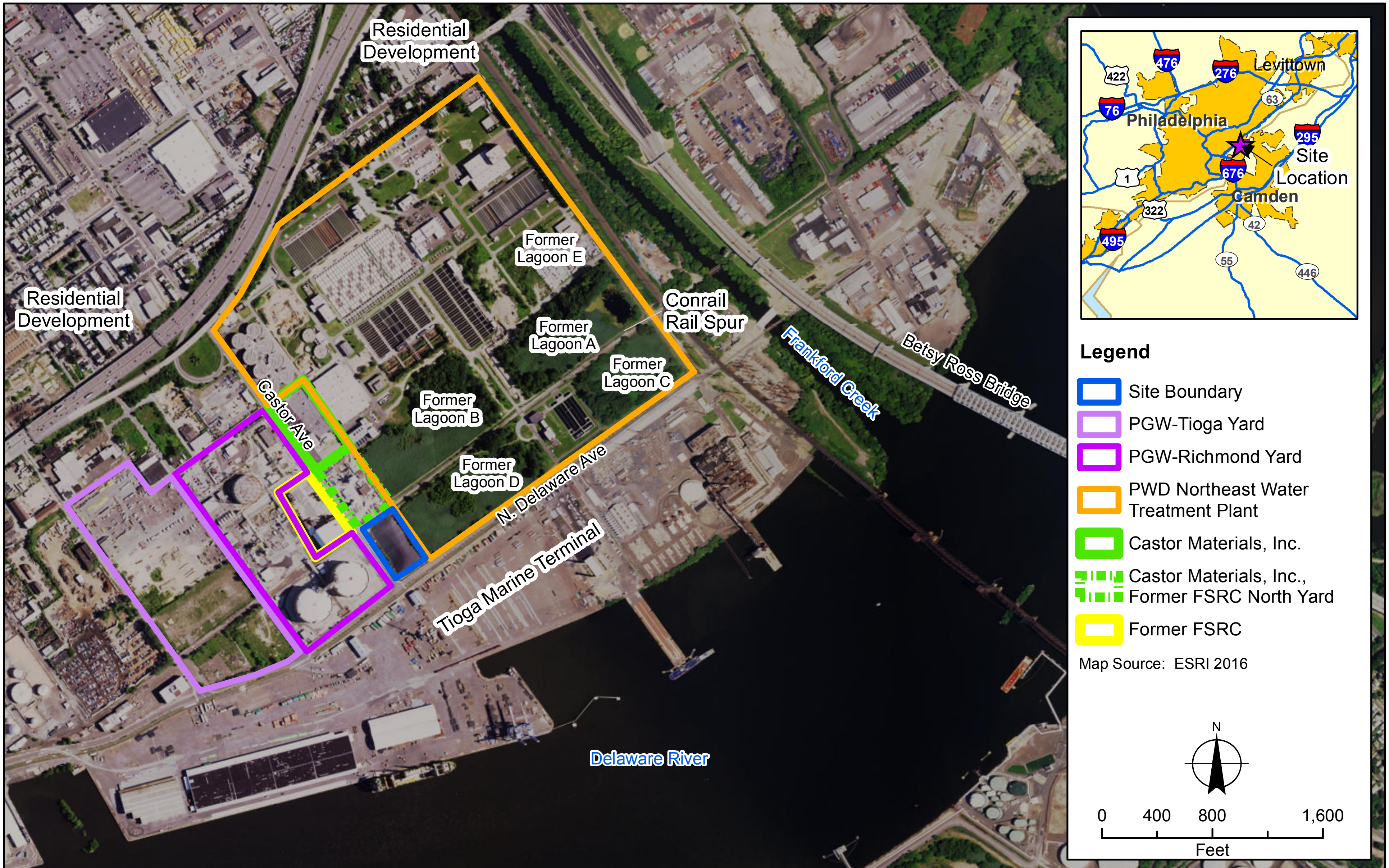

Franklin Slag Pile Superfund Site

OU-2 Groundwater

Philadelphia, Pennsylvania

Figure 1-1

Site Location Map

Franklin Slag Pile Superfund Site

OU-2 Groundwater
Philadelphia, Pennsylvania

Figure 1-2
Surface Soil Sample Location Map

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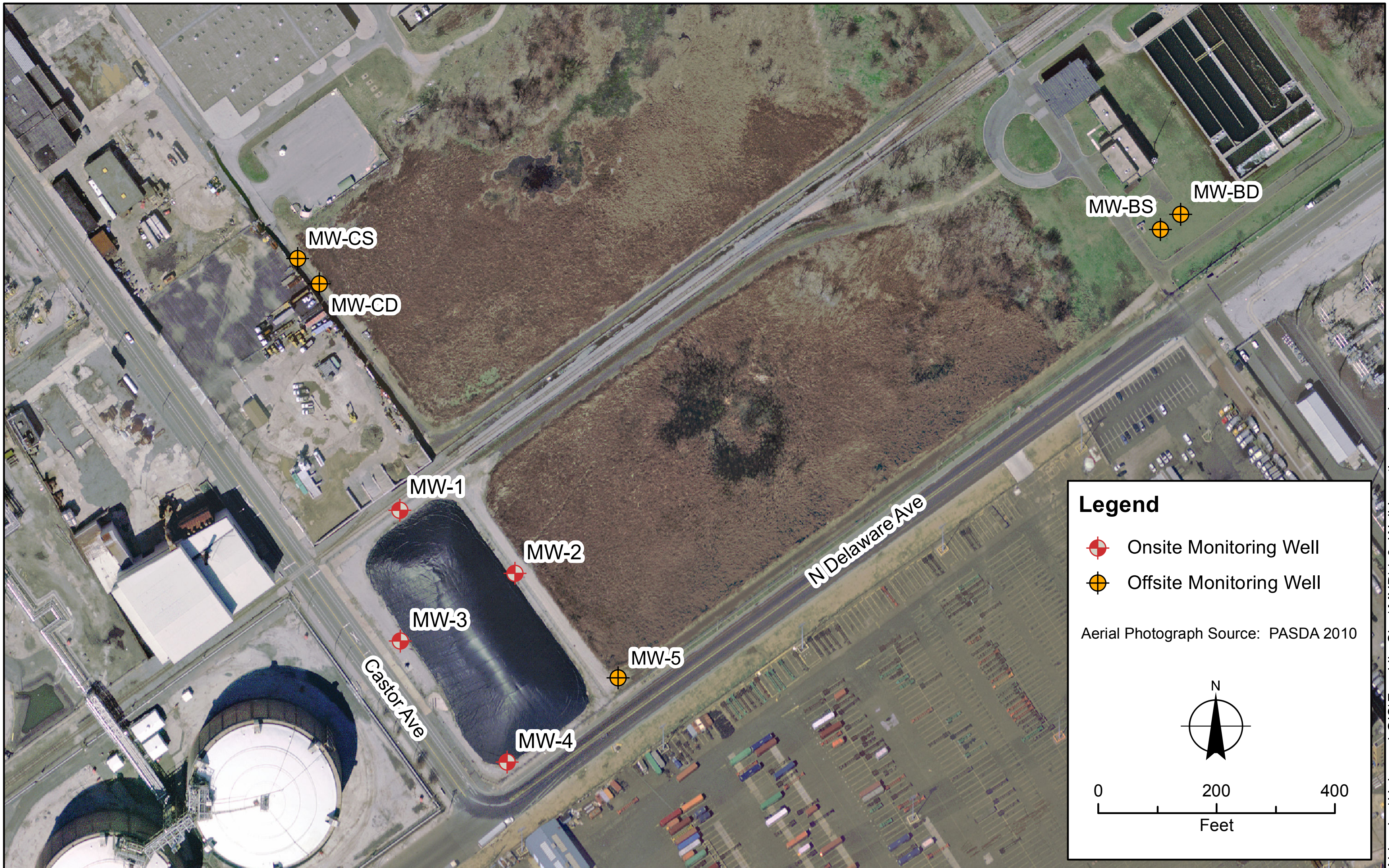

Franklin Slag Pile Superfund Site

OU-2 Groundwater
Philadelphia, Pennsylvania

Figure 1-3
Location of Monitoring Wells

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2. IDENTIFICATION AND SCREENING OF TECHNOLOGIES

2.1 INTRODUCTION

The purpose of this chapter is to assemble pertinent information that will be used in the screening, development, and evaluation of remedial alternatives for contamination at the Site. Specific goals of this chapter are as follows:

- Define the RAOs; identify the media of concern, COCs, and federal, state, and local ARARs; develop PRGs; and identify areas and volumes TBC for remediation (Section 2.2)
- Identify GRAs for the media of concern (Section 2.3)
- Identify technology types and process options and conduct preliminary screening (Section 2.4)
- Perform detailed screening of technology types and process options (Section 2.5).

This information will be used by the decision-makers in development of the ROD for the Franklin Slag Pile Superfund Site.

2.2 REMEDIAL ACTION OBJECTIVES

In order to develop remedial alternatives to address contamination at the Site, RAOs are first developed to decrease risks from complete exposure pathways to acceptable levels.

The RAOs developed for OU-1 (slag/soil) are as follows:

- Prevent future potential human exposure to inorganics (metals) in the slag material.
- Prevent future potential release of inorganics (metals) to the environment from the slag pile.
- Prevent future migration of contaminants in slag and soil that would result in groundwater contamination in excess of the applicable standards.

No separate RAOs were developed for groundwater at the Site (OU-2) because, as stated above, the slag pile was not found to have been a significant contributor to area-wide contamination above and beyond other area sources prior to placement of the HDPE cover. Following placement of the HDPE cover, and after implementation of a permanent remedy for the slag, the slag pile is not expected to contribute detectable contaminants to groundwater. Given the variable groundwater flow regime, remedial actions to address groundwater contamination would need to take a broad, area-wide approach and address contamination that is not Site-related. The RAOs for OU-1 (above) address decreasing the mobility of slag-related contaminants to other media including groundwater.

2.2.1 Media of Concern and Contaminants of Concern

Media of concern at the Site include slag, soil, and groundwater. The OU-1 RI identified potential non-carcinogenic risks primarily to construction workers contacting the slag or offsite surface soil containing elevated metals concentrations. Aluminum, beryllium, chromium, cobalt, copper, iron, lead, and manganese were identified as COCs in slag and associated soil. The OU-2 RI identified arsenic, iron, manganese, cyanide, and PAHs as COPCs in groundwater, although the slag pile is likely not a primary source of these chemicals to groundwater (EA 2018).

2.2.2 Applicable or Relevant and Appropriate Requirements

The development and evaluation of remedial alternatives under CERCLA include an assessment of alternative site remedies based on their ability to meet ARARs. In recognition of the unique characteristics and circumstances associated with remediation of individual sites, neither CERCLA, as amended, nor the NCP provide specific standards for the determination of whether a particular remedy provides sufficient cleanup at a given site. The selected remedial action for the Site must satisfy all ARARs unless specific waivers have been granted according to Section 121(d) of CERCLA.

The NCP (40 CFR Part 300) (EPA 1990) specifies procedures, techniques, materials, equipment, and methods to be employed in identifying, removing, or remedying releases of hazardous substances. In particular, the NCP specifies procedures for deciding the appropriate type and extent of remedial action at a site to effectively mitigate and minimize the threat to, and provide adequate protection of, public health, welfare, and the environment.

The goal of remedy selection is to protect human health and the environment, to maintain protection over time, and to minimize untreated waste (40 CFR 300.430 of the NCP [55 Federal Register 8846]). The remedial action must comply with all ARARs, laws, and standards promulgated by the federal government. In addition, compliance with promulgated state laws is necessary if the state ARAR is more stringent than the federal ARAR.

CERCLA Section 121(e), codified at 40 CFR Part 300.400(e), exempts any onsite response action from complying with the administrative requirements of federal, state, or local permits; however, such actions must comply with the applicable permit’s substantive provisions.

2.2.2.1 Definition of Applicable or Relevant and Appropriate Requirements

EPA defines “applicable” and “relevant and appropriate” in the revised NCP, codified at 40 CFR 300.5 (1994), and has incorporated these definitions in its CERCLA Compliance with Other Laws Manual (Interim Final-EPA/540/G-89/006, Part II-EPA/540/G-89/009). A requirement under CERCLA, as amended, may be either "applicable" or "relevant and appropriate" to a site-specific remedial action, but not both:

- ***Applicable Requirements***—These cleanup standards are standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstances at a CERCLA site.

- ***Relevant and Appropriate Requirements***—These cleanup standards are standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at a CERCLA site that their use is well suited to the particular site. In some circumstances, a requirement may be relevant, but not appropriate, for the site-specific situation.

2.2.2.2 Classifications of Applicable or Relevant and Appropriate Requirements

ARARs for remedial action alternatives at the Site can be generally classified into one of the following three functional groups:

1. ***Chemical-Specific***—Health- or risk-based numerical values or methodologies that establish cleanup levels or discharge limits for particular contaminants. Typical examples of chemical-specific ARARs include MCLs or Ambient Water Quality Criteria.

2. ***Location-Specific***—Requirements that restrict remedial actions based on the characteristics of the Site or its immediate environment. Generally, location-specific requirements serve to protect the individual site characteristics, resources, and specific environmental features. Typical examples of location-specific ARARs include federal/state wetlands protection guidelines.

3. ***Action-Specific***—Requirements that set controls or restrictions on the design, implementation, and performance levels of activities related to the management of hazardous substances, pollutants, or contaminants. Typical examples of action-specific ARARs include National Pollutant Discharge Elimination System requirements or Clean Air Act requirements.

To be consistent with the NCP definition of ARARs and CERCLA, as amended, the following groups of ARARs were considered during the identification process:

- Federal requirements
- More stringent Commonwealth of Pennsylvania requirements.

2.2.2.3 To Be Considered Guidance

Federal and state guidance documents or criteria that are not generally enforceable, but are advisory, do not have the status of potential ARARs. Guidance documents or advisories TBC in determining the necessary level of cleanup for protection of human health or the environment may be used where no specific ARARs exist for a chemical or situation, or where such ARARs are not sufficient to afford protection.

2.2.2.4 Circumstances in which Applicable or Relevant and Appropriate Requirements May Be Waived

Pursuant to Section 300.430(f)(1)(ii)(C) of the NCP, several criteria presently exist in which all ARARs need not be attained. These waivers apply only to meeting ARARs with respect to onsite remedial activities. A waiver must be invoked for each ARAR that will not be attained or exceeded. Other statutory requirements, such as those requiring that remedies must be cost-effective, cannot be waived.

According to Section 300.430(f)(1)(ii)(C) of the NCP, an alternative that does not meet an ARAR under federal environmental or state environmental or facility siting laws may be selected under the following circumstances:

- The alternative is an interim measure and will become part of a total remedial action that will attain the applicable or relevant and appropriate federal or state requirement.
- Compliance with the requirement will result in greater risk to human health and the environment than other alternatives.
- Compliance with the requirement is technically impracticable from an engineering perspective.
- The alternative will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, or limitation through use of another method or approach.
- With respect to a state requirement, the state has not consistently applied, or demonstrated the intention to consistently apply, the promulgated requirement in similar circumstances at other remedial actions within the state.
- For Fund-financed response actions only, an alternative that attains the ARAR will not provide a balance between the need for protection of human health and the environment at the site and the availability of Fund monies to respond to other sites that may present a threat to human health and the environment.

2.2.2.5 Identification of Applicable or Relevant and Appropriate Requirements

Table 2-1 presents potential federal and state/local ARARs and TBC guidance for remedial action at the Site. Each ARAR has been chosen for its potential applicability or relevance and appropriateness according to the procedures identified in the CERCLA Compliance with Other Laws Manual (Office of Solid Waste and Emergency Response Directive 9234.1-01) and guidance for conducting RIs and FSs under CERCLA (EPA 1988).

2.2.3 Preliminary Remediation Goals

PRGs are contaminant concentration levels that are established to meet RAOs. Specifically, PRGs are developed to comply with federal and state ARARs, be protective of human receptors from adverse health effects, and be protective of the environment from detrimental impacts from site-related compounds.

PRGs for the slag material were not developed. Based on testing results, the material is a hazardous waste by characteristic (i.e., toxicity). However, a range of PRGs for the Site was developed for onsite soils, to address the RAOs related to potential future human exposures to metals. Soil PRGs may be applicable depending upon the selected remedial technology. The soil PRGs are based on continued non-residential use of the Site, consistent with the expected future use, and were derived using the results of the OU-1 RI and HHRA and chemical-specific ARARs and TBC guidance. The project PRGs for the metals COCs in soil at the Site are presented in Table 2-2, and additional details regarding the PRG evaluation are provided in Appendix A.

To address the RAOs related to preventing release/migration of contaminants from the slag and soil, a remedy will be chosen to permanently minimize the mass and/or mobility of slag-related contaminants at the Site. To confirm that mobility of contaminants at the Site remains low following implementation of the remedy for slag/soil, groundwater monitoring will be conducted to confirm stable or decreasing trends of COPC concentrations in groundwater. Assessment of COPC concentration trends in groundwater before, during, and after remediation of the slag pile will allow confirmation that no increase in slag-related groundwater impacts has occurred during remediation.

2.2.4 Areas and Volumes of Media for Remediation

2.2.4.1 Operable Unit 1 (Slag Pile and Associated Soil)

OU-1 includes the slag pile and associated onsite soil. The slag pile is situated on an approximately 4-acre lot and is approximately 220 ft wide by 445 ft long and varies in height from grade to 40 ft. The volume of the slag pile is estimated to be about 68,000 cubic yards (TtNUS 2007b), which equates to approximately 108,000 tons of slag.

As indicated above, the remaining volume of contaminated soil onsite is not well delineated. Available documentation does not indicate whether impacted soil remains onsite around the slag pile, and the volume of impacted soil beneath the slag pile has not been characterized. For the purposes of this FS, the volume of potentially impacted soil is estimated to include Site soils from the surface up to 1 ft below ground surface beneath the footprint of the slag pile, which yields a volume estimate of 3,626 cubic yards. Assuming the soil has approximately the same density as the slag, this equates to 5,150 tons of potentially contaminated soil.

2.2.4.2 Operable Unit 2 (Groundwater)

A specific area and volume of contaminated groundwater was not defined in the OU-2 RI because the extent of groundwater contaminated with COPCs extends beyond the boundaries of the Site. In addition, historical activities at adjacent properties have contributed to the groundwater contamination. Therefore, it is not possible to define an area or volume of groundwater that is contaminated primarily by the Site and that will be targeted for remediation.

2.3 GENERAL RESPONSE ACTIONS

GRAs are broad categories of actions that are identified as potential options for achieving the RAOs. The GRAs were selected based on the media of concern at the Site and the chemical properties of the COCs. The five GRAs identified for implementation to address the impacts present at the Site (in no particular order of preference) are as follows:

- No Action
- Limited Action
- Containment
- *Ex Situ* Treatment
- Source Removal.

GRAs and their potential applicability to the media of concern are described below.

2.3.1 No Action

The NCP requires consideration of a “No Action” response. No Action serves as a baseline against which the performance of other remedial alternatives can be compared. This response assumes no active remedial measures are implemented, although any processes that naturally attenuate the contamination would continue under this GRA.

2.3.2 Limited Action

This GRA would include limited actions to reduce exposure to contaminated media, such as institutional controls and access restrictions, as well as environmental monitoring. These limited actions may be used in combination with other actions; however, in some cases, limited actions alone are sufficient to protect human health and the environment. In addition, limited actions may be implemented as the only response in circumstances where active response actions such as treatment or removal of the contaminated media are not feasible. Examples of institutional controls include land use restrictions, and examples of access restrictions include fences, covers/caps, and signs. Monitoring involves the collection of environmental samples to evaluate temporal trends in the quality of environmental media and receptors. Monitoring regimens can include continuous, daily, weekly, monthly, quarterly, semi-annual, annual, or less frequent monitoring. When limited action is taken, CERCLA 5-year reviews are typically required to evaluate and document compliance with the RAOs and assess protectiveness of the remedy, as long as potential risks remain above acceptable levels.

2.3.3 Containment

This GRA reduces potential exposure to COCs by physically containing the contaminants and thus reducing or controlling their mobility. Technologies could include surface barriers (soil covers and multi-media caps), and impermeable vertical barriers. It should be noted that containment may limit future use of the area, as the remedial measures need to remain in place to control contaminant mobility indefinitely, or until the exposure risk decreases or is removed by some other means. When technologies associated with the containment GRA are utilized as the primary remedy, CERCLA 5-year reviews are typically required to evaluate and document compliance with the RAOs and assess protectiveness of the remedy.

2.3.4 Ex Situ Treatment

Ex situ treatment involves the removal of the impacted media followed by the application of treatment technologies to transform, destroy, remove, or immobilize the targeted constituents. Examples of an *ex situ* treatment technology include mixing source material with amendments to retain COCs in the solid phase and/or reduce bioavailability.

2.3.5 Source Removal

This GRA would address contaminated slag and soil by excavating it and removing it from the Site for offsite disposal. This response action would reduce the mass of contaminants at the Site and thus decrease the potential risk from exposure in the long term. Excavation would use conventional earth-moving equipment to remove contaminated media and would require the use of dust and erosion control procedures. The soil would be either disposed of appropriately (onsite or offsite) or re-used for an appropriate application.

2.4 PRELIMINARY IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS

This section identifies and screens specific technologies and process options for the GRAs identified in Section 2.3. Technology types are general categories, whereas process options are specific processes for each technology type. In this section, technologies and process options are screened based on technical implementability. This criterion includes the applicability of the technology for addressing risks associated with exposure to the COCs at the Site, as well as the technology's reliability. Table 2-3 (slag/soil) summarizes the representative technologies and process options identified under each GRA and indicates the technologies and process options that were eliminated from further consideration during this preliminary screening based on the technical implementability criterion. Additional information regarding technologies that were retained for further evaluation is provided in Section 2.5.

2.5 DETAILED SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS

Technologies and process options that have been retained from the preliminary screening in Section 2.4 are evaluated further in the following sections. In Section 2.5.1, technologies are screened for their appropriateness for addressing the Site COCs in slag and onsite soil. Section 2.5.2 presents the technology screening for addressing the COPCs in groundwater. For each technology, there may be more than one process option discussed. Each technology and process option presented is categorized in accordance with the appropriate GRA and is evaluated for effectiveness, implementability, and relative cost using the criteria described below.

Effectiveness

The effectiveness evaluation is focused on the following elements:

- Potential effectiveness of process options in handling the estimated areas or volumes of media and in meeting the RAOs

- Potential impacts to human health and the environment during the construction and implementation phase

- Reliability and proven effectiveness of the process with respect to the COCs and site-specific conditions.

Implementability

The implementability evaluation includes both the technical and institutional (administrative) feasibility of implementing each technology or process option. This initial technology screening eliminates technology types or process options that are clearly ineffective or unworkable at the site. These institutional aspects include:

- Potential for obtaining regulatory approval
- Availability of necessary equipment and skilled workers to implement the technology
- Availability of treatment, storage, and disposal services
- Time required for implementation
- Ability to achieve the applicable remediation standards within a reasonable time frame.

Cost

The screening of alternatives is intended to evaluate the technical feasibility and implementability of remedial technologies in addressing the RAOs under site-specific operating conditions. For this screening evaluation, a qualitative cost analysis has been presented only if costs were uncommonly prohibitive or if other process options within the same technology type were comparably effective and implementable. Preliminary cost estimates for the remedial technologies are presented in Chapters 4 and 5 as part of each of the remedial alternatives developed from the technologies retained in this chapter.

2.5.1 Technologies to Address Slag and Onsite Soil

The results of the technology screening for slag and onsite soil are summarized in Table 2-3.

2.5.1.1 No Action

There are no technologies or process options associated with this response action. This option has been retained as a basis for comparison with the other remedial technologies for slag/soil.

This option includes neither institutional controls, access restrictions, monitoring, repairing the existing HDPE cover (which would remain in place), nor efforts to contain, remove, treat, or dispose of slag or associated soil at the Site. Implementation of a No Action alternative would require a review at least every 5 years to ensure protection of human health and the environment.

Effectiveness—A “No Action” alternative would not be expected to achieve the RAOs for slag/soil. No actions would be taken to prevent or minimize potential human exposure to slag or soil, and no actions would be taken to prevent or minimize further migration of COCs. Due to the uncertainty associated with these conditions, it must be assumed that “No Action” would not achieve the RAOs.

Implementability—Administrative implementation of this option for slag/soil would be difficult due to required regulatory agency approval and potentially unfavorable public opinion.

Cost—No capital or annual operation and maintenance (O&M) costs are associated with the No Action option. The only costs are in conducting the remedial action reviews every 5 years, or as required.

This option will be retained, as a basis of comparison to other alternatives.

2.5.1.2 Limited Action – Land Use Restrictions

Land use restrictions are institutional controls that affect site management and/or activities occurring at the site. Institutional controls are non-engineered instruments, such as administrative and legal controls, that help minimize the potential for human exposure to contamination and/or protect the integrity of the remedy. Land use restrictions do not physically alter conditions at the site and do not reduce the toxicity, mobility, or volume of COCs at the site. Rather, land use restrictions are used to limit the potential for exposure to COCs. Depending upon the site-specific conditions, land use restrictions can be used alone or in conjunction with other remedial actions.

Land use restrictions can be used to control current or future construction and/or residential use of the site. Land use restrictions can include master plan restrictions, zoning limitations, physical limitations on the size and weight of improvements, and construction prohibitions (e.g., preventing excavation or well installations).

Effectiveness—Land use restrictions that limit contact with slag and associated soil would be effective for reducing the potential for exposure to COCs. This option does not prevent release of COCs from the slag pile. Therefore, this option only partially meets the RAOs.

Implementability—The implementation of land use restrictions involves administrative actions to restrict or prohibit future activities at the Site. Monitoring and enforcement are also required.

Cost—Costs for implementing institutional controls such as land use restrictions are generally much lower than other remedial technologies. There are no annual O&M costs associated with this option. The only recurring costs are in conducting periodic remedial action reviews as required.

Land use restrictions will be retained as a process option for slag and soil.

2.5.1.3 Limited Action – Access Restrictions

Limited actions can include access restrictions, which are primarily used to limit the potential for exposure to COCs, and do not provide contaminant reduction. The HDPE cover currently in place on the slag pile is an example of an access restriction, which also provides some limit on contaminant mobility. Control of site access can also be accomplished through actions such as installation of fencing. Depending upon the site-specific conditions, access restrictions can be used alone or in conjunction with other remedial actions.

Effectiveness—The HDPE cover and fencing currently in place at the Site effectively reduce the potential for exposure to COCs by limiting contact with slag and associated soil. These access restrictions require inspections and maintenance for continued effectiveness.

Implementability—An HDPE cover and fencing have already been implemented at the Site, and maintenance of these access restrictions is also implementable.

Cost—Costs for implementing access restrictions are generally lower than other remedial technologies. Annual O&M costs would be associated with maintenance, and potential replacement, of the HDPE cover and the fence. Additional recurring costs would be associated with conducting periodic remedial action reviews as required.

Access restrictions will be retained as a process option for slag and soil.

2.5.1.4 Limited Action – Groundwater, Surface Soil, Air Monitoring

Monitoring involves the collection of environmental samples to evaluate temporal trends in the quality of environmental media and receptors. Groundwater, surface soil, and air monitoring could be conducted using standard methods, to assess potential migration of material from the Site. Monitoring could be conducted regularly or when signs of an issue are observed.

Effectiveness—In general, monitoring can be an effective technique to evaluate the long-term trends of Site COCs and/or treatment technology performances. A monitoring program would not have adverse effects for human health or the environment. Groundwater, surface soil, and air monitoring would help determine whether the RAOs are being met but would not achieve RAOs as a sole remedy. Monitoring would not be effective as a sole remedy because it would not achieve RAOs for OU-1.

Implementability—Groundwater, surface soil, and air monitoring would be easily implementable, and the required materials and services are readily available. Groundwater monitoring would be implementable using the existing monitoring wells at the Site.

Cost—Capital costs for monitoring are primarily associated with sample collection and analytical costs, and are expected to be relatively low. O&M activities typically include sampling, analysis, and report preparation. The O&M costs for this option are expected to be low.

Groundwater, surface soil, and air monitoring will be retained as a process option for slag and soil.

2.5.1.5 Containment – Capping

Installation of a cap could further restrict the potential for contact with slag and soil at the Site and also further limit mobilization of contaminants from the slag. Process options for capping include a soil cover placed over the existing HDPE liner and a low permeability composite (double) barrier.

Soil Cover

A vegetated soil cover placed over the existing HDPE cover would help to retard ultraviolet degradation of the existing cover material, while the vegetation would minimize erosion and promote evapotranspiration of precipitation infiltration. Additional work on side slopes of the slag pile and repairs to the HDPE cover may be needed to facilitate placement of the soil cover.

Effectiveness—A soil cover would decrease the maintenance requirements of the existing HDPE cover, and thereby increase the effectiveness of the cover. The existing cover would continue to limit precipitation infiltration into the slag and underlying soil and groundwater. Such a cover would not meet all PADEP final cover requirements but could be effective. Placement of a soil cover would not adversely impact human health or the environment.

Implementability—Construction of a soil cover over the existing HDPE cover would be implementable. Regular monitoring and maintenance would be required to ensure that the cover remains vegetated and in good condition. The continued presence of slag at the Site, and the need to maintain the integrity of the cover, would limit future use of the Site.

Cost—Placement of a vegetated soil cover would have low to medium capital costs and low O&M costs.

A soil cover is not retained as a process option because it does not meet PADEP final cover requirements.

RCRA Cap

A multi-media RCRA cap over the slag material would consist of two low-permeability layers (a geosynthetic clay liner and a membrane), a drainage layer, and a layer of vegetation-bearing soil. Additional work on side slopes would be needed to facilitate placement of the cap, and stormwater control would be needed to meet slope and drainage requirements under RCRA.

Effectiveness—Capping does not lessen toxicity or volume of hazardous wastes but does prevent direct contact with slag material and also limits precipitation infiltration into the slag and underlying soil and groundwater. Compared to the single-layer HDPE cover currently present at the Site, a RCRA cap would be more durable, leading to a lower risk of cover failure. Potential short-term impacts to human health and the environment would be associated with exposure to contaminated slag and soil, dust generation, stormwater management, and erosion during capping and any associated slag removal and grading activities. Controls for dust, stormwater, and erosion would be implemented to address these impacts.

Implementability—Construction of a RCRA cap over the slag pile would be implementable. Regular monitoring and maintenance would be required to ensure that the cap remains effective. The continued presence of the slag pile at the Site, and the need to maintain the integrity of the cap, would limit the potential for future site reuse.

Cost—Capping would have moderate capital costs and low-moderate O&M costs.

A RCRA cap is retained as a process option.

2.5.1.6 Ex Situ Treatment – Chemical Fixation/Solidification

With *ex situ* chemical fixation or solidification, slag material removed from the pile would be mixed with a matrix (e.g., cement, lime, or other pozzolanic material) to immobilize contaminants in the slag and thus reduce the potential for leaching.

Effectiveness—Chemical fixation of metals at hazardous levels can be effective with a suitable stabilizing agent. When utilized prior to disposal, this technology can allow non-hazardous disposal of materials previously characterized as hazardous.

Implementability—Chemical fixation/stabilization would be implementable if a method can be found to mix a large quantity of hazardous material with a stabilizing agent. The feasibility of this option would also depend on availability of a mechanism to dispose of the stabilized material.

Cost—Chemical fixation/solidification would have medium capital costs and low O&M costs. If removed material were treated using this process option prior to disposal, the treatment would likely yield a decrease in disposal costs.

Chemical fixation/solidification is retained as a process option for combination with other technologies.

2.5.1.7 Ex Situ Treatment – Incineration

Incineration of the slag material removed from the pile could be used as fuel.

Effectiveness—Based on EPA Region 3 correspondence, the slag at the Site has been identified for potential use in incineration. Following incineration, it is expected that some amount of residue would require disposal as hazardous waste.

Implementability—Incineration could be implementable if the slag material is confirmed to be appropriate for use in incineration and if approvals could be obtained to send the slag to a facility for use in incineration.

Cost—Incineration would have high capital costs, primarily associated with transportation of hazardous waste to a potentially distant facility.

Incineration is not retained as a process option because it is likely not implementable.

2.5.1.8 Source Removal – Mechanical Excavation

Mechanical excavation would entail physical removal of the slag and underlying soils containing concentrations of metals above the project PRGs. This technology would be combined with a technology for disposal of the removed slag and soil, and may also be combined with chemical fixation/solidification to decrease mobility of metals in slag/soil prior to transport.

Effectiveness—Excavation would effectively allow removal of contaminated material from the Site and achieve the RAOs for slag and soil. Potential short-term impacts to human health and the environment would be associated with exposure to contaminated soil, dust generation, and erosion created by excavation activities. Controls for dust and erosion would be implemented to address these impacts.

Implementability—Excavation of the slag pile and shallow underlying soil would be implementable, although the volume of material requiring handling would be large (approximately 70,000 cubic yards). The extent of soil with elevated metals concentrations below the slag pile is unknown; if contamination extends below the groundwater table (greater than approximately 6 ft below ground surface), then excavation could require dewatering. Standard excavation equipment such as excavators, front-end loaders, and bulldozers would be used to conduct the excavation activities, and this technology would be paired with another technology for disposal of the excavated material. Backfilling may be required following removal of impacted soil underlying the slag pile. This technology is commonly used and is reliable and implementable.

Cost—This process option would be associated with moderate capital costs and no O&M costs.

Excavation is retained as a process option in combination with other technologies.

2.5.1.9 Source Removal – Offsite Disposal at a RCRA Hazardous Waste Landfill

This process option entails permanent offsite disposal of excavated material at a RCRA permitted hazardous waste landfill. Based on previous analyses, the slag material is RCRA hazardous due to characteristic (toxicity). Therefore, if disposed of directly after excavation, the slag would require transport to a RCRA permitted landfill for permanent disposal. Associated soils excavated with the slag would also be disposed of at a RCRA permitted landfill, if determined to be hazardous.

Effectiveness—Offsite disposal at a hazardous waste landfill would effectively remove contaminated material from the Site and achieve the RAOs for slag and soil. Potential impacts to human health and the environment could be associated with long-distance transport of hazardous material. Appropriate controls would be implemented to minimize potential impacts during transport. The permanent disposal facility would effectively control exposure of humans and the environment to the hazardous materials.

Implementability—Offsite disposal of slag (and possibly soil) at a hazardous waste landfill would be implementable. This process option is commonly used, is reliable and implementable, and was used for disposal of slag and soil removed during the EPA removal action in 1999-2000.

Cost—This process option would be associated with high capital costs and no O&M costs.

Offsite disposal at a RCRA hazardous waste landfill is retained as a process option in combination with other technologies.

2.5.1.10 Source Removal – Solid Waste Facility Disposal

This process option entails permanent offsite disposal of excavated material at a permitted solid waste facility. Although the slag material was determined to be RCRA hazardous due to characteristic (toxicity), treatment following excavation (e.g., chemical fixation/solidification) could be conducted to allow disposal of the slag as non-hazardous solid waste. Associated soils excavated with the slag could also be disposed of as non-hazardous waste, following treatment if required.

Effectiveness—Offsite disposal of slag and associated soil as non-hazardous waste at a solid waste facility would effectively remove contaminated material from the Site and achieve the RAOs for slag and soil. Fewer potential impacts to human health and the environment would be associated with long-distance transport of the treated, non-hazardous material. Appropriate controls would be implemented to minimize potential impacts during transport.

Implementability—Offsite disposal of slag and associated soil at an offsite solid waste facility would be implementable, provided that the material can be successfully treated to meet the requirements for non-hazardous disposal. This technology is commonly used and is reliable and implementable.

Cost—This process option would be associated with medium capital costs and no O&M costs.

Offsite disposal at a solid waste disposal facility is retained as a process option in combination with other technologies.

2.5.2 Technologies to Address Groundwater

2.5.2.1 No Action

There are no technologies or process options associated with this response action. This option includes neither land use controls nor efforts to contain, remove, treat, or dispose of potentially impacted groundwater at the Site.

Effectiveness—The No Action alternative could be effective, as no RAOs have been developed for groundwater.

Implementability—Because no remedial components or monitoring would be performed, the No Action alternative would be readily implementable.

Cost—No capital or annual O&M costs are associated with the No Action option.

No Action is the only option considered for OU-2 because no separate RAOs were developed for this OU (see Section 2.2); therefore, the No Action option is retained.

2.6 SUMMARY OF TECHNOLOGY TYPE AND PROCESS OPTION EVALUATION

Based on the screening of remedial technologies, certain technologies that were not effective or implementable at the Site have been eliminated from further consideration. For OU-2, the only retained option is No Action. Table 2-3 summarizes the remedial technologies/approaches for OU-1 that have been evaluated in this chapter and the determination to retain or eliminate screened technologies. Technologies that have been retained are used in developing remedial alternatives in Chapter 3.

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Table 2-1 Summary of Potential Applicable or Relevant and Appropriate Requirements and To Be Considered Material

ARAR or TBC	Citation	Classification	Site Media Addressed, and Summary of Requirement	Further Detail Regarding ARARs in the Context of the Remedy
Chemical-Specific				
Federal				
National Primary Drinking Water Regulations (Maximum Contaminant Levels and non-zero Maximum Contaminant Level Goals), Safe Drinking Water Act	40 CFR §§ 141.11, 141.51 and 141.62	Relevant and Appropriate	Groundwater; Maximum Contaminant Levels and non-zero Maximum Contaminant Level Goals for Inorganic Chemicals	
Regional Screening Levels for Chemical Contaminants at Superfund Sites	Updated Regional Screening Level Table.	TBC	Groundwater (Tapwater) and Soil; EPA Region 3 utilizes values from this table for risk-based screening and assessment. Includes soil screening levels for protection of groundwater.	
EPA Region 3 BTAG Freshwater Screening Benchmarks for Surface Water and Sediment	BTAG Tables of Freshwater Screening Benchmarks and Freshwater Sediment Screening Benchmarks	TBC	Surface Water and Sediment; EPA Region 3 uses these benchmarks to evaluate sampling data from Superfund sites, to facilitate consistency in screening level risk assessments.	
Clean Water Act Ambient Water Quality Criteria for the Protection of Aquatic Life	40 CFR §131.36	Relevant and Appropriate	Surface Water; Ambient Water Quality Criteria are available for the protection of human health from exposure to contaminants via ingestion of water and/or aquatic biota, and for the protection of aquatic biota.	Ambient Water Quality Criteria are non-enforceable guidelines and may be used to assess discharges to surface water or as benchmarks during long-term monitoring.
State				
Statewide Health Standards, Land Recycling and Environmental Remediation Standards Act (Act 2)	25 Pennsylvania Code §§250.301-308	Relevant and Appropriate	Groundwater and Soil; medium-specific concentrations for protection of human health. Act 2 medium-specific concentrations for soils and groundwater are ARARs if medium-specific concentrations are more stringent than federal standards (e.g., Maximum Contaminant Levels).	

ARAR or TBC	Citation	Classification	Site Media Addressed, and Summary of Requirement	Further Detail Regarding ARARs in the Context of the Remedy
Water Quality Criteria for Toxic Substances	25 Pennsylvania Code, Chapter 93	Applicable	Surface water; Include criteria for Fish and Aquatic Life (Continuous and Maximum) and for Human Health	
Location-Specific				
Federal				
Protection of Floodplains	Executive Order 11988; 40 CFR Part 6, and Appendix A	TBC	Executive Order that is applied by federal agencies to avoid long and short term impacts on flood plains.	
Protection of Wetlands	Executive Order 11 990, Section 7; 40 CFR Part 6, and Appendix A	TBC	Executive Order that is applied by federal agencies to avoid adversely impacting wetlands.	
Clean Water Act	33 USC §§1344, Section 404	Applicable	Wetland degradation is also covered under Section 404 of the Clean Water Act.	
Endangered Species Act	16 USC §1531-1534	TBC	Protects endangered species by limiting actions by the EPA that may jeopardize their habitat. This act may be relevant if any endangered species are identified at site.	
Migratory Bird treaty Act	16 USC §§703-712	TBC	This Act is implemented to protect the lively hood of migrating birds and may be relevant if any remedial action poses deleterious effects on these birds.	
State				
Pennsylvania Scenic Rivers Act	32 PS §820.21-§820.2; §820. 151 -§820. 161	TBC	Requires state agencies to follow management guidelines outlined in the Tulpehocken Creek Study.	
Pennsylvania Fish and Boat Code	58 Pennsylvania Code §65.1 et. seq.	TBC	Sets regulations related to fish consumption advisories and may be relevant if any remedial actions results in discharge to Tulpehocken Creek.	
Pennsylvania Flood Plain Management Act	32 PS §679.101-60, 25 Pennsylvania Code §106.31-§106.33	Relevant and Appropriate	Outlines standards for construction, earthmoving, filling, and excavations within Tulpehocken Creek floodplains and wetlands.	

ARAR or TBC	Citation	Classification	Site Media Addressed, and Summary of Requirement	Further Detail Regarding ARARs in the Context of the Remedy
Action-Specific				
Federal				
Identification of Hazardous Wastes	40 CFR §261.24	Applicable	Defines and describes the process for identifying hazardous wastes based on toxicity characteristic.	Characterization and disposal of excavated soils will be governed by this requirement
Standards applicable to Generators of Hazardous Wastes	40 CFR §262.10(a),(h) and 262.11(c)(1) and 262.12	Applicable	These regulations establish standards for generators of hazardous wastes, including initiating shipments, determination of hazard characteristics, and identification numbers.	Excavation of soil which results in generation of hazardous waste will be governed by generator regulations
RCRA Hazardous Waste Management	40 CFR Part 260, Subtitle C	Applicable	These regulations establish standards for the generation, transport, storage, treatment, and disposal of RCRA hazardous waste.	Offsite disposal will comply with these regulations.
RCRA Land Disposal Restrictions	40 CFR Part 268	Applicable	These regulations place restrictions on land disposal of waste that is considered hazardous. Hazardous waste may require treatment prior to disposal.	Offsite disposal will comply with these regulations.
RCRA Hazardous Waste Generator and Transporter Requirements	40 CFR Parts 262 and 263	Applicable	Sets forth responsibilities for generators and transporters of hazardous waste by requiring specific packaging, labeling, record keeping, and manifest requirements.	Offsite disposal will comply with these regulations.
RCRA Preparedness and Prevention	40 CFR Parts 264.30-31. Subpart C	Applicable	Sets forth requirements for safety equipment and spill control.	TBC during planning and general remediation activities
RCRA Contingency Plan and Emergency Procedures	40 CFR Parts 264.50-56, Subpart D	Applicable	Sets forth emergency procedures to be followed during explosions, fires, etc.	TBC during planning and general remediation activities
Department of Transportation Rules for Hazardous Materials Transport	49 CFR Parts 107, 171-179	Applicable	These regulations establish standards for transporting hazardous materials by requiring appropriate packaging, marking, labeling, and transporting methods.	Offsite disposal will comply with these regulations.
RCRA Management of Remediation Waste	EPA 530-F-98-026 (October 14, 1998)	TBC	Provides guidance for consolidating contaminated soils.	TBC during planning and general remediation activities
Clean Air Act National Primary and Secondary Ambient Air Quality Standards	40 CFR Part 50	Applicable	These regulations establish ambient air quality standards to be followed during remedial actions that result in the generation of dust or airborne contaminants.	TBC during planning and general remediation activities

ARAR or TBC	Citation	Classification	Site Media Addressed, and Summary of Requirement	Further Detail Regarding ARARs in the Context of the Remedy
Clean Water Act National Recommended Water Quality Criteria	40 CFR Part 131 Section 303(c)	Relevant and Appropriate	These regulations establish water quality standards to be followed during remedial actions that result in the discharge of liquids to surface water.	TBC during planning and general remediation activities
Clean Water Act Ambient Water Quality Criteria	40 CFR Part 131; 33 USC 1251 et seq. Section 304(a)(1)	TBC	This regulation establishes Ambient Water Quality Criteria for surface water bodies to protect human health, as well as fresh and salt water aquatic life, from exposure to contaminated surface water.	TBC during planning and general remediation activities
National Pollutant Discharge Elimination System Program	40 CFR 122 including 122.26	Applicable	Sets requirements and permits to control and monitor storm water runoff from construction activities or during remedial actions that generate waste water.	TBC during planning and general remediation activities
State				
Pennsylvania Particulate Emission Regulations	25 Pennsylvania Code, Chapter 123	Potentially applicable	Establishes the fugitive dust regulation for particulate matter.	Excavation of soil and any other construction activities will comply with these regulations.
Pennsylvania Air Pollution Control Act	25 Pennsylvania Code, Chapter 131	Potentially applicable	Ambient air quality standards for discharges of air pollutants.	Potentially applicable for remedial design and implementation
Erosion and Sediment Control	25 Pennsylvania Code 102.4(b)(1), 102.11, 102.22	Relevant and Appropriate	Identifies erosion and sediment control requirements and criteria for activities involving land clearing, grading and other earth disturbances and establishes erosion and sediment control criteria.	These regulations apply to construction activities at the site that disturb the ground surface, including clearing, grading and excavation.
Solid Waste Management Act	35 P.S. §6018.405	Applicable	Sets forth requirements for the transport of property on which hazardous wastes are being or have ever been disposed.	Offsite disposal will comply with these regulations.
Hazardous Waste Management Regulations-Generator Definition	25 Pennsylvania Code §260a.10 (Subpart B)	Applicable	Activities involving the management of hazardous waste, which include treating, storing, transporting, and disposal, must comply with the requirements of these regulations.	TBC during planning and general remediation activities

ARAR or TBC	Citation	Classification	Site Media Addressed, and Summary of Requirement	Further Detail Regarding ARARs in the Context of the Remedy
Hazardous Waste Management Regulations - Empty Containers	25 Pennsylvania Code §261a.7	Applicable	Provides guidelines for managing empty containers or liners that have been used to store hazardous waste.	TBC during planning and general remediation activities
Hazardous Waste Management Regulations-Identification of Hazardous Waste	25 Pennsylvania Code §261a, Subpart A	Applicable	Provides criteria and lists to classify hazardous waste and may be applicable if contaminated soils and/or sediments exhibit the characteristic of a hazardous waste.	TBC during planning and general remediation activities
Hazardous Wale Management Regulations-Operator Requirements	25 Pennsylvania Code §262a.20-23	Applicable	Sets forth a requirement for a generator of hazardous waste to prepare a manifest for transportation of the waste. This requirement may be relevant during remedial actions involving offsite transport for contaminated soils and/or water considered hazardous.	TBC during planning and general remediation activities
Hazardous Waste Management Regulations-Transporter Requirements	25 Pennsylvania Code §263a	Applicable	Requirements for preparing hazardous wastes for off-site transportation; applicable for any remedial actions involving off-site transport for contaminated soils and/or sediments determined to be hazardous	Offsite disposal will comply with these regulations.
Hazardous Waste Management Regulations – Standards for Management of Containers	25 Pennsylvania Code §264a.173	Applicable	Requirements set forth for managing hazardous waste that is stored in containers; may be applicable during remedial activities involving contaminated soil and/or water storing.	TBC during planning and general remediation activities
Hazardous Waste Management Regulations-Standards for Land Treatment	25 Pennsylvania Code §264a.273	Applicable	Requirements set forth for managing hazardous waste in treatment units; may be applicable during remedial activities involving contaminated soil and/or water storing.	TBC during planning and general remediation activities
Hazardous Waste Management Regulations-Management of Waste	25 Pennsylvania Code §264a.251	Applicable	Requirements established for design and operation of waste piles during on-site treatment of hazardous waste.	TBC during planning and general remediation activities

ARAR or TBC	Citation	Classification	Site Media Addressed, and Summary of Requirement	Further Detail Regarding ARARs in the Context of the Remedy
Residual Waste Management Regulations	25 Pennsylvania Code §287.1 through §299.232	Applicable	These regulations were established to set forth requirements for handling residual waste. Residual waste is nonhazardous waste that may be generated during remedial activities.	TBC during planning and general remediation activities
Special Water Pollution Regulations	25 Pennsylvania Code, Chapter 101	Applicable	Sets a requirement to notify downstream waterway users in the event of an accidental release of a toxic substance into the surface water.	TBC during planning and general remediation activities
Pennsylvania Water Quality Standards	25 Pennsylvania Code 693.1 et. seq	Applicable	Sets forth requirements and water quality standards for protected waters of the commonwealth, which include wetlands; may be applicable if any groundwater is discharged during implementation of remedial actions.	TBC during planning and general remediation activities
Pennsylvania Clean Streams Law	25 Pennsylvania Code §91.1 et. seq	Applicable	Sets standards for activities that may require discharging contaminated water into commonwealth streams. The law also applies to the construction of wastewater impoundments.	TBC during planning and general remediation activities
Pennsylvania Pollution Discharge Elimination System	25 Pennsylvania Code 692.1 et. seq	Applicable	These regulations set forth requirements for discharging wastewater into commonwealth surface waters, and may be relevant for remedial actions including the treatment and discharge into waterways.	TBC during planning and general remediation activities
Hazardous Substances Transportation Regulations	Pennsylvania Code Titles 13 and 15	Applicable	Requirements set forth that regulate the transportation of flammable liquids and solids, oxidizing materials, poisons, and corrosive liquids. Spent carbon units will also comply with the requirements of these standards.	TBC during planning and general remediation activities
Pennsylvania Storm Water Management Act	25 Pennsylvania Code Chapter 105 including §105.15; §105.17; §105.188, and §105.20a	Applicable	Act requires the implementation of measures to control erosion and storm water runoff when conducting remedial activities in wetlands or stream ways, and constructing dams.	TBC during planning and general remediation activities
Pennsylvania Air Pollution Control Act	25 Pennsylvania Code Chapter 123 including §123.1, §123.2, §123.41, §127.1	Applicable	Requirements set forth for controlling fugitive emissions, particulate matter, and visible air contaminants that may be generated during remedial activities.	TBC during planning and general remediation activities

ARAR or TBC	Citation	Classification	Site Media Addressed, and Summary of Requirement	Further Detail Regarding ARARs in the Context of the Remedy
Pennsylvania Ambient Air Quality Standards	25 Pennsylvania Code Chapter 131 including §131.1 and §131.3	Applicable	Standards set forth to establish maximum concentrations levels for ambient air contaminants. They are developed to protect the public health, and may be applicable in remedial actions where airborne contamination is present.	TBC during planning and general remediation activities

NOTES:
- ARAR = Applicable or relevant and appropriate requirement.
- BTAG = Biological Technical Assistance Group.
- CFR = Code of Federal Regulations.
- EPA = U.S. Environmental Protection Agency.
- RCRA = Resource Conservation and Recovery Act.
- TBC = To be considered.
- USC = United States Code.

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Table 2-2 Preliminary Remediation Goals for Onsite Soil

Contaminant of Concern	2018 Act 2 Non-Residential MSC (0-2 feet) (mg/kg)	Risk-Based PRG (construction worker)[a] (mg/kg)	Maximum Concentration Offsite Soil (mg/kg)[b]	Maximum Concentration Slag (mg/kg)[c]	Project PRG (mg/kg)[d]
Aluminum	190,000	78,000	28,800	37,400	78,000
Beryllium	6,400	227	41 .3	129	227
Chromium	220 [e]	24.9	283	118	24.9
Cobalt	960	469	195	208	469
Copper	120,000	1,119	6,860	16,600	1,119
Iron	190,000	78,540	117,000	183,000	78,540
Lead	1,000	800 [f]	2,090	6,370	800
Manganese	150,000	1,065	1,580	3,320	1,065

a. Calculated based on risk to construction workers; see Appendix A.
b. Results from the 2007 Remedial Investigation.
c. EPA Site Assessment Technical Assistance Investigation, March 2000.
d. PRG is the lower of the Act 2 Non-Residential MSC or the risk-based PRG.
e. MSC is for chromium VI.
f. Risk-based PRG for lead is the EPA Regional Screening Level for Industrial Soil, November 2018.

NOTES: CFR = Code of Federal Regulations.
EPA = U.S. Environmental Protection Agency.
mg/kg = Milligrams per kilogram.
MSC = Medium-Specific Concentration.
PRG = Preliminary remediation goal.

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Table 2-3 Preliminary and Detailed Screening of Technologies and Process Options for Operable Unit 1 Slag/Soil

			Preliminary Screening			Detailed Screening			
General Response Action	**Remedial Technology**	**Process Option**	**Description**	**Screening Comments**	**Retained for Detailed Screening**	**Effectiveness**	**Implementability**	**Cost**	**Retained for Use in Alternatives**
NO ACTION	None	Not Applicable	No additional remedial activities would be conducted.	Retained for baseline comparison purposes in accordance with NCP 40CFR Section 30Q.430(e).	Yes	Would not achieve remedial action objectives.	Implementable.	Capital: None O&M: None	Yes
LIMITED ACTION	Institutional Controls	Land Use Restrictions	Administrative action used to restrict future activities at the site. Activities such as excavation, or residential and/or industrial development could be restricted or prohibited.	Potentially viable.	Yes	Effectiveness dependent on continued future enforcement to prevent use of site for development. No contaminant reduction anticipated.	Can be added to property deed.	Capital: Low O&M: Low	Yes
	Access Restrictions	Fencing	Fencing would be used to control access to the site if needed to prevent exposure.	Potentially viable.	Yes	Would limit access to existing pile. No contaminant reduction.	Installation and maintenance of fencing are feasible.	Capital: Low O&M: Low	Yes
	Monitoring	Groundwater, Surface Soil, Air Sampling	Groundwater monitoring would be conducted to evaluate potential trends over time. Monitoring of adjacent surface soils and air would be conducted to assess contaminant migration if visual inspection shows a significant breach of the cover.	Potentially viable.	Yes	Allows assessment of effectiveness of other remedial technologies for decreasing contaminant mobility.	Implementable.	Capital: Low O&M: Low	Yes
CONTAINMENT	Cap	Soil Cover	A layer of vegetative bearing soil placed over the site with a vegetative cover to retard ultraviolet degradation of HDPE cover. Vegetative cover would minimize erosion of soil cover and promote evapotranspiration of precipitation reducing runoff.	Grading, slope stabilization and placement of HDPE cover on pile was conducted in 1999-2000. Potentially viable.	Yes	Soil with a vegetative cover would further prevent direct contact and reduce ultraviolet degradation of HDPE cover. Additional work on side slopes may be needed to facilitate placement of soil and vegetation establishment. Does not meet PADEP final cover requirements.	Numerous companies with personnel and heavy equipment to perform grading activities. Offers some additional protection. May be difficult to implement due to smooth HDPE surface and slopes.	Capital: Low to Medium O&M: Low	No
		RCRA Cap	Multi-media cap with two low-permeability layers (a geosynthetic clay liner and a membrane), covered by a layer of vegetative bearing soil constructed over the site to prevent direct contact.	Grading, slope stabilization, and placement of HDPE on pile was conducted in 1999-2000. Additional low permeability layer placed on pile along with soil and vegetative cover. Potentially viable.	Yes	Multi-media cap with two low-permeability layers and soil layer, placed following regrading of side slopes, could comply with PADEP final cover requirements and protect human health. Provides better protection against failure than a single-barrier cap.	Implementable by standard construction; would require specialized equipment and materials to install cap. Additional modification of the shape of the slag pile may be required.	Capital: Medium O&M: Low	Yes
***EX SITU* TREATMENT**	Biological	Bioslurry/Land Farming	Treatment of excavated soil in a slurry reactor or by tilling under controlled conditions using natural or cultured microorganisms to biodegrade organic contaminants.	Not an effective technology for treatment of inorganic compounds. Eliminated.	No	No detailed screening.	No detailed screening.	No detailed screening	No detailed screening
	Physical/ Chemical	Onsite Chemical Fixation/ Solidification	Ex-situ mixing of cement, lime, or other pozzolanic materials with excavated waste/ contaminated soil to immobilize contaminants, prior to transportation and offsite disposal.	Potentially applicable.	Yes	Can be effective if suitable stabilizing agent and method to mix large quantities can be found. Need to address use/disposal of stabilized material.	Need to identify suitable stabilizing agent. Large amount of material to treat, and limited space available for staging and treating excavated material.	Capital: Medium O&M: Low	Yes, for combination with other technologies.
		Offsite Chemical Fixation/ Solidification	Mixing of cement, lime, or other pozzolanic materials with excavated waste/contaminated soil to immobilize contaminants at an offsite treatment facility, prior to disposal.	Potentially applicable.	Yes	Effective with use of suitable stabilizing agent.	Need to identify suitable stabilizing agent, treatment facility.	Capital: Medium O&M: Low	Yes, for combination with other technologies.

			Preliminary Screening			Detailed Screening			
General Response Action	**Remedial Technology**	**Process Option**	**Description**	**Screening Comments**	**Retained for Detailed Screening**	**Effectiveness**	**Implementability**	**Cost**	**Retained for Use in Alternatives**
		Soil Washing/Solvent Extraction	Ex-situ treatment to move contaminants from soil phase into a leaching agent using chemical and solubilization processes. Converts contaminants to a more concentrated or less toxic form.	Contaminants in slag material not soil phase. Eliminated.	No	No detailed screening.	No detailed screening.	No detailed screening	No detailed screening
		Size Separation	Minimize waste by physically screening out size fractions of soils or sediments containing minimal contamination.	Not effective on homogeneous slag material. Eliminated.	No	No detailed screening.	No detailed screening.	No detailed screening	No detailed screening
	Thermal	Thermal Desorption	Application of heat at relatively high temperature to remove volatile and semivolatile organics from excavated soil by volatilization. Vapor phase is treated by incineration or carbon adsorption.	Not effective for treatment of inorganic compounds. Eliminated.	No	No detailed screening	No detailed screening	No detailed screening	No detailed screening
		Thermoplastic Solidification	Ex-situ process where soil is mixed with asphalt, bitumen, paraffin, polyethylene or other organic polymers and heated to form a stable solid.	Typically applied to highly contaminated wastes (nuclear) and mobile wastes that are not amenable to chemical fixation. Eliminated.	No	No detailed screening	No detailed screening	No detailed screening	No detailed screening
		Incineration	Use of high temperature to pyrolize or oxidize organic contaminants in excavated soil into less toxic gases, or to reduce volume of waste material.	Slag at the Site has been identified for potential use in incineration.	Yes	Slag may be effective for use in incineration. Hazardous residue would be expected.	Unknown whether slag could be used in incineration.	Capital: High O&M: None	No
		Vitrification	Excavated material is melted at high temperature to form a glass and crystalline structure with very low leaching characteristics.	Slag material already subjected to high temperatures. Less costly technologies are expected to be effective in preventing direct contact and inhalation exposure. Eliminated.	No	No detailed screening	No detailed screening	No detailed screening	No detailed screening
SOURCE REMOVAL	Excavation	Mechanical Excavation	Slag material and any underlying contaminated soil would be excavated from the pile using conventional construction equipment (i.e., excavators, front-end loaders, bulldozers)	Excavation is an acceptable method removing contaminated slag material. Potentially viable.	Yes	Effective method for removal of contaminated slag and underlying soil.	Implementable with standard construction equipment. Equipment and resources are readily available from various contractors. Large quantity of material.	Capital: Medium O&M: None	Yes, for Combination with other technologies.
	Onsite Disposal	Engineered Disposal Cell	Material from slag pile and any contaminated soil would be excavated and consolidated in an engineered disposal cell to minimize space and closure requirements, reduce infiltration, and minimize direct contact or air-borne release of site contaminants.	Eliminated, based on high capital costs and availability of less costly technologies that are expected to be effective in accomplishing the prevention of direct contact exposure and/or inhalation of slag constituents.	No	No detailed screening	No detailed screening	No detailed screening	No detailed screening
	Offsite Disposal	RCRA Hazardous Waste Landfill	Material would be transported to an offsite RCRA-permitted landfill for permanent disposal.	Some contaminated slag and soil disposed of at offsite RCRA facility during 1999-2000 EPA removal action. Potentially viable.	Yes	Effectively controls exposure to humans and environment. Used for disposal of some materials collected during 1999-2000 removal action. Potential short-term impacts associated with transporting hazardous material.	Implementable. Used during 1999-2000 removal action.	Capital: High O&M: None	Yes, for combination with other technologies.
		Solid Waste Disposal Facility	Material would be transported to an offsite, permitted solid waste facility for permanent disposal.	Material would require treatment such that inorganics are stabilized to not exceed hazardous waste criteria (i.e., TCLP levels). Potentially viable.	Yes	Effectively controls exposure to humans and environment.	Implementable. Would require pretreatment of material to render it RCRA non-hazardous.	Capital: Medium O&M: None	Yes, for combination with other technologies.
		Residual Waste Landfill at PWD Lagoons	Material would be stabilized by in-situ physical/chemical methods and disposed at residual waste landfill to be designed at adjacent PWD lagoons.	Technically feasible but administrative difficulties preclude this option.	No	No detailed screening	No detailed screening	No detailed screening	No detailed screening

			Preliminary Screening			Detailed Screening			
General Response Action	**Remedial Technology**	**Process Option**	**Description**	**Screening Comments**	**Retained for Detailed Screening**	**Effectiveness**	**Implementability**	**Cost**	**Retained for Use in Alternatives**
	Re-Use of Slag as Regulated Fill	Use of slag as regulated fill for construction	Use as regulated fill under PADEP General Permit for beneficial use as construction material.	Slag does not meet the criteria as regulated fill or chemical analysis. Lead exceeds permit criteria.	No	No detailed screening	No detailed screening	No detailed screening	No detailed screening
	Re-Use of Slag in Mine Reclamation	Use of slag as backfill for mine reclamation	Use of slag for reclamation of coal mines.	Pennsylvania Bureau of Mines representatives would not accept material due to high lead content.	No	No detailed screening	No detailed screening	No detailed screening	No detailed screening
	Re-Use of Slag as Roadbed	Use of slag for roadbed materials.	Use of slag for roadbed construction under PADEP General Permit.	Slag does not meet the criteria for chemical analysis for use as roadbed material. Lead exceeds permit criteria.	No	No detailed screening	No detailed screening	No detailed screening	No detailed screening
	Re-Use of Slag as aggregate for cement/concrete	Use as aggregate (product) in cement production.	Use as aggregate in cement production.	Material cannot be reused for cement production due to high lead content.	No	No detailed screening	No detailed screening	No detailed screening	No detailed screening

NOTES:
CFR = Code of Federal Regulations.
EPA = U.S. Environmental Protection Agency.
HDPE = High-density polyethylene.
NCP = National Oil and Hazardous Substances Pollution Contingency Plan.
O&M = Operations and maintenance.
PADEP = Pennsylvania Department of Environmental Protection.
PWD = Philadelphia Water Department.
RCRA = Resource Conservation and Recovery Act.
TCLP = Toxicity Characteristic Leaching Procedure.

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3. DEVELOPMENT OF REMEDIAL ACTION ALTERNATIVES AND EVALUATION CRITERIA

3.1 INTRODUCTION

The goal of remedy selection is to protect human health and maintain protection over time. The remedial action must comply with all applicable or relevant and appropriate laws, regulations, and standards promulgated by the federal government. In addition, compliance with promulgated state laws is necessary if the state ARAR is more stringent than the federal ARAR.

Remedial action alternatives for each OU were developed from the technologies retained during screening (Section 2.5) to address the RAOs (Section 2.2), as described below.

3.2 DEVELOPMENT OF ALTERNATIVES

Five remedial alternatives were developed for OU-1 (slag/soil [S]) to meet the RAOs described in Section 2.2 for soil and slag by preventing future human exposure to metals in the slag and preventing release of metals from the slag to the environment:

- Alternative S1 – No Action
- Alternative S2 – Complete Removal and Offsite Disposal
- Alternative S3 – RCRA Cap, Regrading, and Partial Offsite Disposal
- Alternative S4 – Complete Removal, Onsite Treatment, and Offsite Disposal
- Alternative S5 – Complete Removal, Offsite Treatment and Disposal.

Only one remedial alternative was identified for OU-2 (groundwater [G]), due to the lack of RAOs identified specifically for this medium (see Section 2.2):

- Alternative G1 – No Action.

A detailed analysis of these remedial alternatives with respect to the NCP evaluation criteria (Section 3.3) is presented in Section 4 (OU-1 alternatives) and Section 5 (OU-2 alternatives).

3.3 EVALUATION CRITERIA

Pursuant to EPA guidance, remedial alternatives were examined for adherence to nine criteria, as specified in the NCP. These criteria are as follows:

1. Overall Protection of Human Health and the Environment
2. Compliance with ARARs
3. Long-Term Effectiveness and Permanence
4. Reduction of Toxicity, Mobility, and Volume through Treatment
5. Short-Term Effectiveness
6. Implementability
7. Cost

8. Commonwealth Acceptance
9. Community Acceptance.

In order to facilitate a detailed evaluation of remedial alternatives in this FS, the following rationale was applied to the nine criteria:

1. Overall Protection of Human Health and the Environment

   — Reduction of risks
   — Preservation of natural resources.

2. Compliance with ARARs

   — Compliance with chemical-, action-, and location-specific ARARs, as well as other TBC guidance.

3. Long-Term Effectiveness and Permanence

   — Magnitude of residual risk
   — Adequacy and reliability of controls.

4. Reduction of Toxicity, Mobility, and Volume through Treatment

   — Treatment processes used and materials treated
   — Amount of hazardous materials destroyed or treated
   — Degree of expected reductions in toxicity, mobility, and volume
   — Degree to which treatment is irreversible
   — Type and quantity of residuals remaining after treatment.

5. Short-Term Effectiveness

   — Protection of community and workers during remedial actions
   — Environmental impacts
   — Time until remedial action objectives are achieved.

6. Implementability

   — Ability to construct and operate the technology
   — Availability and reliability of prospective technologies
   — Ease of undertaking additional remedial actions, if necessary
   — Ability to monitor effectiveness of remedy
   — Ability to obtain approvals from other agencies and coordination with those agencies
   — Availability of equipment and specialists and offsite treatment, storage, and disposal services.

7. Cost[1]

   — Capital costs
   — O&M costs
   — 30-year present worth costs.

8. Commonwealth Acceptance

   — Evaluation of Pennsylvania Commonwealth agencies' preferences and concerns regarding the alternatives.

9. Community Acceptance

   — Evaluation of the local community's preferences and concerns regarding the alternatives.

1. Costs developed in this FS are based on 2018 dollars. The preliminary costs developed in this FS are based upon approximate design specifications, monitoring costs, and vendor quotes, where possible. The cost estimates are anticipated to be from within -30 percent to +50 percent of the actual costs for completing the remedial actions. Therefore, the costs are primarily used as an order of magnitude comparison.

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4. DETAILED ANALYSIS OF ALTERNATIVES FOR OPERABLE UNIT 1

This section presents a detailed analysis of the remedial alternatives for OU-1 (slag/soil) with respect to the NCP evaluation criteria (Section 3.3). The remedial alternatives are compared relative to each other with respect to the NCP evaluation criteria in Section 4.6.

4.1 ALTERNATIVE S1 – NO ACTION

4.1.1 Description

Pursuant to Section 300.430(e)(3)(ii)(6) of the revised NCP, the "No Action" alternative is developed to provide a baseline against which the other remedial alternatives are to be compared. The No Action alternative includes no removal actions or institutional controls. No additional monitoring or maintenance would be conducted.

Estimated Capital Cost:	$0
Estimated Average O&M Cost (annual):	$3,104
Estimated Total 30-Year Present Worth Cost:	$82,574
Estimated Construction Timeframe:	Immediate
Estimated Time to Achieve RAOs:	Will not achieve RAOs.

4.1.2 Evaluation

Overall Protection of Public Health and Welfare of the Environment—The No Action alternative would only be protective of human health or the environment as long as the HDPE cover and fencing remain intact. The No Action alternative does not contain provisions to maintain these features, to specifically prevent future human exposures, or to prevent metals in the slag from spreading to the environment. Therefore, the No Action alternative would not be protective of human health or the environment beyond the short term.

Compliance with ARARs—Alternative S1 would not comply with ARARs.

Long-Term Effectiveness and Permanence—The No Action alternative would not be effective in the long-term because no remedial components or institutional controls would be enacted to address risks associated with the slag pile and associated soil. The slag pile, impacted soil, and associated risk would remain, with the potential for contaminants to migrate offsite. The HDPE cover that currently reduces contaminant mobility would not be maintained, and no additional containment measures would be installed. The No Action alternative does not meet the RAOs for OU-1.

Reduction of Contaminant Toxicity, Mobility, and Volume—The No Action alternative does not include technology to destroy, remove, or treat any site contamination, and would not reduce the toxicity, mobility, or volume of COCs associated with slag and soil at the Site.

Short-Term Effectiveness—No remedial actions would be specified under the No Action alternative; therefore, there would be no increased risk to human health or the environment during implementation of this alternative. The No Action alternative would not be effective in the short-term for achieving the RAOs for OU-1.

Implementability—Because no remedial components would be performed, the No Action alternative would be readily implementable in a technical sense. This alternative also would not interfere with potential future remedial actions. However, administratively, this alternative likely would not be acceptable to the Commonwealth or the public because risks associated with the slag pile and associated soil would not be addressed.

Cost—Estimated capital and O&M costs associated with Alternative S1 are presented in Table 4-1. The No Action alternative has no capital costs and no long-term costs except for those associated with conducting 5-year reviews. Per regulatory guidance, costs for the No Action alternative are $0; however, the estimated cost of conducting six 5-year reviews for a No Action remedy over a 30-year period is $82,574 (30-year present worth).

Commonwealth Acceptance—This alternative would not receive approval from the Commonwealth because the risks associated with the slag pile and associated soil would not be addressed.

Community Acceptance—This alternative would not be acceptable to members of nearby communities because the risks associated with the slag pile and associated soil would not be addressed.

4.2 ALTERNATIVE S2 – COMPLETE REMOVAL AND OFFSITE DISPOSAL

This alternative includes: (1) mechanical excavation and removal of the slag pile and offsite disposal as hazardous waste, (2) excavation of onsite soil contaminated with slag-associated metals at concentrations exceeding the project PRGs and offsite disposal at an appropriate facility, (3) site restoration, (4) annual groundwater monitoring for 2 years, (5) institutional controls, and (6) 5-year reviews.

Estimated Capital Cost:	$33,776,447
Estimated Average O&M Cost (annual):	$4,104
Estimated Total 30-Year Present Worth Cost:	$33,888,709
Estimated Construction Timeframe:	12 months
Estimated Time to Achieve RAOs:	< 2 years.

4.2.1 Description

Alternative S2 would address the RAOs through the following remedial components:

- Excavation and removal of the slag pile
- Excavation of onsite soil contaminated with slag-associated metals at concentrations exceeding the project PRGs followed by sampling from the limits of excavation

- Transport to and disposal of the slag and excavated soil at an offsite hazardous waste landfill (note: waste characterization would be performed on the soil to assess its toxicity prior to disposal; if a beneficial reuse option is identified for the slag and/or soil, this alternative could be revised to incorporate offsite beneficial reuse rather than offsite disposal at a landfill)

- Site restoration, including backfilling and grading after excavation is complete

- Collection of groundwater samples annually from existing groundwater monitoring wells for 2 years after completion of slag and soil removal to monitor COPC concentrations and confirm no increasing COPC concentrations associated with OU-1 remedial activities at the Site

- Implementation of institutional controls, such as an environmental covenant, to prevent human contact with remaining soils that present an unacceptable risk to human health. Contact would be prevented by restricting the disturbance of contaminated soil via grading, excavation, or installation of wells and preventing the use of the Site property for purposes other than commercial/industrial (such as residential use, a daycare facility, or a school), unless approved by EPA and PADEP.

- Five-year reviews, which would be required to assess the continued protectiveness of the remedy because COCs would remain onsite at concentrations that exceed levels appropriate for site uses other than commercial/industrial.

4.2.2 Evaluation

Overall Protection of Human Health and the Environment—Alternative S2 would be protective of human health and the environment. Contaminants driving potential risk at the Site would be removed and disposed of in a manner that is protective. Materials exceeding EPA toxicity criteria levels would be disposed of in a RCRA permitted landfill preventing direct exposure to the slag and the release of contaminants to the environment via wind, surface water runoff, and/or groundwater. In addition, land use restrictions, through institutional controls such as title notices and environmental covenants, would prevent exposure to contaminated soil through excavation, etc., or use of the Site property for purposes other than commercial/ industrial (such as residential use, a daycare facility, or a school) unless approved by EPA and PADEP.

Compliance with ARARs—Alternative S2 would be implemented to meet the substantive provisions of the following major ARARs: RCRA transportation and handling; Pennsylvania Particulate Emissions and Air Control Act; Pennsylvania Erosion and Sediment Control; Safe Drinking Water Act, National Primary Drinking Water Regulations; and any more stringent requirements of the Pennsylvania Land Recycling and Environmental Remediation Standards Act, Statewide Health Standards. See the specific provisions identified in Table 2-1.

***Long-Term Effectiveness and Permanence*—**Alternative S2 would provide long-term effectiveness and permanence, as the slag and associated soil would be removed from the Site and permanently disposed of at a RCRA permitted landfill. The PRGs for onsite soils would be achieved to the extent feasible through excavation, and confirmation sampling would be conducted following excavation. Institutional controls would prevent future exposures to remaining soils that present an unacceptable risk to human health, by, for example, prohibiting use of the Site property for residential or other non-commercial/industrial use without approval by EPA and PADEP.

***Reduction of Toxicity, Mobility, or Volume through Treatment*—**Alternative S2 would not reduce the toxicity, mobility, or volume of contaminants within the slag, as no treatment would be implemented. However, the toxicity, mobility, and volume of contaminated material onsite would be decreased by removal of the slag and associated soil from the Site.

***Short-Term Effectiveness*—**Exposure to hazardous levels of inorganics is the main concern with respect to short-term impacts during implementation of Alternative S2, and would be addressed through engineering controls, the use of personal protective equipment (PPE), and observance of Occupational Safety and Health Administration (OSHA) guidelines. Onsite engineering control measures for minimizing dust generation would likely include covering the excavation face and onsite soil stockpiles at the conclusion of daily operations. Restrictions on the size of the working face would also be employed to minimize the emission of particulate contaminants. During the transport of the slag and contaminated soil, the materials would be covered to reduce potential exposure of waste constituents to any communities through which the trucks would travel. Transport would be conducted by waste haulers licensed by the Department of Transportation, with the majority of transport occurring on major highways.

Alternative S2 would be expected to meet RAOs for OU-1 within 2 years after finalization of the ROD for the Site.

***Implementability*—**During the 1999-2000 EPA removal action, approximately 13,198 tons of contaminated soil, slag, and other hazardous debris were removed from the Site and transported to a RCRA permitted landfill located in upstate New York. Experienced firms and personnel are available to conduct the removal activities associated with the implementation of Alternative S2. Groundwater sampling is also a commonly employed technique that has been used previously at the Site. The slag pile contains an unknown quantity of oversized material that may require segregation for disposal purposes. Due to the volume of slag remaining at the Site (approximately 68,000 cubic yards), more than one landfill may be used in order to implement this alternative. In addition, the total time required to implement the remedy could be affected by the number of trucks that are available on a daily basis. Transport via rail, utilizing the rail lines near the Site, may also be feasible. Following removal of the slag pile, it would be advantageous to conduct surface and subsurface soil sampling onsite to determine the volume and feasibility of soil removal required to meet the project PRGs.

***Cost*—**Estimated capital and O&M costs associated with Alternative S2 are presented in Table 4-2. Costs for this alternative are associated with removal and disposal of slag and associated soil and site restoration, as well as groundwater monitoring, institutional controls, and 5-year reviews. The estimated 30-year present worth cost is $33,888,709.

***Commonwealth Acceptance*—**Based on feedback received from PADEP, this alternative may be acceptable to the Commonwealth, as it includes removal of the slag pile, and, therefore, does not require long-term monitoring and maintenance of a cap.

***Community Acceptance*—**Based on public comments received following the 2007 FS for the Site, this alternative may be acceptable to the community, as it includes removal of the slag pile. The community may have concerns about the transport of hazardous materials on public roads, although transportation would be conducted with appropriate controls and in accordance with applicable regulations.

4.3 ALTERNATIVE S3 – RCRA CAP, REGRADING, AND PARTIAL OFFSITE DISPOSAL

This alternative includes: (1) removal of a limited quantity of slag and disposal as hazardous waste, (2) regrading of the remaining slag, (3) installation and maintenance of a RCRA cap on the regraded slag pile, (4) institutional controls, (5) annual groundwater monitoring for 2 years, and (6) 5-year reviews and post-closure monitoring as required.

Estimated Capital Cost:	$6,473,976
Estimated Average O&M Cost (annual):	$16,385
Estimated Total 30-Year Present Worth Cost:	$6,923,236
Estimated Construction Timeframe:	8 months
Estimated Time to Achieve RAOs:	< 2 years.

4.3.1 Description

Alternative S3 would address the RAOs through the following remedial components:

- Excavation and removal of approximately 8,550 cubic yards of slag from the current pile to reduce the pile height to 23 ft and removal and offsite disposal of the HDPE cover currently present on the slag pile

- Transport and disposal of removed slag at a RCRA-permitted hazardous waste landfill

- Regrading of the remaining slag such that the side-slopes meet PADEP requirements

- Placement of a RCRA multi-media cap over the regraded slag pile; the cap would consist of a geosynthetic clay liner, a linear low-density polyethylene (LLDPE) (friction) membrane, a drainage layer, and a 24-inch layer of vegetation-bearing soil

- Maintenance of the cap, including control of tree and plant growth around the cap, and post-closure monitoring in accordance with RCRA regulations

- Collection of groundwater samples annually from existing groundwater monitoring wells for 2 years after capping to monitor COPC concentrations and confirm no increasing COPC concentrations associated with OU-1 remedial activities at the Site

- Fencing of the site and implementation of institutional controls to prevent exposure to contaminated media and prevent activities that would disturb the integrity of the cap and the remedy.

- Five-year reviews, which would be required to assess the continued protectiveness of the remedy because COCs would remain onsite at concentrations that exceed project PRGs.

4.3.2 Evaluation

Overall Protection of Human Health and the Environment—Alternative S3 would be protective of human health and the environment. The RCRA cap would minimize potential exposure to slag contaminants by preventing direct contact or release to the air. Removed slag material exceeding EPA toxicity criteria levels would be disposed of in a RCRA permitted landfill preventing direct exposure to the slag and the release of contaminants to the environment. In addition, institutional controls, such as title notices and land use restrictions, would prevent exposure to contaminated media and protect cap integrity.

Compliance with ARARs—When implemented, Alternative S3 would comply with the substantive provisions of potential PADEP hazardous waste landfill requirements (Pennsylvania Code 25 264.301) for final cover, including slopes, drainage, and permeability requirements. This Alternative would also be implemented to meet the substantive provisions of the following major ARARs: RCRA transportation and handling; Pennsylvania Particulate Emissions and Air Control Act; Pennsylvania Erosion and Sediment Control; Safe Drinking Water Act, National Primary Drinking Water Regulations; and any more stringent requirements of the Pennsylvania Land Recycling and Environmental Remediation Standards Act, Statewide Health Standards. See the specific provisions identified in Table 2-1.

***Long-Term Effectiveness and Permanence*—**The RCRA cap, as part of Alternative S3, would provide long-term effectiveness and maintenance of the cap would minimize residual risks. The vegetated soil cover would minimize ultraviolet degradation of the synthetic membrane. Periodic maintenance would ensure long-term integrity of the cap system. Institutional controls would minimize the likelihood of future exposures and would protect the integrity of the remedy. A post-closure plan to address long-term O&M requirements would be prepared and implemented.

***Reduction of Toxicity, Mobility, or Volume through Treatment*—**Alternative S3 would not reduce the toxicity, mobility, or volume of contaminants within the slag through treatment, as no treatment would be implemented. Soil with COC concentrations exceeding the PRGs for onsite soils would remain onsite. However, the RCRA cap would decrease the mobility of contaminants in the slag pile via containment.

Short-Term Effectiveness**—**During the limited excavation and the removal/replacement of the membrane cap there would be potential short-term exposure of construction workers to the Site COCs. These potential exposures would be addressed through engineering controls, the use of PPE, and observance of OSHA guidelines.

Alternative S3 would be expected to meet RAOs for OU-1 within 2 years after finalization of the ROD for the Site.

Implementability**—**Alternative S3 is implementable. Experienced firms and personnel are available for the construction of a multi-layer RCRA cap and the transport and disposal of slag material that cannot be accommodated at the Site. During the 1999-2000 EPA removal action, slag was removed from the Site and transported to a RCRA permitted landfill located in upstate New York.

Cost**—**Estimated capital and O&M costs associated with Alternative S3 are presented in Table 4-3. Costs for this alternative are associated with removal and disposal of a limited quantity of slag, placement of a RCRA cap over the remaining slag pile, institutional controls, groundwater monitoring, 5-year reviews, and post-closure monitoring and cap maintenance. The estimated 30-year present worth cost is $6,923,236.

Commonwealth Acceptance**—**This alternative may not be acceptable to the Commonwealth because the slag would remain onsite and the RCRA cap would require long-term monitoring and maintenance to ensure the long-term effectiveness of the remedy.

Community Acceptance**—**Based on public comments received following the 2007 FS for the Site, this alternative may not be acceptable to the community because the capped slag pile would remain in its current location in the long-term.

4.4 ALTERNATIVE S4 – COMPLETE REMOVAL, ONSITE TREATMENT, AND OFFSITE DISPOSAL

This alternative includes: (1) mechanical excavation and removal of the slag pile, treatment of the slag to decrease lead toxicity, and offsite disposal as a non-hazardous waste, (2) excavation of onsite soil contaminated with slag-associated metals at concentrations exceeding the project PRGs, treatment of the soil as needed to decrease lead toxicity, and offsite disposal as a non-hazardous waste, (3) site restoration, (4) annual groundwater monitoring for 2 years, (5) institutional controls, and (6) 5-year reviews.

Estimated Capital Cost:	$21,525,842
Estimated Average O&M Cost (annual):	$4,104
Estimated Total 30-Year Present Worth Cost:	$21,638,104
Estimated Construction Timeframe:	18 months
Estimated Time to Achieve RAOs:	< 2 years.

4.4.1 Description

Alternative S4 would address the RAOs through the following remedial components:

- Excavation of slag followed by size segregation, crushing as needed, and treatment with a stabilization agent to decrease the leachability of constituents such that the material does not exceed TCLP criteria for hazardous waste
- Excavation of onsite soil contaminated with slag-associated metals at concentrations exceeding the project PRGs, followed by sampling from the limits of excavation and then TCLP analysis of the excavated soil and treatment with a stabilization agent if necessary to decrease metals leachability such that the soil is non-hazardous
- Post-treatment analysis of slag, and soil where applicable, to verify that the material does not exceed TCLP criteria for hazardous waste
- Transport and disposal of the slag and soil at a residual or non-hazardous waste landfill (note: if a beneficial reuse option is identified for the slag, this alternative could be revised to incorporate offsite beneficial reuse rather than offsite disposal at a landfill)
- Site restoration, including backfilling and grading after excavation is complete
- Collection of groundwater samples annually from existing groundwater monitoring wells for 2 years after completion of slag and soil removal to monitor COPC concentrations and confirm no increasing COPC concentrations associated with OU-1 remedial activities at the Site
- Implementation of institutional controls, such as an environmental covenant, to prevent human contact with remaining soils that present an unacceptable risk to human health. Contact would be prevented by restricting the disturbance of contaminated soil via grading, excavation, or installation of wells and preventing the use of the Site property for purposes other than commercial/industrial (such as residential use, a daycare facility, or a school) unless approved by EPA and PADEP.
- Five-year reviews, which would be required to assess the continued protectiveness of the remedy because COCs would remain onsite at concentrations that exceed levels appropriate for Site uses other than commercial/industrial.

4.4.2 Evaluation

Overall Protection of Human Health and the Environment—Alternative S4 would be protective of human health and the environment. Contaminants driving potential risk at the Site would be removed and disposed of in a manner that is protective. Materials exceeding EPA toxicity criteria levels would be treated prior to removal from the Site to minimize the potential for release of contaminants via leaching from the slag, and the treated material would be disposed of as appropriate in a non-hazardous waste landfill. In addition, land use restrictions, through institutional controls such as title notices and environmental covenants, would prevent exposure to contaminated soil through excavation, etc., or use of the Site property for purposes other than commercial/industrial (such as residential use, a daycare facility, or a school) unless approved by EPA and PADEP.

Compliance with ARARs—Alternative S4 would be implemented to meet the substantive provisions of the following major ARARs: RCRA transportation and handling; Pennsylvania Particulate Emissions and Air Control Act, Pennsylvania Erosion and Sediment Control; Safe Drinking Water Act, National Primary Drinking Water Regulations; and any more stringent requirements of the Pennsylvania Land Recycling and Environmental Remediation Standards Act, Statewide Health Standards. See the specific provisions identified in Table 2-1.

Long-Term Effectiveness and Permanence**—**Alternative S4 would provide long-term effectiveness and permanence, as the slag and associated soil would be treated as appropriate and then removed from the Site and permanently disposed of at a permitted landfill. The PRGs for onsite soils would be achieved to the extent feasible through excavation, and confirmation sampling would be conducted following excavation. Institutional controls would prevent future exposures to remaining soils that present an unacceptable risk to human health by, for example, prohibiting use of the Site property for residential or other non-commercial/industrial use of the property without approval by EPA and PADEP.

Reduction of Toxicity, Mobility, or Volume through Treatment**—**Alternative S4 would reduce the toxicity of the slag by treating it to reduce the mobility of contaminants within the slag. Additionally, the volume of contaminated material onsite would be decreased by removal of the slag and associated soil from the Site.

Short-Term Effectiveness**—**Exposure to hazardous levels of inorganics is the main concern with respect to short-term impacts during implementation of Alternative S4, and would be addressed through engineering controls, the use of PPE, and observance of OSHA guidelines. Onsite engineering control measures for minimizing dust generation would likely include covering the excavation face and onsite soil stockpiles at the conclusion of daily operations. Restrictions on the size of the working face would also be employed to minimize the emission of particulate contaminants. During the transport of the slag and contaminated soil, the materials would be covered to reduce potential exposure of waste constituents to any communities through which the trucks would travel. Transport would be conducted by waste haulers licensed by the Department of Transportation, with the majority of transport occurring on major highways.

Alternative S4 would be expected to meet RAOs for OU-1 within 2 years after finalization of the ROD for the Site.

Implementability**—** Alternative S4 is implementable. Treatability testing has been conducted to identify a suitable stabilization agent (e.g., Blastox®), and additional testing would be conducted as needed to confirm mix ratios, etc. Mixing of the agent and the slag could be accomplished using a pug mill, a mixing system, or a mixing pad. Experienced personnel and equipment are available to conduct the removal and treatment activities. Groundwater sampling is also a commonly employed technique that has been used previously at the Site. The slag pile contains a variety of particle sizes as well as an unknown quantity of oversized material. Based on the nature of the debris thought to be present, the oversized material (e.g., bulk pieces of metal) is not expected to be hazardous. A combination of bulk segregation and sifting, followed by crushing of large slag particles, is expected to be required prior to treatment and disposal. Following treatment of the slag (and soil as needed), the material could be disposed of offsite in either a residual or non-hazardous waste landfill. Due to the volume of slag remaining at the Site (approximately 68,000 cubic yards), more than one landfill may be used to implement this alternative. In addition, the total time required to implement the remedy could be affected by the number of trucks that are available on a daily basis. Transport via rail, using the rail lines near the Site, may also be feasible. Following removal of the slag pile, it would be advantageous to conduct surface and subsurface soil sampling onsite to determine the volume and feasibility of soil removal required to meet the project PRGs.

Cost**—**Estimated capital and O&M costs associated with Alternative S4 are presented in Table 4-4. Costs for this alternative primarily are associated with removal, treatment, and disposal of slag and associated soil and site restoration, as well as groundwater monitoring, institutional controls, and 5-year reviews. The estimated 30-year present worth cost is $21,638,104.

Commonwealth Acceptance**—**Based on feedback received from PADEP, this alternative may be acceptable to the Commonwealth because it includes removal of the slag pile, therefore, does not require long-term monitoring and maintenance of a cap.

Community Acceptance**—**Based on public comments received following the 2007 FS for the Site, this alternative may be acceptable to the community because it includes removal of the slag pile and does not require transport of hazardous materials offsite.

4.5 ALTERNATIVE S5 – COMPLETE REMOVAL, OFFSITE TREATMENT AND DISPOSAL

This alternative includes: (1) mechanical excavation and removal of the slag pile, (2) excavation of onsite soil contaminated with slag-associated metals at concentrations exceeding the project PRGs, (3) transport of the soil and slag to an offsite treatment facility for treatment as needed to decrease lead toxicity, followed by offsite disposal as a non-hazardous waste, (4) site restoration, (5) annual groundwater monitoring for 2 years, (5) institutional controls, and (6) 5-year reviews.

Estimated Capital Cost:	$28,357,802
Estimated Average O&M Cost (annual):	$4,104
Estimated Total 30-Year Present Worth Cost:	$28,470,064
Estimated Construction Timeframe:	12 months
Estimated Time to Achieve RAOs:	< 2 years.

4.5.1 Description

Alternative S5 would address the RAOs through the following remedial components:

- Excavation of and removal of the slag pile

- Excavation of onsite soil contaminated with slag-associated metals at concentrations exceeding the project PRGs, followed by sampling from the limits of excavation

- Transport of the slag and soil to an offsite treatment facility for stabilization of the lead

- Offsite disposal of the treated slag and soil as non-hazardous waste

- Site restoration, including backfilling and grading after excavation is complete

- Collection of groundwater samples annually from existing groundwater monitoring wells for 2 years after completion of slag and soil removal to monitor COPC concentrations and confirm no increasing COPC concentrations associated with OU-1 remedial activities at the Site

- Implementation of institutional controls, such as an environmental covenant, to prevent human contact with remaining soils that present an unacceptable risk to human health. Contact would be prevented by restricting the disturbance of contaminated soil via grading, excavation, and installation of wells and preventing the use of the Site property for purposes other than commercial/industrial (such as residential use, a daycare facility, or a school) unless approved by EPA and PADEP.

- Five-year reviews, which would be required to assess the continued protectiveness of the remedy because COCs would remain onsite at concentrations that exceed levels appropriate for site uses other than commercial/industrial.

4.5.2 Evaluation

Overall Protection of Human Health and the Environment—Alternative S5 would be protective of human health and the environment. Contaminants driving potential risk at the Site would be removed and disposed of in a manner that is protective. Materials exceeding EPA toxicity criteria levels would be treated prior to disposal to minimize the potential for release of contaminants via leaching from the slag, and the treated material would be disposed of as appropriate in a non-hazardous waste landfill. In addition, land use restrictions, through institutional controls such as title notices and environmental covenants, which would prevent exposure to contaminated soil through excavation, etc., or use of the property for purposes other than commercial/industrial (such as residential use, a daycare facility, or a school), unless approved by EPA and PADEP.

Compliance with ARARs—Alternative S5 would be implemented to meet the substantive provisions of the following major ARARs: RCRA transportation and handling; Pennsylvania Particulate Emissions and Air Control Act, Pennsylvania Erosion and Sediment Control; Safe Drinking Water Act, National Primary Drinking Water Regulations; and any more stringent requirements of the Pennsylvania Land Recycling and Environmental Remediation Standards Act, Statewide Health Standards. See the specific provisions identified in Table 2-1.

***Long-Term Effectiveness and Permanence*—**Alternative S5 would provide long-term effectiveness and permanence, as the slag and associated soil would be treated as necessary and then permanently disposed of at a permitted landfill. The PRGs for onsite soils would be achieved to the extent feasible through excavation, and confirmation sampling would be conducted following excavation. Institutional controls would prevent future exposures to remaining soils that present an unacceptable risk to human health by, for example, prohibiting use of the Site property for residential or other non-commercial/industrial use without approval by EPA and PADEP.

***Reduction of Toxicity, Mobility, or Volume through Treatment*—**Alternative S5 would reduce the toxicity of the slag by treating it to reduce the mobility of contaminants within the slag. Additionally, the volume of contaminated material onsite would be decreased by removal of the slag and associated soil from the Site.

***Short-Term Effectiveness*—**Exposure to hazardous levels of inorganics is the main concern with respect to short-term impacts during implementation of Alternative S5 and would be addressed through engineering controls, the use of PPE, and observance of OSHA guidelines. Onsite engineering control measures for minimizing dust generation would likely include covering the excavation face and onsite soil stockpiles at the conclusion of daily operations. Restrictions on the size of the working face would also be employed to minimize the emission of particulate contaminants. During the transport of the slag and contaminated soil, the materials would be covered to reduce potential exposure of waste constituents to any communities through which the material would travel. Transport would be conducted in accordance with Department of Transportation regulations.

Alternative S5 would be expected to meet RAOs for OU-1 within 2 years after finalization of the ROD for the Site.

***Implementability*—**Alternative S5 is implementable. Treatability testing has been conducted to confirm that the slag can be treated using reagents and dosages typically utilized for treatment. Experienced personnel and equipment are available to conduct the removal activities. Groundwater sampling is also a commonly employed technique that has been used previously at the Site. Treatment of the slag and soil in a dedicated offsite treatment facility would increase implementability, relative to onsite treatment. The slag pile contains a variety of particle sizes as well as an unknown quantity of oversized material. Based on the nature of the debris thought to be present, the oversized material (e.g., bulk pieces of metal) is not expected to be hazardous. Some degree of segregation of oversized materials may be required prior to transportation offsite; however, no onsite sifting or crushing is assumed as part of this alternative. Following treatment of the slag and soil as needed, the material would be disposed of offsite in a non-hazardous waste (Subtitle C) landfill near the treatment facility. The total time required to implement the remedy could be affected by the availability of vehicles/railcars to transport the material. Following removal of the slag pile, it would be advantageous to conduct surface and subsurface soil sampling onsite to determine the volume and feasibility of soil removal required to meet the project PRGs.

Cost**—**Estimated capital and O&M costs associated with Alternative S5 are presented in Table 4-5. Costs for this alternative primarily are associated with slag/soil removal, offsite treatment and disposal, and site restoration, as well as groundwater monitoring, institutional controls, and 5-year reviews. The estimated 30-year present worth cost is $28,470,064.

Commonwealth Acceptance**—**Based on feedback received from PADEP, this alternative may be acceptable to the Commonwealth because it includes removal of the slag pile, therefore, does not require long-term monitoring and maintenance of a cap.

Community Acceptance**—**Based on public comments received following the 2007 FS for the Site, this alternative may be acceptable to the community because it includes removal of the slag pile. The community may have concerns about the transport of hazardous materials on public roads, although transportation would be conducted with appropriate controls and in accordance with applicable regulations.

4.6 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES FOR OPERABLE UNIT 1

This section presents the final step of the analysis of alternatives for OU-1. Here, the alternatives, which were evaluated individually against the criteria described in Sections 4.1 through 4.5, are compared to each other for their relative effectiveness for each of those criteria. The comparison of alternatives is intended to identify the advantages and disadvantages of each alternative relative to the others, based upon seven criteria, so that the key decision-making trade-offs can be identified. Table 4-6 summarizes this comparative analysis.

4.6.1 Overall Protection of Human Health and the Environment

Alternatives S2, S3, S4, and S5 would provide overall protection of human health and the environment. For the short term, Alternative S1 would also be protective as the HDPE cover and fence would remain in place; however, this alternative would not be protective in the future due to the lack of maintenance of the HDPE cover and fence.

4.6.2 Compliance with ARARs

Alternatives S2, S3, S4, and S5 would comply with the substantive requirements of the ARARs discussed above. Alternative S1 would not comply with ARARs.

4.6.3 Long-Term Effectiveness and Permanence

Under Alternative S1, future risks would remain unchanged, as the existing HDPE cover would be effective until it deteriorates or tears. Alternatives S2 through S5 offer long-term protection of human health and the environment. Alternative S3 would provide long-term effectiveness via maintenance of the RCRA cap and via institutional controls to prevent exposure to contaminated media and to protect the integrity of the cap. Alternatives S2, S4, and S5 would include the removal of the slag pile as well as removal of underlying contaminated soil exceeding the project PRGs from the Site to the extent feasible, thus providing the highest degree of long-term effectiveness and permanence. In addition, Alternatives S2, S4, and S5 would provide long-term effectiveness via institutional controls such as prohibiting the use of the Site property for purposes other than commercial/industrial, such as residential use, a daycare facility, or a school, unless approved by EPA and PADEP. Five-year reviews would be required under Alternative S3 due to COCs remaining onsite at concentrations exceeding PRGs. Five-year reviews would also be required for Alternatives S2, S4, and S5 to ensure that the institutional controls were still protective.

4.6.4 Reduction of Toxicity, Mobility, and Volume of Contaminants

There would be no reduction of toxicity, mobility, or volume through treatment for Alternatives S1, S2, and S3 because no treatment would occur. Alternative S4 would reduce toxicity and mobility of constituents in the slag via stabilization prior to its removal from the Site, whereas Alternative S5 would reduce the toxicity and mobility of constituents in slag via stabilization after transport to an offsite treatment facility.

4.6.5 Short-Term Effectiveness

The short-term effectiveness of Alternatives S2, S3, S4, and S5 would be similar because appropriate controls would be used to minimize adverse impacts to workers and the local community during implementation. Alternatives S2 and S5 would present the most potential for short-term impacts due to the excavation and offsite disposal of hazardous materials including the excavated slag. Engineering controls and worker PPE would be used to mitigate risks to workers, the community, and the environment during excavation and transport. Under Alternative S4, the treatment of the slag to stabilize metals prior to transport would decrease the potential for impacts during transport. Alternative S3 would present some opportunity for short-term impact because some hazardous material would be excavated and disposed of offsite and portions of the pile would be periodically uncovered as the old cover is removed and the new cover installed. Engineering controls would minimize the duration that the slag is uncovered and thus mitigate potential short-term risks to workers, the community, and the environment.

Alternatives S2, S3, S4, and S5 would be expected to meet RAOs within 2 years after finalization of the ROD. Under each of these alternatives, implementing institutional controls, such as environmental covenants, may take 6 months or longer.

4.6.6 Implementability

All of the alternatives are implementable, as experienced firms and personnel are readily available. Alternative S1 would be the most easily implemented from a technical perspective, as no additional actions would be taken; however, it likely would not be implementable administratively, given that it likely would not be acceptable to the Commonwealth or the public.

Alternatives S2, S4, and S5 would be the next most easily implemented, as they would involve relatively straightforward removal, followed by treatment and/or disposal at appropriate offsite facilities, with only 2 years of groundwater monitoring.

Under Alternative S3, long-term maintenance of the RCRA cap and post-closure monitoring would be required.

Implementation of institutional controls under alternatives S2, S3, S4, and S5 would require coordination with the property owners and potentially any lending institutions that may hold mortgages to the property.

The logistics of Alternative S4 would be the most complex, as the slag pile and underlying contaminated soils would be excavated, treated onsite, tested to confirm treatment was effective, and transported to a non-hazardous waste landfill.

4.6.7 Cost

The costs associated with each alternative are provided in Table 4-6 and are summarized below. Alternative S1, No Action, would be the least expensive alternative to implement. Alternative S3 is less expensive than Alternatives S2, S4, and S5 but more expensive than Alternative S1. Alternative S4 is less expensive than Alternative S2 because it avoids transport and disposal costs associated with hazardous material. Alternative S5 is also somewhat less expensive than Alternative S2, but more expensive than Alternative S4, because it would involve transport but not disposal of hazardous material.

In summary, total costs (as adjusted for present worth over the specified time periods) are as follows:

- Alternative S1 – No Action: $82,574
- Alternative S2 – Complete Removal and Offsite Disposal: $33,888,709
- Alternative S3 – RCRA Cap, Regrading, and Partial Offsite Disposal: $6,923,236
- Alternative S4 – Complete Removal, Onsite Treatment, Offsite Disposal: $21,638,104
- Alternative S5 – Complete Removal, Offsite Treatment and Disposal: $28,470,064.

4.6.8 Commonwealth Acceptance

Based on feedback received from PADEP, it is expected that Alternatives S2, S4, and S5 are most acceptable to the Commonwealth.

4.6.9 Community Acceptance

Based on comments received following the 2007 FS, the community is not in favor of Alternatives S1 or S3 because the slag pile would remain onsite. It is anticipated that Alternative S4 may be more acceptable than Alternatives S2 and S5 due to potential concerns related to transport of hazardous material on public roads. Additional community input will be gathered following finalization of the FS, during the public comment period associated with the ROD process.

Table 4-1 Estimated Cost of Alternative S1—No Action

Item No.	Cost Categories and Items	Units	Unit Cost	Quantity (#)	Total Cost
A. CAPITAL COSTS					
1	**No Action**				
	Not applicable	Not applicable			$0
	Line Item Total				$0
				Total	$0
B. O&M COSTS					
2	**Administrative Requirements**				
2.1	Five-Year Reviews	Each	$15,522	6	$93,130
				Total O&M Costs:	**$93,130**

C. 30-YEAR PRESENT VALUE [1]

O&M Costs	$82,574

D. COST SUMMARY

Cost Element	Cost ($)
Capital Costs	$0
O&M Costs	$82,574
30-Year Total Present Worth Costs	**$82,574**

Notes:

1. Present Value = Future Value / (1+i)^n, where i is the Real Discount Rate (0.7%) and n is time in years.

Table 4-2 Estimated Cost of Alternative S2—Complete Removal and Offsite Disposal

Item No.	Cost Categories and Items	Units	Unit Cost	Quantity (#)	Total Cost
A. CAPITAL COSTS					
1	**Project Planning**				
1.1	Remedial Action Plan	LS	$10,000	1	$10,000
2	**Slag Pile Excavation**				
2.1	Decontamination Facilities for Project Duration	LS	$194,965.84	1	$194,966
2.2	Slag Pile Excavation and Metals Analysis	LS	$566,543.29	1	$566,543
3	**Soil Excavation (Assume Top 1 ft soil removed)**				
3.1	Soil Excavation, Backfilling and Metals Analysis	LS	$202,141.31	1	$202,141
4	**Slag/Soil Transportation and Disposal**				
4.1	Material Loading, including dump truck	LS	$247,140.74	1	$247,141
4.2	32-ft Dump Truck liners	EA	$30.34	3,562.00	$108,076
4.3	Transport Bulk Solid Hazardous Waste	MI	$2.71	1068600	$2,894,196
4.4	Disposal Bulk Haz Waste at RCRA Landfill	TON	$200.00	113151.6	$22,630,320
5	**Site Restoration**				
5.1	Grading and Gravel Placement	LS	$26,142	1	$26,142
6	**Institutional Controls**				
6.1	Administrative Land Use Controls	LS	$277,868.73	1	$277,869
7	**Reporting**				
7.1	Post Construction Documents	LS	$20,000	1	$20,000
				Subtotal:	$27,177,394
				Field Oversight (20%)	$247,387
				Project Management (10%)	$154,480
				Capital Costs Subtotal:	$27,579,261
				Indirects (35%)	$681,334
				Profit (10%)	$2,757,926
				Contingency (10%)	$2,757,926
				Total Capital Costs:	**$33,776,447**
B. O&M COSTS					
8	**Administrative Requirements**				
8.1	Five-Year Reviews	Each	$15,522	6	$93,130
9	**Monitoring**				
9.1	Annual Groundwater Monitoring	Per year	$15,000	2	$30,000
				Total O&M Costs:	**$123,130**

C. 30-YEAR PRESENT VALUE [1]

O&M Costs	$112,262

D. COST SUMMARY

Cost Element	Cost ($)
Capital Costs	$33,776,447
O&M Costs	$112,262
30-Year Total Present Worth Costs	**$33,888,709**

Notes:

1. Present Value = Future Value / (1+i)^n, where i is the Real Discount Rate (0.7%) and n is time in years.

Table 4-3 Estimated Cost of Alternative S3—RCRA Cap, Regrading, and Partial Offsite Disposal

Item No.	Cost Categories and Items	Units	Unit Cost	Quantity (#)	Total Cost
A. CAPITAL COSTS					
1	**Project Planning**				
1.1	Remedial Action Plan	LS	$20,000	1	$20,000
2	**Limited Slag Removal**				
2.1	Decontamination Facilities for Project Duration	LS	$153,817.25	1	$153,817
2.2	Limited Slag Pile Excavation and Metals Analysis	LS	$62,051.32	1	$62,051
3	**Slag Transportation and Disposal**				
3.1	Material Loading, including dump truck	LS	$29,759.42	1	$29,759
3.2	32-ft Dump Truck liners	EA	$30.34	429	$13,016
3.3	Transport Bulk Solid Hazardous Waste	MI	$2.71	128700	$348,571
3.4	Disposal Bulk Haz Waste at RCRA landfill	TON	$200.00	13618.35	$2,723,670
4	**RCRA Capping**				
4.1	Regrading	LS	$54,438.63	1	$54,439
4.2	Capping	LS	$762,369.77	1	$762,370
4.3	Fencing Around Site	LS	$39,884.32	1	$39,884
5	**Institutional Controls**				
5.1	Administrative Land Use Controls	LS	$277,868.73	1	$277,869
6	**Reporting**				
6.1	Post Construction/O&M Documents	LS	$25,000	1	$25,000
				Subtotal:	$4,510,447
				Field Oversight (20%)	$220,464
				Project Management (10%)	$142,519
				Capital Costs Subtotal:	$4,873,430
				Indirects (35%)	$625,860
				Profit (10%)	$487,343
				Contingency (10%)	$487,343
				Total Capital Costs:	**$6,473,976**
B. O&M COSTS					
7	**Administrative Requirements**				
7.1	Five-Year Reviews	Each	$15,521.66	6	$93,129.99
8	**Monitoring and Maintenance**				
8.1	Cap Inspections and Maintenance	Per Year	$10,000	30	$300,000.00
8.2	Periodic Soil and/or Air Monitoring	Each Event	$17,108.08	4	$68,432.32
8.3	Annual Groundwater Monitoring	Per year	$15,000	2	$30,000.00
				Total O&M Costs:	**$491,562**

C. 30-YEAR PRESENT VALUE [1]

O&M Costs	$449,260

D. COST SUMMARY

Cost Element	Cost ($)
Capital Costs	$6,473,976
O&M Costs	$449,260
30-Year Total Present Worth Costs	**$6,923,236**

Notes:

1. Present Value = Future Value / (1+i)^n, where i is the Real Discount Rate (0.7%) and n is time in years.

Table 4-4 Estimated Cost of Alternative S4—Complete Removal, Onsite Treatment, and Offsite Disposal

Item No.	Cost Categories and Items	Units	Unit Cost	Quantity (#)	Total Cost
A. CAPITAL COSTS					
1	**Project Planning**				
1.1	Remedial Action Plan	LS	$20,000	1	$20,000
2	**Slag Pile Excavation**				
2.1	Decontamination Facilities for Project Duration	LS	$226,413.83	1	$226,414
2.2	Slag Pile Excavation and Metals Analysis	LS	$642,082.39	1	$642,082
3	**Soil Excavation (Assume Top 1 ft soil removed)**				
3.1	Soil Excavation, Backfilling, and Metals Analysis	LS	$202,141.31	1	$202,141
4	**Slag/Soil Treatment**				
4.1	Blastox for Lead Stabilization (delivered, per ton of slag/soil`	TON	$15.00	113145	$1,697,175
4.2	Slag Crushing, Slag/Soil Treatment via Mixing	LS	$3,307,666.09	1	$3,307,666
5	**Slag/Soil Transportation and Disposal**				
5.1	Material Loading, including dump truck	LS	$258,929.96	1	$258,930
5.2	32-ft Dump Truck liners	EA	$31.40	3732	$117,195
5.3	Transport Bulk Solid Non-Hazardous Waste	MI	$3.17	279900	$887,283
5.4	Disposal Bulk Non-Haz Waste at Landfill	TON	$70.00	118677.6	$8,307,432
6	**Site Restoration**				
6.1	Grading and Gravel Placement	LS	$26,141.72	1	$26,142
7	**Institutional Controls**				
7.1	Administrative Land Use Controls	LS	$277,868.73	1	$277,869
8	**Reporting**				
8.1	Post Construction Documents	LS	$20,000	1	$20,000
				Subtotal:	$15,990,329
				Field Oversight (20%)	$892,247
				Project Management (10%)	$667,842
				Capital Costs Subtotal:	$15,990,329
				Indirects (35%)	$2,337,447
				Profit (10%)	$1,599,033
				Contingency (10%)	$1,599,033
				Total Capital Costs:	**$21,525,842**
B. O&M COSTS					
9	**Administrative Requirements**				
9.1	Five-Year Reviews	Each	$15,522	6	$93,130
10	**Monitoring**				
10.1	Annual Groundwater Monitoring	Per year	$15,000	2	$30,000
				Total O&M Costs:	**$123,130**

C. 30-YEAR PRESENT VALUE [1]

O&M Costs	$112,262

D. COST SUMMARY

Cost Element	Cost ($)
Capital Costs	$21,525,842
O&M Costs	$112,262
30-Year Total Present Worth Costs	**$21,638,104**

Notes:
1. Present Value = Future Value / (1+i)^n, where i is the Real Discount Rate (0.7%) and n is time in years.

Table 4-5 Estimated Cost of Alternative S5—Complete Removal, Offsite Treatment and Disposal

Item No.	Cost Categories and Items	Units	Unit Cost	Quantity (#)	Total Cost
A. CAPITAL COSTS					
1	**Project Planning**				
1.1	Remedial Action Plan	LS	$10,000	1	$10,000
2	**Slag Pile Excavation**				
2.1	Decontamination Facilities for Project Duration	LS	$194,965.84	1	$194,966
2.2	Slag Pile Excavation and Metals Analysis	LS	$566,543.29	1	$566,543
3	**Soil Excavation (Assume Top 1 ft soil removed)**				
3.1	Soil Excavation, Backfilling, and Metals Analysis	LS	$202,141.31	1	$202,141
4	**Slag/Soil Transportation and Disposal**				
4.1	Transportation, Stabilization, and Disposal Bulk Non-Haz Waste at Landfill	TON	$185.00	113151.6	$21,955,356
5	**Site Restoration**				
5.1	Grading and Gravel Placement	LS	$26,142	1	$26,142
6	**Institutional Controls**				
6.1	Administrative Land Use Controls	LS	$277,868.73	1	$277,869
7	**Reporting**				
7.1	Post Construction Documents	LS	$20,000	1	$20,000
				Subtotal:	$23,253,017
				Field Oversight (20%)	$157,530
				Project Management (10%)	$129,766
				Capital Costs Subtotal:	$23,253,017
				Indirects (35%)	$454,181
				Profit (10%)	$2,325,302
				Contingency (10%)	$2,325,302
				Total Capital Costs:	**$28,357,802**
B. O&M COSTS					
9	**Administrative Requirements**				
9.1	Five-Year Reviews	Each	$15,522	6	$93,130
10	**Monitoring**				
10.1	Annual Groundwater Monitoring	Per year	$15,000	2	$30,000
				Total O&M Costs:	**$123,130**

C. 30-YEAR PRESENT VALUE [1]

O&M Costs	$112,262

D. COST SUMMARY

Cost Element	Cost ($)
Capital Costs	$28,357,802
O&M Costs	$112,262
30-Year Total Present Worth Costs	**$28,470,064**

Notes:
1. Present Value = Future Value / (1+i)^n, where i is the Real Discount Rate (0.7%) and n is time in years.

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Table 4-6 Comparative Analysis Summary of Alternatives for OU-1 (Slag/Soil)

Criterion	Alternative S1 No Action		Alternative S2 Complete Removal and Offsite Disposal		Alternative S3 RCRA Cap, Regrading, and Partial Offsite Disposal		Alternative S4 Complete Removal, Onsite Treatment, and Offsite Disposal		Alternative S5 Complete Removal, Offsite Treatment and Disposal	
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT										
Minimize Exposure to Inorganic Contaminants in Slag and Underlying Soil	Protective in short term but not in long term due to lack of maintenance of RCRA cap and fence.	N	Removal of slag and any underlying contaminated soil followed by appropriate disposal would eliminate exposure potential. Institutional controls would prevent uses of the site other than commercial/industrial.	Y	Construction and maintenance of RCRA cap would minimize potential exposure to slag contaminants. Institutional controls would prevent further development of the site, to maintain cap integrity.	Y	Removal of slag and any underlying contaminated soil followed by appropriate disposal would eliminate exposure potential. Institutional controls would prevent uses of the site other than commercial/industrial.	Y	Removal of slag and any underlying contaminated soil followed by appropriate disposal would eliminate exposure potential. Institutional controls would prevent uses of the site other than commercial/industrial.	Y
COMPLIANCE WITH ARARs										
Comply with Chemical, Location, and Action-Specific ARARs and TBCs	Would not comply with ARARs.	N	Would comply; soil exceeding PRGs would be removed, and remedy would be conducted in a manner that complies.	Y	Would comply; material exceeding PRGs would be capped to prevent exposure, and remedy would be conducted in a manner that complies.	Y	Would comply; soil exceeding PRGs would be removed, and remedy would be conducted in a manner that complies.	Y	Would comply; soil exceeding PRGs would be removed, and remedy would be conducted in a manner that complies.	Y
LONG-TERM EFFECTIVENESS AND PERMANENCE										
Magnitude of Residual Risk	Potential future risks would remain.	W	Eliminates risks.	B	Maintenance of RCRA cap would minimize future risks.	A	Eliminates risks.	B	Eliminates risks.	B
Adequacy and Reliability of Controls	No new controls. Existing controls limited.	W	Not applicable (material would be removed from site).	B	Cap maintenance and institutional controls would prevent contact with slag and associated soil.	A	Not applicable (material would be removed from site).	B	Not applicable (material would be removed from site).	B
Need for 5-Year Review	Yes	A	Yes, if institutional controls required based on as-left metals concentrations	B	Yes	A	Yes, if institutional controls required based on as-left metals concentrations.	B	Yes, if institutional controls required based on as-left metals concentrations.	B
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT										
Reduction of Toxicity, Mobility, or Volume Through Treatment	None	W	No treatment; however, volume of contaminated material onsite decreased through removal.	A	No treatment; however, mobility of contaminants decreased using RCRA cap.	A	Would reduce toxicity/mobility of slag constituents.	B	Would reduce toxicity/mobility of slag constituents.	B
SHORT-TERM EFFECTIVENESS										
Protection of Community and Workers During Remedial Action	Not applicable	NA	Risk associated with excavation and transport of hazardous material. Engineering controls and PPE would be used to mitigate risks.	B	No significant risk anticipated. Engineering controls and PPE would be used to mitigate risks.	B	Risk associated with excavation of hazardous material. Treatment prior to transport, engineering controls, and PPE would mitigate risks.	B	Risk associated with excavation and transport of hazardous material. Engineering controls, and PPE would mitigate risks.	B
Environmental Impacts	Not applicable	NA	Engineering controls would minimize impacts during removal activities.	A	Engineering controls would minimize impacts during cap placement and monitoring activities.	A	Engineering controls would minimize impacts during removal and treatment activities.	A	Engineering controls would minimize impacts during removal and treatment activities.	A
Time to Meet Remedial Action Objectives	Not applicable	NA	2 years	A	2 years	A	2 years	A	2 years	A
IMPLEMENTABILITY										
Ability to Construct and Operate	No construction or operation involved.	B	Implementable. 12,932 tons of hazardous materials were similarly removed and disposed of in 1999-2000. Requires institutional controls.	B	Implementable. Excavation/ disposal and capping are readily implementable technologies. Requires long-term monitoring/maintenance and institutional controls.	A	Implementable. More complex to implement than Alternatives S2 and S3. Requires institutional controls.	A	Implementable, similar to Alternative S2. Requires institutional controls.	B
Ease of Doing More Action if Needed	Additional actions could be implemented.	A	No further action required	NA	Additional actions could be implemented.	A	No further action required	NA	No further action required	NA

Criterion	Alternative S1 No Action		Alternative S2 Complete Removal and Offsite Disposal		Alternative S3 RCRA Cap, Regrading, and Partial Offsite Disposal		Alternative S4 Complete Removal, Onsite Treatment, and Offsite Disposal		Alternative S5 Complete Removal, Offsite Treatment and Disposal	
Ability to Monitor Effectiveness	Not applicable	**NA**	None required	**NA**	Monitoring would provide assessment of potential exposures, contaminant migration, or changes in site conditions	**A**	None required	**NA**	None required	**NA**
Ability to Obtain Approvals	No approvals required	**B**	Approvals for transportation and disposal, institutional controls, and 5-year reviews should be obtainable.	**A**	Approvals for institutional controls and 5-year reviews should be obtainable.	**A**	Approvals for treatment, transportation, and disposal, institutional controls, and 5-year reviews should be obtainable.	**A**	Approvals for transportation and disposal, institutional controls, and 5-year reviews should be obtainable.	**A**
Availability of technologies, equipment, specialists, etc.	Not applicable	**NA**	Equipment and personnel are available; common techniques would be used.	**B**	Equipment and personnel are available; common techniques and materials would be used.	**B**	Equipment, personnel, and materials should be available; additional treatability testing may be required.	**A**	Equipment and personnel are available; common techniques would be used.	**B**
COST (a)										
Capital Cost	$0		$33,776,447		$6,473,976		$21,525,842		$28,357,802	
Annual O&M Costs	$3,104		$4,104		$16,385		$4,104		$4,104	
Present Worth Cost	$82,574		$33,888,709		$6,923,236		$21,638,104		$28,470,064	
STATE ACCEPTANCE										
Commonwealth acceptance	Not acceptable	**W**	Preferred by PADEP due to lack of requirements for long-term maintenance of a cap.	**B**	Not preferred by PADEP due to long-term maintenance requirements.	**W**	Preferred by PADEP due to lack of requirements for long-term maintenance of a cap.	**B**	Preferred by PADEP due to lack of requirements for long-term maintenance of a cap.	**B**
COMMUNITY ACCEPTANCE										
Community acceptance	Not acceptable	**W**	Acceptable to residents, based on past public comments, because of slag removal.	**B**	Not acceptable to residents, based on past public comments, because slag pile would remain onsite.	**W**	Preferred by residents, based on past public comments, because of slag removal and lack of hazardous waste transport.	**B**	Acceptable to residents, based on past public comments, because of slag removal.	**B**

(a) Net present value costs are for 30 years and are based on a 0.7 percent discount rate.

NOTES:
- A = Average.
- B = Better.
- ARAR = Applicable or relevant or appropriate requirement.
- N = No (for threshold criteria).
- NA = Not applicable.
- O&M = Operation and maintenance.
- PADEP = Pennsylvania Department of Environmental Protection.
- PPE = Personal protective equipment.
- PRG = Preliminary remediation goal.
- RCRA = Resource Conservation and Recovery Act.
- TBC = To be considered guidance.
- Y = Yes (for threshold criteria).
- W = Worse.

5. DETAILED ANALYSIS OF ALTERNATIVES FOR OPERABLE UNIT 2

This section presents a detailed analysis of the remedial alternative for OU-2 (groundwater) with respect to the NCP evaluation criteria (Section 3.3).

5.1 ALTERNATIVE G1 – NO ACTION

5.1.1 Description

The No Action alternative includes no remedial actions for groundwater.

Estimated Capital Cost:	$0
Estimated Average O&M Cost (annual):	$0
Estimated Total 30-Year Present Worth Cost:	$0
Estimated Construction Timeframe:	Immediate
Estimated Time to Achieve RAOs:	Will not achieve RAOs.

5.1.2 Evaluation

Overall Protection of Public Health and Welfare of the Environment—As stated above, the slag pile was not found to have been a significant contributor to area-wide groundwater contamination above and beyond other area sources, and therefore no RAOs were developed for groundwater (see Section 2.2). Based on this, the No Action alternative for OU-2 is considered protective.

Compliance with ARARs—No RAOs were developed for OU-2, and no ARARs were determined to apply to OU-2 based on the conclusion that the slag pile was not a significant contributor of the area-wide groundwater contamination (see Section 2.2).

Long-Term Effectiveness and Permanence—The No Action alternative for OU-2 would be effective in the long-term, because the slag pile was not found to have been a significant contributor to groundwater contamination.

Reduction of Contaminant Toxicity, Mobility, and Volume—No treatment or other controls are specified under the No Action alternative to reduce the toxicity, mobility, and volume of COPCs in groundwater. Based on the conclusion that the slag pile was not a significant contributor of the area-wide groundwater contamination (see Section 2.2), no treatment is required.

Short-Term Effectiveness—No remedial actions would be specified under the No Action alternative; therefore, there would be no increased risk to the human health or the environment during implementation of this alternative. The No Action alternative in combination with Alternative S2, S3, S4, or S5 for OU-1 would be effective in the short-term.

***Implementability*—**Because no remedial components or monitoring would be performed, the No Action alternative would be readily implementable. This alternative also would not interfere with potential future remedial actions or remedial actions for OU-1.

***Cost*—**The No Action alternative has no capital costs and no long-term costs. Per regulatory guidance, the cost for the No Action alternative is $0.

***Commonwealth Acceptance*—**This alternative likely would receive approval from the Commonwealth if combined with Alternative S2, S3, S4, or S5 for OU-1.

***Community Acceptance*—**This alternative, combined with Alternative S2, S3, S4, or S5 for OU-1, would likely be acceptable to members of nearby communities.

6. REFERENCES

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Appendix A

Evaluation of Preliminary Remediation Goals for Operable Unit 1, Franklin Slag Pile

**Evaluation of Preliminary Remediation Goals for
Operable Unit 1, Franklin Slag Pile**

Risk results from the human health risk assessments (HHRAs) for Operable Unit (OU)-1 and OU-2 were reviewed to determine preliminary remediation goals (PRGs) for the Franklin Slag Pile Superfund site (the Site). The remedial investigation (RI) for OU-1 was completed in 2007 and did not assess impacts to groundwater at the Site. The RI for OU-2, which assessed potential impacts to groundwater from the slag pile, was finalized in 2018. As a result, the Site is divided into two OUs: OU-1 (slag pile and associated soil) and OU-2 (groundwater). PRGs were only calculated for OU-1; therefore, the following text only pertains to OU-1.

The HHRA for OU-1 (slag/soil) concluded that there are potential unacceptable risks to selected receptors from exposure to the slag in the pile and surrounding soils. Non-cancer hazards for the construction worker exposure to the slag pile and surrounding soils were above the acceptable level of 1. Carcinogenic risks were below or within the U.S. Environmental Protection Agency (EPA) acceptable cancer risk range of 10^{-6} to 10^{-4} for all receptors evaluated. Metals (including aluminum, beryllium, chromium, cobalt, copper, iron, lead, and manganese) were identified as contaminants of concern (COC) in slag and any underlying contaminated soil associated with the slag pile.

PRGs were determined for chemicals with target organ specific hazard indices (HIs) greater than 1. The EPA Regional Screening Level (RSL) calculator was used to determine risk-based PRGs. PRGs were determined for a resident and construction worker. The resident is not a likely future receptor for the Site due to the industrial land use of the area surrounding the Site. The resident is used to represent an unlimited exposure condition. The construction worker is the likely current and future use receptor for the Site. However, PRGs determined for the construction worker do not allow for an unrestricted site use, and their use as cleanup goals would require restrictions or land use controls.

EPA default exposure parameters for both receptors were used in the calculator. These exposure parameters are similar to those used in the 2007 HHRA, except for the determination of the inhalation of particulate exposure route. The determination of potential hazards from the inhalation exposure route have changed since completion of the 2007 HHRA. The primary difference in the calculations is with the determination of the particulate emission factor (PEF). The 2007 HHRA determined a PEF of $2.6\text{x}10^{6}$ cubic meters per kilogram (m^3/kg). The EPA RSL calculator determines a different PEF for the construction worker and the resident. For the construction worker, the RSL calculator determined a PEF of $1.4\text{x}10^{7}$ m^3/kg based upon other construction activities. For the resident, the RSL calculator determined a PEF of $3.23\text{x}10^{9}$ m^3/kg. The 2007 HHRA noted that the "inhalation of fugitive dust was a predominant exposure pathway" (Tetra Tech NUS, Incorporated 2007). The increase for both receptors in the PEF would decrease the overall hazard from site exposures; however, an analysis of the changes reveals that the inhalation exposure route would remain a concern.

The EPA RSL calculator determines PRGs based upon the following equations:

$$PRG_{Ingestion}\left(\frac{mg}{kg}\right) = \frac{THQ\ x\ AT\ x\ BW}{EF\ x\ ED\ x\ IR\ x\ RBA\ x\ CF_1\ x\ \frac{1}{RfD}}$$

$$PRG_{Dermal}\left(\frac{mg}{kg}\right) = \frac{THQ\ x\ AT\ x\ BW}{EF\ x\ ED\ x\ SA\ x\ AF\ x\ ABS\ x\ CF_1\ x\ \frac{1}{RfD\ x\ GIABS}}$$

$$PRG_{Inhalation}\left(\frac{mg}{kg}\right) = \frac{THQ\ x\ AT}{EF\ x\ ED\ x\ ET\ x\ CF_2\ x\ \frac{1}{RfC}\ x\ \frac{1}{PEF}}$$

$$PRG_{Total}\left(\frac{mg}{kg}\right) = \frac{1}{\frac{1}{PRG_{Ingestion}}\ x\ \frac{1}{PRG_{Dermal}}\ x\ \frac{1}{PRG_{Inhalation}}}$$

where:

THQ = Target Hazard Quotient (unitless)
IR = Ingestion Rate (milligrams per day [mg/day])
SA = Surface Area for Contact (square centimeters [cm^2])
GIABS = Fraction of chemical absorbed in gastrointestinal tract (dimensionless) (chemical-specific)
ABS = Fraction of chemical absorbed dermally (dimensionless) (chemical-specific)
AF = Adherence Factor (milligrams per square centimeter [mg/cm^2])
EF = Exposure frequency (days/year)
ET = Exposure Time (hours)
ED = Exposure duration (years)
BW = Body weight (kilograms [kg])
PEF = Particulate emission factor (m^3/kg)
AT = Averaging time (days)
CF_1 = Conversion Factor (10^{-6} kg/mg)
CF_2 = Conversion Factor (1 day/24 hours)
RfD = Reference Dose (mg/kg-day)
RfC = Reference Concentration (mg/m^3).

Exposure parameters were taken from the EPA RSL calculator. Toxicity values used to determine the PRGs were taken from the EPA RSL table. For the construction worker, subchronic RfDs were selected by the RSL calculator, when available. For all COCs identified for the slag, EPA guidance does not set forth ABS values. The RSL calculator was manually updated to include the ABS values set forth by EPA Region 3 for metals in soils. For all COCs, the ABS value was set to 0.01 (EPA 1995). All inputs, including exposure parameters and toxicity values, for the RSL calculator and final calculations are presented in Attachment 1.

As noted, the primary human health concerns were exceedance of target organ non-cancer hazards. As a result, the target organs for each COC are presented on the following table to determine the appropriate hazard quotient (HQ) for each COC.

Chemical	Target Organ	HQ
Aluminum	Central Nervous System	0.5
Beryllium	Gastrointestinal	0.33
Chromium, hexavalent	None	1
Cobalt	Thyroid	1
Copper	Gastrointestinal	0.33
Iron	Gastrointestinal	0.33
Lead	Developmental	1
Manganese	Central Nervous System	0.5

The following risk-based PRGs for the construction worker were determined.

Chemical of Concern	Cancer PRG at 10^{-6} (mg/kg)	Non-Cancer PRG (mg/kg)	Target Organ	Selected PRG (mg/kg)
Aluminum	NA	78,000	CNS	78,000
Beryllium	1,760	227	Gastrointestinal	227
Chromium, hexavalent	24.9	1,550	None	24.9
Cobalt	469	541	Thyroid	469
Copper	NA	1,119	Gastrointestinal	1,119
Iron	NA	78,540	Gastrointestinal	78,540
Lead	NA	800	Developmental	800
Manganese	NA	1,065	CNS	1,065
NOTES: CNS = Central Nervous System. NA = Not applicable.				

The following table presents a comparison of the risk-based PRGs using the EPA RSL calculator and the Pennsylvania Department of Environmental Protection (PADEP) Medium-Specific Concentrations (MSCs) for nonresidential receptors.

Chemical of Concern	PADEP MSC (mg/kg)	Risk-Based PRG (mg/kg)
Aluminum	190,000	78,000
Beryllium	6,400	227
Chromium, hexavalent	220	24.9
Cobalt	960	469
Copper	120,000	1,119
Iron	190,000	78,540
Lead	1,000	800
Manganese	150,000	1,065

The following risk-based PRGs for the resident were determined.

Chemical of Concern	Cancer PRG at 10^{-6} (mg/kg)	Non-Cancer PRG (mg/kg)	Target Organ	Selected PRG (mg/kg)
Aluminum	NA	38,950	CNS	38,950
Beryllium	3,780	51	Gastrointestinal	51
Chromium, hexavalent	0.3	234	None	0.3
Cobalt	1,010	23	Thyroid	23
Copper	NA	1,033	Gastrointestinal	1,033
Iron	NA	18,084	Gastrointestinal	18,084
Lead	NA	400	Developmental	400
Manganese	NA	930	CNS	930
NOTES: CNS = Central Nervous System. NA = Not applicable.				

The following table presents a comparison of the risk-based PRGs using the EPA RSL calculator and the PADEP MSCs for residential receptors.

Chemical of Concern	PADEP MSC (mg/kg)	Risk-Based PRG (mg/kg)
Aluminum	190,000	38,950
Beryllium	440	51
Chromium, hexavalent	4	0.3
Cobalt	66	23
Copper	8,100	1,033
Iron	150,000	18,084
Lead	500	400
Manganese	10,000	930

A comparison of the risk-based PRGs determined using the RSL calculator to the PADEP MSCs reveals a significant difference between the values. There are a number of differences in the way the RSL calculator determines a PRG and the PADEP MSCs for inorganics in soil. First, the PADEP MSCs only take into account the ingestion exposure route. The RSL calculator takes into account ingestion, dermal contact, and inhalation exposure routes. Second, the soil ingestion rates for the PADEP MSCs are lower than the default ingestion rates in the RSL calculator. The PADEP MSCs assume a soil ingestion rate of 50 mg/day for nonresidential receptors and 100 mg/day for residential receptors. The RSL calculator assumes a soil ingestion rate of 330 mg/day for the construction worker and 200 mg/day for the resident child. Thirdly, the PADEP MSCs assume a lower exposure frequency for both the nonresidential and residential receptors than the RSL calculator. The PADEP MSCs assume exposure frequencies of 180 days/year for the nonresidential receptor and 250 days/year for the residential receptor. The RSL calculator assumes exposure frequencies of 250 days/year for the construction worker and 350 days/year for the residential receptor. Additionally, the PADEP MSCs for aluminum and iron (nonresidential MSC) are based upon the calculated physical capacity of the soil to contain these chemicals. The selection of these MSCs based upon the physical capacity means that the risk-based numbers determined by PADEP would be higher. Based upon these differences

between the PADEP MSCs and the risk-based PRG calculations, the risk-based PRGs are significantly lower for all COCs.
References cited:

Tetra Tech NUS, Incorporated. 2007. *Remedial Investigation Report for Franklin Slag Pile Site, Philadelphia, Pennsylvania*. Final. Prepared for U.S. EPA Region III, Philadelphia, Pennsylvania. June.

U.S. Environmental Protection Agency (EPA). 1995. AP-42 *Compilation of Air Pollutant Emissions Factors, Volume I: Stationary Point and Area Sources*. Fifth Edition, Chapter 12: Metallurgical Industry, Section 12.9 Secondary Copper Smelting, Refining, and Alloying. January.

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Attachment 1

Site-specific

Construction Worker Equation Inputs for Soil - Other Construction Activities

* Inputted values different from Construction Worker defaults are highlighted.

Variable	Construction Worker Soil - Other Default Value	Form-input Value
$A_{c\text{-}doz}$ (areal extent of dozing) acres	.	4
A_{excav} (area of excavation site) m^2	.	16187
$A_{c\text{-}grade}$ (areal extent of grading) acres	.	4
A (PEF Dispersion Constant)	2.4538	2.4538
A_{surf} (areal extent of site) m^2	2023.43	2023.43
A_{till} (areal extent of tilling) acres	.	4
A (VF Dispersion Constant)	2.4538	2.4538
B_l (dozing blade length) m	.	2.4
B_l (grading blade length) m	.	2.4
B (PEF Dispersion Constant)	17.566	17.566
B (VF Dispersion Constant)	17.566	17.566
C (PEF Dispersion Constant)	189.0426	189.0426
C (VF Dispersion Constant)	189.0426	189.0426
d_{excav} (average depth of excavation site) m	.	0.6
F_D Unitless Dispersion Correction Factor	0.185837208	0.18583721
foc (fraction organic carbon in soil) g/g	0.006	0.006
F(x) (function dependant on U_m/U_t derived using Cowherd et al. (1985))	0.194	0.194
$M_{m\text{-}doz}$ (Gravimetric soil moisture content) %	7.9	7.9
$M_{m\text{-}excav}$ (Gravimetric soil moisture content) %	12	12
M_{wind} (dust emitted by wind erosion) g	51288.84717	51288.8472
$N_{A\text{-}doz}$ (number of times site was dozed)	.	1
$N_{A\text{-}dump}$ (number of times soil is dumped)	2	2
$N_{A\text{-}grade}$ (number of times site was graded)	.	2
$N_{A\text{-}till}$ (number of times soil is tilled)	2	2
n (total soil porosity) L_{pore}/L_{soil}	0.43396	0.43396
p_b (dry soil bulk density) g/cm^3	1.5	1.5
p_b (dry soil bulk density) g/cm^3	1.5	1.5
p_s (soil particle density) g/cm^3	2.65	2.65
Q/C_{sa} (g/m^2-s per kg/m^3)	14.31407	14.31407
Q/C_{vol} (g/m^2-s per kg/m^3)	14.31407	14.31407
Q/C_{sa} (g/m^2-s per kg/m^3)	14.31407	14.31407
p_{soil} (density) g/cm^3 - chemical-specific	1.68	1.68
A_c (acres)	0.5	0.5

Site-specific

Construction Worker Equation Inputs for Soil - Other Construction Activities

* Inputted values different from Construction Worker defaults are highlighted.

Variable	Construction Worker Soil - Other Default Value	Form-input Value
A_s ($VF_{mlim-sc}$ acres)	0.5	0.5
A_s ($VF_{ulim-sc}$ acres)	0.5	0.5
s_{doz} (soil silt content) %	6.9	6.9
AF_{cw} (skin adherence factor - construction worker) mg/cm^2	0.3	0.3
AT_{cw} (averaging time - construction worker) days	365	365
BW_{cw} (body weight - construction worker) kg	80	80
ED_{cw} (exposure duration - construction worker) yr	1	1
EF_{cw} (exposure frequency - construction worker) day/yr	250	250
ET_{cw} (exposure time - construction worker) hr/day	8	8
THQ (target hazard quotient) unitless	0.1	1
IR_{cw} (soil ingestion rate - construction worker) mg/day	330	330
LT (lifetime) yr	70	70
SA_{cw} (surface area - construction worker) cm^2/day	3527	3527
TR (target cancer risk) unitless	0.000001	0.000001
S_{doz} (dozing speed) kph	11.4	11.4
S_{grade} (dozing speed) kph	11.4	11.4
s_{till} (soil silt content) %	18	18
t_c (overall duration of construction) hours	8400	8400
T_c (overall duration of construction) s	30240000	30240000
$Theta_a$ (air-filled soil porosity) L_{air}/L_{soil}	0.28396	0.28396
$Theta_w$ (water-filled soil porosity) L_{water}/L_{soil}	0.15	0.15
T (time over which traffic occurs) s	7200000	7200000
T_t (overall duration of traffic) s	7200000	7200000
U_m (mean annual wind speed) m/s	4.69	4.69
U_t (equivalent threshold value) m/s	11.32	11.32
V (fraction of vegetative cover)	0	0

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Site-specific

Construction Worker Regional Screening Levels (RSL) for Soil - Other Construction Activities

Chemical	CAS Number	Mutagen?	Volatile?	Ingestion SF (mg/kg-day)$^{-1}$	SFO Ref	Inhalation Unit Risk (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	Soil Saturation Concentration (mg/kg)	S (mg/L)	K_{oc} (cm^3/g)	K_d (cm^3/g)	HLC (atm-m^3/mole)	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Normal Boiling Point T_{boil} (K)	BP Ref	Critical Temperature T_{crit} (K)
Aluminum	7429-90-5	No	No	-		-		1.00E+00	U	5.00E-03	U	1.00E+00	-	1.00E+00	-	-	-	1.50E+03	-	-		2.79E+03	U	6.70E+03
Beryllium and compounds	7440-41-7	No	No	-		2.40E-03	U	5.00E-03	U	2.00E-05	U	7.00E-03	-	1.00E+00	-	-	-	7.90E+02	-	-		3.04E+03	U	5.20E+03
Chromium(III), Insoluble Salts	16065-83-1	No	No	-		-		1.50E+00	U	5.00E-03	U	1.30E-02	-	1.00E+00	-	-	-	1.80E+06	-	-		-		-
Chromium(VI)	18540-29-9	Yes	No	5.00E-01	U	8.40E-02	U	5.00E-03	U	3.00E-04	U	2.50E-02	-	1.00E+00	-	1.69E+06	-	1.90E+01	-	-		-		-
Chromium, Total	7440-47-3	No	No	-		-		-		-		1.30E-02	-	1.00E+00	-	-	-	1.80E+06	-	-		2.91E+03	U	8.56E+03
Cobalt	7440-48-4	No	No	-		9.00E-03	U	3.00E-03	U	2.00E-05	U	1.00E+00	-	1.00E+00	-	-	-	4.50E+01	-	-		3.20E+03	U	7.40E+03
Copper	7440-50-8	No	No	-		-		1.00E-02	A	-		1.00E+00	-	1.00E+00	-	-	-	3.50E+01	-	-		2.87E+03	U	5.12E+03
Iron	7439-89-6	No	No	-		-		7.00E-01	U	-		1.00E+00	-	1.00E+00	-	-	-	2.50E+01	-	-		3.27E+03	U	9.34E+03
Manganese (Non-diet)	7439-96-5	No	No	-		-		2.40E-02	U	5.00E-05	U	4.00E-02	-	1.00E+00	-	-	-	6.50E+01	-	-		2.37E+03	U	4.32E+03

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Site-specific

Construction Worker Regional Screening Levels (RSL) for Soil - Other Construction Activities

Chemical	CAS Number	T_{crit} Ref	chemtype	D_{ia} (cm^2/s)	D_{iw} (cm^2/s)	D_A (cm^2/s)	Particulate Emission Factor (m^3/kg)	Volatilization Factor (m^3/kg)	Ingestion SL TR=1E-06 (mg/kg)	Dermal SL TR=1E-06 (mg/kg)	Inhalation SL TR=1E-06 (mg/kg)	Carcinogenic SL TR=1E-06 (mg/kg)	Ingestion SL THQ=1 (mg/kg)	Dermal SL THQ=1 (mg/kg)	Inhalation SL THQ=1 (mg/kg)	Non carcinogenic SL THI=1 (mg/kg)	Screening Level (mg/kg)		% of Total HI	Final HQ (mg/kg)	Selected Screening Level (mg/kg)
Aluminum	7429-90-5	U	INORGANIC	-	-	-	1.38E+07	-	-	-	-	-	3.39E+05	-	2.89E+05	1.56E+05	1.56E+05	max	0.5	78000	78000
Beryllium and compounds	7440-41-7	U	INORGANIC	-	-	-	1.38E+07	-	-	-	1.76E+03	1.76E+03	1.70E+03	-	1.16E+03	6.88E+02	6.88E+02	nc	0.33	227.04	227
Chromium(III), Insoluble Salts	16065-83-1		INORGANIC	-	-	-	1.38E+07	-	-	-	-	-	5.09E+05	-	2.89E+05	1.84E+05	1.84E+05	nc	1	184000	184000
Chromium(VI)	18540-29-9		INORGANIC	-	-	-	1.38E+07	-	4.96E+01	-	5.02E+01	2.49E+01	1.70E+03	-	1.73E+04	1.55E+03	2.49E+01	ca*	1	1550	24.9
Chromium, Total	7440-47-3	U	INORGANIC	-	-	-	1.38E+07	-	-	-	-	-	-	-	-	-			1		
Cobalt	7440-48-4	U	INORGANIC	-	-	-	1.38E+07	-	-	-	4.69E+02	4.69E+02	1.02E+03	-	1.16E+03	5.41E+02	4.69E+02	ca**	1	541	469
Copper	7440-50-8	U	C	-	-	-	1.38E+07	-	-	-	-	-	3.39E+03	-	-	3.39E+03	3.39E+03	nc	0.33	1118.7	1,119
Iron	7439-89-6	U	INORGANIC	-	-	-	1.38E+07	-	-	-	-	-	2.38E+05	-	-	2.38E+05	2.38E+05	max	0.33	78540	78540
Manganese (Non-diet)	7439-96-5	U	INORGANIC	-	-	-	1.38E+07	-	-	-	-	-	8.15E+03	-	2.89E+03	2.13E+03	2.13E+03	nc	0.5	1065	1065

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Site-specific

Resident Equation Inputs for Soil

* Inputted values different from Resident defaults are highlighted.

Variable	Resident Soil Default Value	Form-input Value
A (PEF Dispersion Constant)	16.2302	14.0111
A (VF Dispersion Constant)	11.911	11.911
A (VF Dispersion Constant - Mass Limit)	11.911	11.911
B (PEF Dispersion Constant)	18.7762	19.6154
B (VF Dispersion Constant)	18.4385	18.4385
B (VF Dispersion Constant - Mass Limit)	18.4385	18.4385
$City_{PEF}$ (Climate Zone) Selection	Default	Philadelphia, P
$City_{VF}$ (Climate Zone) Selection	Default	Default
C (PEF Dispersion Constant)	216.108	225.3397
C (VF Dispersion Constant)	209.7845	209.7845
C (VF Dispersion Constant - Mass Limit)	209.7845	209.7845
foc (fraction organic carbon in soil) g/g	0.006	0.006
F(x) (function dependent on U_m/U_t) unitless	0.194	0.0993
n (total soil porosity) L_{pore}/L_{soil}	0.43396	0.43396
p_b (dry soil bulk density) g/cm^3	1.5	1.5
p_b (dry soil bulk density - mass limit) g/cm^3	1.5	1.5
PEF (particulate emission factor) m^3/kg	1359344438	3232997754
p_s (soil particle density) g/cm^3	2.65	2.65
Q/C_{wind} (g/m^2-s per kg/m^3)	93.77	87.36897722
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18	68.18
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18	68.18
A_s (PEF acres)	0.5	0.5
A_s (VF acres)	0.5	0.5
A_s (VF mass-limit acres)	0.5	0.5
AF_{0-2} (mutagenic skin adherence factor) mg/cm^2	0.2	0.2
AF_{2-6} (mutagenic skin adherence factor) mg/cm^2	0.2	0.2
AF_{6-16} (mutagenic skin adherence factor) mg/cm^2	0.07	0.07
AF_{16-26} (mutagenic skin adherence factor) mg/cm^2	0.07	0.07
AF_{res-a} (skin adherence factor - adult) mg/cm^2	0.07	0.07
AF_{res-c} (skin adherence factor - child) mg/cm^2	0.2	0.2
AT_{res} (averaging time - resident carcinogenic)	365	365
BW_{0-2} (mutagenic body weight) kg	15	15
BW_{2-6} (mutagenic body weight) kg	15	15
BW_{6-16} (mutagenic body weight) kg	80	80

Site-specific

Resident Equation Inputs for Soil

* Inputted values different from Resident defaults are highlighted.

Variable	Resident Soil Default Value	Form-input Value
BW_{16-26} (mutagenic body weight) kg	80	80
BW_{res-a} (body weight - adult) kg	80	80
BW_{res-c} (body weight - child) kg	15	15
$DFS_{res-adj}$ (age-adjusted soil dermal factor) mg/kg	103390	103390
$DFSM_{res-adj}$ (mutagenic age-adjusted soil dermal factor) mg/kg	428260	428260
ED_{res} (exposure duration) years	26	26
ED_{0-2} (mutagenic exposure duration) years	2	2
ED_{2-6} (mutagenic exposure duration) years	4	4
ED_{6-16} (mutagenic exposure duration) years	10	10
ED_{16-26} (mutagenic exposure duration) years	10	10
ED_{res-a} (exposure duration - adult) years	20	20
ED_{res-c} (exposure duration - child) years	6	6
EF_{res} (exposure frequency) days/year	350	350
EF_{0-2} (mutagenic exposure frequency) days/year	350	350
EF_{2-6} (mutagenic exposure frequency) days/year	350	350
EF_{6-16} (mutagenic exposure frequency) days/year	350	350
EF_{16-26} (mutagenic exposure frequency) days/year	350	350
EF_{res-a} (exposure frequency - adult) days/year	350	350
EF_{res-c} (exposure frequency - child) days/year	350	350
ET_{res} (exposure time) hours/day	24	24
ET_{0-2} (mutagenic exposure time) hours/day	24	24
ET_{2-6} (mutagenic exposure time) hours/day	24	24
ET_{6-16} (mutagenic exposure time) hours/day	24	24
ET_{16-26} (mutagenic exposure time) hours/day	24	24
ET_{res-a} (adult exposure time) hours/day	24	24
ET_{res-c} (child exposure time) hours/day	24	24
THQ (target hazard quotient) unitless	0.1	1
$IFS_{res-adj}$ (age-adjusted soil ingestion factor) mg/kg	36750	36750
$IFSM_{res-adj}$ (mutagenic age-adjusted soil ingestion factor) mg/kg	166833.3	166833.3
IRS_{0-2} (mutagenic soil intake rate) mg/day	200	200
IRS_{2-6} (mutagenic soil intake rate) mg/day	200	200

Site-specific

Resident Equation Inputs for Soil

* Inputted values different from Resident defaults are highlighted.

Variable	Resident Soil Default Value	Form-input Value
IRS_{6-16} (mutagenic soil intake rate) mg/day	100	100
IRS_{16-26} (mutagenic soil intake rate) mg/day	100	100
IRS_{res-a} (soil intake rate - adult) mg/day	100	100
IRS_{res-c} (soil intake rate - child) mg/day	200	200
LT (lifetime) years	70	70
SA_{0-2} (mutagenic skin surface area) cm^2/day	2373	2373
SA_{2-6} (mutagenic skin surface area) cm^2/day	2373	2373
SA_{6-16} (mutagenic skin surface area) cm^2/day	6032	6032
SA_{16-26} (mutagenic skin surface area) cm^2/day	6032	6032
SA_{res-a} (skin surface area - adult) cm^2/day	6032	6032
SA_{res-c} (skin surface area - child) cm^2/day	2373	2373
TR (target risk) unitless	0.000001	0.000001
T_w (groundwater temperature) Celsius	25	25
$Theta_a$ (air-filled soil porosity) L_{air}/L_{soil}	0.28396	0.28396
$Theta_w$ (water-filled soil porosity) L_{water}/L_{soil}	0.15	0.15
T (exposure interval) s	819936000	819936000
T (exposure interval) yr	26	26
U_m (mean annual wind speed) m/s	4.69	4.29
U_t (equivalent threshold value)	11.32	11.32
V (fraction of vegetative cover) unitless	0.5	0.5
VF_{ml} (volitization factor - mass limit) m^3/kg	.	0

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Site-specific
Resident Regional Screening Levels (RSL) for Soil

Chemical	CAS Number	Mutagen?	Volatile?	Ingestion SF $(mg/kg\text{-}day)^{-1}$	SFO Ref	Inhalation Unit Risk $(ug/m^3)^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	Soil Saturation Concentration (mg/kg)	S (mg/L)	K_{oc} (cm^3/g)	K_d (cm^3/g)	HLC (atm-m^3/mole)	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Normal Boiling Point T_{boil} (K)	BP Ref	Critical Temperature T_{crit} (K)	T_{crit} Ref	CHEM TYPE
Aluminum	7429-90-5	No	No	-		-		1.00E+00	P	5.00E-03	P	1.00E+00	-	1.00E+00	-	-	-	1.50E+03	-	-		2.79E+03	CRC89	6.70E+03	CRC89	INORGANIC
Beryllium and compounds	7440-41-7	No	No	-		2.40E-03	I	2.00E-03	I	2.00E-05	I	7.00E-03	-	1.00E+00	-	-	-	7.90E+02	-	-		3.04E+03	PERRY	5.21E+03	CRC89	INORGANIC
Chromium(III), Insoluble Salts	16065-83-1	No	No	-		-		1.50E+00	I	-		1.30E-02	-	1.00E+00	-	-	-	1.80E+06	-	-		-		-		INORGANIC
Chromium(VI)	18540-29-9	Yes	No	5.00E-01	C	8.40E-02	S	3.00E-03	I	1.00E-04	I	2.50E-02	-	1.00E+00	-	1.69E+06	-	1.90E+01	-	-		-		-		INORGANIC
Chromium, Total	7440-47-3	No	No	-		-		-		-		1.30E-02	-	1.00E+00	-	-	-	1.80E+06	-	-		2.92E+03	PHYSPROP	8.56E+03	YAWS	INORGANIC
Cobalt	7440-48-4	No	No	-		9.00E-03	P	3.00E-04	P	6.00E-06	P	1.00E+00	-	1.00E+00	-	-	-	4.50E+01	-	-		3.20E+03	CRC89	7.40E+03	YAWS	INORGANIC
Copper	7440-50-8	No	No	-		-		4.00E-02	H	-		1.00E+00	-	1.00E+00	-	-	-	3.50E+01	-	-		2.87E+03	PHYSPROP	5.12E+03	YAWS	INORGANIC
Iron	7439-89-6	No	No	-		-		7.00E-01	P	-		1.00E+00	-	1.00E+00	-	-	-	2.50E+01	-	-		3.27E+03	PERRY	9.34E+03	CRC89	INORGANIC
Manganese (Non-diet)	7439-96-5	No	No	-		-		2.40E-02	S	5.00E-05	I	4.00E-02	-	1.00E+00	-	-	-	6.50E+01	-	-		2.37E+03	PHYSPROP	4.33E+03	CRC89	INORGANIC

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Site-specific
Resident Regional Screening Levels (RSL) for Soil

Chemical	CAS Number	D_{ia} (cm^2/s)	D_{iw} (cm^2/s)	D_A (cm^2/s)	Particulate Emission Factor (m^3/kg)	Volatilization Factor (m^3/kg)	Ingestion SL TR=1E-06 (mg/kg)	Dermal SL TR=1E-06 (mg/kg)	Inhalation SL TR=1E-06 (mg/kg)	Carcinogenic SL TR=1E-06 (mg/kg)	Ingestion SL Child THQ=1 (mg/kg)	Dermal SL Child THQ=1 (mg/kg)	Inhalation SL Child THQ=1 (mg/kg)	Noncarcinogenic SL Child THI=1 (mg/kg)	Ingestion SL Adult THQ=1 (mg/kg)	Dermal SL Adult THQ=1 (mg/kg)	Inhalation SL Adult THQ=1 (mg/kg)	Noncarcinogenic SL Adult THI=1 (mg/kg)	Screening Level (mg/kg)		% of Total HI	Final HQ (mg/kg)	Selected Screening Level (mg/kg)
Aluminum	7429-90-5	-	-	-	3.23E+09	-	-	-	-	-	7.82E+04	-	1.69E+07	7.79E+04	8.34E+05	-	1.69E+07	7.95E+05	7.79E+04	nc	0.5	38,950	38,950
Beryllium and compounds	7440-41-7	-	-	-	3.23E+09	-	-	-	3.78E+03	3.78E+03	1.56E+02	-	6.74E+04	1.56E+02	1.67E+03	-	6.74E+04	1.63E+03	1.56E+02	nc	0.33	51	51
Chromium(III), Insoluble Salts	16065-83-1	-	-	-	3.23E+09	-	-	-	-	-	1.17E+05	-	-	1.17E+05	1.25E+06	-	-	1.25E+06	1.17E+05	max	1	117,000	117,000
Chromium(VI)	18540-29-9	-	-	-	3.23E+09	-	3.06E-01	-	3.90E+01	3.04E-01	2.35E+02	-	3.37E+05	2.34E+02	2.50E+03	-	3.37E+05	2.48E+03	3.04E-01	ca	1	234	0.30
Chromium, Total	7440-47-3	-	-	-	3.23E+09	-	-	-	-	-	-	-	-	-	-	-	-	-			1		
Cobalt	7440-48-4	-	-	-	3.23E+09	-	-	-	1.01E+03	1.01E+03	2.35E+01	-	2.02E+04	2.34E+01	2.50E+02	-	2.02E+04	2.47E+02	2.34E+01	nc	1	23	23
Copper	7440-50-8	-	-	-	3.23E+09	-	-	-	-	-	3.13E+03	-	-	3.13E+03	3.34E+04	-	-	3.34E+04	3.13E+03	nc	0.33	1,033	1,033
Iron	7439-89-6	-	-	-	3.23E+09	-	-	-	-	-	5.48E+04	-	-	5.48E+04	5.84E+05	-	-	5.84E+05	5.48E+04	nc	0.33	18,084	18,084
Manganese (Non-diet)	7439-96-5	-	-	-	3.23E+09	-	-	-	-	-	1.88E+03	-	1.69E+05	1.86E+03	2.00E+04	-	1.69E+05	1.79E+04	1.86E+03	nc	0.5	930	930

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Key: I = IRIS; P = PPRTV; D = DWSHA; O = OPP; A = ATSDR; C = Cal EPA; X = APPENDIX PPRTV SCREEN (See FAQ #29); H = HEAST; F = See FAQ; E = see user guide Section 2.3.5; W = see user guide Section 2.3.6; L = see user guide on lead; M = mutagen; S = see user guide Section 5; V = volatile; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; n = noncancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; SSL values are based on DAF=1; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide); U = User-provided