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DRAFT BASELINE HUMAN HEALTH RISK ASSESSMENT (VERSION 2)

RIVERSIDE INDUSTRIAL PARK SUPERFUND SITE
NEWARK, NEW JERSEY

RAMBOLL

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CONTENTS

FIGURES

TABLES

APPENDICES

ACRONYMS AND ABBREVIATIONS

ADAFs:	Age-dependent adjustment factors
ADD:	Average daily dose
ALM:	Adult Lead Model
AEC:	Area of Environmental Concern
AOC:	Area of Concern
AST:	Aboveground Storage Tank
ATSDR:	Agency for Toxic Substances and Disease Registry
BER:	Baseline Environmental Risk
bgs:	Below Ground Surface
BHHRA:	Baseline Human Health Risk Assessment
BLL:	Blood lead level
BN:	Base Neutral
CCI:	Chemical Compounds, Inc.
CEA:	Classification Exception Area
CERCLA:	Comprehensive Environmental Response, Compensation, and Liability Act
COPC:	Chemical of Potential Concern
CT:	Central Tendency
DCE:	1,2-~~d~~Dichloroethene
DER:	Declaration of Environmental Restriction
DQO:	Data Quality Objectives
EDL:	Estimated detection limit
EFH:	Exposure Factors Handbook
EPC:	Exposure Point Concentration
ES:	Environmental Standards
ESNR:	Environmentally Sensitive Natural Resources
FC:	Fraction Contacted
FS:	Feasibility Study
GWQS:	Groundwater Quality Standards
HI:	Hazard Index
Honeywell:	Honeywell International, Inc.
HQ:	Hazard Quotient
IEUBK:	Integrated Exposure Uptake Biokinetic Model for Lead in Children
IGWSSL:	Impact to Groundwater Soil Screening Level
IRIS:	Integrated Risk Information System
ISRA:	Industrial Site Recovery Act
KM:	Kaplan-Meier
LADD:	Lifetime Average Daily Dose

LNAPL:	Light Non-Aqueous Phase Liquid
LSRP:	Licensed Site Remediation Professional
MCL:	Maximum Contaminant Level
MEK:	Methyl ethyl ketone
mg/kg:	Milligrams per kilogram
mg/L:	Milligrams per liter
MRL:	Minimal Risk Level
MTBE:	Methyl tert-butyl ether
NAAQS:	National Ambient Air Quality Standard
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NFA:	No Further Action
NHANES:	National Health and Nutrition Examination Survey
NJDEP:	New Jersey Department of Environmental Protection
NJDOH:	New Jersey Department of Health
NOAA:	National Oceanic and Atmospheric Administration
OLEM:	Office of Land and Emergency Management
OSWER:	Office of Solid Waste and Emergency Response
PAR:	Pathway Analysis Report
PbB:	Blood Lead Concentration
PCB:	Polychlorinated Biphenyl
PCE:	Tetrachloroethylene
PHC:	Petroleum hydrocarbons
PID:	Photoionization Detector
PM:	Particulate Matter
PP:	Priority pollutant
PPG:	PPG Industries, Inc.
ppm:	Parts per million
PPRTV:	Provisional Peer Reviewed Toxicity Values
QAPP:	Quality Assurance Project Plan
RAGS:	Risk Assessment Guidance for Superfund
RAGS D:	Risk Assessment Guidance for Superfund, Part D
RAP:	Remedial Action Permit
RAR:	Remedial Action Report
RAWP:	Remedial Action Work Plan
RBA:	Relative Bioavailability Factor
RfD:	Reference Dose
RfC:	Reference Concentration
RI:	Remedial Investigation
RI/FS:	Remedial Investigation and Feasibility Study

RIR:	Remedial Investigation Report
RME:	Reasonable Maximum Exposure
RP:	Responsible Party
RSL:	Regional Screening Level
SCSR:	Site Characterization Summary Report
SF:	Slope Factor
Site:	Riverside Industrial Park Superfund Site
SOW:	Statement of Work
SQL:	Sample Quantitation Limit
STSC:	Superfund Technical Support Center
SVOC:	Semi-Volatile Organic Chemical
TCA:	1,1-Ttrichloroethane
TCDD:	Ttetrachlorodibenzo-*p*-dioxin
TCE:	Trichloroethene
TCLP:	Toxicity Characteristics Leaching Procedure
TCR:	Target Cancer Risk
TEF:	Dioxin Toxicity Equivalency Factor
TEQ:	Dioxin Toxicity Equivalence
THQ:	Target Hazard Quotient
TPH:	Total petroleum hydrocarbon
UCL:	Upper Confidence Limit on the Mean
URF:	Unit Risk Factor
USEPA:	United States Environmental Protection Agency
USCS:	Unified Soil Classification System
UST:	Underground Storage Tank
VISL:	Vapor Intrusion Screening Level
VOC:	Volatile Organic Chemical
WHO:	World Health Organization

EXECUTIVE SUMMARY

~~This~~This document presents the Draft (Version 2) [EPA1]Baseline Human Health Risk Assessment (BHHRA) for the Riverside Industrial Park Superfund Site (Site). The BHHRA is a component of the Remedial Investigation/Feasibility Study (RI/FS) for the ~~Site~~Site, which is in Newark, New Jersey. The BHHRA quantitatively evaluates cancer risks and non-cancer health hazards from exposure to chemicals of potential concern (COPCs) at the Site at each of the 15 individual properties (lots) that comprise the Site. Currently, seven of the properties are occupied and eight of the properties are vacant. ~~Five properties currently owned by the City of Newark as well as two other properties (Lots 57 and 70) are likely to be redeveloped in the near future.~~ The BHHRA evaluates exposure under current industrial land use, future industrial/commercial land use and hypothetical future residential land use. The cancer risks and non-cancer hazards for young children (~~<~~ 6 years and younger), adolescents (10 to 18 years), and adults (older than ~~>~~ 18 years ~~old~~) from exposure to contaminated media (e.g., soil, groundwater, and air) under these land uses are evaluated under baseline conditions, which means in the absence of any remedial actions or institutional controls (ICs). The BHHRA uses current United States Environmental Protection Agency (USEPA) risk assessment policy, guidance, and guidelines.

USEPA uses risk assessment to evaluate the likelihood and degree of chemical exposure and the possible adverse health effects associated with such exposure. This information is used to inform risk management decisions at the Site. The basic steps of the Superfund human health risk assessment process are the following: 1) data collection and analysis (i.e., data evaluation), which evaluates the nature and extent of chemical contamination in environmental media; 2) exposure assessment, which is an estimate of the reasonable maximum exposure (RME) under both current and future land-use conditions, and an estimation of human chemical intake through exposure routes such as ingestion, inhalation, or skin contact; 3) toxicity assessment, which is an evaluation of chemical toxicity including cancer risk and non-cancer health effects from exposure to chemicals; and 4) risk characterization, which describes the risks and hazards from the chemical exposures at the Site, the possible adverse health effects associated with such exposure, and the associated uncertainty.

The results of the BHHRA will be considered in the risk management decisions and in the establishment of acceptable exposure levels for use in developing remedial alternatives to address this contamination in the Feasibility (FS) phase of the Remedial Investigation/Feasibility (RI/FS) process.

Site Background and Setting

The site location, history, geology, hydrogeology, land use and groundwater use are summarized in Section 2. The Site is 7.6 acres and is located on the west bank of the Passaic River in Newark, Essex County, New Jersey (Figure 2-1). Riverside Avenue and McCarter Highway border the Site to the west along with a segment of railroad track adjacent to McCarter Highway. The Site was once part of the Passaic River (tidal zone) that was filled with fill material in the late 1800s and early 1900s. The source(s) of the fill is not known, and fill emplacement occurred over at least a 20-year period. The fill material consists predominantly of sands, silts, and gravel along with and man-made materials such as brick, pieces of concrete block, wood, glass, and cinders. Based upon historical maps, previous investigations, and data obtained during the RI, fill material is present in surface soils throughout the Site and in subsurface soils where historical filling was conducted to reclaim land from the Passaic River. This material is considered contaminated “historic fill” as it complies with the New Jersey Department of Environmental Protection (NJDEP) definition of historic fill; however, historic fill in some areas appears to have been impacted due to historical and/or current operations and chemical/waste handling at the Site. From approximately 1902 to 1971, the Site housed paint, varnish, linseed oil, resin, and other coatings manufacturing facilities operated by the Patton Paint Company (which merged into the Paint and Varnish Division of Pittsburgh Plate Glass Company in 1920 and has been known as PPG Industries since 1968) from approximately 1902 until 1971. Since then, the Site has been used for a wide variety of industrial purposes by numerous companies, and is currently subdivided into 15 lots, as shown on Figure 2-2. Basic raw materials used by past and current tenants/owners at the Site included natural gums and resins, flax seed, linseed oil, acetone, solvents, pigments, paint thinners, and specific chemicals identified as having been stored in aboveground storage tanks (ASTs) and underground storage tanks (USTs) at the Site, including non-chlorinated solvents, such as toluene, xylene, ethylbenzene, and methyl ethyl ketone (MEK). Table 2-1 summarizes current information for each of the 15 lots (e.g., size, owner, use, existing deed restrictions). Additional details can be found in the Remedial Investigation Report (RIR). Seven of the 15 lots are occupied and eight are unoccupied. Approximately 70% of the Site is paved or covered by buildings, and the Site is partially fenced. The site is currently zoned for industrial use.

Identified groundwater units at the Site include a surface shallow fill unit and a deep unit. Groundwater in both the shallow and deep units primarily flows to the east towards the Passaic River. There is a local flow pattern in the shallow unit in the northwest portion of the site, where groundwater flows off-site and is limited by the extent of the fill. The groundwater in both the shallow and deep units are classified as Class IIA by the State of New Jersey which assumes all water may potentially be used as a drinking supply unless restrictions are enforced by NJDEP. It is noted that potable use of shallow groundwater at the Site is unlikely since the Site and surrounding area are served by the City of Newark's potable water system, and the site-specific conductivity readings of the shallow groundwater indicate possible brackish conditions. The information on potential risks/hazards for hypothetical ~~the~~ future potable use of the groundwater will inform decisions regarding the need for ICs.~~,~~

Data Analysis and Collection

Samples of environmental media, including soil, groundwater, and indoor air, were collected during the RI to characterize the nature and extent of contamination at the Site. The data evaluation presented ~~described~~ in Section 3 identifies RI data that are relevant and meet data quality objectives ~~of acceptable quality~~ to support quantitative risk assessment. The complete analytical data summary is provided in the RIR. RIR Tables 2-7A through 2-9 and Figures 4-1 through 4-22 summarize soil data results. RIR Tables 2-15A through 2-15D and Figures 4-23 through 4-50 summarize groundwater results. RIR Table 2-22 summarizes indoor air results.

COPCs are identified based on comparing the soil, groundwater, and indoor air data collected during the RI against risk-based screening levels, which assume exposure under a residential land use scenario. The COPCs selected for quantitative risk assessment are summarized in Table 3-5.

Exposure Assessment

The exposure assessment presented in Section 4~~BHHRA~~ characterizes the exposure setting and human receptors at and around the Site ~~in Section~~ 4. Exposure pathways are identified based on consideration of the sources and locations of contaminants found at the Site, the likely environmental fate of the contaminants, and the location and activities of the potentially exposed receptors in the absence of remedial actions or ICs~~institutional controls~~. For each potential exposure pathway, the BHHRA identifies the receptor ~~population~~, exposure point, ~~its exposure points,~~ and route of exposure~~s~~. It also determines the exposure point concentrations (EPCs) for the COPCs for each property in each medium (i.e., soil, groundwater, indoor air), and estimates the transfer of COPCs between environmental media, as well as the exposure assumptions regarding receptor characteristics (e.g., body weight) and behavior (e.g., ~~body weight,~~ soil ingestion rate, exposure frequency, and exposure duration).

The exposure assessment is an estimate of the exposure to the RME individual. In accordance with USEPA risk assessment guidance, actions at Superfund sites are based on an estimate of the RME expected to occur under both current and future conditions at the site. The RME is defined as the highest exposure that is reasonably expected to occur at a site. USEPA guidance also recommends that exposures based on central tendency (CT), or average, exposures at a site be estimated, depending on the results of the RME evaluations. The RME and CT exposures are used to estimate cancer risks and non-cancer health hazards, however, risk management decisions are based on the RME individual.

A separate analysis was conducted to evaluate exposures to lead by various individuals (i.e., receptors) under the current and future land use. The lead evaluation included comparing the EPCs (~~i.e~~i.e., average concentrations) against the screening levels of 200 mg/kg (milligram/kilogram~~ppm~~) for hypothetical future residents and 800 mg/kg~~ppm~~ for nonresidential receptors (e.g., industrial workers). In addition, USEPA's ~~uses the~~ Integrated Exposure Uptake Biokinetic (IEUBK) Model for Lead in Children and ~~the~~ Adult Lead Methodology (ALM) are used to estimate the concentration of lead in the blood of children and adults, respectively, who might be exposed to lead-contaminated soils. The ~~IEUBK model and the ALM~~ estimated blood lead concentrations are used ~~needed~~ to evaluate the potential need for remedial action. ~~Lead exposure was also evaluated using the lead Integrated Exposure Uptake and Biokinetic Model and the Adult Lead Model~~

Current Land ~~Use.~~

~~Under~~Use Under current land use, the potentially exposed individuals ~~populations~~ at and around the Site are assumed to include:

- Outdoor Workers (only at occupied lots);
- Indoor Workers (only at occupied lots);
- Utility Workers;
- Construction Workers;
- Trespassers (adolescents and adults);
- Visitors (children and adults; only at occupied lots); and
- Off-Site Workers and Residents (children and adults; via wind transport).

Because the Site is located within a designated "dedicated industrial zone" for industrial and commercial uses, the most likely future use for all 15 lots is industrial. Potential future exposures are evaluated for every receptor at each of the 15 properties at the Site (i.e., each property is assessed assuming future ~~redevelopment under both~~ industrial land use and residential land use). The results of the future land use evaluation will be used to inform decisions regarding the need for ICs.

Future Land Use

Under future land use, the potentially exposed individuals ~~populations~~ at and around the Site are assumed to include:

- Outdoor Workers;

- Indoor Workers;
- Utility Workers;
- Construction Workers;
- Trespassers (adolescents and adults);
- Visitors (children and adults);
- Off-Site Workers (via wind transport of on-site soil and migration of shallow and deep groundwater);
- Off-Site Residents (children and adults; via wind transport of on-site soil and migration of deep groundwater).

TAs required by USEPA Region 2, tTheThe BHHRA also includes a hypothetical future hypothetical residential scenario which assumes the Site will have medium-density residential units like those located west of McCarter Highway, as well as hypothetical future potable use scenarios for shallow and deep groundwater to further assess risks from exposure to groundwater at the Site (non-potable exposures such as vapor intrusion or incidental ingestion are also assessed for pertinent receptors). As noted above, the results of the future land use evaluation will be used to inform decisions regarding the need for ICs.

Toxicity Assessment

The toxicity assessment presented in Section 5 is an evaluation of adverse health effects from exposure to the chemicals of potential concern (COPCs) (USEPA, 1989b). Consistent with Superfund guidance, two types of adverse health effects were evaluated: 1) the incremental risk of developing cancer due to exposure to chemicals and 2) the hazards associated with non-cancer health effects, such as reproductive impairment, developmental disorders, disruption of specific organ functions, and learning problems. The cancer risk is expressed as a probability and is based on the cancer potency of the chemical, known as a cancer slope factor (SF) for oral exposure and a unit risk factor (URF) for inhalation exposure. The non-cancer health hazard is expressed as the ratio of the chemical intake (dose) to a reference dose (RfD) for oral exposure or reference concentration (RfC) for inhalation exposures. The chronic (7 years or more) RfD or RfC represents an estimate (with uncertainty spanning perhaps an order of magnitude or greater) of a daily exposure level for human populations, including sensitive populations (e.g., children), that is likely to be without an appreciable risk of deleterious effects during a lifetime. Chemical exposures exceeding the RfD or RfC do not predict specific diseases.

The toxicity values were compiled from the hierarchy of sources recommended by the USEPA (OSWER Directive 9285.7-53, 2003), as follows:

- Integrated Risk Information System (IRIS);
- Provisional Peer -Reviewed Toxicity Values (PPRTV); and
- Other Toxicity Values based on review by the Superfund Technical Support Center (STSC).

When a toxicity value is not available from the first two tiers of the hierarchy, other USEPA and non-USEPA sources (e.g., Agency for Toxic Substances and Disease Registry (ATSDR) of toxicity values are used) after evaluation by USEPA STSC.

For arsenic, the USEPA's PEA's IRIS cancer and noncancer oral toxicity values are based on exposure to arsenic in water. To account for the lower bioavailability of arsenic in soil relative to water, USEPA recommends using a default relative bioavailability factor (RBA) of 0.6 in evaluating exposure from ingestion of arsenic in soil. According to USEPA, less than 5% of measured RBAs are expected to exceed the default RBA of 0.6. The RBA of 0.6 was used in the assessment of exposures to arsenic in soil consistent with USEPA guidanceOSWER Directive 9200.1-113 (USEPA, 2012a, 2012b).

For COPCs without toxicity values, toxicity values from chemicals with structural similarity may be used are used as surrogates, based on recommendations from the USEPA STSC. and asthis information is further discussed in Section 5.1.

The BHHRA evaluated non-cancer hazards based on oral RfDs and inhalation RfCs that represent health protective estimates of the daily exposure to the human population, including sensitive subpopulations (e.g., children), which are likely to be without an appreciable risk of deleterious effects. These RfDs and RfCs typically incorporate several uncertainty factors to account for uncertainties in their derivation, which in combination result in overall uncertainty factors ranging from 1 to 3,000 for individual the COPCs. (USEPA, 2002a)

The BHHRA also included an evaluation of potential cancer risks based on oral cancer SFs and inhalation unit risk factors (URFs). USEPA (2005b) indicates that early-life exposure to carcinogenic chemicals with a mutagenic mode of action (MMOA) can result in a greater contribution to cancers appearing later in life. To account for this, age-dependent adjustment factors (ADAFs) are used to adjust toxicity values for carcinogenic COPC with a MMOA to assess potential exposures of trespassers, visitors, and future residents (USEPA 2005a, 2005b). Cancer risk for exposures from 0 to less than 2 years of age, and from 2 to less than 16 years of age, and individuals 16 years and older, are multiplied by the USEPA-recommended ADAFs of 10, 3 and 1 and 3, respectively, or consistent with the chemical-specific recommendations in the IRIS chemical assessment.

Risk Characterization

Estimated RME cancer risks and non-cancer hazards relating to COPC exposure under current land use (industrial), and future land use, including an assessment of residential land use to support evaluation of ICs, (industrial) and hypothetical residential land use are presented in Section 6 and listed below. For known or suspected carcinogens, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) established that acceptable exposure levels are generally concentration levels that represent an incremental upper-bound lifetime cancer risk in the range from 10^{-4} to 10^{-6} (one in ten thousand to one in a million) or less. Therefore, the cumulative cancer risk estimates for each receptor population are identified as below, above or within the NCP's cancer risk range of 10^{-4} to 10^{-6}. For systemic toxicants, the NCP established that acceptable exposure levels shall represent concentration levels to which the human population, including sensitive subgroups, may be exposed without adverse effect during a lifetime or part of a lifetime, incorporating an adequate margin of safety. Therefore, noncancer hazards, in the form of hazard quotient (HQ) for individual chemicals or a hazard index (HI) representing the sum of the HQs for all chemicals or chemicals with the same toxic endpoint, are compared to a protection goal of a Hazard Quotient for individual chemicals or Hazard Index representing the sum of Hazard Quotients for all chemicals or chemicals with the same toxic endpoint (HQ or HI) = 1.

Section 6.2 summarizes the results of the assessments for cancer risks, non-cancer hazards, and exposure to lead.

Current Land Use (Section 6.2.1) Current Receptors.

Under current land use, the potentially exposed populations at and around the Site are assumed to include outdoor workers (only at occupied Lots 1, 57, 59, 60, 62, 69, and 70), Section 6.2.1.1), indoor workers (only at occupied lots, Section 6.2.1.2)), utility workers (Section 6.2.1.3); construction workers (only at Lots 57, 58, 61, 63, 64, 68, and 70, Section 6.2.1.4), trespassers (Section 6.2.1.5), visitors (only at occupied lots, Section 6.2.1.6)), and off-site workers and residents (via wind transport, Section 6.2.1.7).

For exposures to COPCs in indoor air, soil and groundwater, the cumulative cancer risk estimates are below or within NCP's risk range (10^{-4} to 10^{-6}) and the noncancer hazard index (HIs) estimates are at or below the protection goal of 1, after accounting for toxicTarget endpointOrgan-sSpecific Hazard Isndex - identified in the Supplementary Guidance for Conducting Health Risk Assessment of Chemical Mixtures (USEPA, 2000b). COPCs with single-chemical cancer risks above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are benzene and chloroform in indoor air; arsenic, benzene, benzo(a)pyrene, dibenz(a,h)anthracene, naphthalene, polychlorinated biphenyls (PCBs), and 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD)tetrachlorodibenzo-p-dioxin in soil; and pentachlorophenol and dibenz(a,h)anthracene in groundwater. The details are provided in Chapter 6, Sections 6.2.1.1 through 6.2.1.7).

ANo verage ssSoil lead average concentrations EPCs are greater than the USEPA Region 2 nonresidential screening level of 800 mg/kgmg/kg at any lot, except for currently occupied Lot 70 and currently unoccupied Lot 63. The estimated portion of the fetal blood lead distribution exceeding the goal of no more than 5% of the population with blood lead levels (BLLs) greater than 5 micrograms/deciliter (ug/dL) level is identified is greater than 5% for outdoor workers at Lot 70 (average concentration 934 mg/kg and 7.7% of BLLs greater than 5 ug/dlL), trespassers at Lots 63 (average concentration of 2,5080 mg/kg and 38% with BLLs greater than 5 ug/dlL) and Lot 70 (average concentration of 934 mg/kg and 7.7% with BLLs greater than 5 ug/dlL), and construction workers at Lot 63 (with average concentration of 2,530 mg/kg and 81% with BLLs greater than 5 ug/dlL) and Lot 70 (average concentration 970 mg/kg and 28% with BLLs greater than 5 ug/dlL). Also for cConstruction workers, at the following lots had average soil lead concentration less than 800 mg/kg but the BLLs that exceeded the goal of no more than 5% of the population with BLLs greater than 5 ug/dlL: and 70, and construction workers at Lots 61 (average concentration of 500 mg/kg and 6.8% with BLLs greater than 5 ug/dlL), Lot 6463 (average concentration 688 mg/kg with 14% with BLLs > 5 ug/dlL), 654 (average concentration 510 mg/kg and 7.2% with BLLs greater than 5 ug/dl), Lot 68 (average concentration 586 mg/kg and 9.9% with BLLs greater than 5 ug/dlL). , and 70. However, oOutdoor workers and trespassers are not not actually expected to contact soil at Lot 70 since, -currently, because Lot 70 is paved and partly capped (Figure 6-1). The estimated portion of the child blood lead distribution exceeding the goal of no more than 5% of the population with BLLs greater than 5 ug/dL is identified for child visitors at Lot 1 (average concentration 580 mg/kg and 5.2% with BBLs > 6 ug/dL), Lot 62 (average concentration 567 mg/kg with 5.1% with BBLs > 5 ug/dl), and Lot 70 (average concentration 934 mg/kg with 8.5% with BBLs > 5%).

Since no cumulative cancer risk estimates are above the upper-end of the NCP risk range (10^{-4}) and no HI estimates are above the protection goal of 1 after accounting for toxicarget endpoint-specific HIs as outlined in USEPA (2000b)toxic endpoint specific, the only chemical of concern (COPC) that warrants evaluation in the Feasibility Study (FS) for current land use exposure is lead in soil..

Future Commercial/Industrial Land Use (Section 6.2.2)

Under future commercial/industrial land use, the potentially exposures -exposed populations at and around the Site are conservatively assumed to be the same as for current land use except that each of the 15 properties are evaluated for all receptors (i.e. receptors may be present at all lots in the future). The potentially exposed individuals ~~populations~~ at and around the Site are ~~conservatively~~ assumed to include outdoor workers (Section 6.2.2.1), indoor workers (Section 6.2.2.2), utility workers (Section 6.2.2.3), construction workers (Section 6.2.2.4), trespassers (Section 6.2.2.5), visitors (Section 6.2.2.6), off-site workers (via wind transport and future shallow groundwater migration) (Section 6.2.2.7), and off-site residents (via wind transport) (Section 6.2.2.8).

For exposures to COPCs in soil and groundwater, the cumulative cancer risk estimates are below or within NCP's risk range (10^{-4} to 10^{-6}). COPCs with single-chemical cancer risks above the ~~above the~~ lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are arsenic, benzene, tetrachloroethene, trichloroethene, xylenes, polycyclic aromatic hydrocarbons (PAHs), PCBs, and 2,3,7,8-TCDD ~~tetrachlorodibenzo-p-dioxin~~ in soil; and pentachlorophenol and dibenz(a,h)anthracene in groundwater. The noncancer HI estimates are at or below the protection goal of 1, after accounting for ~~the~~ toxic~~arget~~ endpoint-specific HIs~~toxic-endpoint HI~~, except for:

- indoor worker exposure to soil via vapor intrusion at Lot~~s~~ 58 (HI = 4 due to~~based on~~ trichloroethylene at location B-16 and xylenes at location B-13), Lot 62 (HI = 3 due to~~associated with~~ naphthalene at location B-93), Lot 64 (HI = 2~~,~~ due to benzene at location B-74 and xylenes at location B-34) and Lot 68, (HI = 5 due to~~from~~ trichloroethylene at location B-56), and
- child visitor outdoor exposure to soil at Lot 63 (HI = 3 primarily due ~~associated with exposure~~ to copper) and Lot 70 (HI = 2 with the toxic~~arget~~ endpoint-specific HI~~s analysis~~ indicating no exceedance of the p~~P~~rotection g~~G~~oal of 1).

COPCs with single-chemical soil vapor intrusion ~~hazard quotient (~~HQs~~) estimates~~ above the protection goal of 1 are t~~t~~richloroethene (Lot 58, location B-16 and Lot 68, location B-56),~~ and~~ xylenes (Lot 58, ~~at~~ location B-13), ~~and Lot 68 trichloroethylene at location B-56), xylenes (Lot 58 xylene at location B-13),~~ and naphthalene (Lot 62, location B-93). ~~, and the~~ COPCs with single-chemical child visitor outdoor soil HQ~~ estimates~~ above the protection goal of 1 is copper at Lot 63. Detailed discussion of these results ~~are~~is provided in Section 6.2.2.

Soil lead EPCs are greater than the USEPA Region 2 nonresidential screening level of 800 mg/kg~~mg/kg~~ at Lots 63 and 70. The estimated portion of the fetal blood lead distribution exceeding the goal of 5 ug/dL level is greater than 5% for outdoor workers, indoor workers, utility workers, and trespassers exposed to soil from the corresponding 0 to 2 ft. interval, 0 to 4 ft. interval, and all sampled depths at Lots 63 and 70, ~~indoor workers at Lot 63,~~ and construction workers at Lots 61, 62, 63, 64, 65, 68, and 70. For visitors, the estimated portion of the child visitor's blood lead distribution that exceeds the USEPA ~~Region 2's~~ lead goal of no more than 5% of the population with BLLs greater than 5 ug/dL ~~for the 0 to 2 ft. depth interval~~ is greater~~less~~ than 5% for soil from the 0 to 2 ft. interval at Lots 1, 62, 63, 64, 65, and 70 and greater than 5% for soil from all sampled depths at Lots 63, 64, 68, and 70~~for each property~~. A hot spot analysis identified one location from Lot 64 (B-75 from 1 to 3 ft. below ground surface (bgs), which is adjacent to Lot 63) that could affect the conclusions of the risk assessment for future outdoor worker exposures to lead. Although prolonged exposure to this location in isolation is not anticipated, it will be retained for further evaluation in the FS.

Since no cumulative cancer risk estimates are above the ~~upper-end~~upper end of NCP risk range (10^{-4}), no COPCs warrant evaluation in the FS for future cancer risk. For future noncancer hazards, the COPCs that warrant evaluation in the FS are trichloroethene at Lots 58 and 68, xylenes at Lot 58 and naphthalene at Lot 62 for future noncancer vapor intrusion exposure and copper at Lot 63 for future child outdoor visitor exposure. The exposure assumptions for young child, up to six years of age, ~~,~~visiting the ~~under the age of 6 years old~~ industrial properties ~~assumes~~assume a frequency of 52 days per year that may under- or overestimate exposures depending on the activities of the child. Lead is also a COPC [EPA2]that warrants evaluation in the FS for future exposures.

These conclusions remain the same for the scenario in which soil below the 0 to 2 ft. depth interval (or 0 to 4 ft. depth interval for utility worker) is brought to the surface in the future, in the course of site redevelopment, eexcept for the lead hot spot analysis. A hot spot analysis identified three locations from Lot 64 (B-75 at 1 to 3 ft. bgs of 8,690 mg/kg, B-74 at 3 to 4 ft. bgs of 3,080 mg/kg and B-70 at 5 to 7 ft. bgs of 3,020 mg/kg, which are adjacent to Lot 63) that could affect the conclusions of the risk assessment for future outdoor worker exposure to lead if soil from the subsurface is brought to the surface, during site redevelopment. Although prolonged exposure to these locations in isolation is not anticipated, they will be retained for further evaluation in the FS.

Hypothetical Future Residential Land Use and Potable Groundwater Use (Section 6.2.2.9)

As required by USEPA, the BHHRA includes a future hypothetical residential scenario which assumes the Site will have medium-density residential units like those west of McCarter Highwaythat west of McCarter Highway. Additionally, future hypothetical potable shallow and deep groundwater use is evaluated for on- and off-site workers, visitors and residents to facilitate development of appropriate ICsinstitutional controls for the Site. The future hypothetical residential land use and potable use scenarios are included to facilitate development of appropriate ICsinstitutional controls for the Site.

Section 6.2.2.9 provides the results of the analysis for future residents. For outdoor exposures to soil for the 0 to 2 ft. interval, the cumulative cancer risk estimates to the future resident are within or at the upper end of NCP's range except for Lot 67, which is above the NCP's risk range (10^{-4} to 10^{-6}) with a risk of 2 x 10^{-4} for the future adult/child resident. For adult residents, the HI estimates are at or below the protection goal goal of 1 except for Lot 63 where the total HI = 2. For the future child residents, the HI estimates are above the goal of protection goal of 1 ranging from an HI = 2 to 20 across all Lots except for except for Lot 59 where the HI = 1.

For the scenario in which soil below the 0 to 2 ft. depth interval is brought to the surface in the course of future. development of the Site, site redevelopment, the cumulative cancer risk estimates are within or at the upper end of NCP's range (10^{-4} to 10^{-6}) for the adult/child resident on all lots. .For adult residents, the HI estimates are at or below the protection goal of 1 except for Lot 70 where the total HI = 1. For child residents, the HI estimates are above the protection goal of 1 except for Lots 1 and 59 with the HI for the other lots ranging from 2 to 20. COPCs with single-chemical cancer risks above the above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), or HQ above the protection goal of 1 are arsenic, benzene, trichloroethene, PAHs, PCBs, and 2,3,7,8-TCDDtetrachlorodibenzo-p-dioxin.

For the 0 to 2 ft. interval, the soil lead average concentrations EPCs are above the USEPA Region 2 residential screening level of 200 mg/kg at each property except Lot 60 and Lot 66. For the scenario in which subsurface soil is moved to the surface in the futureduring site redevelopment, the lead soil lead average concentration EPCs exceeds the USEPA Region 2 residential screening level of 200 mg/kg mg/kg at each property except Lots 59 and Lot 60. The estimated portion of the fetal blood lead distribution exceeding the 5 ug/dL level is greater than 5% for soil from the 0 to 2 ft. interval at all properties except Lots 60 and 66 and greater than 5% for soil from all sampled depths at all properties except Lots 59 and 60 under both scenarios.

For soil vapor intrusion exposures, residents' cumulative cancer risk estimates are above NCP's risk range (10^{-4} to 10^{-6}) for Lots 1, 57, 62, 64, 67, 68, and 70. Both adult and child resident HI estimates are above the protection goal goal of 1 for every property except for Lots 59 and 69. For shallow groundwater vapor intrusion exposures, cumulative cancer risk estimates are within NCP's risk range

(10^{-4} to 10^{-6}) and HI estimates are below the goal of ~~prote~~protection of ~~goal of~~ 1 except for Lots 58 and 59. COPCs with single-chemical risks that are above the lower end of NCP's risk range (10^{-6}) and single-chemical HQs that are above the protection goal ~~goal~~ of 1. Chemicals with cancer risks within the risk range are benzene, 1,2-dibromo-3-chloropropane, naphthalene The non-cancer HI exceeded the protection goal of 1 at Lots 58 and 59 based on xylenes using the maximum concentration as the EPC ~~for benzene, chloroform, cyanide, 1,2-dibromo-3-chloropropane, tetrachloroethene, trichloroethene, naphthalene, mercury, vinyl, chloride, xylenes, and 2,3,7,8-tetrachlorodibenzo-p-dioxin~~.

Risk and HI estimates from potable use of shallow and deep groundwater, if it were to occur in the future, are above NCP's risk range (10^{-4} to 10^{-6}) and protection goal of 1 for all properties. COPCs with the highest single chemical cancer risks (i.e., above the upper end of NCP's range of 10^{-4}) are 1,3-dichloropropene (total), 1,2-dibromo-3-chloropropane, benzene, vinyl chloride, pentachlorophenol, benzo(a)pyrene, dibenz(a,h)anthracene, naphthalene, and arsenic. The COPCs with the highest single chemical HQs (i.e., above 10) are trichloroethene, 1,2,4-trichlorobenzene, 2-hexanone, xylene, naphthalene, cyanide, and iron. For shallow groundwater future exposure to lead, the maximum lead concentration is below the federal action limit of 0.015 mg/L at each property except Lots 57, 60, 63, 64, 67, and 69. It is noted that potable use of shallow groundwater at the Site is unlikely since the Site and surrounding area are served by the City of Newark's potable water system, and the site-specific conductivity readings of the shallow groundwater indicate possible brackish conditions.

Since the hypothetical residential scenario and the hypothetical potable groundwater use scenarios are included in the BHHRA to facilitate development of appropriate ICs ~~institutional controls~~ for the Site, the identification of potential COPCs will be further evaluated in the ~~that warrant further evaluation in the~~ FS.~~for these hypothetical scenarios is not necessary~~.

Uncertainty Analysis

Various uncertainty analyses were conducted to determine if the RME cancer risks and non-cancer hazards could potentially be underestimated or overestimated based on inputs and assumptions used in the risk assessment and are presented in Section 6.3.

Data Evaluation

Total chromium was ~~conservatively~~ assessed using a screening level for trivalent chromium. Hexavalent chromium, which was also analyzed in every sample using a different analytical method, was assessed separately. Total mercury was ~~conservatively~~ assessed using a screening level for elemental mercury, which may overestimate hazards to the RME individual.

Only detected chemicals were used to determine COPCs, which potentially underestimates risks and hazards if chemicals are present at concentrations below the sample quantitation limits (SQLs). For chemicals that were not detected in a matrix (soil, groundwater, and indoor air), the SQLs were compared to the screening levels to determine if additional COPCs would be identified assuming chemicals would be present at concentrations below the SQLs. While some SQLs for chemicals not detected in a matrix exceeded screening levels (mostly SVOCs in groundwater), the expected magnitude of this bias is anticipated to be low.

Exposure Point Concentrations (EPCs)

EPCs were calculated based on available data that resulted in the calculation of a 95% upper confidence limit (UCL) on the arithmetic mean or the maximum concentrations. Further analysis was conducted to evaluate if the dataset included a hot spot. If a hot spot (areas of very high contaminant concentrations relative to other areas of a site) is located near an area which, because of the site or population characteristics, is visited more frequently, exposure to the hot spot is should beassessed separately from the calculation of the EPCs consistent with USEPA's ProUCL guidance. For this BHHRA, the potential for hot spots at each of the 15 properties was evaluated. The results of the hot spot analysis did not affect the conclusions of the risk assessment except for lead at Lot 64, a(Sample B-75 from 1 to 3 ft. bgs, which is adjacent to Lot 63) that could affect the conclusions of the risk assessment for future outdoor worker exposure tos discussed in the results summary above lead. Non-detected and rejected results for COPCs were also reviewed and determined unlikely to impact the conclusions of the risk assessment. Conservative assumptions related to off-site air modeling likely overestimate exposure to the RME individual.

Exposure Factors

Health protective assumptions related to utility worker and construction worker soil ingestion rates, trespassers' exposure frequency, and the visitor receptor including a young child (younger than < 6 years) child and the child visitors' exposure frequency may over or underestimate RME exposures.

Cumulative cancer risk and HI estimates for soil and groundwater are summed to account for potential concurrent exposures to both media (e.g., utility or construction worker exposure to both soil and groundwater during excavations). The exposures to both soil and groundwater are calculated at the magnitudes, frequencies, and durations assumed for each medium and the risks and HI are then summed to determine the combined cumulative cancer risk and combined HI. This summation may overestimates the RME (e.g., a utility worker's skin cannot be completely covered with soil and groundwater at the same time or future residents cannot be inside and outside at the same time). The evaluation of combined cumulative cancer risk and combined HI did not affect the conclusions of the HHRA.

Lead

Uncertainties related to lead screening levels for both the nonresidential screening level of 800 mg/kg and the residential screening level of 200 mg/kg may overestimate lead hazardsrisk. The value of 800 mg/kg was developed to reflect no more than 5% of the workers with BLLs greater than 5 ug/dl dL including outdoor workers, utility workers and construction workers. Section 6.3.4. provides a summary of the uncertainties in the application of the ALM model to worker exposure including a discussion of -potential overestimates of the lead exposures. Uncertainties associated with the lead assessment for child visitors also may overestimate lead exposures.[EPA3]

Toxicity Values

Use of dermal toxicity values extrapolated from oral toxicity values may overestimate or underestimate cancer risk and HI estimates. Some COPCs lack toxicity values, which may underestimate cancer risk and HI estimates. Uncertainties related to the ratio of hexavalent and trivalent chromium that chromate workers were exposed in the study used to derive the inhalation URF were evaluated and determined to only marginally change the conclusions of the risk assessment since inhalation exposure to hexavalent chromium only occurs from soil particulate inhalation (i.e., chromium is not volatile). Uncertainties related to using the USEPA's IRIS weight of evidence classification for ethyl benzene, which classifies ethyl benzene as a noncarcinogen, were evaluated using California EPA cancer toxicity values adopted under Prop 65. Using CalEPA's cancer toxicity values for ethyl benzene was determined to only marginally change the conclusions of the risk assessment.

The single-chemical residential soil vapor intrusion HQ for mercury and cyanide are above the noncancer protection goal of 1 for several properties. The use of a noncancer inhalation toxicity value (RfC) for mercury and cyanide assumes that these metals are present in the volatile forms (i.e., elemental mercury and hydrogen cyanide). The type of mercury and cyanide present in the fill or used at the site is unknown and the analytical methods measures total concentrations, which could consist of various forms of inorganic mercury and cyanide. The use of an RfC to assess total mercury and total cyanide is health protective ~~conservative~~ and may overestimate noncancer hazards from vapor inhalation depending on the form of mercury and cyanide ~~actually~~ present at the site.

1. INTRODUCTION

This draft[EPA4] Baseline Human Health Risk Assessment (BHHRA) Version 2 for the Riverside Industrial Park Superfund Site (Site) located in Newark, New Jersey was prepared on behalf of PPG Industries, Inc. (PPG) pursuant to the US Environmental Protection Agency (USEPA) Administrative Settlement Agreement and Order on Consent for Remedial Investigation and Feasibility Study (the Agreement, USEPA 2014c), CERCLA Docket No. 02-2014-2011. Soil, groundwater, and indoor air samples collected during the remedial investigation to characterize the nature and extent of contamination at the Site are evaluated in the BHHRA.

This BHHRA characterizes the exposure setting and receptors at and around the Site. Exposure pathways are identified based on consideration of the sources and locations of contaminants related to the Site, the likely environmental fate of the contaminants, and the location and activities of the potentially exposed populations in the absence of institutional controls or remedial action. For each potential exposure pathway, the BHHRA identifies the receptor population, its exposure points, and its exposure routes. The BHHRA presents the protocol for selecting the chemicals of potential concern (COPCs) for each medium, exposure point concentrations (EPCs) for the COPCs, exposure assumptions regarding receptor characteristics and behavior (e.g., body weight, soil ingestion rate, exposure frequency), and selecting toxicity values for COPCs.

The number of COPC are summarized by media are below.

- Soil COPCs
  - 8 VOCs
  - 11 SVOCs
  - PCBs
  - Cyanide
  - 17 Metals
  - 2,3,7,8-TCDD
- Shallow Groundwater COPCs
  - 23 VOCs
  - 14 SVOCs
  - PCBs
  - Cyanide
  - 15 Metals
- Deep Groundwater
  - 11 VOCs
  - 3 SVOCs
  - Cyanide
  - 8 Metals
  - 5 VOCs

The significance of potential exposures to concentrations of COPCs in soil and groundwater was evaluated based on conservative estimates of RME under current and potential future land use at the Site. The significance of potential exposures was determined by comparing estimates of cumulative cancer risks and noncancer HIs with USEPA's limits for RME risk (i.e., a cancer risk limit of 10^{-4} and a HI limit of 1, respectively).

Under current land use, the potentially exposed populations at and around the Site are conservatively assumed to include:

- Outdoor Workers (only at occupied lots);
- Indoor Workers (only at occupied lots);
- Utility Workers;
- Construction Workers;
- Trespassers;
- Visitors (only at occupied lots);
- Off-Site Workers and Residents (via wind transport).

Potential future exposures are evaluated for every receptor at each of the 15 properties at the Site (i.e., each property is assessed assuming future redevelopment under both industrial land use and residential land use). As required by USEPA, the BHHRA includes a hypothetical residential scenario which assumes the Site will have medium-density residential units like those west of McCarter Highway, as well as a hypothetical potable and nonpotable use scenario for shallow and deep groundwater use to facilitate development of appropriate institutional controls for the Site.

Under current land use, the cumulative cancer risk and HI estimates for exposures to indoor air, soil and groundwater do not exceed USEPA's limits for RME risk. No lead EPCs exceed the USEPA Region 2 nonresidential screening level of 800 mg/kg at currently occupied lots.

Under future commercial/industrial land use at the Site, the cumulative cancer risk and HI estimates for exposures to soil and groundwater do not exceed USEPA's limits for RME risk, except for indoor worker exposure to soil via vapor intrusion for Lots 58, 62, and 68. The vapor intrusion HI estimates above USEPA's limit of 1 are primarily from TCE (Lot 58 and 68), xylenes (Lot 58 and Lot 68), and naphthalene (Lot 62). Lead EPCs exceed the USEPA Region 2 nonresidential screening level of 800 mg/kg at Lot 63 and Lot 70. The estimated portion of the fetal blood lead distribution exceeding the 5 ug/dl level is less than 5% at each property except Lot 63. As an additional comparison, the lead EPCs in Lot 63 are below the nonresidential screening level of 2,520 mg/kg calculated using a target blood lead level of 10 ug/dL (instead of 5 ug/dL). The scenario in which soil below the 0 to 2 foot depth interval (0 to 4 foot depth interval for utility worker) is brought to the surface in the course of site redevelopment was also evaluated and also do not exceed USEPA's limits for RME risk. Risks from potable and nonpotable use of shallow and deep groundwater, if to occur in the future, are unacceptable. However, such groundwater use at the Site is unlikely since the shallow groundwater is brackish and the Site and surrounding area are served by the City of Newark's potable water system.

Under hypothetical future residential land use at the Site, the cumulative cancer risk and HI estimates for outdoor exposures to soil for the 0 to 2 foot interval exceed USEPA's limits for RME risk, except at Lot 59. The cumulative cancer risk and HI estimates for outdoor exposures to soil for the scenario in which soil below the 0 to 2 foot depth interval is brought to the surface in the course of site redevelopment exceed USEPA's limits for RME risk, except at Lot 1 and Lot 59. These estimates of unacceptable risk are due to a number of VOCs, SVOCs, PCBs, metals and dioxins (only at Lot 70).

For the 0- to 2-foot interval, the lead EPCs exceed the USEPA Region 2 residential screening level of 200 mg/kg at each property except Lot 60 and Lot 66. For the scenario in which subsurface soil is moved to the surface during site redevelopment, the lead EPCs exceed the USEPA Region 2 residential screening level of 200 mg/kg at each property except Lot 59 and Lot 60. The estimated portion of the blood lead distribution above USEPA Region 2 goal of 5 ug/dL for child resident at each property exceed 5% for the 0 to 2 foot depth interval and for the scenario that subsurface soil is moved to the surface during site redevelopment.

The residents' cumulative cancer risk and HI estimates for soil vapor intrusion exceed USEPA's limits for RME risks except for Lot 59 and Lot 69. The cumulative risk estimates above USEPA's limit for RME risk are primarily from benzene, TCE, PCE, xylenes, naphthalene, and mercury. The residents' cumulative risk estimates for shallow groundwater vapor intrusion are within USEPA's limits for RME risks except at Lot 58. For Lot 58, the HI of 2 is primarily from xylenes.

Risks from potable and nonpotable use of shallow and deep groundwater, if to occur in the future, are unacceptable. However, such groundwater use at the Site is unlikely since the shallow groundwater is brackish and the Site and surrounding area are served by the City of Newark's potable water system.

In summary, there are no unacceptable risks under current land use. The media and exposure routes that may need to be evaluated in the FS are:

- Soil lead exposure point concentrations (EPCs) at Lot 63 for future outdoor worker (0- to 2-foot and soil brought to the surface during site redevelopment).
- Soil EPCs at Lot 58, Lot 62 and Lot 68 for future indoor worker exposure via vapor intrusion.

The following is also discussed to facilitate development of appropriate institutional controls for the Site:

- Properties with shallow groundwater EPCs that exceed tap water RSLs.
- Sitewide deep groundwater which exceeds tap water RSLs.
- Properties with soil EPCs that, with residential risk estimated (outdoors or indoors), exceed USEPA's limit for Reasonable Maximum Exposure (RME) risk or lead EPC that exceeds the target blood lead level.

~~1. INTRODUCTION~~

~~This Baseline Human Health Risk Assessment (BHHRA) for the Riverside Industrial Park Superfund Site (Site) located in Newark, New Jersey was prepared on behalf of PPG Industries, Inc. (PPG) pursuant to the US Environmental Protection Agency (USEPA) Administrative Settlement Agreement and Order on Consent for Remedial Investigation and Feasibility Study (the Agreement, USEPA 2014c), CERCLA Docket No. 02-2014-2011.~~ Specifically, the BHHRA was prepared in accordance with Task 7 in the Agreement's Statement of Work (SOW~~), using data~~). Data collected during the Remedial Investigation (RI) described in the Remedial Investigation and Feasibility Study (RI/FS) Work Plan (Task 2 of the SOW) (Woodard & Curran, 2017) and in the Quality Assurance Project Plan (QAPP[1]) Addendum 4 (Woodard and Curran, 2019a~~).~~) was evaluated for use for risk assessment purposes. (see Sections 2.6 and 2.7 and Data Usability Worksheet). Findings of the ~~2019~~2020 Draft RI Report (RIR) Version 2 (Woodard & Curran ~~2019b~~2020) have also been used in preparing this report. This report addresses USEPA Region 2's comments on the October 2018 Pathway Analysis Report (PAR), April 2019 PAR, and July 2019 Draft BHHRA report in accordance with agreed-upon resolutions (see Section 1.1 and Appendix A). The Site information and USEPA Region 2 staff are listed on Risk Assessment Guidance for Superfund (RAGS) Part D Table 0, Appendix ~~B~~A.

As part of the BHHRA for the RI/FS, this BHHRA characterizes the exposure setting and receptors at and around the Site. Exposure pathways are identified based on consideration of the sources and locations of contaminants related to the Site, the likely environmental fate of the contaminants, and the location and activities of the potentially exposed receptors ~~populations in th~~in the absence of ICs ~~institutional controls or remedi~~or remedial action. For each potential exposure pathway, the BHHRA identifies the receptors~~ population~~, its exposure points, and its exposure routes. The BHHRA presents the protocol for selecting the chemicals of potential concern (COPCs) for each medium, calculating exposure point concentrations (EPCs) for the COPCs, exposure assumptions regarding receptor characteristics (e.g., body weight) and behavior (e.g., ~~body weight,~~ soil ingestion rate, exposure frequency, exposure duration), and selecting toxicity values for COPCs. In addition, it provides information on the Risk Characterization and the Uncertainty Analysis.

The BHHRA is structured using the most current USEPA risk assessment guidance, guidelines and policies ~~used by USEPA~~ (listed below). The exposure assumptions used in the assessment are ~~those recommended by USEPA~~ typically standard default exposure assumptions [2]developed for ~~estimating reasonable maximum exposure~~ use at Superfund Sites to evaluate cancer risks and noncancer hazards for the Reasonably Maximally Exposed (RME~~).~~) individual, since the decisions regarding the need for response actions are based on the RME individual. As defined in USEPA 1991, RME is defined as the highest exposure that is reasonably expected to occur at a site. RMEs are estimated for individual pathways. If a population is exposed via more than one pathway, the combination of exposures across pathways also must represent an RME.

Following the Risk Assessment Guidance for Superfund (RAGS), the BHHRA is organized as follows:

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[1] Unless noted otherwise, references to the QAPP includes the original QAPP plus the four addendums.

[2] Standard default exposure factors recommended by USEPA for estimating RME are used where available and appropriate (USEPA, 2014b). Where standard default exposure factors are not available or appropriate for an exposure scenario, similarly conservative exposure factors are developed based on site-specific considerations and professional judgment.

- Data evaluation including Identification of Chemicals of Potential Concern (COPCs);
- ToxicityExposure Assessment;
- ExposureToxicity Assessment; and
- Risk Characterization including Uncertainty Analysis.

1.1 Overview

Potential exposure pathways, exposure routes, and potentially exposed populations under current and future land-use scenarios are identified in this report. Also presented herein are exposure factors and daily intakes for exposures that are quantified in the BHHRA, as well as the toxicity values that are used to quantify cancer and non-cancer risks and noncancer hazards. The exposure pathways and receptors, exposure factors, intakes, toxicity values, and risk results are presented in the standard tables in Risk Assessment Guidance for Superfund (RAGS), Part D (USEPA, 2001).

This BHHRA is developed in accordance with USEPA guidance, including but not limited to those listed below, as amended by USEPA Region 2 comments on the October 2018 version of the PAR and, the April 2019 version of the PAR, and the July 2019 version of the BHHRA (Appendix AB):

- Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Parts A, D, E, and F (USEPA, 1989; USEPA, 2001; USEPA, 2004b; USEPA, 2009).
- Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. (USEPA, 2002b).
- Adult Lead Model and Update to the Adult Lead Methodology's Default Baseline Blood Lead Concentration and Geometric Standard Deviation Parameters (USEPA, 2003b, 2017b).
- User's Guide for the Integrated Exposure Uptake Biokinetic (IEUBK) Model for Lead in Children (USEPA, 2007).
- Office of Land and Emergency Management (OLEM) Updated Scientific Considerations for Lead in Soil Cleanups. OLEM 9200.2-167. (USEPA, 2016). https://semspub.epa.gov/work/08/1884204.pdf (USEPA, 2016).
- Office of Solid Waste and Emergency Response (OSWER). Human Health Toxicity Values in Superfund Risk Assessments. OSWER Directive 92857.7-53. (USEPA, 2003a). https://www.epa.gov/sites/production/files/2015-11/documents/hhmemo.pdf (USEPA, 2003a).
- User's Guide for Evaluating Subsurface Vapor Intrusion Into Buildings (USEPA, 2004a, 2017a).
- Exposure Factors Handbook including updates (USEPA, 2011).
- Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors (USEPA, 2014b).
- ProUCL Version 5.1 User Guide and ProUCL Version 5.1 Technical Guide (USEPA, 2015b, 2015c).
- Regional Screening Levels (RSLs) (USEPA, November 2019). https://www.epa.gov/risk/regional-screening-levels-rsls.
- Integrated Risk Information System (IRIS) (on-line database of toxicity information). https://www.epa.gov/iris.

- Provisional Peer Reviewed Toxicity Values (PPRTV) (on-line database of toxicity value derived for use in the Superfund program when such value is not available from IRIS). https://www.epa.gov/pprtv/provisional-peer-reviewed-toxicity-values-pprtvs-assessments https://hhpprtv.ornl.gov/quickview/pprtv_papers.php.

- Supplementary Guidance for Conducting Health Risk Assessments of Chemical Mixtures (USEPA, 2000). https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=20533

- Human Health Toxicity Values in in Superfund Risk Assessments. OSWER Directive 9285.7-53.. (USEPA, 2003a). https://nepis.epa.gov/Exe/ZyNET.exe/91015CKS.TXT?ZyActionD=ZyDocument&Client=EPA&Index=2000+Thru+2005&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C00thru05%5CTxt%5C00000030%5C91015CKS.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL .

- Recommendations for Default Value for Relative Bioavailability of Arsenic in Soil. OSWER Directive 9200.1-113. —(USEPA, 2012). OSWER Directive 9200.1-113. https://semspub.epa.gov/work/HQ/175338.pdf .

- REVIEW OF THE REFERENCE DOSE AND REFERENCE CONCENTRATION PROCESSES. USEPA 2002.A Review of the Reference Dose and Reference Concentration Processes. –EPA/630/P-02/002F. (USEPA, 2002a).

- Guidelines for Carcinogen Risk Assessment. USEPA 2005, EPA/630/P-03/001B. (USEPA, 2005).

1.2 Report Organization

The rest of this report is organized as follows:

- **Section 2 - Site Background and Setting:** Presents the site location and description, site history, site geology and hydrogeology, and local land use.
- **Section 3 - Data Evaluation:** Presents a summary of the environmental media sampling and analysis performed during the RI, RI analytical data for use in the BHHRA, data usability, and COPCs identification.
- **Section 4 - Exposure Assessment:** Presents the potential exposure pathways under current and future land use at and around the Site, exposure point concentrations (EPCs) for the COPCs (both measured and model-estimated concentrations including equations and assumptions used in the modeling), exposure factors for estimating the RME, and methods for evaluating exposure to lead.
- **Section 5 - Toxicity Assessment:** Presents the toxicity values compiled for the COPCs, per USEPA's hierarchy of sources, and discussion regarding the use of surrogates and route-to-route extrapolation in the absence of toxicity values from the hierarchy.

- **Section 6 - Risk Characterization:** Presents the results from integrating the exposure and toxicity assessments into quantitative estimates of cancer ~~and non-cancer risks~~risk and noncancer hazard index (HI) as well as lead exposure hazards~~risks~~, and discussion of uncertainties associated with the risk and hazard estimates.
- **Section 7 - Summary and Conclusions:** Summarizes the results of the BHHRA and presents conclusions based on the results.
- **Section 8 - References:** Lists the references cited in this report.

2. SITE BACKGROUND AND SETTING

The following subsections describe the site and its location (Section ~~2.1),~~2.1), its history (Section ~~2.2),~~2.2), geology ~~and hydrogeology~~ (Section ~~2.3),~~2.3), hydrology (Section 2.4), local land use (Section ~~2.4),~~2.5), and local groundwater use (Section ~~2.5).~~2.6). This information provides a basis for the discussion of potential exposure pathways at the Site in Section ~~4.~~4.

2.1 Site Location and Description

As discussed in the RIR, the Site is 7.6 acres and is located on the west bank of the Passaic River in Newark, Essex County, New Jersey (Figure 2-1). Riverside Avenue and McCarter Highway border the Site to the west along with a segment of railroad track adjacent to McCarter Highway. The ~~majority of the~~ Site was ~~reclaimed from~~once part of the Passaic River (tidal zone) that was filled with ~~imported~~ fill~~. An 1892 Sanborn map suggests that some filling occurred~~ material in the late 1800s~~;~~ and early 1900s. The source(s) of the fill is not known, and fill emplacement occurred over at least a 20-year period. Through previous investigations and confirmed in the remedial investigation, the fill can contain cinders and debris. Previous investigation reports concluded fill was contaminated prior to emplacement by designating the fill as "historic fill" per NJDEP regulations. Because not all lots have been subjected to pre-remedial ~~investigation~~ investigations, this designation was not site wide, however, ~~the major filling events at~~ NJDEP maps indicate historic fill is site wide. The fill material consists predominantly of sands, silts, and gravel along with ~~and~~ man-made materials such as brick, pieces of concrete block, wood, glass, and cinders. The fraction of each material in the fill varies across the Site ~~occurred between 1892 and 1909.~~. Based upon historical maps, previous investigations, and data obtained during the RI, fill material is present in surface soils throughout the Site and in subsurface soils where historical filling was conducted to reclaim land from the Passaic River. This material is considered "historic fill" as it complies with the NJDEP definition of historic fill (NJDEP, 2011 and NJDEP, 2013); however, historic fill in some areas appears to have been impacted due to historical and~~-~~/or current operations and chemical/waste handling at the Site. From approximately 1902 to 1971, the Site housed paint, varnish, linseed oil, resin, and other coatings manufacturing facilities operated by the Patton Paint Company (which merged into the Paint and Varnish Division of Pittsburgh Plate Glass Company in 1920~~,~~ and has been known as PPG Industries since 1968) from approximately 1902 until 1971. Since then, the Site has been used for a wide variety of industrial purposes by numerous companies, and is currently subdivided into 15 lots, as shown on Figure 2-2.Basic raw materials used ~~in the manufacturing processes~~by past and current tenants/owners at the Site included natural gums and resins, flax seed, ~~non-chlorinated~~linseed oil, acetone, solvents ~~and~~, pigments, paint thinners, and specific chemicals identified as having been stored in aboveground storage tanks (ASTs) and underground storage tanks (USTs) at the Site ~~(refer to Section 2.2),~~, including non-chlorinated solvents, such as toluene, xylene, ethylbenzene, and methyl ethyl ketone (MEK). ~~Pigments were often metallic chemicals and would have included compounds of cadmium, chromium, lead, titanium, and zinc. Basic lead carbonate (white lead) would have been one of the pigments, and small quantities of mercury may have been used as a preservative in certain paints. Since then, the Site has been used for a wide variety of industrial purposes by numerous companies, and is currently subdivided into 15 lots, as shown on Figure 2-2.~~ Table 2-1 summarizes current information for each of the 15 lots (e.g., size, owner, use, existing deed restrictions). Additional details can be found in the RIR.

2.2 Site History

Detailed descriptions of the site's ownership history, operational history, historical activities, documented releases, and previous site investigations are provided in the RIR. Since 1971, at least 12 documented spills and releases have occurred at the Site, and the Site is subject to at least seven New Jersey Industrial Site Recovery Act (ISRA) remediation cases under NJDEP environmental regulations. Prior to 1971, a vapor cloud released in 1969 from one of the resin reactors in the former PPG Resin Plant (Building #17) ignited, causing a fire/explosion. Resin material burned and several process tanks failed during the fire, thus releasing their contents, as discussed in RIR Section ~~6~~7.2.

Numerous environmental investigations and NJDEP~~-lead~~-led remedial actions have been completed on the Site prior to initiating the USEPA CERCLA RI in 2017. In addition, USEPA requested New Jersey Department of Health (NJDOH) conduct a Letter Health Consultation (LHC) for the Riverside Industrial Park Superfund site through a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). The Health Consultation included a review of Site environmental data provided by USEPA concerning potential health risks. NJDOH's review was limited to Building #7 and Building #12 and site-wide areas based on limited sample screening, and the NJDOH evaluation only assessed workers' and adult trespassers' exposures to surface soil through incidental ingestion or skin contact. Other potential receptor populations, exposure pathways (inhalation and vapor intrusion), and media (groundwater and air) were not evaluated, nor was the entire Site evaluated for human health risk. The NJDOH presented their findings in a Letter Health Consultation for the Site, dated December 23, 2015. ~~The findings of current risks presented in this BHHRA are consistent~~This letter stated past, present, and future exposures to surface soil contaminated with ~~the NJDOH findings regarding risk (~~lead at the Site is not expected to be harmful to adult facility workers or to the unborn babies of pregnant workers at the Site; and past, present, and future exposures to surface soil contaminated with PAH compounds, bis(2-ethylhexl)phthalate, and arsenic at the Site is not expected to harm human health~~) at the Site~~ (NJDOH, 2015~~).~~. The previous areas of concern (AOCs) identified on individual lots were identified in the Site Characterization Summary Report (SCSR~~.~~). The previous AOCs were investigated during implementation of the ~~RI.~~ NJDEP lead RIs. References to "exceedances" in this Section pertain to the specific standards and criteria available at the time of previous investigations and remedial actions which may not be equal to the Project Action Limits (PALs) evaluated for the USEPA CERCLA RI.

Details regarding these investigations and actions are provided in the RIR, Section 1.4. ~~The previous investigation findings listed historic fill as being present. Historic fill has contaminants not related to operations at the Site. Due to the widespread presence of historic fill, it is treated as a site-wide AOC.~~

The sections ~~below~~ provide ~~background on~~ a summary of previous investigations at each ~~lot~~ Lot. The findings of these investigations were considered when preparing the sampling program for the RI and conceptual site model for the ~~Site.~~ BHHRA.

Lot 1

Lot 1 (1.229 acres) contains Buildings #2 and #3 and former Building #4, as shown on Figure 2-2. Building #4 and a portion of Building #3 were demolished in 1982 after a fire. Buildings #2 and #3 are interconnected and have a common basement. Lot 1 is a New Jersey known contaminated site associated with Acupak (ISRA Case #88484) and Samax (ISRA Case #E20110199).

Previous investigations have identified several AOCs including an AST farm (former location of PPG linseed oil tanks), hazardous materials/drum storage areas, and loading/unloading areas. Based upon the ISRA site investigation performed on behalf of Samax in 2008, the hazardous materials/drum storage areas were eliminated as an AOC with additional investigation not warranted.

Results of samples collected in 2008 and 2010 from Lot 1 ~~are~~were provided in the NJDEP RIR (Envirotactics, Inc. [Envirotactics], 2017) and are summarized as follows:

- No volatile organic compounds (VOCs) ~~or~~were reported at Samax locations BE-1, BE-2, and BE-3; however, the reporting limits (RLs) were above applicable remediation standards and no total petroleum hydrocarbon (TPH) impacts in soil were noted above applicable remediation standards in the AST area.
- Borings installed in the loading dock area (SB-1 and SB-2) indicated no VOC or TPH impacts above remediation standards.

~~•~~ Soil impacts for semivolatile organic ~~compounds~~compound (SVOCs) and metals were detected at the former AST farm.

- In ~~2012, soil and groundwater investigations were proposed to NJDEP by 29 Riverside LLC (RP) related to~~ the 2010 Samax ~~case. In June 2015, three monitoring wells were observed on Lot~~ BE-1 ~~adjacent to the Lot 62 property line. In 2016, the current owner stated he~~sample (7.5 – 8.0 ft ~~eet below ground surface [~~bgs~~]~~), lead was ~~not aware of the wells.~~reported at 1,100 ~~milligrams per kilogram (~~mg/kg~~)~~ and zinc at 970 mg/kg.

The Licensed Site Remediation Professional (LSRP) for Samax (Lot 1) provided groundwater data, well permits, and groundwater results from four monitoring wells at the Site on March 25, 2016. The data indicate that some VOCs, base neutral (BN), and methyl tert-butyl ether (MTBE) exceeded the NJDEP Groundwater Quality Standards (GWQS) during some of the sampling rounds between 2013 and 2015. Additionally, iron, magnesium, and sodium exceeded their respective NJDEP GWQS. All four of the monitoring wells are located on the east side of the former AST farm area.

An NJDEP RIR (Envirotactics, 2017) was completed in 2017. The 2017 NJDEP RIR and Classification Exception Area (CEA) for Lot 1 submitted on behalf of Samax (former Lot 1 tenant) is provided in Appendix A. The New Jersey primary identification (PI) number is 563216.

In May 2013, nine soil borings (BE-6 through BE-14) were installed along the eastern exterior of the AST farm and in the area of the historic fill to better evaluate 2008 and 2010 soil concentrations above NJDEP standards (Envirotactics, 2017). Several soil borings were also installed in the accessible areas north and east of Sample BE-2/TWP-2 to determine the toluene source. Evidence of petroleum contamination was observed in Soil Borings BE-8, BE-10, BE-11, and BE-14 from approximately 5 to 10 ft. ~~eet~~ below grade. A total of 13 soil samples were collected from each soil boring at depths biased toward the highest field screening readings and analyzed for Target Compound List (TCL) VOCs+10, TCL SVOCs+20, and Target Analyte List (TAL) metals. Soil Samples BE-8, BE-9, and BE-13 detected benzo(a)pyrene and/or lead above their respective NJ Non-Residential Direct Contact Soil Remediation Standard (NRDCSRS), Residential Direct Contact Soil Remediation Standard (RDCSRS), and/or Impact to Groundwater Soil Screening Level (IGWSSL). Methylene chloride and bromomethane were also detected above the default IGWSSL in Samples BE-6, BE-9, BE-10B, and BE-11B; however, because these samples were collected from beneath the water table and per NJDEP guidance, the IGWSSL do not apply.

In May 2013, four groundwater samples (TWP-3 through TWP-6) were collected from points installed in soil borings BE-6, BE-8, BE-9, and BE-11. The samples were analyzed for TCL VOC and TCL BN; TAL metals were not sampled due to high turbidity in the temporary well points (TWPs). The only identified exceedance was a VOC total tentatively identified compound (TIC) concentration, which was reported at a concentration of 1,080 parts per billion (ppb) in TWP-6. As there were no toluene exceedances, it was determined by the LSRP that the horizontal extent was confirmed by these TWPs, and four permanent monitoring wells (MW-1 through MW-4) were installed along the eastern side of the AST farm. Monitoring Wells MW-1, MW-3, and MW-4 are identified as existing Wells E-5 through E-7 in the RIR. Samax Well MW-2 was not located during the RI. Four groundwater sampling events were completed at these wells, each sampled for TCL VOCs, TCL BN, and/or TAL metals. No VOC compounds were detected in any of the monitoring wells above their respective GWQS during the two most recent events. Arsenic was detected above the GWQS in MW-1 during the August 2013, July 2014, and April 2015 sampling events. Only metals exceeded applicable NJDEP GWQS (Envirotactics, 2017).

In the 2017 NJDEP RIR, the only remedial action proposed was for historic fill and included the implementation of engineering and institutional controls to address soil contamination and a historic fill CEA for groundwater. The historic fill CEA indicates arsenic, iron, lead, manganese, and sodium concentrations above the NJDEP GWQS are a result of historical fill. Samax is awaiting direction from USEPA on implementation of the remedial actions under New Jersey PI #563216.

Lot 57

Lot 57 (0.42 acres) contains Building #10, as shown on Figure 2-2.

An acetone spill related to refilling of a 4,500-gallon acetone AST occurred in 1988. In June 1988, approximately 3 cubic yards of acetone-impacted soil were removed from Lot 57 by HABA International, Inc. The excavation was 4 ~~feet~~ft. by 5 ~~feet~~ft. by 5 ~~feet~~ft. deep and located on the northern end of Building #10. The post-excavation soil results reportedly indicated that no VOC contamination existed; however, tabulated results or laboratory reports had not been located in NJDEP files.

Lot 58

Lot 58 (0.2523 acres), contains Buildings #15 and #15A, as shown on Figure 2-2. Former Building #23 was removed between 1979 and 1987.

As described in the RIR, nine AOCs pertaining to environmental conditions were identified at Lot 58 in 2009 by Newark's consultant (PMK Group, Inc. [PMK]/Birdsall Services Group [Birdsall], 2009) as follows:

- *AOC 1*: Twelve 20,000-gallon ASTs and two 110,000-gallon ASTs (one previously removed). It is noted that USEPA identified 16 ASTs in Building #15 which is consistent with historical PPG drawings.
- *AOC 2*: AST associated pump stations and pipe tunnel to east.
- *AOC 3*: Former 1,800-~~square foot~~sq. ft. drum storage area and staging area.
- *AOC 4*: Trench drain from lacquer/thinner pump station.
- *AOC 5*: NJDEP "State Fill" area (Historic Fill Area).
- *AOC 6*: Stained floor area within Building #15A.
- *AOC 7*: Tire dump with other solid waste and debris.

- *AOC 8*: Hazardous building materials and equipment.
- *AOC 9*: Adjoining and surrounding contaminated sites.

Following NJDEP regulations, AOCs 1 through 6 were investigated via a surficial geophysical survey, soil borings and sampling, and groundwater samples were collected from soil borings. AOCs 7 through 9 did not require environmental investigation and would reportedly be addressed via materials recycling, solid waste management, pre-demolition materials testing, or additional historic research.

Historical (2009) groundwater samples from TWPs indicated concentrations of metals, VOCs, SVOCs, and pesticides above the NJDEP ~~Groundwater Quality Standards (~~GWQS~~).~~.

Soil sample results indicated cadmium, lead, mercury, ethylbenzene, methylene chloride, tetrachloroethylene (PCE), toluene, trichloroethene (TCE), and/or xylenes were above NJDEP standards. Elevated concentrations of ethylbenzene, toluene, and xylenes (potential indicators of petroleum contamination) were reported in the 2009 soil boring SB-2. Isolated SVOCs were also detected at concentrations above the NJDEP standards. ~~Polychlorinated biphenylbiphenyls (~~PCBs~~)~~ and pesticides were not detected above applicable NJDEP standards.

~~In 2011, the USEPA, in~~In response to notification by an Ardmore representative, the USEPA inspected tanks in Building #15 after precipitation water was removed from the building~~.~~ to determine if hazardous material was present in the Building during a Time Critical CERCLA Removal Action. The tanks were determined to be empty, and there were no visible signs of contamination. ~~Sample~~There were no visible signs of contamination in the 2 inches of water remaining in the building floor and sample results received later confirmed that observation. ~~Based upon their inspections~~Therefore, USEPA determined that there were no hazardous materials present and, therefore, Building #15 posed no threat to human health and the environment~~.~~ as described in USEPA's 2011 Pollution Situation POLREP# 9 Report (USEPA, 2011c).

Lot 59

Lot 59 (0.405 acre) contains Building #14, as shown in Figure 2-2.

No environmental investigations have been identified at the property. As summarized in the RIR, several spills have been associated with Lot 59, as follows:

- A 1987 allyl chloride spill.
- A 1990 release to the Passaic River attributed to poor housekeeping.
- A material identified as HC Blue 2 was spilled in October 1993 as a result of a fire.
- A 1994 interior spill of anhydrous ammonia liquid occurred on March 29, 1994.

Documentation of the specific locations of the spills/releases has not been found.

Lot 60

Lot 60 (0.703 acre) contains Building #1, as shown in Figure 2-2.

A 2008 ~~Preliminary Assessment Report~~PAR identified nine Areas of Environmental Concern (AECs); however, no further action was recommended~~.~~ (Whitman, 2008). Subsequent NJDEP correspondence to Color Enterprises (RP, successor to Roloc) required further investigation of one AEC, namely ASTs and associated piping. Soil and groundwater were investigated in November 2008.

Soil borings SB-PAD-1 through SB-PAD-4 were completed in 2008 around the concrete AST pad that formerly housed the acetone, toluene, MEK, and alcohol ASTs. The ASTs had been removed prior to the sampling event. The results of these samples indicated that alcohols were not present; however, cis-1,2-dichloroethene (DCE), MEK, 1,1-trichloroethane (TCA), PCE, and TCE were detected above existing NJDEP soil standards. No other results exceeded NJDEP soil standards at that time. (Whitman, 2009).

~~Proposed actions in the remedial investigation portion of a 2009 report included further horizontal and vertical delineation of VOCs in the AST pad area located at the southeast corner of the lot building. According to a conference call with the LSRP for Lot 60 in July 2015, the remedial investigation for the lot is in the process of being finalized (see RIR Section 2.1.4 for additional update).~~

The Site is identified as Roloc/Color Enterprises (PI #467682). The 2017 NJDEP RIR/Remedial Action Work Plan (RAWP) (First Environment, Inc. [First Environment], 2017) discussed supplemental activities conducted related to a former AST pad on Lot 60. In May 2009, Roloc's contractor Whitman collected 13 soil samples (SB-PAD-1R, SB-PAD-3R, SB-PAD-5, SB-PAD-5, SB-PAD-5D, SB-PAD-6, SB-PAD-6D, SB-PAD-7, SB-PAD-7D, SB-PAD-8, SB-PAD-8D, SB-PAD-9, and SB-PAD-9D) adjacent to and below the former AST. Samples were collected between 5.5 and 9 feet bgs and sampled for TCL VOCs. One sample, SB-PAD-5D, had a concentration of benzene (0.553 part per million [ppm])~~])~~, which is below the NJDEP RDCSRS but exceeds the NJDEP Default IGWSSL. All other samples were either not detected or detected below the most stringent applicable NJDEP standard.

During the May 2009 investigation, a TWP was installed to a depth of 10 feet bgs near the southwest corner of the former AST pad. One groundwater sample was collected and analyzed for TCL VOC. TCE and PCE were identified at concentrations (both 1.78 micrograms per liter [µg/L]) exceeding the NJDEP GWQS of 1 µg/L. Subsequently, a monitoring well (MW-1) was installed in May 2012 by First Environment to a depth of 15 feet bgs. Monitoring Well MW-1 is identified as existing Well E-8 within the RIR. A groundwater sample was collected in June 2012 from MW-1 and analyzed for TAL metals and TCL VOC. The following compounds were identified above their respective NJDEP GWQS: mercury (5.9 µg/L), arsenic (12 µg/L), total chromium (84 µg/L), lead (330 µg/L), aluminum (11,000 µg/L), iron (33,000 µg/L), and manganese (90 µg/L).

In March 2017, First Environment began further characterization of the nature and extent of VOCs in soil adjacent to and below the former AST pad. Six soil borings (PAD-1, PAD-1N, PAD-1S, PAD-1W, PAD-5, and PAD-5W) were completed with one sample collected from each location. All VOCs were either not detected or detected below the most stringent applicable NJDEP standard. Following these investigations, First Environment determined that No Further Action (NFA) was required for the soil adjacent to and below the former AST pad, as detectable concentrations of VOCs identified above the IGWSSL were only identified at a depth below the seasonally high groundwater table and not within the unsaturated zone.

In March 2017, First Environment collected an additional groundwater sample using low-flow sampling techniques to be analyzed for PCBs, TCL BN+15+SIM, and TCL VOCs+15, including 1,4-dioxane. 1,4-dioxane was detected at a concentration of 0.7 µg/L, exceeding the NJDEP GWQS of 0.4 µg/L. Other VOCs were either not detected or detected below the NJDEP GWQS. No concentrations of polycyclic aromatic hydrocarbons (PAHs) or PCBs were detected. Based on these analytical results, First Environment in April 2017 collected another groundwater sample for 1,4-dioxane. There were no detectable concentrations of 1,4-dioxane in that sample. A final confirmatory sample was collected from MW-1 in May 2017, and again, no concentrations of 1,4-dioxane were detected. Following these investigations, First Environment determined that NFA was required for groundwater in this area other than a CEA for historic fill impacts to groundwater. The historic fill CEA indicated mercury, arsenic, aluminum, chromium, iron, and lead concentrations were above the NJDEP GWQS. The 2017 NJDEP RIR/RAWP and CEA submitted on behalf of Roloc are provided in the SCSR.

The RP is awaiting direction from USEPA on implementation of the RAWP.

Lot 61

Lot 61 (0.265 acres) contains Building #6, as shown on Figure 2-2.

No investigations have specifically addressed potential environmental impacts on this lot; however, an investigation at the western adjoining lot (Lot 62) included the advancement of one boring in 2006 on Lot 61 at the northeast corner of the lot. A groundwater sample (TB-3) from this soil boring indicated that the NJDEP GWQS for PCE, TCE, ~~and~~ vinyl chloride, cadmium, chromium, and lead were exceeded.

The deed notice filed by the property owner (City of Newark) indicates there is potential for encountering contaminated historic fill beneath Building #6. The concrete building slab is identified as an engineering control. The Responsible Party (RP) associated with the deed notice is Honeywell, successor to BBI. The deed notice identifies contaminants associated with the historic fill as being VOCs and metals. The New Jersey PI number is G0000005586.

Lot 62

Lot 62 (0.492 acres) contains Building #9, as shown on Figure 2-2.

In 1998, Industrial Development Associates (property owner) received a No Further Action (NFA) determination from NJDEP related to Chemical Compounds, Inc. (CCI) operations. ~~The soil samples collected on behalf of CCI were considered to be representative of historic fill. Soil TPH concentrations ranged from 9,610 milligrams per kilogram (mg/kg) to 13,300 mg/kg. PCB concentrations up to 0.501 mg/kg were reported. The benzo(a)pyrene concentration in one sample exceeded the NJDEP standards at the time. Arsenic, lead, and mercury concentrations in soil exceeded NJDEP standards.~~ Open space south of Building #9 was used for outdoor storage of containers during PPG activities based on a historic "Newark Varnish Plant" photograph published in the book Glass-Paints (PPG, 1923). The photograph depicts 55-gallon drums and barrels staged on the plant grounds to the south of Building #9. Outdoor storage of containers may have also included portions of Lots 63 and 64 based on this photograph.

Three soil borings (SB-4 through SB-6) were advanced in May 2008, and a subsurface soil sample was analyzed from each boring. The soil samples collected on behalf of CCI were considered to be representative of historic fill (Whitman, 2012b).

2008 soil TPH concentrations ranged from 9,610 mg/kg to 13,300 mg/kg. These elevated TPH concentrations are near Lot 64 USTs. Total PCB Aroclor concentrations up to 0.501 mg/kg were reported (assuming non-detected concentrations are incorporated into the result as zero). The benzo(a)pyrene concentration in one sample exceeded the New Jersey Soil Remediation Standards (SRS). Arsenic, lead, and mercury concentrations in some soil exceeded New Jersey SRS. Concentration ranges in subsurface soil for these three metals are as follows:

- Arsenic 9.62 mg/kg - 34.2 mg/kg
- Lead 153 mg/kg - 653 mg/kg
- Mercury 0.716 mg/kg - 0.814 mg/kg

Monitoring Wells MW-3 (southern edge of lot) and MW-4 (northeast lot corner) were installed and sampled in 2008. Two TWPs (TB-1 and TB-2) were installed on the south side of Building #9 on Lot 62, and grab groundwater samples were collected in 2006. In TB-1, lead (126 µg/L), acetone (73.1 µg/L), butylbenzene (51.9 µg/L), isopropyl benzene (151 µg/L), n-propylbenzene (73.8 µg/L), and toluene (1.98 µg/L) were detected. In TB-2, lead (260 µg/L), chromium (23.1 µg/L), butylbenzene (53.6 µg/L), isopropyl benzene (47.8 µg/L), n-propylbenzene (60.7 µg/L), and 1,2,4-TMB (2.18 µg/L) were detected. No SVOCs were detected in either sample.

Groundwater results showed the NJDEP GWQS for benzene, arsenic, beryllium, and lead were exceeded in Monitoring Well MW-3, and arsenic, beryllium, chromium, and lead exceeded the NJDEP GWQS at Monitoring Well MW-4.

The two monitoring wells previously installed by Whitman, on behalf of CCI, were located on the property and were evaluated/sampled during the RI. CCI Wells MW-3 and MW-4 were identified as E-3 and E-4 in the RI.

Lot 63

Lot 63 (0.541 acres) contains Building #7 and former Building #7A, as shown on Figure 2-2.

Frey warehoused, packaged, repackaged and distributed client-owned chemicals on Lot 63. Historical drawings show the previous presence of eight 10,000-gallon oil ASTs in the northwest portion of Lot 63. The 1931 drawing also identifies two 50,000-gallon naphtha ASTs near the southwest corner of Building #7. These ASTs are no longer present.

Frey discharged transfer line washings to the Building #7 basement, and NJDEP classified the basement as a solid waste management unit. An NJDEP inspection noted Frey repacking activities were performed on the first floor, and that the basement acted as "a drain for any spill" on the first floor. On October 1, 1984, the NJDEP reported that the basement of Building #7 had a strong odor of chlorinated organic chemicals. (NUS, 1989). A November 1984 Closure Plan submitted by Frey was rejected by the NJDEP, and Frey was subsequently issued an Administrative Order and Notice of Civil Penalty in May 1987. Analyses taken from the basement of Building #7 reportedly showed the presence of petroleum hydrocarbons (PHC) and trans-1,2-DCE. Resolution of Frey's violation is not documented in NJDEP files.

Building #7 ASTs used by Frey/Jobar include ASTs with 1,500- to 3,000-gallon capacities on the second floor and 2,000-gallon ASTs on the third floor.

A 2010 Building #7 AST inventory by USEPA indicated 10 empty ASTs on the second floor and 93 ASTs (79 empty) located on the third floor. Tanks on Floors 2 and 3 were identified as "varnish" tanks by USEPA. Beginning in late 2011, USEPA started the process of the solid residue removal from the tanks. The majority of the tanks were empty. The tank contents varied from a "caramel-like" substance to a hardened material that required chipping. Removed material was placed in drums and staged onsite for disposal. Simultaneously, USEPA began the process of removing basement liquid and sludge.

In early 2012, Floor 2 and Floor 3 tank work along with basement liquid/sludge removal was stopped due to USEPA budget constraints. In October 2012, Hurricane Sandy caused flooding at the Site. USEPA reported that the basements in Buildings #7 and #15 were flooded after the hurricane. In May 2014, the removal of Building #7 basement liquids and sludges resumed and was completed in August 2014.

A PAR for Lot 63 was conducted for the City of Newark. (Weston, 2009). The applicable AOCs identified in the 2009 PAR are as follows:

- *AOC A-1*: ASTs and Associated Piping
- *AOC A-3*: Piping, Above Ground and Below Ground Pumping Stations, Sumps, and Pits
- *AOC C-1*: Floor Drains, Trenches, Piping, and Sumps
- *AOC E-1*: Electrical Transformers and Capacitors
- *AOC E-1A*: Discolored or Spill Areas
- *AOC F-1*: Loading or Transfer Areas

Other documents identify AOC F-1 as drum storage areas southwest and southeast of Building #7.

The (2009) soil analytical results indicated exceedances of TPH, VOCs, SVOCs, metals, and PCBs above NJDEP standards. The petroleum fingerprint analysis performed on the groundwater sample indicated the presence of mineral spirits and diesel fuel/fuel oil #2. (PMK/Birdsall, 2009).

Two monitoring wells (ERT-2 and ERT-3) were installed in 2011 on Lot 63. Benzene was the only compound reported above NJDEP GWQS in Lot 63 groundwater. (Lockheed Martin, 2011). These monitoring wells were not located or observed during the RI. It is unknown whether the wells were properly decommissioned.

A 2008 deed notice identifies two areas beneath the footprint of Building #7 on the north and east sides as being potentially impacted by historic fill, with the building slab acting as an engineering control. Honeywell is the responsible entityparty for maintaining the engineering control. The New Jersey PI number is G0000005586.

In June 2015, surface debris dump piles were present. In 2017, USEPA initiated an emergency response action to remove debris and biohazard labeled medical waste scattered on the ground (USEPA, 2017). Dumping continues in 2019 on Lot 63.

Lot 64

Lot 64 (0.934 acres) contains Building #12 and former Building #5, as shown on Figure 2-2.

A UST inventory was completed in 2009 by USEPAPMK/Birdsall, and 9 of the 10 identified USTs contained residual fluid and/or sludge, and one UST was empty. Sampling of UST contents indicated various VOCs and SVOCs. were present in trace amounts. Some of the compounds detected included fuel-related constituents, phenol, PCE, TCE, acetone, polycyclic aromatic hydrocarbons (PAHs),, and acids. Historical samples indicate water in the tanks with trace (<1%) VOCs in the tanks.

Subsequent to the 2009 inventory, USEPA planned to remove 2 of the 10 USTs. The contents were removed, but due to structural integrity concerns, the tanks were reportedly not removed and soil sampling via test pits was undertaken by Tetra Tech EM (Tetra Tech) Inc. in 2012. A black viscous light non-aqueous phase liquid (LNAPL) sheen/film was observed in two of the six test pits (TP-3 and TP-5) located to the north (TP-3) and east (TP-5) of the UST field. Because of data quality issues, no usable results were generated from the test pit soil samples. No formal UST closure reports have been identified; however, USEPA documentation indicates that 2 of the 10 USTs were removed by USEPA. (USEPA electronic correspondence, January 13, 2012).

Six 7,000-gallon oil ASTs shown on the 1931 map in the southern portion of Building #12 are no longer present.

The October 2009 New Jersey baseline environmental risk (BER) investigation report for the case known as "The Passaic River Mystery Oil Spill" (Case #09-10-29-1320-36) was attributed to ASTs in the basement of Building #12. According to USEPA documents, the source of the spill was identified at low tide when a pipe discharging the spill was observed. The pipe was sealed, stopping the release. The pipe that discharged into the Passaic River was traced to a catch basin. An oily substance in the discharge was observed in the catch basin; a sewer pipe from Building #12 was observed to discharge into the basin. The discharge from the Building #12 sewer pipe resembled the spill material observed in the Passaic River. Section V.16 of the Order states that USEPA traced the source to two basement tanks in a vacant building located on Lot 64 that had recently been connected to a storm sewer by a hose. Based on its investigation during removal activities, USEPA has expressed the opinion that contents of the two basement tanks appeared to have been intentionally discharged into the sewer. The sewer line was plugged and tanks secured by USEPA.

As described in the RIR, a 2009 PAR for Lot 64 (Weston, 2009) identified the following AOCs:

- *AOC A-1*: ASTs and Associated Piping
- *AOC A-2*: USTs and Associated Piping
- *AOC B-1*: Storage Pads Includingincluding Drum and/or Waste Storage
- *AOC D-1*: Waste Piles
- *AOC D-2*: Open Pipe Discharges
- *AOC E-1*: Electrical Transformers and Capacitors
- *AOC F-1*: Loading or Transfer Areas

The 2009 and 2010 samples were collected by Birdsall (Birdsall, 2009) and USEPA (TetraTech 2010a, 2010b) and Lockheed Martin (2010a, 2010b). As part of the Lot 64 investigation, there was one monitoring well installed (ERT-1/2011) on adjacent Lot 65. Benzene and methylene chloride were the only compounds reported above NJDEP GWQS in Lot 65 groundwater. (Lockheed Martin, 2011).

No pre-RI monitoring wells were observed during the RI. Surface debris and waste were removed by USEPA in 2017 and 2018.

Lot 65

Lot 65 (0.289-acre) is vacant, as shown on Figure 2-2. Based upon aerial photographs, PPG records, and Sanborn maps, there were no buildings situated on this lot.

No environmental investigation reports have been found which were completed specifically for this lot; however, in 2006, a groundwater sample was collected from a soil boring on Lot 65 for limited parameters. Lead and 4-chloroaniline were detected above NJDEP GWQS. at TB-7 (Whitman, 2012a). Lot 65 soil results were generated during investigations focused on adjacent lots and indicated exceedances of industrial USEPA Regional Screening Levels (RSLs) (published at the time of the investigation). The RSLs are used for screening and not are not a the basis for decision-making. [EPA5]

Surface debris piles were present in June 2015 along with a vandalized office trailer. Additional surface debris piles were observed in July 2015 indicating an active dumping area for construction and miscellaneous debris. Surface debris and waste were removed by USEPA in 2017 (USEPA, 2017). The office trailer was removed in 2019.

Lot 66

Lot 66 (0.345 acre) contains vacant Building #17 and former Building #17A, as shown on Figure 2-2.

An unknown liquid was released to the Passaic River on January 9, 1992 as a result of illegal dumping. Chemical Compounds, Inc. (CCI) was reportedly pumping the contents of a pit into an open lot (NJDEP Case #92-1-9-1027-18). Frey Industries, Inc. is also listed as an RP related to this release. The location of the pit and resolution of the case were not found in historical records.

A July 1992 release to the Passaic River was reportedly caused by the failure of an industrial sewer line. The release likely occurred in the vicinity of Lot 66. The release was described as a blue/purple dye, wastewater liquid that containedwith aniline (dye chemical intermediate).being a component. The location of the sewer line breach was not found in historical records.

One soil boring (SB-COMP) was advanced in May 2008, and a subsurface soil sample was collected and analyzed from the boring. TPH was detected at 1,400 mg/kg and PAHs were not detected (Whitman, 2012a).

A 2010 vapor intrusion investigation of Building #17 was performed because of a PCE spill on Lot 68. The conclusions indicated that the results for the Celcor Building/Building #17 did not exceed NJDEP vapor intrusion screening limits.

Several SVOCs and PCBs were reported in soil above USEPA RSL (industrial) or NJDEP Impact to Groundwater Soil Screening Level (IGWSSL).

Three TWPs (TB-4, TB-5, and TB-6) were installed on Lot 626, and grab groundwater samples were collected in 2006. NJDEP GWQS exceedances of isopropylbenzene, chromium, and lead were identified northwest of Building #17 (upgradient, TB-4 and TB-5), and NJDEP GWQS exceedances of carbon disulfide, benzo(a)anthracene, benzo(a)pyrene, chrysene, fluoranthene, pyrene, chromium, and lead were identified at TB-6 located downgradient of the wastewater AST. One monitoring well (MW-2) was installed and sampled in 2008. This well is present on the east side of Building #17 and was evaluated/sampled during the RI as well E-2.

In July 2015, surface debris and waste piles were present and removed by USEPA in 2017 under an emergency response action (USEPA, 2017).

Lot 67

Lot 67 (0.394 acres) is a vacant lot, as shown on Figure 2-2. A small shedbuilding with unknown use exists on the eastern side of the lot adjacent to the Passaic River. According to public records, Lot 67 could be the location of the pit mentioned in allegations of CCI's 1992 illegal dumping on an open lot (NJDEP Case #92-1-9-1027-18).

The southwestern portion of Lot 67 is under a groundwater Classification Exception Area (CEA)CEA and a deed notice with engineering controls to address groundwater impacts and soil contamination related to historic fill and a Lot 68 PCE spill. Honeywell International, Inc. (Honeywell) is responsible for maintaining the CEA as well as the engineering controls. The New Jersey PI number is G0000005586.

Three soil borings were advanced in May 2008, and a subsurface soil sample was collected and analyzed from each boring. Several metals and SVOCs were detected in soil above USEPA's RSL [EPA6](industrial) or NJDEP IGWSSL in Lot 67. (Whitman, 2012a).

In July 2015, surface debris piles along with abandoned equipment were present, and USEPA removed these piles in 2017 under an emergency response action (USEPA, 2017).

Lot 68

Lot 68 (0.534 acres) is currently vacant. Former Building #20, referred to as a shed, was located along the southern property line of this lot, as shown on Figure 2-2. During PPG operations, two naphtha ASTs with 5-foot-high dike containment walls were present along with a 1,400 sq. ft. drum storage shed (Building #20). The naphtha AST area is currently overgrown and a debris pile. In 2019, vegetation was removed from the former AST area by a Newark tenant.

A PCE spill occurred in 1987. Delineation of the spill-related contamination was performedperformed, and a cleanup plan developed (Dunn, 1990, 1991, and 1992).

Approximately 228 tons of soil were removed from the lot in April 1992. Post-remediation soil sampling was conducted in 1995 (Rust, 1995).

Several metals, and VOCs, and SVOCs were detected in soil above USEPA RSL (industrial) or NJDEP IGWSSL criteria on Lot 68. Groundwater samples were collected in 1995 and 1997. Several chlorinated VOCs (PCE, 1,1,1-TCA, 1,2-DCE, 1,1-DCA, TCE, and vinyl chloride) and lead were above maximum contaminant levels (MCLs) in groundwater. Exceedances are listed in the deed notice and CEA.

CCI Monitoring Well MW-1 is present near the northwestern corner of Lot 67 (on Lot 68) and was evaluated/sampled during the RI. This well is included as E-1 in the RI.

Lot 68 is a New Jersey known contaminated site (NJDEP Case No. 88434). A PCE spill occurred in 1987. Removal of spill-related contaminated soil was undertaken. A deed notice with an engineered asphalt/concrete cap is present related to shallow soil impacts of arsenic, lead, PCE, TCE, and zinc. There is also a groundwater CEA covering cis-1,2-DCE, trans-1,2-DCE, PCE, TCE, and vinyl chloride. Honeywell is responsible for maintaining the CEA as well as the engineering controls. The New Jersey PI number is G0000005586.

Lot 69

Lot 69 (0.326 acres), the northern most parcel, contains Building #13 and Building #19, as shown on Figure 2-2.

In 1989, three areas of potential environmental concern were identified that included a drum handling area, the loading dock area, and the tractor trailer product transfer area. In 1989, excavations were completed in the drum handling area, the loading dock area, and the tractor trailer product transfer area with visually contaminated soil removed. Confirmatory soil samples were collected from the excavations. Gloss Tex's post-remediation soil samples collected from the three excavation areas indicated PHC and BN concentrations below New Jersey standards at the time. (AccuTech Environmental Services, 1989). A negative declaration affidavit was submitted to the NJDEP in November 1989 indicating no additional remedial measures were warranted.

Lot 70

Lot 70 (0.456 acre) contains Building #16, as shown on Figure 2-2.

Federal Refining Company (Federal) spilled an unknown quantity of nitrocellulose in 1990 and released hydrochloric acid gas in 1993. Lot 70 is a New Jersey known contaminated site with a deed notice (engineering controls [cap] for metal impacts) and groundwater CEA for arsenic, barium, benzene, cadmium, lead, and zinc. Federal is responsible for ensuring the protectiveness of the deed notice and CEA.

A 1985 preliminary Lot 70 screening was conducted on the lot prior to Federal occupying the property. (Environmental Strategies & Applications, Inc., 2003). Six soil samples were collected from a maximum depth of 2 feet below ground surface (ft. bgs) and analyzed for VOCs, BN, pesticides/PCBs, acid extractables, and priority pollutant (PP) metals. Organic analyses (i.e. VOCs, BN, pesticides/PCBs, acid extractables) indicated no detections with the exception of one sample with trace levels of pesticides. Metals were detected exceeding NJDEP standards in areas where pavement primarily exists.

Federal assessed groundwater quality in 2001. Groundwater contained elevated concentrations of acetone (14,000 to 29,000 ~~milligrams per liter [~~mg/L~~]),~~), barium, and lead above the NJDEP GWQS. The occurrence of acetone was attributed to an adjacent property (Lot 57 – HABA acetone release).

AOCs were developed during the 2001-2003 preliminary assessment phase, and subsequent NJDEP correspondence requested further investigation in the majority of AOCs identified. The work was undertaken with the findings presented in a ~~2007 RIR.~~ 2005 NJDEP RIR (Environmental Strategies & Applications, Inc., 2005) and the 2007 RIR/RAWP (TRC Environmental Corporation, 2007).

According to the 2008 ~~Remedial Action Work Plan (~~RAWP (TRC Environmental Corporation, 2008), the NJDEP agreed to list the groundwater CEA contaminants related to historic fill (arsenic, barium, cadmium, lead, and zinc) for Lot 70 and directed Federal to list benzene as a site ~~contaminants of concern (~~COC~~)~~ in the CEA. The CEA for Lot 70 was reportedly established on March 30, 2010 for an indeterminate duration.

A 2011 Soil NJDEP RIR (TRC Environmental Corporation [TRC], 2011) indicates AOCs 2, 3, 5, 10, 15, 25, and 32 have not received NFA determinations. The report provides the results of additional soil delineation sampling conducted in January 2011. Concentrations of PAHs, PCBs, arsenic, cadmium, and lead were detected above non-residential NJDEP standards at Lot 70. Concentrations of cadmium and/or lead exceeded NJDEP's historic fill maximum of 510 ~~parts per million (ppm~~mg/kg~~)~~ and 10,700 ~~ppm~~mg/kg respectively. Concentrations of PCBs exceeded 50 ~~ppm~~mg/kg at AOCs 2 and 3. The utilization of institutional and engineering controls was identified for addressing soil and fill impacts along with excavation of lead and cadmium hot spots that exceed historic fill maximums. Excavation of soil/fill with PCB concentrations greater than 50 ~~ppm~~mg/kg was also planned, according to the NJDEP RIR.

A revised Soil RAWP and a Remedial Action Report (RAR) (TRC, 2013/2015) were submitted to NJDEP in August 2013 and May 2015, respectively, on behalf of the owner. A copy of the reports was obtained from the NJDEP in August 2015 for review. The documented remedial objective of the RAR was to complete delineation of PCBs in soil at AOC 5, excavate areas of historic fill with PCB concentrations greater than 50 ~~ppm~~mg/kg at AOC 2 and AOC 5, terminate the site-wide historic fill Declaration of Environmental Restriction (DER), construct engineering controls to address the historic fill material, establish a new site-wide Deed Notice, and apply for a soil Remedial Action Permit (RAP) through the NJDEP. Actions implemented to fulfill these objectives and findings presented in the RAR are summarized below:

- In March 2012, previously documented soil with PCB concentrations greater than 50 ~~ppm~~mg/kg was excavated from AOC 2; previously collected samples were used for delineation purposes.
- In March 2012, previously documented soil with PCB concentrations greater than 50 ~~ppm~~mg/kg was excavated from AOC 5. Confirmatory soil samples indicated PCB concentrations less than 50 ~~ppm~~mg/kg.
- The May 4, 1998, DER was terminated on July 11, 2014, due to the identification of additional COCs associated with the historic fill (AOC 15).
- A Deed Notice was recorded on December 4, 2014, restricting the Site to non-residential use only.
- Engineering control was updated in August 2014 to include a 4-inch thick asphalt cap over the entire exterior of the parcel. All engineering controls detailed in the August 9, 2013 RAWP were implemented with the exception of placement of rip-rap cover adjacent to the river. This area (a

10- to 12-~~foot~~ft. zone) was identified as a riparian zone and designated as an Environmentally Sensitive Natural Resources (ESNR).

- An NJDEP RAP Application – Soil was submitted with the May 2015 RAR.
- PAHs, PCBs, benzene, arsenic, cadmium, lead, and heptachlor epoxide are present above NJDEP standards and associated with historic fill material~~.~~ (TRC, 2015)

2.3 Regional and Site Geology ~~and Hydrogeology~~

As ~~detailed~~discussed in the RIR (Section 3.3), the regional geologic setting consists of alluvial deposits (Qal) overlying Glacial Lake Bayonne deposits, overlying the Rahway Till on top of bedrock (Standford, 2001). The alluvial deposits consist of sand, gravel, silt, and clay deposits left by the Passaic River. The Glacial Lake Bayonne deposits consist of two units in the area including a coarser grained deltaic type deposit comprised of sand and gravel (Qbn), and a lake-bottom silt and clay unit representing more quiescent deposition (Qbnl). The Rahway Till is a basal till comprised of silty sand and sandy, clayey silt containing pebbles, cobbles and the occasional boulder. In general, borings at the Site encountered fill, alluvium, and potentially portions of the Glacial Lake Bayonne deposits including deltaic sands and gravels and the finer grained lake bottom silts and fine sands. The bedrock underlying the unconsolidated material is part of the Passaic Formation, which is described as reddish-brown siltstone and sandstone. The deepest borings completed during the RI encountered the deeper Glacial Lake Bayonne deposit (Qbnl); therefore, the Rahway Till and bedrock were not investigated during the RI.

The majority of the current lots that comprise the Site are located within the footprint of the historical Passaic River. As described in further detail below, the western edge of the Site was likely not part of the river as demonstrated by the lack of riverbed sediment (silt loam) in the borings. This agrees with the historical shoreline development map (Figure 1-3 in the RIR). Fill was observed in borings in the adjacent shore area indicating this area was filled to the current topography.

The majority of the site lots were reclaimed from the Passaic River from 1892 to 1909. The lots that comprise the Site were created by placement of fill at various timeframes throughout history leading to surface soils of the Site being non-indigenous materials.

The Site consists of large quantities of fill material that were historically placed into ~~the tidal flat of the Passaic River~~river and adjacent shore to raise the surface elevation to today's approximate elevation~~. While an 1892 Sanborn map suggests that some filling occurred in the late 1800s, the major filling events at the Site occurred between~~ , the majority of which was completed from 1892 ~~and~~to 1909. Fill material is defined as the material present above the silt loam (which represents the former Passaic River sediment bed and native material). The fill material consists predominantly of sandy consistency, sands, silts, and gravel along with and man-made materials such as brick, pieces of concrete block, wood, glass, and cinders. The fraction of each material in the fill varies across the Site; however, most of the historic fill material at the Site is characterized as a Loamy Sand or Sand Loam (Unified Soil Classification System [USCS] classification SW-SM or SM). ~~The composition of the fill material is relatively consistent across the Site, and based on boring logs and the~~The thickness of fill material ranges in thickness from 6 to 15 feet~~. Lower portions of the fill are saturated, as evidenced by the observed water table depths which are generally less than 6 feet below grade. Within the saturated zone is a~~ at Boring B-90.

Geologic cross-sections can be found in the RIR. The cross-sections were developed using the RI boring logs and were refined based on USEPA's evaluation of geologic record sample testing (Technical Memorandum on Geological Record Samples, dated June 14, 2019; Appendix E). Fill material is documented at the surface throughout the Site with greater fill thicknesses associated with areas reclaimed from the Passaic River. Below the fill material, the next deeper layer ~~composed of~~that makes up the geology immediately under the Site is a silt loam, representing the former Passaic River sediment bed. Consistent with historical maps of shoreline development, this layer was not identified in borings on the northwest side of the Site~~.~~ , where less shoreline modifications occurred.

The permeability ~~of the silt loam is lower than that of the fill material above it, the clay to silt content varies within this layer (ranging from a low plastic material on the south side of the Site to a medium plastic material on the north side of the Site).~~in the silt loam, as determined by geotechnical testing results (see section 2.2.3.5 of the RIR for additional details), indicates two samples have permeabilities of 1.1x10^{-5} and 3.3x10^{-7} cm/s. The permeability of the fill material and sands above it are likely variable due to variations in the silt to sand content but are believed to generally have higher permeabilities in most areas due to method of placement (fill). No permeability testing was conducted on the fill material. One of the ~~three~~two geotechnical samples collected from the ~~RI also included an~~silt loam layer has a permeability result (3.3x10^{-7} cm/s) similar to a clay. An isolated 0.~~5 foot~~4 ft. lens of silt loam was characterized as a sandy lean clay with silty sand and sand above and below this lens at the central portion of the Site. The silt loam material (representing the former Passaic River sediment bed) is consistently observed across the ~~site~~Site below the fill (except in the northwest corner~~).~~), which can be viewed on geologic cross-sections found in the RIR. The silt loam layer grades into a fine to coarse grained sand and gravel with depth which includes alluvium deposits (Qal horizon, described in the field as "running sands" with a USCS classification of SM to SP and a USDA soil texture of Sand to Loamy Sand to Sandy Loam) and glacial lake deltaic deposits (Qbn horizon with varying amounts of Fine Gravel). The Qbn horizon is described as being multi-colored, well-graded and poorly graded with a USCS classification of GW to GW-GM to SP-SM. The Qbn unit is followed by a silt unit encountered at a depth of 39 to 42 feet along the east side of the Site and from 20 to 40 feet along the west side of the Site. The silt is identified as glacial lake bottom deposits (Qbnl horizon with a USCS classification of ML to SM and a USDA soil texture of Silt to Silt loam to a Sandy loam). One geotechnical sample collected from the upper portion of the Qal horizon was determined to have a permeability 2.5x10^{-5} cm/s which is characteristic of a clean sand or gravel (Freeze and Cherry, 1979) and supports the Qal unit as having a USCS classification of SM to SP.

2.4 Regional and Site Hydrogeology

The hydrogeology of the Site is influenced by a number of factors including, but not limited to, the regional setting, the geologic materials present, the nature and distribution of the fill placed at the Site, and the tides in the adjacent river.

The Site is located within the Newark Basin region of the Piedmont Province. Groundwater within this region can occur within alluvium, glacial sediments, bedrock overburden soil or within bedrock. Only sand and gravel aquifers within stratified glacial deposits have been reported as being capable of deriving sufficient volumes of water for use (New Jersey Department of Conservation and Economic Development [NJDCED], 1968). Other glacial deposits of till, lacustrine lake bottom sediments, and unstratified glacial deposits tend to be poor water producers and may act as confining or semi-confining units limiting vertical groundwater flow (NJDEP, 2012). Unconfined aquifer conditions in unconsolidated sediments are more common in the region unless coarser sediments are overlain by silt, clay or till. The thickness, type, and extent of glacial deposits is variable. NJDEP has described bedrock groundwater flow within the Newark Basin as a leaky, multi-unit aquifer where bedding-plane partings act as discrete aquifer units and nearly vertical bedrock jointing provides leakage between aquifer units (NJDEP, 2012). The Passaic River acts as a regional discharge point for groundwater in the Newark, New Jersey area.

Identified groundwater units at the Site include a surface shallow fill unit. Wells monitoring this unit have an average depth to groundwater of approximately 5.1 feet bgs with recharge attributed primarily from precipitation and higher surface elevation areas to the west as well as recharge from the Passaic River during high tide. The deeper aquifer of the Site (i.e., deep unit) is composed of alluvium (Qal) and glacial lake deltaic deposits (Qbn) which are hydraulically connected. Wells monitoring the deep unit have an average depth to groundwater of 7.0 feet bgs with recharge attributed primarily from higher surface elevation areas to the west as well as some leakage from the overlying shallow fill unit. Groundwater movement within the shallow fill ~~material is~~unit would be expected to have a limited vertical component of flow due to the ~~permeability differences between the coarser fill material and the underlying fine-grained semi-confining unit.~~ observed permeability/grain-size differences between the fill material and underlying fine-grained unit (silt loam), although the silt loam layer is thin and ~~does contain~~ contains a sand fraction (See Section 2.2.3.5 table and Appendix E of the RIR). Monitored groundwater elevations also suggest these deep wells are under tidal influence which suggests some recharge from the Passaic River. Both the shallow fill unit and the deep unit are considered to discharge to the Passaic River. The lacustrine lake bottom sediments (Qbnl) underlying the deltaic deposits is believed to represent a semi-confining unit to vertical groundwater flow. No geological units deeper than Qbnl were investigated as part of the RI.

Total dissolved solids were not measured during the field program; however, specific conductivity readings were recorded and can be used to asses groundwater quality.~~Site-specific conductivity readings of the shallow groundwater indicate possible brackish conditions~~
~~Underlying the silt loam layer is a reddish-brown, silty sand that is identified as a glacial outwash deposit Additional information regarding soil stratigraphy and groundwater flow in this deep unit are described in the RIR.~~
~~The primary groundwater flow direction in both the fill unit (i.e., shallow groundwater unit) and native deep unit (i.e., deep groundwater unit) is to the south-southeast toward the Passaic River. In the northwestern portion of the Site, groundwater flow in the fill unit suggests a secondary flow pattern westward towards Riverside Ave. and eastward toward the River[3]. However, the groundwater flow direction reverses when there is an increase in the river level. Elevation of groundwater in the fill and native deep unit is also influenced by tidal changes which are greatest in areas adjacent to the river. Groundwater and river surface water elevations obtained during low tide and high tide were used to develop water table contour maps for evaluating groundwater flow direction changes associated with tidal fluctuations at the Site. These contour maps and detailed summary of the tidal evaluation can be found in Section 3.4.2 of the RIRin most areas of the Site.~~ Typical specific conductivity readings for fresh water range from 0 to 1 millisiemens per centimeter (mS/cm) and conductivity in brackish water ranges from 1 to 46 mS/cm (Sensorex website, www.senorex.com). Field conductivity readings collected during groundwater sampling events indicate 25 of the 36 wells on the Site ~~have~~ had ~~a~~ conductivity readings above 1 mS/cm. Groundwater samples from four of the five deep wells had conductivity readings that slightly exceeded 1 mS/cm. Higher specific conductivity readings in the

~~[3] The RIR suggested this may be influenced by variabilities in the fill material, the lack of the silt loam layer in this area, and many underground utility lines.~~

range of possible brackish conditions were generally associated with wells in the northern portion of the Site closer to the river (MW-116, MW-118, MW-119, and MW-121).

Groundwater Flow

Groundwater flow was evaluated in the shallow fill unit and the deep unit. The six groundwater potentiometric maps developed for the shallow fill unit (Figures 2-5 to 2-10 of the RIR) identify similar flow patterns across the Site showing groundwater flow primarily to the east during both high and low tide. As a result of the complicated infilling history of the Site, the nature and variability in the transmissivities of the fill materials onsite appear to be the primary factor controlling the groundwater flow patterns in the shallow fill unit. In general, the groundwater contours suggest increased gradients to the east during low tide (closer spaced contours) in many areas of the Site.

While the overall flow in the shallow fill unit is toward the east, the fill groundwater contour maps indicate several local flow patterns that appear during both low and high tide including saddles, mounds, and a local flow direction to the northeast in the vicinity of Lot 58. As indicated previously, these local flow patterns are likely the result of the variability in transmissivities of the fill materials; however, the presence of underground structure foundations (i.e., basements, USTs) or underground utility trenches at the Site may also cause local flow path anomalies because of the shallow water table. The following local flow patterns were observed during both low tide and high tide representations in the shallow fill unit:

- A groundwater low is present in the northwestern portion of the Site adjacent to Riverside Avenue in the vicinity of Lot 58. This local low is primarily controlled by the groundwater elevation at Monitoring Wells MW-114, MW-115, and MW-124. A possible explanation for this groundwater elevation low may be related to variabilities in the fill material, the lack of the silt loam layer (former riverbed) in this area of the Site possibly creating increased leakage into the alluvium unit, or related to underground utility lines exiting the property in this area that are connected with main lines within Riverside Avenue. Additionally, the well screens of MW-114 and MW-115 intersect the fill/alluvium boundary and water levels may not solely represent conditions in the shallow fill unit; however, the screened interval of MW-124 is entirely within the shallow fill unit and reflects the same groundwater elevation low identified in MW-114 and MW-115. It appears there may be increased leakage from the shallow fill unit into the deeper alluvium (Qal) in this area compared to other areas of the Site that may be cause of lower groundwater elevations.

- A local groundwater high/mound is present on the south side of the Site on Lot 64 in the area of UST field. The mound is controlled by the groundwater elevation at Monitoring Well MW-106 which is located on the south side of the UST field. The fill material surrounding the UST field may be the cause of mounding. A water line also borders the UST field to the north, east, and west.

- A local saddle in the water table is present on the northern half of the property that extends between MW-114 and MW-117. This general area receives flow from the north and south during both the high tide and low tide. A comparison between the low and high tide groundwater contour maps indicates that flow toward the saddle is generally consistent during both low and high tide with similar gradients when comparing each set of low and high tide contour maps. In general, flow toward the river (east) is greater during low tide than high tide.

With regard to groundwater flow and transport at the Site and where present, the intervening silt loam with vertical conductivities that are several orders of magnitude lower than the horizontal conductivities in the overlying and underlying units is likely to limit vertical movement of both flow and contaminants at the Site, although the silt loam does contain a sand fraction.

Two groundwater contour maps developed for the native deep unit beneath the fill material also indicate flow to the east (Figures 2-12 and 2-13 of the RIR). Similar to the shallow fill unit groundwater contour maps, an increased gradient to the east is evident at low tide compared to high tide. Also, similar to the shallow fill unit, a groundwater elevation high exists on the western portion of the property on Lot 64 (in vicinity of MW-203) suggesting aquifer recharge from the west. The thickness of the interval monitored at MW-203 (Qal) is thinnest at this location. Slightly lower than expected groundwater elevations at MW-205 were observed given groundwater flows to the east. This is possibly the result of MW-205 monitoring a deeper unit (Qbn) which is coarser-grained and may suggest a downward gradient between the Qal and Qbn units.

The February 2019 tidal study transducer data was also evaluated to show the mean water levels and potentiometric surface in the shallow fill unit and deep unit -(Serfes 1991 method). The results are provided on Figures 3-9 and 3-10 of the RIR. These maps have similar flow patterns as other potentiometric surface maps with steeper gradients in the south portion of the Site and more gentle gradients in the north. The Serfes method requires data through a full tidal cycle. Data from USGS Passaic River gauge at PVSC in Newark, Jew Jersey (USGS #01392650) was used to estimate a peak portion of the low tide surface water elevations because the site river gauge (RG-2) only monitors low tide water levels until the adjacent mud flat goes dry and does not monitor the low tide peak of tide cycle.

A comparison of groundwater elevations between nested pairs of shallow fill and deep wells that are in close proximity to one another indicate a slight downward gradient between the shallow fill unit and the deep unit. The difference in groundwater elevations between nested wells increases during low tide suggesting a greater downward vertical gradient during low tide.

~~2.4~~2.5 Land Use

~~As discussed above, the Site is~~ The Site is zoned for industrial use (City of Newark, 2013), and is sub-divided into 15 lots, seven of which are occupied and the other eight ~~of which~~ are unoccupied. ~~The Site is mostly~~ As summarized in Table 2-1, the seven occupied lots are Lots 1, 57, 59, 60, 62, 69, and 70 and the eight unoccupied lots are Lots 58, 61, 63, 64, 65, 66, 67 and 68. Five of the unoccupied lots are currently owned by the City of Newark (Lots 58, 61, 63, 64, and 68) while the remaining lots are currently owned by various entities, as shown on Table 2-1. The occupied lots are currently used for industrial purposes. Approximately 70% of the Site is paved or covered by buildings, and the Site is partially fenced but there have been numerous reports of trespassing.~~.~~

Surrounding properties include bulk storage ASTs to the north, an auto body shop to the northwest across Riverside Avenue, and a construction contracting business to the south. There are medium-density residential units west of McCarter Highway.

As discussed in the Reuse Assessment Report (Appendix O of the RIR););), the five lots owned by the City of Newark (which are part of the Redevelopment Agreement with 123-131 Riverside Urban Renewal, LLC) and Lots 57 and 70 are expected to be used in the future under an redeveloped in the near future for industrial land use reuse. The property owners of the remaining eight lots have indicated their intentions to continue current commercial/industrial uses. . In addition to current use, Table 2-1 includes the potential for future development. [EPA7]

Portions of five lots within the Site are subject to NJDEP Deed Notice/Declaration of Environmental Restriction, which are ICs institutional controls[4] that limit use of the properties to non-residential uses, as listed on Table 2-1. While current deed restrictions and ICs institutional controls are noted for informational purposes, this BHHRA is conducted in the absence of remedial actions and ICsinstitutional controls.

The Site is part of the "North Ward" sub-district of the Passaic riverfront, which is located between Delavan and Fourth Avenue, and is a "dedicated industrial zone" for industrial and commercial uses, as discussed in the Reuse Assessment Report (Appendix O of the RIR). New industrial development and increased future use of marine transportation is anticipated for the "North Ward" area according to the Reuse Assessment Report. Based on this Report and other factors, the reasonably anticipated future land use at the Site will remain industrial. Examples of uses that may be permitted in a "dedicated industrial zone" according to the Reuse Assessment Report include but are not limited to: light and heavy manufacturing; public parks, playgrounds, gardens, and open space; and warehouse and distribution. Residential uses (e.g., one- to four-family dwellings, townhouses, and apartment dwellings above first floor commercial units) are not permitted in a "dedicated industrial zone". Although no information in the reuse study findings suggests rezoning, USEPA Region 2 acknowledges in the State of New Jersey, and especially in urban areas near waterways, former industrially zoned areas are being re-zoned and re-developed for future recreation and residential use.

2.52.6 Local Groundwater Use

Deeper groundwater beneath the Site, which is within native materials, and shallow groundwater in the fill material, isare [EPA8]currently designated as Class IIA by the State of New Jersey which assumes all water may potentially be used as a drinking supply unless restrictions are enforced by NJDEP. Per N.J.A.C. 7:9C-1.5 (e) 1, the primary designated use for Class IIA groundwater shall be potable water[5] and conversion (through conventional water supply treatment, mixing or other similar technique) to potable water. Class II-A secondary designated uses include agricultural water and industrial water. As discussed in Section 2.2.8 of the RIR, prior NJDEP investigations at the Site have conducted well searches as part of receptor evaluations and identified no domestic wells or irrigation wells within one-half mile of the Site. The most recent receptor evaluation (March 2005) was conducted as part of a NJDEP RIR for Lot 70. Subsequent updates to the receptor evaluation, including one in 2017, confirmed that there are no domestic wells or irrigation wells within one-half mile of the Site.

[4] The BHHRA is conducted in the absence of remedial actions and institutional controls.

[5] Potable use of the groundwater in the future is improbable since the Site and surrounding area use water supplied by the City and site-specific conductivity readings of the shallow groundwater indicate possible brackish conditions due to tidal influence of the adjacent Passaic River. However, the designation of the groundwater as Class IIA would not prevent the potential future use of the groundwater for drinking water purposes.

The Reuse Assessment Plan (Woodard & Curran, 2015)[6] was implemented during the RI. The reuse assessment involved collecting and evaluating information to develop assumptions regarding the types or broad categories of reuse that might reasonably occur at a Superfund Site (e.g., residential, commercial/industrial, recreational, and ecological), so that cleanup standards and remedies can be tied to reasonably expected future land use.

The Site is comprised of 15 separate lots with multiple past and current owners and tenants. Some of the lots have been investigated and remediated under NJDEP regulations. Interviews were conducted with current property owners or their representatives regarding future use of their properties. The City of Newark owned properties are subjected to a redevelopment agreement. The other 10 lots are under the ownership of multiple private entities and are either vacant, or actively being used for various warehousing/storage, distribution and/or light manufacturing operations. No property owners indicated their intentions to change the current commercial/industrial uses at their properties.

The Site is located within a designated "Dedicated Industrial Zone" allowing commercial and industrial uses. These allowable uses are consistent with the more than 100 years of commercial and industrial uses at the Site. At least five lots within the Site are subject to a Deed Notice/DER as required by NJDEP regulations, which are institutional controls that limit use of the properties to non-residential uses.

Based on a review of key considerations identified during preparation of this reuse assessment, both the current and reasonably anticipated future land use at the Site are consistent with industrial, non-residential uses. Although no information in the reuse study findings suggests rezoning, it needs to be acknowledged that in the State of New Jersey, and especially in urban areas near waterways, former industrially zoned areas are being re-zoned and re-developed for future recreation and residential use.

As part of the RI activities, the potential for groundwater receptors within one mile of identified groundwater contamination at the Site was evaluated via the NJDEP data miner computer radius report. The X&Y well search spreadsheet is provided in Appendix M of the RIR along with other well search documents. The X&Y well search identified over 2,000 permits/records within one mile of the Site (Figure 2-15 of the RIR). This list was pared down by removing the wells related to monitoring and remediation, as well as other non-groundwater removal well uses and decommissioned wells. The resulting list of 95 well permits and/or records included the following uses, in order of prevalence: industrial (68), domestic (13), dewatering (6), irrigation (4), geothermal (2), and public water supply (1). Forty-nine of these permits/records are for locations in Essex County on the west side of the Passaic River. Sixty-one of the 95 permits/records are permits only, which signify that permission was granted for well installation but are not proof that wells were installed. Six wells permitted for dewatering, industrial purposes, and irrigation were identified as being within 1,000 ~~feet~~ft. of the Site. Site-specific conductivity readings of the shallow groundwater indicate possible brackish conditions due to tidal influence of the adjacent Passaic River.

The groundwater was evaluated as a potable water supply as a means to identify whether restrictions or ICs may be necessary to prevent potential use of the groundwater for potable purposes.

[6] A copy of the Reuse Assessment Report is provided in Appendix O of the RI Report.

3. DATA EVALUATION

Samples of environmental media, including indoor air, soil and groundwater, were collected during the RI to characterize the nature and extent of contamination at the Site. The data evaluation described in this section identifies RI data that are relevant and of acceptable quality to support quantitative risk assessment. Note that other field samples (including waste characterization, sewer effluent, and temporary well point) were collected to support the RI, but these data are not incorporated into the risk assessment because they are not representative of a ~~media~~ medium of concern. The complete analytical data summary is provided in the RIR. RIR Tables 2-~~7~~7A through 2-9 and Figures 4-1 through 4-~~21~~22 summarize soil data results. RIR Tables 2-15A through 2-15D and Figures 4-~~22~~23 through 4-~~49~~50 summarize groundwater results. RIR Table 2-22 summarizes indoor air results. The following subsections provide a summary of the sampling and analysis performed during the RI (Section ~~3.1),~~3.1), usability and suitability of the data for risk assessment purposes (Section ~~3.2),~~3.2), and the COPCs selected for quantitative risk assessment (Section ~~3.3).~~3.3).

3.1 Sample Collection and Analysis

The RI/FS Workplan outlined the RI field investigation tasks, which were divided into two phases. Phase 1 sampling was completed between September 2017 and June 2018, and Phase 2 sampling was completed between November 2018 and February 2019. All soil sampling locations, groundwater monitoring wells, and building designations for indoor air samples ~~as~~are shown on Figure 3-1. The individual samples included in each dataset are listed in Appendix I. [EPA9]

3.1.1 Soil

~~***Phase 1***~~

As summarized in the RIR, soil samples were collected from 69 locations at the Site~~.~~ during Phase 1. A surface soil sample (typically 0- to 1-~~foot~~ft. bgs[7]) and a deeper soil sample were collected at each location. Only vadose zone (i.e., unsaturated) soil samples were collected for laboratory analysis. The subsurface soil sample selected for analysis was the deepest unsaturated sample or was chosen based on photoionization detector (PID) screening measurements or visual observations. These samples were collected as summarized in the RIR and analyzed for VOCs, SVOCs, PCBs, and metals, including hexavalent chromium, cyanide and mercury. Three samples were collected from fill (B-38(FILL)-10091 at Lot 64, and B-59(FILL)-100317 and B-60(FILL)-092617 at Lot 68). Per USEPA Region 2, these samples are not included in the BHHRA.

Supplemental surface (0 to 0.5 ~~feet~~ft. bgs[8]) soil samples were collected ~~from 15 locations at the Site~~ to characterize the extent to which the Site has been affected by dioxin/furans and pesticides/herbicides from past flooding of the Passaic River. Ten surface soil samples were analyzed for dioxin/furans and five surface soil samples were analyzed for pesticides/herbicides.

~~***Phase 2***~~

Per QAPP Addendum 4 (~~2019a~~2019), 62 additional soil samples were collected from 26 locations at the Site during Phase 2. Some of the samples were collected to characterize the extent of contamination around select Phase 1 locations, and the remaining samples were collected in areas

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[7] Concrete, asphalt or stone was present at 44 boring locations within the top 0.5 ~~feet~~ft. The surface samples were collected directly below this material at these borings and therefore will not have a start depth of 0 ft. bgs.

[8] Two samples were collected in paved areas immediately below the pavement and its subbase gravel.

that were not selected for sampling in Phase 1. At select locations, soil samples were collected from a depth of 11 to 13 ~~feet~~ft. bgs to characterize the saturated zone. The Phase 2 soil samples were collected in the same manner as the Phase 1 soil samples, and were analyzed for VOCs, SVOCs, PCBs, and metals, including hexavalent chromium, cyanide and mercury.

Each soil boring and monitoring well are assigned a Lot number for use in calculating EPCs (see Section 4.3). Three borings (B-89, B-94, and B-80) are on Lot boundaries. These borings were collected in Phase 2 to further characterize elevated concentrations identified at Phase 1 borings. These soil borings were assigned the Lot number of the boring for which they are characterizing. B-89 and B-94 are assigned Lot 64 because they are characterizing the high lead concentration at B-74 on Lot 64. B-80 is assigned to Lot 68 because it is characterizing the high TCE concentration at B-56 on Lot 68.

The BHHRA dataset includes the described Phase 1 and 2 soil samples collected at all depths (i.e., ground surface to maximum sampled depth of approximately 13 ft.); results are grouped into datasets according to depth ranges representing the exposure pathways as outlined below and discussed further in Section 4.3.2. By including all of these samples, the BHHRA evaluates current and potential future exposures in the absence of existing buildings and pavement, ICs~~institutional controls~~, and if subsurface soil is brought to the surface in the ~~during~~ future ~~redevelopment~~.

- Surface soil (0 to 2 ft.): outdoor workers, trespassers, visitor, future residents, off-site workers and off-site residents.
- Depth of utilities (0 to 4 ft.): utility workers.
- All Depths: construction worker exposures, exposure via vapor intrusion, as well as exposure of outdoor workers, utility workers, trespassers, visitors, future residents, off-site workers, and off-site residents if subsurface soil is moved to the surface in the future during site ~~re~~development (e.g., while installing building footers/foundations or underground utilities).

3.1.2 Groundwater

~~Phase 1~~

As summarized in the RIR, eight existing monitoring wells in the shallow saturated ~~zone~~unit, identified as E-1 through E-8, were redeveloped; and 22 new monitoring wells were installed in the shallow saturated ~~zone~~unit and developed~~ as summarized in the RIR.~~. Two rounds of groundwater sampling were conducted at all 30 wells in March and June 2018, and the samples were analyzed for VOCs, SVOCs, PCBs, and metals, including hexavalent chromium, cyanide and mercury.

~~Phase 2~~

Per QAPP Addendum 4, one additional ~~shallow~~ monitoring well was installed in the shallow saturated unit and five ~~deep~~ monitoring wells were installed in the deep saturated unit and developed. Samples were collected from all 36 monitoring wells at the Site in ~~January~~February 2019 and analyzed for the same chemicals as in Phase 1.

3.1.3 Indoor Air

Phase 1 groundwaterGroundwater results from 2018 indicated that indoor air sampling should be performed in on-site buildings to assess the potential for vapor intrusion. As summarized in QAPP Addendum 4, indoor air samples were collected from the seven on-site, occupied buildings (i.e., Buildings 1, 2, 3, 9, 10, 14, and 16).) in January and February 2019 Three ambient air samples were also collected near these buildings to assess potential background sources of volatile organic compounds (VOCs). These air samples were analyzed for select VOCs that were present in shallow groundwater above USEPA vapor intrusion screening levels (benzene; 1,1,2-trichloroethane; carbon tetrachloride; trichloroethene; chloroform; vinyl chloride; naphthalene; ethylbenzene; xylenes; and isopropyl benzene (cumene)).

3.2 Data Usability

Soil, groundwater, and indoor air data that meet established data quality objectives (DQO) outlined in the USEPA-approved QAPP (Appendix E of the RI/FS Workplan) and QAPP Addenda are considered for use in the BHHRA. All data collected for the RI and risk assessment were subjected to a quality assessment for data usability. This assessment included evaluation of qualified data for precision, accuracy, representativeness, comparability, and completeness. A detailed discussion of datathe quality of data collected for the RI is presented in Sections 2.6 and 2.7 of the RIR, and a. A summary of the data quality assessment pertinent to the risk assessment is discussed below. and presented in RAGS, Part D Data UseabilityUseabilityUsability Worksheet (Appendix A).

3.2.1 Data Usability Assessment

Validation of soil and groundwater data was performed by Environmental Standards (ES), and validation reports can be found in Appendix H of the RIR. These reports discuss whether the precision, accuracy, representativeness, comparability, completeness, and sensitivity of the data are sufficient for the intended use of the data in the BHHRA.

Select parameters were analyzed by more than one method in accordance with the QAPP (i.e., VOCs). Each method provided a result for these parameters. The reported results were selected based upon review of the data, including concentrations with respect to calibration ranges, dilutions, and laboratory/validation qualifiers. Data was validated consistent with USEPA Region 2 validation guidance documents and the reporting protocol as outlined in the QAPP and applicable documents listed in the RIRvalidation reports, which provided data selected for use in the BHHRA.

Elevated sample quantitation limits[9] (SQLs) for VOCs and SVOCs were present in both soil and groundwater samples due to the presence of various compounds that necessitated sample dilution prior to analyses. Data with elevated SQLs were qualified with few data rejections. Overall, the sensitivity, accuracy and precision of the data is sufficient to meet RI objectives. Over 90% of the data is usable for its intended project objectives, as discussed in Section 2.6 of the RIR. Rejected data were not concentrated on one lot or area.

[9] In the project EQuIS database repository, the SQL is located in the MDL field. As agreed during the 10/10/2019 call with USEPA, the SQL will be used for risk assessment purposes. According to Section 3.2.4 of the 1991 Guidance for Data Useability in Risk Assessment (Part A), the sample quantitation limit (SQL) is the method detection limit (MDL) adjusted to reflect sample-specific action such as dilution or use of smaller aliquot sizes than prescribed in the method.

Usability of the validated data for quantitative risk assessment is interpreted consistent with USEPA guidance on human health risk assessment (USEPA, 1989, 1992a), as follows:

- Constituent concentrations qualified as not detected (i.e., U or UJ qualified data) during data validation are evaluated as non-detects. ~~If~~ U-qualified data ~~are~~ used in the calculation of ~~95%~~ UCLs~~, they~~ are handled using the Kaplan-Meier (KM) method included in USEPA's ProUCL software~~.~~ used to calculate Exposure Point Concentrations (EPCs) in the BHHRA to determine Chemicals of Potential Concern (COPCs) (i.e., the full SQL is included in the ProUCL input file).
- Constituent concentrations qualified as not usable (i.e., R qualified data) during data validation are generally not used. However, SQLs for rejected dioxin/furan analyses are still conservatively considered in calculating dioxin toxicity equivalence (TEQ), ~~as required by EPA.~~consistent with instructions in USEPA's Advanced KM Dioxin TEQ calculator. Rejected data and associated uncertainties are summarized in Section 6.3.2.3. of the BHHRA.
- Concentrations qualified as estimated (i.e., J qualified data) are included ~~for quantitative assessment~~as detected results in the BHHRA.
- Concentrations of COPCs in duplicate field samples are averaged to obtain a representative concentration for the sample ~~location~~ in the BHHRA. When a constituent is detected in only one sample of a duplicate pair, the detected result is used. When both results in a duplicate pair are detected, the results are averaged, and when neither result is detected, the ~~SQLs are averaged~~maximum SQL between the parent and duplicate results is used.
- The ~~concentration of~~ concentrations of chlordane (total), 1,3-dichloropropene (total), endosulfan, and xylenes (total) ~~is~~[10] are the sum of the concentrations of the isomers that were detected and ~~half~~ the ~~quantitation limits~~SQL of the isomers that were not detected in the same sample ~~but detected in the same matrix at the Site.~~, as required by USEPA Region 2. If no isomer was detected in a sample, ~~xylene~~the chemical is considered to be not detected in the sample, and the maximum SQL among the isomers is used to represent the total ~~xylenes~~concentration in ProUCL.
- The concentration of PCBs (total) is the sum of the concentrations of the Aroclors (the trade name of the commercial PCB mixtures) that were detected. Non-detected Aroclors were incorporated into the sum as zero. If no Aroclor was detected in a sample, PCBs ~~is~~are considered to be not detected in the sample, and the maximum SQL among the Aroclors is used to represent total PCBs in ProUCL. ~~Aroclor 1016 was~~Out of the nine Aroclors analyzed, only ~~detected in one soil sample collected from a soil pile. Aroclor~~Aroclors 1254, 1260, and ~~1260~~1262 were detected in ~~both~~ soil and/or groundwater samples. The Aroclor mixtures used historically at the Site have likely weathered over time since only higher chlorinated Aroclors were detected.
- ~~A TEQ was calculated using USEPA's Advanced~~Each soil and groundwater sample collected in the RI was analyzed for both total and hexavalent chromium. USEPA noted that e-stimating trivalent chromium concentrations by subtracting hexavalent chromium concentrations from total chromium concentrations, and substituting ½ MDL when hexavalent chromium was non-detect, are not appropriate because the hexavalent chromium and total chromium data were obtained from different analytical methods with different detection limits. USEPA Region 2 determined that the total chromium concentrations should just be evaluated as trivalent chromium with an acknowledgement in the Uncertainty Analysis that the hazards for exposure to total chromium

[10] Chlordane (total) includes alpha-chlordane and gamma-chlordane, 1,3-dichloropropene (total) includes cis-1,3-dichloropropene and trans-1,3-dichloropropene, endosulfan includes endosulfan I and endosulfan II, and xylenes (total) includes m,p-xylene and o-xylene.

may be overestimated. Per USEPA Region 2, the total chromium concentrations are therefore to be assessed as trivalent chromium. The uncertainty with assuming the total chromium ais entirely trivalent chromium (i.e., not accounting for any hexavalent chromium present in the total chromium concentration) is discussed in the Uncertainty Analysis (Section 6.3.1.1).

- TEQs are calculated using USEPA's Advanced KM Dioxin TEQ Calculator, which calculates four TEQ results depending on how non-detected congeners are handled. The estimated detection limit (EDL) is used for non-detected concentrations of PCDD/PCDFdioxin and furan congeners[11]. The highest TEQ result[12] among the four TEQ results calculated using the Advanced TEQ calculator is used for the 10 samples with dioxin analyses was the TEQ calculated using the nonparametric statistical technique based on the Kaplan-Meier (KM) method for handling non-detects. Therefore, the KM method TEQ is selected. . USEPA's Advanced KM Dioxin TEQ calculator uses the 2005 WHO toxicity equivalence factors (TEFs) as recommended by in *Recommended Toxicity Equivalence Factors (TEFs) for Human Health Risk Assessments of 2,3,7,8-Tetrachlorodibenzo-p-dioxin and Dioxin-Like Compounds*, EPA/100/R 10/005 (USEPA (2010).

Only data for chemicals that the analytical laboratory could affirmatively identify are included for quantitative assessment of cancer risk and noncancer hazard for the various receptors and lots. The concentrations of Chemicals of Potential Concern (COPCs) (including metals) are conservatively assumed to be site-related (i.e., do not account for background since this is evaluated in the FS), even though some of the concentrations may include contributions from background (natural or anthropogenic). Whether this assumption materially affects the BHHRA conclusions will be evaluated during the Feasibility Study, as requested by USEPA.

3.2.2 Sample Quantitation Limits

Data quality objectives and project quantitation limit goals were documented in the USEPA-approved QAPP and provided to the laboratory prior to analysis of samples from the Site, to ensure that SQLs do not exceed (to the extent possible) the risk-based screening levels for COPC selection and are adequate for risk assessment purposes. However, as described above, SQLs for some analytical results were unavoidably elevated because of high concentrations of other co-associated chemicals that necessitated sample dilution, or other matrix interferences. Some SQLs were for non-detect results in the UCL datasets used to calculated the chemical-specific upper confidence limits (UCL) on the mean are reviewed to determine if the SQLs are "unusually high" (defined in RAGS Part A Section 5.3.2 as higher than the maximum site-wide detected concentration), and therefore, in the dataset). If a non-detect result is identified as unusually high, it is removed from the UCL dataset[13] as recommended by USEPA guidance in RAGS Part A Guidance.

Since the COPC list for shallow groundwater is determined using the maximum detected concentrations site-wide (and not for each property as it is with soil), there are instances where a shallow groundwater COPC is not detected at a specific property. Two of the 1,2-dibromo-3-

[11] Per the QAPP (Woodard & Curran 2019) and RI Work Plan (Woodard & Curran 2017), only dioxin and furan congeners were analyzed. Dioxin-like PCB congeners were not analyzed for specifically but maybe present in the Aroclor mixture to varying degrees depending on the Aroclor..Aroclor.

[12] The TEQs calculated using the nonparametric statistical technique based on the Kaplan-Meier (KM) method for handling non-detects equal the highest TEQs calculated using the Advance TEQ calculator except for the Lot 63 result. For Lot 63, the highest TEQ is calculated using the full detection limit for non-detects.

[13] Removing unusually high SQLs from the UCL datasets only applies to non-detected results. All detected results were included in the dataset.

chloropropane SQLs (0.44 mg/L and 0.044 mg/L, both from Lot 57) exceed the one detected concentration of 1,2-dibromo-3-chloropropane at the site (0.001 mg/L from Lot 69) by more than 10 times. For one of these instances, the 1,2-dibromo-3-chloropropane SQL of 0.44 mg/L at Lot 57 is 1,000 times higher than the SQLs for this chemical found in the majority of the other groundwater samples. Therefore, both Lot 57 non-detect 1,2-dibromo-3-chloropropane SQLs (0.44 mg/L and 0.044 mg/L) are considered unusually high for the matrix and have been removed from the Lot 57 UCL dataset.

Uncertainties associated with elevated quantitation limitsSQLs are discussed in Section 6.3.1.6.3.1.1.

3.3 Identification of Chemicals of Potential Concern

Chemicals of potential concern (COPCs) are identified based on the soil, groundwater, and indoor air data collected during Phase 1 and Phase 2 of the RI. COPCs are not identified based on data from temporary well points because those screening data were collected to assist in the placement of monitoring wells rather than for use in quantitative risk assessment.

COPCs are identified using a screening process consistent with the approaches described in Sections 6.1.17, 6.3.1, and 9.3.1 of the RI/FS Work Plan, which are summarized in the following subsections. The screening process compares the maximum concentration of the chemical with Regional Screening Levels (RSLs) associated with exposures to a future resident and chemical-specific toxicity values. The values used in the screening are based on a risk level of 1 x 10^{-6} (one in a million) or a Hazard Quotient = 0.1 to reflect potential exposures to multiple chemicals. The toxicity values used are based on the hierarchy of toxicity values that include: the Integrated Risk Information System or IRIS, Provisional Peer Reviewed Toxicity Values (PPRTVs), and other resources evaluated by the Superfund Technical Support Center (STSC). Chemicals identified in the screening process are retained for further evaluation and cancer risks and noncancer hazards are calculated for the various receptors identified at the Site (e.g., outdoor worker, indoor worker, future resident, etc.).

The Superfund Technical Support Center (STSC) recommended the following surrogates, which USEPA transmitted to PPG on September 18, 2018: fluorene as a surrogate for carbazole; diethylphthalate as a surrogate for dimethylphthalate; and cyclohexane as a surrogate for methylcyclohexane. The most conservative screening level for mercury, which is mercury (elemental) (CAS 7439-97-6), is used for mercury total. Since every soil sample was analyzed for both hexavalent and total chromium, total chromium is assessed with trivalent chromium screening levels for COPC selection as required by USEPA Region 2. While the current and reasonably expected future use of the Site is industrial, as discussed in Section 2.4,2.5, the selection of COPCs retained for quantitative risk assessment uses residential and tap water[14] screening levels, which may identify some chemicals as COPCs when they would not be expected to pose an unacceptable risk under the current or reasonably expected future industrial use of the Site. Residential screening levels[15] are used to select COPCs to be protective of hypothetical future exposures for a young child, the most sensitive (hypothetical) receptor. Use of Regional Screening Levels (RSLs) based on a hazard quotient (HQ) = 0.1 addresses the potential for

[14] Tapwater RSLs are used to identify COPCs in groundwater consistent with the NJDEP's default Class IIA designation of groundwater at the Site.

[15] The residential cancer RSLs assume exposures of 6 years as a child and 20 years as an adult for a total 26-year residence time. The residential noncancer RSLs assume exposures of 6 years as a child only. The residential exposure frequency is 350 days/year for soil and groundwater ingestion, dermal contact and inhalation exposures.

exposures to several chemicals that may affect the same target organ. All known human carcinogens[16] detected in soil, groundwater, or indoor air are included as COPCs~~. –~~, regardless of whether they exceed screening levels specified below. ~~Per USEPA Region 2, T~~the data used to determine COPCs in each matrix (and presented on RAGS D Table 2 in Appendix A) are the maximum concentration detected in the medium or duplicate averaged results. ~~to be consistent with the risk estimates.~~

3.3.1 Soil

For each of the 15 existing lots that comprise the Site, the maximum concentration of a chemical detected at the lot (from any depth) is compared to the USEPA's ~~May~~November 2019[17] residential RSLs calculated at a target cancer risk (TCR) of 10^{-6} and target hazard quotient (THQ) of 0.1, as specified in the SOW, and the soil lead screening levels specified by USEPA Region 2, as discussed in Section ~~4.4.1.~~4.4.8~~4.5.1~~. This comparison is shown on Appendix A, Table ~~3-1~~2.01. The locations of the maximum detected ~~COPC~~ concentrations at each Lot are presented on this table.

3.3.2 Shallow Groundwater

The maximum concentration of a chemical detected in the shallow groundwater data (site-wide) is compared to the following screening levels:

- USEPA's ~~May~~November 2019[~~18~~17~~16~~14] tap water RSLs calculated at a TCR of 10^{-6} and THQ of 0.1.
- USEPA's residential groundwater vapor intrusion screening levels (VISLs)[19] calculated at a ~~Target Cancer Risk (~~TCR~~)~~ of 10^{-6} and THQ of 0.1 using Henry's law constants at 25 degrees Celsius[~~20~~].

This comparison is shown on Appendix A, Table ~~3-~~2.02. Separate COPC lists ~~we~~are developed based on each set of screening levels. The locations of the site-wide maximum detected ~~COPC~~ concentrations are presented on the ~~is~~ table.

3.3.3 Deep Groundwater

The maximum concentration of a chemical detected in the deep groundwater data (site-wide) is compared to USEPA's ~~May~~November 2019[17~~16~~14] tap water RSLs calculated at a TCR of 10^{-6} and ~~Total Hazard Quotient (~~THQ~~)~~ of 0.1. This comparison is shown on Appendix A, Table ~~3-3~~2.02. The locations of the site-wide maximum detected concentrations are presented on this table.

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[16] Classified as "Group A - Human Carcinogen" per USEPA's 1986 Guidelines for Carcinogen Assessment (USEPA, 1986) or "Carcinogenic to Humans" per the USEPA's 2005 Guidelines for Carcinogen Risk Assessment (USEPA, 2005a).

[17] The most current version of the RSLs at the time of submittal were used in the risk assessment (November 2019).

~~[18] The most current version of the RSLs at the time of submittal were used in the risk assessment (May 2019).~~

[19] Section 6.1.17 of the RI/FS Work Plan also lists the 2013 New Jersey VISLs as screening levels. However, because the NJ VISLs do not identify any additional COPCs and because this BHHRA is prepared according to USEPA guidance, using only USEPA's VISLs is appropriate and sufficient. Therefore, the NJ VISLs are not presented in this report.

~~[20] Section 6.1.17 of the RI/FS Work Plan also lists the 2013 New Jersey VISLs as screening levels. However, these VISLs do not identify any additional COPCs, and therefore, are not presented in this report.~~

3.3.4 Indoor Air

The indoor air samples were analyzed for a specific list of VOCs, as discussed in Section ~~3.1.3.~~3.1.3. The maximum concentration of a chemical detected in the indoor air data (site-wide) is compared to USEPA's residential indoor air VISLs[21] calculated at a TCR of 10^{-6} and THQ of 0.1. This comparison is shown on Appendix A, Table ~~3-4~~2.03. The locations of the site-wide maximum detected ~~COPC~~ concentrations are presented on this table.

3.3.5 Results

Table 3-~~5~~1 summarizes the lists of soil COPCs (one for each lot), the list of shallow groundwater COPCs using tap water RSLs (site-wide), the list of shallow groundwater COPCs using USEPA VISLs (site-wide), the list of deep groundwater COPCs using tap water RSLs (site-wide), and the list of indoor air COPCs (site-wide).

Due to a lack of toxicity information and screening levels, ~~the following chemicals are~~2-nitrophenol is retained as ~~COPCs: methylcyclohexane; carbazole; dimethylphthalate; and 2-nitrophenol.~~ a COPC, and will be discussed in the Uncertainty Section (Section 6.3.5.2).

Calcium, magnesium, and potassium are not retained as COPCs since they are essential nutrients (USEPA, 1989). In addition, sodium is not retained because the shallow groundwater is under tidal influence of the adjacent Passaic River and site-specific conductivity readings of the shallow groundwater indicate possible brackish conditions; sodium concentrations are naturally present at higher levels. ~~Selection of the COPCs are also presented in RAGS Part D Table 2 format in Appendix B. The occurrence, distribution and selection of COPCs are summarized in Table 2.01 for soil (lot by lot), Table 2.02 for shallow groundwater (site-wide), Table 2.03 for deep groundwater (site-wide), and Table 2.04 for indoor air. These tables include the minimum and maximum concentrations along with the detection frequency. The maximum concentration listed on the tables is used to identify COPCs.~~

[21] USEPA's residential indoor air VISLs are the same values as the November 2019 residential indoor air RSLs.

4. EXPOSURE ASSESSMENT

~~This section presents the~~Exposure assessment is the process of estimating the type and magnitude, frequency, and duration of a human receptor's exposures to chemicals in the environment. The three main elements of exposure assessment are the characterization of exposure setting, the identification of potential exposures (i.e., conceptual site model) and the quantification of exposure. The quantification of exposure includes two main elements, the calculation of the ~~exposure point concentration~~EPC and the calculation of intakes e.g., amount of soil ingested on a daily basis that results in a calculated dose in units of milligrams/kilograms/day (mg/kg-day). ~~-~~The potential exposure pathways under current and anticipated future land use at and around the 15 lots that comprise the Site~~. These exposure pathways~~ are summarized in the diagram on Figure 4-1, and are presented with more details in the following RAGS Part D tables in Appendix ~~B~~A: Table 1.01 for current exposures at occupied lots; Table 1.02 for current exposures at unoccupied lots; and Table 1.03 for future exposures at all lots. The lots grouped into each of these tables are expected to have the same set of exposure pathways, based on consideration of the lots' current and expected (as well as hypothetical) future uses. These exposure pathways are discussed in Section ~~4.1.~~4.1. The methodology used to calculate exposure is discussed in Section 4.2. The calculation of exposure point concentrations (EPCs) is discussed in Section ~~4.2,~~4.3, and the exposure factors for each receptor are discussed in Section ~~4.3.~~4.4. The methods for evaluating exposure to lead ~~is~~are discussed in Section ~~4.4.~~0~~4.5~~.

~~4.1 Identification of Potential Exposures~~

4.1 Conceptual Site Model

Currently, outdoor workers, indoor workers, and visitors are present at the occupied lots (Lots 1, 57, 59, 60, 62, 69, and 70), while utility workers and trespassers are potentially present at any lot (i.e., occupied or unoccupied). Based on information provided in the Reuse Assessment Report (Appendix O of the RIR), Lots 57, 58, 61, 63, 64, 68, and 70 may be redeveloped in the near future, and therefore, construction workers would be present at those lots; the other lots may be redeveloped at some point in the future and, therefore, construction workers also may be present at those lots. Under future conditions, every receptor listed in Figure 4-1 is assumed to be present at every lot (i.e., each lot is assessed assuming future redevelopment under industrial land use and residential land use, even though residential land is improbable). ~~Exposures to~~Current exposures of off-site workers and off-site residents to on-site soil via inhalation of COPCs that may migrate in air/dust from the Site are considered. Future exposures of off-site workers to shallow groundwater that has migrated off-site in the future and exposure to shallow and deep groundwater from potable use are also considered~~ under current and future conditions~~. These receptors and their potential exposures are summarized in Figure 4-1 and discussed in the following subsections. As discussed in Section 1, this BHHRA evaluated reasonable maximum exposures (RME). The BHHRA is conducted assuming ~~in~~ the absence of remedial actions and/or ICs~~institutional controls~~.

4.1.1 Current Land Use

The Site is zoned for industrial use (City of Newark, 2013), and is sub-divided into 15 lots, seven of which are occupied and the other eight are unoccupied. As discussed in Section ~~2~~2 and summarized in Table 2-1, the ~~7~~seven occupied lots ~~(~~are Lots 1, 57, 59, 60, 62, 69, and 70~~)~~ and ~~3 of~~ the eight unoccupied lots ~~(Lots 65, 66, and 67) are owned by several entities, and the other 5 unoccupied lots (~~are Lots 58, 61, 63, 64, 65, 66, 67 and 68~~) are owned by the City of Newark. The~~. Approximately 70% of the Site is ~~mostly~~ paved or covered by buildings, and the Site is partially fenced.

Under current land use, the potentially exposed populations at and around the Site are conservatively assumed to include all the following:

- Outdoor Workers (only at occupied lots);
- Indoor Workers (only at occupied lots);
- Utility Workers;
- Construction Workers;
- Trespassers; (adolescents and adults);
- Visitors (children and adults; only at occupied lots);
- Off-Site Workers and Residents (children and adults; via wind transport). of on-site soil).

These receptors are assumed to be adults except for where noted.

Currently, outdoor and indoor workers are present at occupied lots (i.e., Lots 1, 57, 59, 60, 62, 69, and 70). Outdoor workers as described in USEPA's soil screening guidance (USEPA, 2002b) are conservatively assumed to be at the Site, and are evaluated as the receptor with the highest outdoor exposures. These workers are assumed to be full-time employees at the site who spend most of the workday outdoors conducting maintenance activities. These activities (e.g., moderate digging, landscaping) typically involve exposures to surface soil (at depths of 0 to 2 feetft. bgs). Potential routes of exposure to surface/shallow soil would include incidental ingestion, dermal contact, and inhalation of airborne soil particulates. Inhalation exposure to volatile constituents from surface and subsurface soil (i.e., 0 ft. bgs to maximum sampled depth of approximately 13 ft. bgs) is also possible while outdoors. As discussed in Section 4.3,4.4.1, the exposure factors for these potential exposures are those recommended by USEPA (2002b), except where updated by OSWER Directive 9200.1-120 (USEPA, 2014b). Part-time and temporary on-site employees would have outdoor exposures that are lower than those for the long-term outdoor workers and thus are adequately addressed by the evaluation of these higher exposed receptors.

Indoor workers are full-time employees at the site who spend most, if not all, of the work day in indoor activitiesindoors and may be exposed via inhalation of volatile constituents from subsurface soil (i.e., 0 ft. bgs to maximum sampled depth of approximately 13 ft. bgs) and shallow groundwater due to vapor intrusion. As described in USEPA (2002b), an indoor worker has no direct contact with outdoor soils. This worker may, however, be exposed to contaminants through ingestion of and dermal contact with outdoor surface (0 to 2 ft. bgs) soils that have been incorporated into indoor dust. The exposure factors for evaluating these potential vapor intrusion exposures are discussed in Section 4.3. During brief periods outdoors, these workers may have exposure to contaminants in surface soil (0 to 2 feet bgs) in unpaved areas via incidental ingestion, dermal contact, and inhalation of soil vapors and airborne soil particulates. They may also have ingestion and dermal contact exposures indoors, to the extent such soil is tracked indoors. These exposures to soil are conservatively evaluated using the outdoor workers' soil exposures.4.4.2. As stated above, part-time and temporary on-site employees would have indoor exposures that are lower than those for the long-term indoor workers.

Utility workers occasionally perform repair of underground utilities at the Site and are potentially present at any lot (i.e., occupied or unoccupied). The depth of underground utilities (i.e., the surface of the frost line) is typically to four ft. according to USEPA Region 2 and consistent with recommendations from the NJ board of Utilities (https://www.state.nj.us/bpu/agenda/rules/natgaspipelinereadoption.pdf). . Utility workers are not employees at the Site, and may be on-site occasionally to repair underground utilities which involves exposure to surface and subsurface soil (0 to 4 feetft. bgs) and shallow groundwater. during subsurface excavation. As shown on Table 2-10 of the RIR, groundwater is shallower than 4 ft. bgs in some but not all portions of the Site. Therefore, assuming utility workers may contact groundwater during excavation at any property is conservative. Potential routes of exposure would include incidental ingestion, dermal contact, and inhalation of soil or groundwater vapors and airborne soil particulates. The exposure factors for evaluating these potential exposures are discussed in Section 4.4.3.

Underutilized (or unoccupied) Lots 57, 58, 61, 63, 64, 68, and 70 may be redeveloped in the near future, and therefore, construction workers would be present at those lots. Construction workers are contractors, not employees at the Site, and may be on-site for relatively short periods (up to several months) to perform construction activities (e.g., building construction). During such construction activities, these construction these workers may contact surface and subsurface soil (i.e., 0 feetft. bgs to maximum sampled depth of approximately 13 feetft. bgs) and shallow groundwater. during subsurface excavation. Potential routes of exposure would include incidental ingestion, dermal contact, and inhalation of soil or groundwater vapors and airborne soil particulates. The exposure factors for evaluating these potential exposures are discussed in Section 4.4.4.

Trespassers are potentially present at any lot (i.e., occupied or unoccupied). Based on observations of USEPA contractors and others, it appears that older adolescents/teenagers are the most likely age group to engage in trespassing activities at the Site, and thus, USEPA required that an adolescent trespasser age range from 10 to 18 be evaluated in addition to an adult trespasser. Trespassers have been frequently observed at the site both in cars and on foot by USEPA staff and RI contractors. Evidence of trespassing, including extensive graffiti inside and outside of abandoned buildings, frequent extensive illegal dumping and frequent vandalism of property fencing, has also been observed by USEPA staff and RI contractors. These trespassers may contact contaminants in surface (0 to 2 ft. bgs) soil in unpaved areas. Potential routes of exposure to surface soil would include incidental ingestion, dermal contact, and inhalation of airborne soil particulates. In these areas of the Site, trespassers may also inhale vapors emitted from exposed soil.Inhalation exposure to volatile constituents from surface and subsurface soil (i.e., 0 ft. bgs to maximum sampled depth of approximately 13 ft. bgs) is also possible while outdoors. The exposure factors for evaluating these potential exposures for adolescent trespassers are discussed in Section 4.3. Adult4.4.5. Since adult trespassers have been frequently seen at the site, adult trespassers' exposures to soil are conservatively evaluated using the outdoor workers' soil exposures.

Visitors could potentially be present at the occupied lots. Visitors are children and adults who are on-site occasionally and for short periods during which they may contact contaminants in surface (0 to 2 ft. bgs) soil in unpaved areas via incidental ingestion, dermal contact, and inhalation of airborne soil particulates and vapors emitted from exposed soil. These potential exposures are conservatively evaluated by scaling residential soil exposures to account for the reduced. Inhalation exposure frequency and exposure time spent on-site, as discussed in Section 6.2.1.6.to volatile constituents from surface and subsurface soil (i.e., 0 ft. bgs to maximum sampled depth of approximately 13 ft. bgs) is also possible while outdoors. Visitors may also be exposed via inhalation of volatile constituents from subsurface soil (i.e., 0 ft. bgs to maximum sampled depth of approximately 13 ft. bgs) and shallow groundwater due to vapor intrusion while indoors, and . The exposure factors for evaluating these potential exposures are evaluated using indoor workers' exposures. for visitors are discussed in Section 4.4.6.

Adjacent to the Site, east of McCarter Highway, are other industrial properties. Off-site workers could potentially be exposure to on-site surface (0 to 2 ft. bgs) soil that migrates off-site via windblown soil vapor and particulates or on-site groundwater that might migrate off-site in the future in the small area in the northwestern corner of the Site. Off-site worker exposures are evaluated using on-site worker exposures. No site-related contamination (soil or groundwater) is known to extend off-site.

West of McCarter Highway are residential properties with medium-density residential units. While no site-related contamination is known to extend off-site, off-site Off-site residents and workers may be exposed to constituents in on-site surface (0 to 2 ft. bgs) soil that migrate off-site via windblown soil vapor and particulates emanating from on-site areas without groundcover. The potential for this exposure is expected to be minimal for off-site residents since the residences nearest the Site are across McCarter Highway (which is elevated) and uphill from the Site. Off-site workersresidential exposures to on-site soil that migrates off-site via windblown soil vapor and particulates are conservatively evaluated using on-site workerfuture residential exposures. No site-related contamination (soil or groundwater) is known to extend off-site.

Shallow and deep groundwater are not currently used for potable purposes at or around the Site, and as indicated previously, the site-specific conductivity readings of the shallow groundwater indicate possible brackish conditions. Potable water at the Site and surrounding area is supplied by the City of Newark.

4.1.2 Future Land Use

Potential future exposures are evaluated under future industrial/commercial land use and under hypothetical future residential land use. Potential future exposures are evaluated for every receptor listed under current land use at each lot with the addition of a hypothetical future resident (i.e., **each** lot is assessed assuming future redevelopment under both industrial land use and residential land use).

Future Industrial/Commercial Land Use

Because the Site is located within a designated "dedicated industrial zone" for industrial and commercial uses, the most likely future use for all 15 lots is industrial. Under post-redevelopment industrial reuse of the Site, the potentially exposed populations are the same as for current land use except that outdoor workers, indoor workers, and visitors may be present at any of the redeveloped lots. These potential receptors and exposure pathways are discussed in Section 4.1.1.4.1.1. If the lots are redeveloped for a permitted use other than industrial (e.g., commercial use, park, open space), potential exposures would be lower than those being evaluated for industrial land use using the receptors discussed in Section 4.1.1.4.1.1.

Under future industrial/commercial land use, the potentially exposed populations at and around the Site are conservatively assumed to include all the following:

- Outdoor Workers;
- Indoor Workers;
- Utility Workers;

- Construction Workers;
- Trespassers (adolescents and adults);
- Visitors (children and adults)
- Off-Site Workers (via wind transport of on-site soil and migration of shallow and deep groundwater);
- Off-Site Residents (children and adults; via wind transport of on-site soil and migration of deep groundwater).

These receptors are assumed to be adults expect except for where noted.

Outdoor workers as described in USEPA's soil screening guidance (USEPA, 2002b) are conservatively assumed to be at the Site and are evaluated as the receptor with the highest outdoor exposures. These workers are assumed to be full-time employees at the Site who spend most of the workday outdoors conducting maintenance activities. These activities (e.g., moderate digging, landscaping) typically involve exposures to surface soil (at depths of 0 to 2 ft. bgs). Potential routes of exposure to surface/shallow soil would include incidental ingestion, dermal contact, and inhalation of airborne soil particulates. Inhalation exposure to volatile constituents from surface and subsurface soil (i.e., 0 ft. bgs to maximum sampled depth of approximately 13 ft. bgs) is also possible while outdoors. Potential exposures from all sampled depths (i.e., 0 ft. bgs to maximum sampled depth of approximately 13 ft. bgs) for all routes of exposure are also assessed, to evaluate the scenario in which soil below the 0 to 2 ft. depth interval is brought to the surface in the course of site redevelopment. As discussed in Section 4.4.1, the exposure factors for these potential exposures are those recommended by USEPA (2002b), except where updated by OSWER Directive 9200.1-120 (USEPA, 2014b). Part-time and temporary on-site employees would have outdoor exposures that are lower than those for the long-term outdoor workers and thus are adequately addressed by the evaluation of these higher exposed receptors.

Indoor workers are full-time employees at the Site who spend most, if not all, of the work day indoors and may be exposed via inhalation of volatile constituents from subsurface soil (i.e., 0 ft. bgs to maximum sampled depth of approximately 13 ft. bgs) and shallow groundwater due to vapor intrusion. As described in USEPA (2002b), an indoor worker has no direct contact with outdoor soils. This worker may, however, be exposed to contaminants through ingestion of outdoor surface (0 to 2 ft. bgs) soils that have been incorporated into indoor dust. Potential routes of exposure to surface soil incorporated into indoor dust would include incidental ingestion and dermal contact. Potential exposures from all sampled depths (i.e., 0 ft. bgs to maximum sampled depth of approximately 13 ft. bgs) are also assessed, to evaluate the scenario in which soil below the 0 to 2 ft. depth interval is brought to the surface in the course of site redevelopment. The exposure factors for evaluating these potential exposures are discussed in Section 4.4.2. As stated above, part-time and temporary on-site employees would have indoor exposures that are lower than those for the long-term indoor workers.

Utility workers occasionally perform repair of underground utilities at the Site. Utility workers are not employees at the Site and may be on-site occasionally to repair underground utilities which involves exposure to surface and subsurface soil (0 to 4 ft. bgs) and shallow groundwater during subsurface excavation. Potential routes of exposure would include incidental ingestion, dermal contact, and inhalation of soil or groundwater vapors and airborne soil particulates. For soil exposures, potential exposures from all sampled depths (i.e., 0 ft. bgs to maximum sampled depth of approximately 13 ft.

bgs) for all routes of exposure are also assessed, to evaluate the scenario in which soil below the 0 to 2 ft. depth interval is brought to the surface in the course of site redevelopment. The exposure factors for evaluating these potential exposures are discussed in Section 4.4.3.

Construction workers are contractors, not employees at the Site, and may be on-site for relatively short periods (up to several months) to perform construction activities (e.g., building construction). During such construction activities, construction these workers may contact surface and subsurface soil (i.e., 0 ft. bgs to maximum sampled depth of approximately 13 ft. bgs) and shallow groundwater during subsurface excavation. Potential routes of exposure would include incidental ingestion, dermal contact, and inhalation of soil or groundwater vapors and airborne soil particulates. The exposure factors for evaluating these potential exposures are discussed in Section 4.4.4.

After redevelopment, trespassers would potentially be present at any lot, although the redeveloped site would be less attractive to trespassers since vacant buildings will no longer be present. Trespassers are adolescents (10 to 18 years old) and adults. Trespassers may contact contaminants in surface (0 to 2 ft. bgs) soil in unpaved areas. Potential routes of exposure to surface soil would include incidental ingestion, dermal contact, and inhalation of airborne soil particulates. Inhalation exposure to volatile constituents from surface and subsurface soil (i.e., 0 ft. bgs to maximum sampled depth of approximately 13 ft. bgs) is also possible while outdoors. Potential exposures from all sampled depths (i.e., 0 ft. bgs to maximum sampled depth of approximately 13 ft. bgs) for all routes of exposure are also assessed, to evaluate the scenario in which soil below the 0 to 2 ft. depth interval is brought to the surface in the course of site redevelopment. The exposure factors for evaluating these potential exposures for adolescent trespassers are discussed in Section 4.4.5. Adult trespassers' exposures to soil are conservatively evaluated using the outdoor workers’ soil exposures.

Visitors are children and adults who are on-site occasionally and for short periods during which they may contact contaminants in surface (0 to 2 ft. bgs) soil in unpaved areas via incidental ingestion, dermal contact, and inhalation of airborne soil particulates. Inhalation exposure to volatile constituents from surface and subsurface soil (i.e., 0 ft. bgs to maximum sampled depth of approximately 13 ft. bgs) is also possible while outdoors. Potential exposures from all sampled depths (i.e., 0 ft. bgs to maximum sampled depth of approximately 13 ft. bgs) for all routes of exposure are also assessed, to evaluate the scenario in which soil below the 0 to 2 ft. depth interval is brought to the surface in the course of site redevelopment. Visitors may also be exposed via inhalation of volatile constituents from subsurface soil (i.e., 0 ft. bgs to maximum sampled depth of approximately 13 ft. bgs) and shallow groundwater due to vapor intrusion while indoors. The exposure factors for evaluating these potential exposures for visitors are discussed in Section 4.4.6.

Adjacent to the Site, east of McCarter Highway, are other industrial properties. Off-site workers could potentially be exposed to on-site surface (0 to 2 ft. bgs) soil that migrates off-site via windblown soil vapor and particulates or on-site shallow groundwater that might migrate off-site in the future in the small area in the northwestern corner of the Site. Potential exposures from all sampled depths (i.e., 0 ft. bgs to maximum sampled depth of approximately 13 ft. bgs) are also assessed, to evaluate the scenario in which soil below the 0 to 2 ft. depth interval is brought to the surface in the course of future site reredevelopment. As discussed in Section 2.3, shallow groundwater at the Site is under tidal influence of the adjacent Passaic River and flows toward the River, except at a small area in the northwestern corner of the Site. This off-site area to the northwest is zoned industrial[22] and is

[22] As shown in Figure 5 of the Reuse Assessment Report (Appendix O of the RIR).

currently a truck storage facility. Shallow groundwater flow off-site in this direction is expected to be limited by the extent of the historic fill. Off-site worker exposures to on-site soil that migrates off-site via windblown soil vapor and particulates and on-site shallow groundwater that might migrate off-site in the future are evaluated using on-site worker exposures.

West of McCarter Highway are residential properties with medium-density residential units. While shallow groundwater does not flow under residential areas since it is limited by the extent of the historic fill, off-site residents may be exposed to constituents in on-site surface (0 to 2 ft. bgs) soil that migrate off-site via windblown soil vapor and particulates emanating from on-site areas without groundcover. Potential exposures from all sampled depths (i.e., 0 ft. bgs to maximum sampled depth of approximately 13 ft. bgs) are also assessed, to evaluate the scenario in which soil below the 0 to 2 ft. depth interval is brought to the surface in the course of site redevelopment. The potential for this exposure is expected to be minimal for off-site residents since the residences nearest the Site are across McCarter Highway (which is elevated) and uphill from the Site. Off-site residential exposures are evaluated using on-site future residential exposures.

While shallow groundwater at the Site is classified by default by the NJDEP as Class IIA, potable use of the shallow groundwater in the future is improbable since the Site and surrounding area use water supplied by the City and site-specific conductivity readings of the shallow groundwater indicate possible brackish conditions due to tidal influence of the adjacent Passaic River. However, for consistency with NJDEP's classification and to facilitate development of appropriate ICs~~institutional controls~~ for the Site, suitability of the shallow groundwater for potable[23] use is evaluated. If shallow groundwater is used for drinking, showering or washing (i.e., potable use) in the future, outdoor workers, indoor workers, visitors, and off-site workers could be exposed through ingestion, dermal contact, and inhalation of vapors during potable use. Other pathways associated with nonpotable groundwater exposures, such as vapor intrusion or via inhalation of vapor in ambient air, are also evaluated for pertinent receptors, as discussed above.
Deep groundwater at the Site is not currently used for any purpose and future groundwater use is unlikely since the Site and surrounding area use water supplied by the City. However, if deep groundwater is used for drinking, showering or washing in the future (i.e., potable use), outdoor workers, indoor workers, visitors, off-site workers and off-site residents could be exposed through ingestion, dermal contact, and inhalation of vapors during potable use.

Hypothetical Future Residential Land Use

Portions of five lots within the Site are currently subject to NJDEP Deed Notice/Declaration of Environmental Restriction, which are institutional controls[24] that limit use of the properties to non-residential uses, as listed on Table 2-1. Residential land use at the Site in the future is improbable since the Site is located within a dedicated industrial zone where residential use is not permitted, as discussed in Section ~~2.4.~~2.5. The BHHRA includes a hypothetical residential scenario which assumes the Site will have medium-density residential units like ~~those west of McCarter Highway~~that west of McCarter Highway, to facilitate development of appropriate institutional controls for the Site. For this purpose, the BHHRA evaluates, for each lot, on-site future residential soil exposure via incidental

[23] The evaluation of groundwater exposure via potable use also includes nonpotable groundwater uses such as car or parts washing.

[24] The BHHRA is conducted in the absence of remedial actions and institutional controls.

ingestion, dermal contact, and inhalation of soil vapor and particulates, as well as exposure via vapor intrusion from soil and shallow groundwater.

While shallow groundwater at the Site is classified by NJDEP as Class IIA[25], potable and nonpotable use of the shallow groundwater in the future is improbable since the Site and surrounding area use water supplied by the City and site-specific conductivity readings of the shallow groundwater indicate possible brackish conditions due to tidal influence of the adjacent Passaic River. However, for consistency with NJDEP's default classification and to facilitate development of appropriate institutional controls for the Site, suitability of the shallow groundwater for potable and nonpotable[26] usesuse is evaluated by comparing the. If shallow groundwater data to USEPA's RSLs for tap water. is used in the future, hypothetical future residents could be exposed through ingestion, dermal contact, and inhalation of vapors during potable use. Other pathways associated with nonpotable groundwater exposures, such as vapor intrusion or via inhalation of vapor in ambient air, are also evaluated. Deep groundwater at the Site is not currently used for any purpose and future groundwater use is unlikely since the Site and surrounding area use water supplied by the City. However, if deep groundwater is used in the future, outdoor workers, indoor workers, visitors orhypothetical future residents could be exposed through ingestion, dermal contact, and inhalation of vapors during potable and nonpotable uses. Suitability of the deep groundwater for potable and nonpotable uses is evaluated by comparing the deep groundwater data to USEPA's RSLs for tap water. use.

4.2 As discussed in Section 2.3, shallow groundwater at the Site is under tidal influence of the adjacent Passaic River and flows toward the River, except at a small area in the northwestern corner of the Site. The off-site area to the north of this area is zoned industrial[27] and is currently a truck storage facility. Shallow groundwater flow off-site in this direction is expected to be limited by the extent of the historic fill, which may extend off-site. Off-site workers exposure to on-site soil that migrates off-site via windblown soil vapor and particulates or on-site groundwater that might migrate off-site in the future in the small area in the northwestern corner of the Site are conservatively evaluated using on-site worker exposures.Quantification of Exposure

In this section, the basic approach for calculating human intake levels is presented. Exposure estimates represent the daily dose of a chemical taken into the body, averaged over the appropriate exposure period. Chemical intake is expressed in terms of a dose, having units of milligram chemical per kilogram body weight per day (mg/kg-day). In general, quantitative exposure estimates involve the following:

- determination of exposure point concentrations (the concentrations of COPCs in environmental media at the point of human exposure, see Section 4.3);
- identification of applicable human exposure models and input parameters (exposure frequency, duration, etc., see Section 4.4); and

[25] Per N.J.A.C. 7:9C-1.5 (e) 1, the primary designated use for Class II-A groundwater shall be potable water and conversion (through conventional water supply treatment, mixing or other similar technique) to potable water. Class II-A secondary designated uses include agricultural water and industrial water.

[26] Hypothetical future nonpotable groundwater use is conservatively evaluated using USEPA's RSLs for tap water (i.e., potable use).

[27] As shown in Figure 5 of the Reuse Assessment Report (Appendix O of the RIR).

- estimation of human intakes using exposure algorithms. The primary source for the exposure algorithms used in the risk assessment is USEPA's Risk Assessment Guidance for Superfund, Part A (RAGS) (USEPA, 1989), Part D (USEPA, 2001), Part E (USEPA, 2004b), and Part F (USEPA, 2009).

The generalized equation for calculating chemical intakes is:

$$\text{Intake}\left({}^{mg}/_{kg\text{-}day}\right) = \frac{EPC \times CR \times EF \times ED \times CF \times RBA}{BW \times AT}$$

where:

Intake = the amount of chemical at the exchange boundary (mg/kg body weight/day)
EPC = exposure point concentration - the average chemical concentration contacted over the exposure period at the exposure point (e.g., mg/kg-soil)
CR = contact rate - the amount of affected medium contacted per unit time or event (e.g., mg/day)
EF = exposure frequency - describes how often exposure occurs (days/year)
ED = exposure duration - describes how long exposure occurs (year)
RBA = relative bioavailability adjustment (unitless)
CF = conversion factor (10^{-6} kg/g)
BW = body weight - the average body weight over the exposure period (kg-body weight)
AT = averaging time - period over which exposure is averaged (days) over a lifetime for evaluating cancer risks and over the exposure duration for evaluating non-cancer health hazards

Exposure factors (e.g., contact rate, exposure frequency, exposure duration, body weight) describe the exposure of a receptor for a given exposure scenario. These values are the input parameters for the exposure algorithms used to estimate chemical intake (USEPA, 1989; 1991a; 1992a, 1997f). The general equation above is slightly modified for each pathway. The specific exposure factors for each pathway are summarized and discussed in detail in Section 4.4.

For each of the potentially complete exposure pathways identified in Figure 4-1 and RAGS Part D Table 1, RME exposure estimates are calculated in the BHHRA. RME is defined as the maximum exposure that is reasonably expected to occur at the Site (USEPA, 1989). A combination of USEPA recommended values from the USEPA's Standard Default Exposure Assumptions (USEPA 2014b) and site-specific values are used for the input parameters.

Potential exposures to lead in soil are evaluated separately from the assessment for other COPCs because USEPA (2003b) evaluates the significance of lead exposures using blood lead level as an index of exposure, rather than in terms of cancer risk or noncancer hazards.

~~4.2~~4.3 Calculation of Exposure Point Concentrations

EPCs for soil, groundwater, and indoor air are calculated following the methodology in the following sub-sections and are shown in RAGS Part D Table 3 format in Appendix ~~B~~A.

~~4.2.1~~4.3.1 Exposure Units

According to USEPA guidance (1989), the ~~exposure point concentration (~~EPC~~)~~ should be a conservative estimate of the arithmetic mean concentration to which a receptor is exposed over the duration of exposure. In calculating an EPC for a receptor, the concentration data used should be representative of the area over which the receptor is expected to contact, and for which it is reasonable to assume that the amount of time the receptor spends at different parts of the area is approximately the same (USEPA, 1992b). Then the concentration data for such an exposure unit may be used in calculating ~~a 95%~~an upper confidence limit (UCL) on the arithmetic mean to represent the EPC.

For evaluating potential exposures to soil and shallow groundwater at this Site, the EPCs are calculated by using the 15 existing lots as the exposure units. Use of these exposure units for evaluating current potential exposures is consistent with the current activity patterns of the more highly exposed receptors discussed in Section ~~4.1.1~~4.1.1 (e.g., outdoor worker, indoor worker); these exposure units may be conservative for other receptors, such as trespassers who may spend time at multiple unoccupied lots.

For evaluating future potential exposures to soil and shallow groundwater, the 15 lots were chosen as the exposure units in consultation with USEPA. The choice was based on the following considerations: (1) no specific plans for redevelopment of the Site are available; (2) different lots may be developed at different times by different owners (see Table 2-1); and (3) the lots are relatively small (see Table 2-1), so subdivision of lots is unlikely during future site redevelopment. If lots are combined during future site redevelopment, the EPCs calculated in the BHHRA may be higher than necessary for the combined lots.

For evaluating future potential exposures to deep groundwater, the entire Site is used as the exposure unit, because of the limited number of deep groundwater samples and the only potential future exposure is potable ~~and nonpotable~~ groundwater use.

For evaluating current potential exposures due to vapor intrusion, each occupied on-site building from which an indoor air sample was collected is used as the exposure unit.

~~4.2.2~~4.3.2 Sampled Media

For each of the 15 lots, soil EPCs for each soil COPC for that lot are calculated using data for: surface soil (0 to 2 ~~feet~~ft. bgs); depth of utilities (0 to 4 ~~feet~~ft. bgs)[28]; and all depths (0 ~~feet~~ft. bgs to maximum sampled depth of approximately 13 ~~feet).~~ft.). Although receptors could have exposure to soil at other depth intervals, these three intervals are considered the most relevant and useful for the receptors being evaluated, based on consultation with USEPA. The calculation of soil EPCs for these depth intervals is discussed in the next ~~two~~three subsections. These are followed by subsections discussing the calculation of EPCs for shallow groundwater, deep groundwater, and indoor air.

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[28] Samples with top depth < 2 ~~feet~~ft. are assigned to the 0 to 2 ~~foot~~ft. interval, which includes samples collected under concrete (see footnote ~~4).~~8~~7~~4). All samples with top depth < 4 ~~feet~~ft. are assigned to the 0 to 4 ~~foot~~ft. interval.

~~4.2.2.1~~4.3.2.1 Soil – Surface (0 to 2 ~~feet~~ft. bgs)

The surface soil EPCs are used to assess exposure for outdoor workers, trespassers, visitors, future residents, off-site workers and off-site residents.

For each lot, a ~~95%~~ UCL on the mean[29] is calculated for each soil COPC for that lot using the surface soil data collected at that lot. The non-detect results (represented by SQLs) are handled using the Kaplan-Meier method included in USEPA's ProUCL software, after removing unusually high SQLs (i.e., those higher than the maximum detected concentration~~)~~, see Section 3.2.2) as recommended in Section 5.3.2 of RAGS Part A. Where multiple UCLs are listed as "suggested UCLs to use" by ProUCL, the minimum UCL was selected. If the UCL is greater than the maximum detected concentration in the data set or if ProUCL did not generate a UCL due to low detection within the dataset, the maximum detected concentration in the data set is used as the EPC, consistent with Section 6.4.1 of RAGS Part A. If ProUCL did not generate a UCL due to no detections within the dataset, one half of the max SQL is (conservatively) used as the EPC. The ProUCL outputs for UCL calculations and summary of unusually high SQLs are provided in Appendix E. Outliers in each data set (if any) are identified using ProUCL Rosner and Dixon tests. The goal of the outlier analysis is to identify hot spots, which are evaluated in the uncertainty analysis (Section ~~6.3).~~6.3).

~~4.2.2.2~~4.3.2.2 Soil – Depth of Utilities (0 to 4 ~~feet~~ft. bgs)

The EPCs based on soil data from the depth of underground utilities (the surface to the frost line while repairing utilities, typically to four ~~feet~~ft. according to USEPA Region 2) are used for assessing exposure of utility workers. For each lot, a ~~95%~~ UCL on the mean is calculated for each soil COPC for that lot using soil data collected from 0 to 4 ~~feet~~ft. bgs. The methodology for handling non-detects, UCLs greater than the maximum detected concentration, and outliers is the same as for surface soil EPCs.

~~4.2.2.3~~4.3.2.3 Soil – All Depths

The soil EPCs based on data from "all depths" (i.e., ground surface to maximum sampled depth of approximately 13 ~~feet)~~ft.) are used to assess construction worker exposures, exposure via vapor intrusion, as well as exposure of outdoor workers, utility workers, trespassers, visitors, future residents, off-site workers, and off-site residents if subsurface soil is moved to the surface in the future during site redevelopment (e.g., while installing building footers/foundations or underground utilities).

For each lot, a ~~95%~~ UCL on the mean is calculated for each soil COPC for that lot using all the soil data (i.e., from any depth) collected at that lot. The methodology for handling non-detects, UCLs greater than the maximum detected concentration, and outliers is the same as for surface soil EPCs.

~~4.2.2.4~~4.3.2.4 Shallow Groundwater

Shallow groundwater EPCs are used to assess construction worker exposures via groundwater contact and exposure via vapor intrusion. For these exposure pathways, a ~~95%~~ UCL on the mean is calculated for each lot and groundwater COPC ~~for a lot~~ using all shallow groundwater data (i.e., from all RI sampling rounds) collected at that lot. The methodology for handling non-detects, UCLs greater than the maximum concentration, and outliers is the same as for the surface soil EPCs. If ~~a site-wide~~

[29] If the UCL suggested by ProUCL is based on 95% H distribution statistic, then the methodology presented in ProUCL Technical Guide, Section 2.5.1.3 and Table 2-10 are used to individually select the UCLs, per USEPA Region 2.

~~shallow groundwater COPC was~~ProUCL did not ~~detected in~~generate a UCL due to no detections within the dataset, one half of the ~~maximum~~max SQL ~~was~~is ~~(conservatively)~~ used as the EPC.

For evaluating the drinking water pathway, the EPC for each groundwater COPC at a lot is set to the maximum detected concentration of the COPC at that lot. If a COPC was not detected within the dataset, one half of the maximum SQL is (conservatively) used as the EPC. This approach is taken because it is impractical at this Site to calculate EPCs using the 3 wells at the center of the plume as recommended in OSWER Directive 9283.1-42. At this Site, exceedances of tap water RSLs are widespread in the shallow groundwater across the Site, so that distinct plumes are not apparent. As shown on RAGS D Table ~~3~~ 2, the maximum detected concentrations for chemicals that exceed the tap water RSLs span many monitoring wells. The approach used here is consistent with Section 5 of OSWER Directive 9283.1-42, which states "if less than 3 wells are within the core of the plume, OSWER recommends that maximum detections be used as the EPC for that contaminant." (USEPA, 2014a).

~~While there~~There are two lots (59 and 61) with no shallow monitoring wells and there are no plans to install wells at these lots. Therefore, there is no data to directly evaluate exposure to shallow groundwater at these lots. However, there are shallow monitoring wells near the boundaries of these lots. The shallow groundwater risks for these two lots are expected to be similar to those for the adjacent lots. Thus, risks for these two lots will be estimated using shallow groundwater risks from the adjacent lots~~.~~ with the highest risk estimates.

~~4.2.2.5~~4.3.2.5 Deep Groundwater

The EPC for deep groundwater is used to assess the drinking water pathway. The EPC for each deep groundwater COPC is set to the site-wide maximum detected concentration for that COPC, since only five deep monitoring wells have been installed at the Site to assess whether the deep groundwater has been impacted. The five deep monitoring wells were sited based on Phase 1 soil and groundwater results.

~~4.2.2.6~~4.3.2.6 Indoor Air

Indoor air samples were collected from each occupied on-site building[30] to assess current indoor worker exposure from vapor intrusion. The EPC for each indoor air COPC for each building is set to the detected concentration in that building, as only one indoor air sample If an indoor air COPC was not detected at a building, then one half the SQL is ~~(conservatively)~~ used as the EPC.

~~4.2.3~~4.3.3 Modeled Concentrations

The modeling methodologies for estimating COPC concentrations in indoor and outdoor air due to emissions from soil and groundwater are discussed below. The model-predicted EPCs are presented in RAGS Part D Table 3 format in Appendix ~~B~~A. Outdoor air EPCs are presented in Tables 3.01.02 and 3.02.02 for soil and groundwater, respectively, and indoor air EPCs are presented in Tables 3.01.03 and 3.02.03 for soil and groundwater, respectively.

[30] While Lot 69 is currently occupied, no active operations are conducted in either Building #13 or Building #19. Building #13 is used for drum storage and Building #19 is the size of a one car garage and is used for storage. Therefore, no indoor air sample was collected at this building.

The Henry's law constant, which is used to model contaminant volatilization from soil and groundwater, is adjusted for source temperature using the Clausius-Clapeyron relationship as shown in USEPA's fact sheet "Correcting the Henry's Law Constant for Soil Temperature" (USEPA 2001, eq. 1):

$$H_{TS} = \frac{exp\left[-\frac{\Delta H_{v,TS}}{R_c}\left(\frac{1}{T_S}-\frac{1}{T_R}\right)\right]H_{pc,R}}{R \cdot T_S}$$

Where:

H_{TS} is the dimensionless Henry's law constant at T_S, T_S is the source temperature (K), $\Delta H_{v,TS}$ is the enthalpy of vaporization at T_S (cal/mol), T_R is the reference temperature (K), $H_{pc,R}$ is the Henry's law constant in partial pressure/concentration terms at T_R (atm*m^3/mol), and R_C and R are the ideal gas constant, with R_C = 1.9872 cal/mol/K and R=8.205 * 10^{-5} atm*m^3/mol/K). NOTE: To be consistent with USEPA and other guidance which use the variable H for the Henry's law constant in dimensionless terms, the above renames the variables from USEPA 2001 eq.1 (which designated the dimensionless Henry's law constant as H'_{TS})

This expression combines the adjustment of the Henry's law constant for temperature and the calculation of the dimensionless form of the Henry's law constant from the version in partial pressure per molar concentration terms. The conversion from partial pressure per molar concentration terms to dimensionless is expressed as:

$$H_R = \frac{H_{pc,R}}{R \cdot T_R}$$

Where:

H_R is the dimensionless Henry's law constant at T_R and other variables are as defined above

USEPA eq.1 above can be rewritten as the following, which is more useful if the Henry's law constant was published in the dimensionless form or previously calculated:

$$H_{TS} = exp\left[-\frac{\Delta H_{v,TS}}{R_c}\left(\frac{1}{T_S}-\frac{1}{T_R}\right)\right]\frac{T_R}{T_S}H_R$$

In Attachment D1.3, the Henry's law constants are shown in dimensionless form, and the product of the exponential and T_R/T_S term is shown under the column heading "Henry Adjustment Multiplier".

The following equation extrapolates the enthalpy of vaporization from the published value at the normal boiling point to the source temperature (T_s) based on available thermodynamic parameters (USEPA 2001, eq. 2):

$$\Delta H_{v,TS} = \Delta H_{v,b}\left(\frac{1-T_S/T_C}{1-T_B/T_C}\right)^n$$

Where:

$\Delta H_{v,b}$ is the enthalpy of vaporization at the normal (i.e., atmospheric) boiling point (cal/mol), T_B is the normal boiling point (K), T_C is the critical temperature (K), and the exponent n is an empirically defined term set to 0.3 for $T_B/T_C < 0.57$, 0.41 for $T_B/T_C > 0.71$, and $0.74*T_B/T_C-0.116$ for T_B/T_C between 0.57 and 0.71.

For volatilization from groundwater and deep soil sources, USEPA (2001) specifies to adjust the Henry's law constant using the annual average shallow groundwater temperature. The annual average shallow groundwater temperature used to adjust the Henry's law constant is 13 °C, with is the value used by NJDEP groundwater VISL guidance (NJDEP 2013). NJDEP notes "shallow ground water temperatures in New Jersey generally fluctuate between 10 and 15°C." This temperature is also consistent with the rough contour map of average shallow groundwater temperatures in the United States in the USEPA fact sheet (USEPA 2001, Figure 1) and with the field temperature measurements for shallow groundwater at the Site, which have an annual average of average annual temperature is 12.14 °C as shown in Attachment D.1.2 (rounding up is conservative since higher temperatures result in increased volatilization).

~~4.2.3.1~~4.3.3.1 Indoor Air

As discussed in Section 6.6 of USEPA's 2015 Vapor Intrusion Guidance (USEPA 2015a), mathematical models can provide an acceptable line of evidence supporting risk management decisions pertaining to vapor intrusion. In certain situations (e.g., for future construction on vacant properties), it is particularly useful to employ mathematical modeling to predict reasonable maximum indoor air concentrations due to vapor intrusion, because indoor air testing is not possible before the building is constructed. As noted previously, measured indoor air concentrations were used to evaluate this pathway under current conditions in existing occupied buildings. Mathematical modeling is most appropriately used in conjunction with other lines of evidence (e.g., data that characterize potential subsurface vapor sources and associated geologic and hydrologic conditions in the vadose zone).

Indoor air concentrations due to migration of vapors from soil and shallow groundwater into a building are estimated using the model described by Johnson and Ettinger (1991), which USEPA recommends for screening level evaluations (USEPA 2017a). The overall modeling approach may be summarized as follows:

$$C_{building} = \alpha \ C_{source}$$

Where:

$C_{building}$ is the indoor air concentration~~,~~ (mg/m^3), α is an attenuation coefficient~~,~~ (dimensionless), and C_{source} is the source vapor concentration~~.~~ (mg/m^3).

For vapor intrusion from shallow groundwater, C_{source} is determined by Henry's law~~:~~ (USEPA 2004a, Equation 2):

$$C_{source} = H \ C_{GW} \cdot \frac{1000 \ L}{m^3}$$

~~Where:~~

Where:

C_{source} is the vapor concentration at the source of contamination (mg/m^3), H is the dimensionless Henry's law constant (~~at~~adjusted to the~~ site-specific average~~

groundwater temperature of 13 °C) and C_{gw} is the concentration in groundwater~~.~~ (mg/L).

For vapor intrusion from soil, C_{source} is based on three-phase equilibrium between concentrations in the adsorbed ~~phased~~phase, soil pore moisture, and vapor phase~~:~~ (USEPA 2004a, ~~E~~equation 1):

$$C_{source} = \cancel{C_{soil} / \left(\frac{K_d}{H} + \frac{\theta_w}{H \cdot \rho_b} + \frac{\theta_a}{\rho_b} \right)} C_{soil} \cdot \frac{1000\ L}{m^3} \Big/ \left(\frac{K_d}{H} + \frac{\theta_w}{H \cdot \rho_b} + \frac{\theta_a}{\rho_b} \right)$$

Where:

K_d is the soil-water partition coefficient (L/kg) (which, for organics, is the product of K_{oc}, the organic carbon partition coefficient~~,~~ (L/kg), and f_{oc}, the organic carbon content of the soil~~),~~ (dimensionless)) , θ_w is the water-filled soil porosity~~,~~ (dimensionless), θ_a is the air-filled soil porosity~~, and~~ (dimensionless), ρ_b is the dry soil bulk density (kg/L), and other variables are as defined above

The calculations of indoor air concentrations normalized by soil or groundwater concentration are shown in Appendix D~~;~~ Attachments D.3.1-D.3.3 (for indoor workers), D.7.1-D.7.5 (for visitors), and D.8.1-D.8.5 (for residents); these values are multiplied by the EPCs in each lot for the risk calculations in each lot.

The equation for the steady-state[EPA10] attenuation coefficient assuming no source depletion over time (USEPA 2017a, equation 10, Johnson and Ettinger 1991) is as follows:

$$\alpha = \frac{\left(\frac{D_T^{eff} A_{bf}}{Q_{building} L_T} \right) exp\left(\frac{Q_{soil} L_{crack}}{D_{crack} A_{crack}} \right)}{exp\left(\frac{Q_{soil} L_{crack}}{D_{crack} A_{crack}} \right) + \left(\frac{D_T^{eff} A_{bf}}{Q_{building} L_T} \right) + \left(\frac{D_T^{eff} A_{bf}}{Q_{soil} L_T} \right) \left(exp\left(\frac{Q_{soil} L_{crack}}{D_{crack} A_{crack}} \right) - 1 \right)}$$

Where:

D_T^{eff} is the total overall effective diffusion coefficient in the subsurface soil~~,~~ (m^2/d), D_{crack} is the effective diffusion coefficient in the crack soil~~,~~ (m^2/d), A_{bf} is the building area through which vapor intrusion can occur~~,~~ (m^2), A_{crack} is the total area of foundation cracks~~,~~ (m^2), $Q_{building}$ is the building ventilation rate~~,~~ (m^3/d), Q_{soil} is the flow rate of soil gas through the foundation cracks~~,~~ (m^3/d), L_T is the source-to-building separation distance~~,~~ (m), and L_{crack} is the thickness of the foundation slab~~.~~ (m).

The variation in soil moisture content with height above the water table is approximated using the water-retention curve recommended by van Genuchten (1980) and USEPA (2017a, equation 4a):

$$\theta_w = \theta_r + \frac{\theta_s - \theta_r}{(1 + (\alpha_1 \cdot h)^N)^{1/(1-N)}}$$

Where:

θ_r is the residual soil moisture content~~,~~ (dimensionless), θ_s is the total soil porosity~~,~~ (dimensionless), α ~~a_1~~ (cm^{-1}) and N (dimensionless) are parameters of the water retention curve, ~~and~~ h is the air entry pressure head (expressed as a positive number ~~with dimensions of length~~in centimeters in this form of the equation)~~.~~), and other variables are as defined above. For a moisture profile at equilibrium in soil above a water table, the head *h* is the height above the water table (or $L_{T\text{-}gw}$).

The soil properties for the USDA Soil Conservation Service class of “sand” (USEPA 2017a) are used as a conservative representation of the historic fill areas of the site. As the most conservative (i.e., driest) of the SCS soil types, sand is also used for the crack soil.

The effective diffusion coefficient at a given height in the vadose zone and in the crack (USEPA, 2017a, equation 8) are calculated as follows:

$$D^{eff}(z) = \frac{\theta_a(z)^{10/3} \cdot D_i \cdot H + \theta_w(z)^{\frac{10}{3}} \cdot D_w / H}{\theta_s{}^2} \cdot \frac{86400\ s}{d} \cdot \frac{m^2}{10000\ cm^2}$$

$$D_{crack} = \frac{\theta_{a,crack}{}^{10/3} \cdot D_i \cdot H + \theta_{w,crack}{}^{10/3} \cdot D_w}{\theta_s{}^2}$$

$$D_{crack} = \frac{\theta_{a,crack}{}^{10/3} \cdot D_i \cdot H + \theta_{w,crack}{}^{\frac{10}{3}} \cdot D_w / H}{\theta_s{}^2} \cdot \frac{86400\ s}{d} \cdot \frac{m^2}{10000\ cm^2}$$

Where:

$D_{eff}(z)$ and D_{crack} are the effective diffusivities (m²/d) in soil at height z (m) and in the crack respectively, $\theta_a(z)$ and $\theta_{a,crack}$ are the air-filled soil porosities (dimensionless) at height z and in the crack respectively, $\theta_w(z)$ and $\theta_{w,crack}$ are the water-filled soil porosities (dimensionless) at height z and in the crack respectively, D_i is the chemical diffusivity in air, (cm^2/s), D_w is the chemical diffusivity in water, (cm^2/s), and *H* is the Henry’s law constantother variables are as defined above

The total effective diffusion coefficient over the distance L_T from the source to the building foundation is determined by integrating as follows (Johnson and Ettinger 1991, equation 12):

$$D_T^{eff} = \frac{L_T}{\int_{z_{sourcv}}^{z_{slab}} \frac{dz}{D^{eff}(z)}}$$

Where:

z_{source} is the height above the water table of the vapor source and(m), z_{slab} is the height above the water table to the bottom of the foundation slab (m), and other variables are as defined above.

For vapor intrusion from shallow groundwater, z_{source} is 0, at the water table. For vapor intrusion from soil, the source is conservatively assumed to be originally present immediately below the foundation slab.

Finally, the flow rate of soil gas into the building (Q_{soil}, in m^3/s) is estimated per Nazaroff (1988) (Johnson and Ettinger 1991; USEPA 2004a, equation 15), as follows:

$$Q_{soil} = \frac{2\pi \cdot \Delta P \cdot k_v \cdot X_{crack}}{\mu \ln(2\, Z_{crack}/r_{crack})} \cdot \frac{86{,}400\ s}{day}$$

Where:

> *ΔP* is the indoor-outdoor pressure differential~~,~~ (kg/m-s^2), k_v is the soil vapor permeability~~,~~ (m^2), *μ* is the viscosity of air~~,~~ (kg/m-s), X_{crack} is the length of the perimeter crack~~,~~ (m), Z_{crack} is the depth below grade to the bottom of the crack (e.g., for a slab-on-grade building, the slab thickness~~), and~~) (m), r_{crack} is the crack width (m), and other variables are as defined above.

Indoor air concentrations from migration of vapors from soil are calculated to account for the potential that the COPC mass in the soil may completely deplete as the COPC volatilizes and migrates into the building during the exposure period. Specifically, soil vapor intrusion calculations include a mass balance check which ensured that the mass of a COPC assumed to infiltrate the building over the exposure period does not exceed an upper-bound estimate of the COPC's mass in the vadose zone underlying the building. The indoor air concentration calculated using this mass balance check is given by the following equation:

$$C_{building,ML} = C_{soi\sout{lurce}} \cdot \ \rho_b \cdot \left(\frac{\Delta H}{ach \ \cdot H_b \cdot ED}\right) \cdot \frac{1000\ L}{m^3} \cdot \frac{d}{24\ h}$$

Where:

> Where $C_{building,ML}$ is the indoor air concentration at the mass balance limit (mg/m^3), C_{soil} is the concentration is soil (mg/kg), ~~. . . (units);~~ *ΔH* is the contaminant thickness (conservatively assumed to be the distance between groundwater and a building foundation) (m), *ach* is the air exchange rate~~,~~ (1/hr), ρ_b is the soil bulk density~~,~~ (kg/L), H_b is the building occupied height~~, and~~ (m), *ED* is the exposure duration~~.~~ (d), and other variables are as defined above. A 10-~~foot~~ft. (3.048 m) contaminant thickness is conservatively used based on the deepest water table depth at the Site.

The indoor air concentration at the mass balance limit normalized by the soil concentration $C_{building,ML,normalized}$ (mg/m^3 per mg/kg) is defined as follows:

$$C_{building,ML,normalized} = \frac{C_{building,ML}}{C_{soil}}$$

Since future redevelopment plans are not known at this time, the area for potential future buildings (both industrial/commercial and residential) are conservatively based on the residential building size of 10 meters by 10 meters recommended by USEPA (2004a)[31]. The values of all generic, site-specific, and chemical-specific parameters are shown in Appendix D, Attachments D.3.1-D.3.3, D.7.1-D.7.5, and D.8.1-D.8.5.

The calculation of residential vapor intrusion risks in the BHHRA conservatively uses default building characteristics for residential slab-on-grade buildings based on USEPA (2004a) recommended values

[31] The 10 m by 10 m building from the 2004 User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings is a more conservative estimate of building size that the default value from the 2017 ~~J&E~~Documentation for EPA's Implementation of the Johnson and Ettinger Model ~~User's Guide~~to Evaluate Site Specific Vapor Intrusion into Buildings (USEPA 2017a) which is a central tendency estimate. As stated in Section 3.2 of the 2017 ~~J&E~~Documentation for EPA's Implementation of the Johnson and Ettinger Model ~~User's Guide~~to Evaluate Site Specific Vapor Intrusion into Buildings "The default value is 150 m^2, with a range of 80 to 200 square m^2 (USEPA, 2004a)."

for building dimensions (10 meters by 10 meters) and residential air exchange rate (0.25 per hour). A slab-on-grade building is assumed based on the shallow depth to water at the Site (3 to 10 ~~feet~~ft. bgs). These building characteristics are conservative since the medium-density residential buildings west of McCarter Highway are larger.

To assess vapor intrusion for future industrial buildings, the same building footprint dimensions are conservatively used (10 meters by 10 meters) with a conservative air exchange rate more appropriate for industrial/commercial buildings of 1 per hour, and a 10-~~foot~~ft. ceiling height. These industrial building characteristics are considered conservative since the existing industrial buildings at the Site are larger than 100 square meters, ranging from approximately 220 to 1,070 square meters, and likely to have higher air exchange rates.

The vapor concentrations in indoor air from potable use of groundwater indoors are estimated using the fixed emission factor of 0.5 L/m^3 based on household uses of water (USEPA 1991b). This methodology is used for the derivation of the RSLs (USEPA 2019):

$$C_{building} = \left(0.5\ \frac{L}{m^3}\right)\ C_{gw}$$

This calculation is restricted to chemicals which meet the conditions for classification as "volatile" (USEPA 2019), (i.e., having a vapor pressure greater than 1 mmHg and/or a Henry's law constant in pressure per molarity terms greater than 10^{-5} m^{3}atm/mol). The vapor pressure and Henry's law constant used for this determination are at the reference temperature (i.e., are not adjusted to the subsurface temperature of 13 °C).

~~4.2.3.2~~4.3.3.2 Vapor Emission from Soil

The COPC concentrations in outdoor air due to vapor emissions from soil are calculated from the volatilization factor (*VF* in m^3/kg) (USEPA, 2002b, equation E-1), as follows:

$$C_{air} = C_{soil}/VF$$

$$VF = \frac{Q}{C}\,\cancel{/J_v}\cdot\frac{kg}{1000\ g}\,/J_v$$

Where:

> J_v is the normalized average flux of vapor at the ground surface~~, and~~ ~~(~~(mg/m^2-s) per ~~/~~(mg/kg)~~)~~, *Q/C* is the dispersion factor~~,~~ ~~(~~(g/m^2-s)~~/~~ per (kg/m^3)~~)~~ discussed in Section ~~4.2.3.5).~~4.3.3.5), and other variables are as defined above.

The average flux term in the default *VF* from the Supplemental Soil Screening Guidance (USEPA 2002b, eq. 4-8) is based on the Jury model (Jury et al., 1983) with the concentrations assumed initially present from the ground surface to an infinite depth. The Soil Screening Guidance (USEPA 1996) also included a model (Section 3.1.1, eq. 56) with the same assumptions except assuming the concentrations are initially present from the ground surface to a finite depth (conservatively assumed to be the depth to groundwater in this case). This equation is as follows:

$$J_s = C_o\left(\frac{D_A}{\pi t}\right)^{1/2}\left(1 - \exp\left(\frac{\cancel{-d_s}-{d_s}^2}{4D_A t}\right)\right)$$

Where:

J_s is the contaminant flux at the ground surface (mg/cm²-s) at time t, (s), C_0 is the volumetric concentration at time t=0, (mg/cm³), D_A is the apparent diffusivity, and (cm³²/s), d_s is the initial bottom depth of soil contamination (cm).

Changing to a flux J_v normalized by the soil concentration removes the C_0 term, and averaging the flux over the exposure period gives the following (also in Jury et al. 1990)

$$J_v = \frac{1}{T}\left(\sqrt{\frac{4D_A}{\pi T}}\cdot\left(1-\exp\left(-\frac{d_s{}^2}{4D_A T}\right)\right)+d_s erfc\left(\frac{d_s}{2\sqrt{D_A T}}\right)\right)$$

Where:

T is the exposure period, and *erfc* is the complementary error function (cm), and other variables are as defined above.

The apparent diffusivity (USEPA 1996, eq. 57) is calculated as:

$$D_A = \frac{\left(\theta_a{}^{10/3}\cdot D_i\cdot H+\theta_w{}^{10/3}\cdot D_w\right)/n^2}{\rho_b\cdot K_d+\theta_w+\theta_a\cdot H}$$

Where:

θ_a is the air-filled soil porosity, (dimensionless), θ_w is the water-filled soil porosity, (dimensionless), n is the total soil porosity, (dimensionless), D_i is the chemical diffusivity in air, (cm²/s), D_w is the chemical diffusivity in water, (cm²/s), H is the dimensionless Henry's law constant, ρ_b is the dry soil bulk density, (kg/L/kg or g/cm³), and K_d is the soil-water partition coefficient (L/kg) (which, for organics, is the product of K_{oc}, the organic carbon partition coefficient, (L/kg), and f_{oc}, the organic carbon content of the soil).), and other variables are as defined above.

The soil moisture content is evaluated at the ground surface with the soil properties discussed in Section 4.2.3.1.4.3.3.1.

The volumetric soil concentration at time 0, C_0 (in mg/cm³), is the product of the initial soil concentration in mass terms C_{soil} (mg/kg) and the soil bulk density ρ_b (L/kgg/cm³) as follows:

$$C_0 = C_{soil}\cdot\rho_b\cdot\frac{kg}{1000g}$$

The contaminant flux (J_s) at time t must be integrated over the exposure period and divided by the exposure period to obtain the average flux during the exposure period (J_s^{ave} in g/cm²-s). The simplifying case in which the concentration is assumed initially present from the surface to an infinite depth (i.e., in which the limit of the above as d_s approaches infinity and the exponential term disappears) may be solved analytically in terms of simple functions, as discussed above. The simplifying assumption of infinite depth results in an overestimate of the average flux, as discussed in USEPA 1996 (Section 2.6.1), especially for relatively volatile compounds and receptors with relatively short exposure durations, so that the total emissions over the exposure duration may exceed the total mass of the compound in the soil down to the depth of d_s. One approach is to simply cap the emission rate so that all of the mass in soil from the surface down to d_s is emitted over the exposure duration.

A more realistic approach is to integrate the above equation for J_s over time, which USEPA (1996, section 3.1.1) recommends calculating numerically:

"To estimate the average contaminant flux […] the time-dependent contaminant flux must be solved for various times and the results averaged. A simple computer program or spreadsheet can be used to calculate the instantaneous flux of contaminants at set intervals and numerically integrate the results to estimate the average contaminant flux."

The integration for Js^{ave} may be expressed in terms of the complementary error function, erfc[32], to be evaluated in closed form (performed in Microsoft Excel for this evaluation) as shown in AttchementAttachment D.10. defined as the complement of the integral of the Gaussian distribution., as follows:

$$erfc(x) = 1 - \frac{2}{\sqrt{\pi}} \int_0^x exp(-t^2)\,dt$$

This function may be used to express the time-averaged flux from time 0 to T (the exposure duration) as follows, defining integration-by-parts variables u and v and substitution variable w, then using integration by parts.:

$$J_s^{ave} = \frac{1}{T}\int_0^T C_0 \sqrt{\frac{D_A}{\pi t}}\left(1 - exp\left(\frac{-d_s^{\,2}}{4D_A t}\right)\right)dt$$

$$u = 1 - exp\left(\frac{-d_s^{\,2}}{4D_A t}\right);\; du = -exp\left(\frac{-d_s^{\,2}}{4D_A t}\right)\cdot\frac{-d_s^{\,2}}{4D_A}\cdot\frac{-1}{t^2}dt$$

$$dv = C_0\sqrt{\frac{D_A}{\pi t}}dt\;;\; v = C_0\sqrt{\frac{D_A}{\pi}}2\sqrt{t};$$

$$w = \frac{d_s}{\sqrt{4D_A t}};\; dw = \frac{d_s}{\sqrt{4D_A}}\cdot\frac{-1}{2}t^{-\frac{3}{2}}dt\;;\; W = \frac{d_s}{\sqrt{4D_A T}}$$

Then using integration by parts:

$$J_s^{ave} = \frac{1}{T}\int_{t=0}^T u\,dv = \frac{1}{T}\left([u\cdot v]_{t=0}^T - \int_{t=0}^T v\,du\right)$$

$$[u\cdot v]_{t=0}^T = \left[C_0\sqrt{\frac{D_A}{\pi}}\cdot 2\sqrt{t}\cdot\left(1 - \exp\left(\frac{-d_s^{\,2}}{4D_A t}\right)\right)\right]_0^T = C_0\sqrt{\frac{D_A}{\pi}}\cdot\left(2\sqrt{T}\cdot\left(1 - \exp\left(\frac{-d_s^{\,2}}{4D_A T}\right)\right) - 0\cdot(1-0)\right)$$

[32] When the Soil Screening Guidance and Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites Guidance were written, the error function and its complement (most often used in statistics) were not part of the most common spreadsheets or software packages, so evaluating the function would have itself required a numerical integration. With the functions now built in as part of Microsoft Excel and programs such as Mathematica and Mathcad, erfc can now be practically evaluated as part of a closed form solution.

$$\int_{t=0}^{T} v\,du = \int_{t=0}^{T} C_0 \sqrt{\frac{D_A}{\pi}}\, 2\sqrt{T}\cdot \exp\left(\frac{-d_s^2}{4D_A t}\right)\cdot \frac{d_s^2}{4D_A}\cdot\frac{-1}{t^2}\, dt$$

$$\int_{t=0}^{T} v\,du = C_0 \int_{t=0}^{T} -\frac{2}{\sqrt{\pi}}\frac{t^{-3/2}}{2}\cdot\frac{d_s^2}{\sqrt{4D_A}}\cdot\exp\left(\frac{-d_s^2}{4D_A t}\right)dt = C_0\frac{-2\cdot d_s}{\sqrt{\pi}}\int_0^W \exp(-w^2)\,dw$$

$$J_s^{ave} = \frac{1}{T}\left(d_s C_0 + C_0\sqrt{\frac{4D_A T}{\pi}}\cdot\left(1-\exp\left(\frac{-d_s^2}{4D_A T}\right)\right) - C_0\frac{2\cdot d_s}{\sqrt{\pi}}\int_0^W \exp(-w^2)\,dw\right)$$

$$J_s^{ave} = \frac{C_0}{T}\left(\sqrt{\frac{4D_A T}{\pi}}\cdot\left(1-\exp\left(\frac{-d_s^2}{4D_A T}\right)\right) + d_s\cdot erfc(W)\right)$$

The flux normalized by soil concentration is defined as $J_v = J_s^{ave} / C_{soil}$, which simplifies to the following (with J_v in mg/cm²-s per mg/kg):

$$J_v = \frac{\rho_b}{T}\left(\sqrt{\frac{4D_A T}{\pi}}\cdot\left(1-\exp\left(-\frac{d_s^2}{4D_A T}\right)\right) + d_s erfc\left(\frac{d_s}{\sqrt{4D_A T}}\right)\right)\cdot\frac{kg}{1000\ g}\cdot\frac{10^4\ cm^2}{m^2}$$

This is also consistent with the Jury et al (1990) solution for the cumulative volatilization losses in the special case with no degradation, aboveground resistance to mass transport, or subsurface advection. The values of all generic, site-specific, and chemical-specific parameters are shown in Appendix D., Attachments D.2.2 (outdoor workers), D.4.2 (utility workers), D.5.5 (construction workers), D.6.2 (trespassers), D.7.7-D.7.9 (visitors), and D.8.8-D.8.10 (residents).

4.2.3.34.3.3.3 Vapor Emission from Groundwater

For evaluating utility workers' and construction workers' exposures to COPCCOPCs in outdoor air due to groundwater vapor emission from pooled water in excavation pits, the COPC outdoor air concentration is calculated using the approach discussed in Section 4.2.3.24.3.3.2 but with a source groundwater concentration and appropriate vapor flux and *Q/C* (discussed in Section 4.2.3.5).4.3.3.5).

The normalized vapor flux J of a chemical from groundwater pooled on the floor of an excavation pit is estimated using the mass transfer coefficients recommended in USEPA guidance (USEPA, 1995, equations 29 and 30):

$$F = KC_L\frac{10^4\ g/cm^2 s}{g/cm^2 s}$$

$$\frac{1}{K} = \frac{1}{k_L} + \frac{R\cdot T_{gw}}{H_{pc}\cdot k_G}$$

Where:

$J = \left(\frac{1}{k_l}+\frac{1}{Hk_g}\right)^{-1}$ *F* is the maximum flux (g/m²s), K is the overall mass transfer coefficient (cm/s), C_L is the groundwater concentration (g/cm³), *R* is the ideal gas constant (8.2x10^{-5} m³atm/mol-K), T_{gw} is the groundwater temperature (13°C =286 K), H_{pc} is the Henry's law constant at the groundwater temperature (m³atm/mol), $\left(\frac{m}{10^2 cm}\right)\left(\frac{10^3 L}{m^3}\right)$

Where:

k_l and k_g k_L and k_G are the liquid-phase and gas-phase mass transfer coefficients given(cm/s) respectively. NOTE: For consistency with other concentration and exposure calculations, which define chemical-specific variables implicitly for a single chemical, these rename the variables in the source to remove the subscript i for "component i" and rename the Henry's law constant in pressure/concentration terms.

The normalized vapor flux J_v (Lmg/m²s per mg/L), or the flux per groundwater concentration, is determined by the followingsubstituting the above into the definition of $J_v = F/C_L$, converting the Henry's law constant to dimensionless form, and converting units:

$$J_v = \left(\frac{1}{k_l} + \frac{1}{H \cdot k_g}\right)^{-1} \left(\frac{m}{10^2 cm}\right)\left(\frac{10^3 L}{m^3}\right)$$

The liquid-phase and gas-phase mass transfer coefficients are estimated as follows per USEPA (1995, equations 31 and 32):

$$k_{lL} = \left(\frac{MW_o}{MW}\right)^{0.5} \left(\frac{T}{298K}\right)\left(\frac{T_{gw}}{298K}\right) k_{l,o}$$

$$k_{gG} = \left(\frac{MW_w}{MW}\right)^{0.335} \left(\frac{T}{298K}\right)^{1.005} \left(\frac{T_{gw}}{298K}\right)^{1.005} k_{g,w}$$

Where:

MW, MW_o, and MW_w are the molecular weights of the chemical, oxygen, and water, T respectively (g/mol), T_{gw} is the absolute groundwater temperature of water, (286 K), $k_{l,o}$ is the liquid-phase mass transfer coefficient for oxygen (0.002 cm/s), and $k_{g,w}$ is the gas-phase mass transfer coefficient for water vapor (0.833 cm/s).

The calculations of the volatilization factors are shown in Appendix D, Attachments D.4.5 (utility workers) and D.5.5 (construction workers).

4.2.3.44.3.3.4 Dust Emission

For evaluating potential exposure of outdoor workers', residents'workers, visitors, residents, trespassers, off-site workers, off-site residents'residents to COPCs in windblown dust, the emission of particulates up to 10 µm in diameter (PM_{10}) are calculated using the wind erosion model recommended by USEPA (USEPA 1996 eq. 10, USEPA 2002b eq. 4-5). The concentration of COPCs on the particulates is assumed to be equal to that in the bulk soil, so the concentrations in air are calculated by dividing the soil concentration by the particulate emission factor (*PEF*):

$$C_{air} = C_{soil}/PEF$$

The *PEF* of a COPC in windblown dust from soil (in m³/kg) is calculated as

$$PEF = Q/C \cdot \frac{3600\ s/h}{0.036 \cdot (1-V) \cdot \left(\frac{U_m}{U_t}\right)^3 \cdot F(x)} \frac{3600\ s/h}{0.036\ \frac{g}{m^2 h} \cdot (1-V) \cdot \left(\frac{U_m}{U_t}\right)^3 \cdot F(x)}$$

Where:

Q/C is the dispersion factor, ((g/m²/s) per /(kg/m³)), as discussed in Section 4.2.3.5,4.3.3.5, *V* is the fraction of vegetative cover, (dimensionless), U_m is the mean annual wind speed (9.8 mph or 4.38 m/s) at the nearest weather station which is located in Newark, NJ (NOAA 2015), U_t is the equivalent threshold wind speed at the anemometer height at which U_m was measured, (m/s), and *F(x)* is a function dependent on U_m/U_t (dimensionless) based on the derivation in Cowherd et al (1985).

The values of all generic, site-specific, and chemical-specific parameters are shown in Appendix D., Attachments D.2.3 (outdoor workers), D.6.3 (trespassers), D.7.10 (visitors), and D.8.11 (residents).

During utility repair and construction activities that involve soil excavation or other soil movement, the PM_{10} level is expected to not exceed the 24-hour average NAAQS for PM_{10} of 150 ug/m³ since it is reasonable to expect that such activities will be managed to avoid violation of the NAAQS., and in compliance with OSHA standards for construction work. Using the NAAQS for the PM_{10} level is conservative because the general standard of practice for dust control in commercial/industrial construction is to ensure that PM_{10} emissions from construction activities remain below the limit, regardless of the activities generating the emissions or whether the particulates contain hazardous constituents. This approach is also more practical than using PM_{10} emission models, which address limited types of emission sources and require making many assumptions for model parameters that are often difficult to justify when no specific construction plans are available.

Because the concentration of COPCs on the particulates is assumed to be equal to that in the bulk soil, the COPC concentration in air (C_{air})and the *PEF* are as follows:

$$C_{air} = \left(150 \frac{ug}{m^3}\right) \cdot C_{soil}$$

$$PEF = \frac{C_{soil}}{C_{air}} = \left(\frac{1}{150 \frac{ug}{m^3}}\right) \cdot \frac{10^9 ug}{kg} = 6.67 \times 10^6 \frac{m^3}{kg}$$

4.2.3.54.3.3.5 Air Dispersion

Outdoor air concentrations for receptors exposed to average concentrations over years are estimated using the empirical correlations presented in USEPA's Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (USEPA 2002b, eq. D-1).

$$Q/C = A \cdot exp\left(\frac{(ln(A_{site}) - B)^2}{C}\right) \cdot \frac{kg}{1000\ g}$$

Where:

Where:

Q/C is the inverse of the ratio of the long-term geometric mean air concentration to the emission flux (~~in g~~kg/m²~~/~~ s per kg/m³), A_{site} is the source area (~~in~~ acres), and *A*, *B*, and *C* are coefficients based on air dispersion modeling for particular climate zones.

The closest meteorological station with correlation coefficients is Philadelphia, PA. Separate sets of coefficients are published by USEPA (2002b) for Q/C_{vol} (for use with vapor emissions) and Q/C_{wind} (for use with the windblown dust *PEF*), but for Philadelphia these are the same: *A*~~=~~ = 14.0111, *B* = 19.6154, and *C*~~=~~ = 225.3397.

For emissions from soil, the source area is conservatively based on the largest lot size (1.2 acres for Lot 1). ~~For emissions from groundwater during excavations to the water table, the air concentrations are estimated using a source area of a 15 foot by 15 feet excavation pit that extends into the water table.~~ The *Q/C* is shown in Attachments D.2.1 (outdoor worker), D.6.1 (trespasser), and D.8.7 (resident).

~~The dispersion factors calculated using the correlation above are annual averages used for evaluating long-term~~ For exposures ~~(e.g., outdoor workers' exposures). For shorter-term exposures, the dispersion factor is adjusted for averaging time (USEPA 2002, eq. E-17).~~

$$VF_{sc} = Q/C_{sa} \cdot \frac{1}{F_D} \cdot \frac{1}{< J_T >}$$

with~~Where:~~

~~VF_{sc} is~~ a ~~subchronic volatilization factor, Q/C_{sa} is the dispersion factor based on a 1-hour averaging time, $<J_T>$ is the averaged normalized vapor flux, and F_D is the dispersion factor based on the following adjustment (USEPA 2001, eq. E-16):~~

$$F_D = 0.1852 + \frac{5.3537}{t_c} - \frac{9.6318}{t_c^{\,2}}$$

~~Where:~~

~~t_c is the~~total duration ~~(in hours) over which the concentration is averaged.~~

~~For utility workers, the air concentration is adjusted to a 24-hour average (since these workers are assumed to be at the Site for 5 days per quarter, as discussed in Section 4.3). To calculate a 24-hour average *Q/C*, the 1-hour average *Q/C* is calculated by multiplying by annual *Q/C* by the F_D based on 1~~ of less than a year ~~(0.19), then the 1-hour average *Q/C* is divided by the F_D based on 24 hours (0.4). Air concentrations for utility worker~~ and/or a low frequency (in this case, the construction worker ~~exposure to groundwater pooled in an excavation pit are also adjusted to a 24-hour average (since the excavation pit is expected to be open for a relatively short period). For construction worker exposure~~ and utility worker exposures to vapors from soil~~, since the workers are assumed to be present at the Site for up to six months (as discussed in Section 4.3), a 6-month average *C/Q* is calculated.~~ and groundwater and visitor ex), there is a chance that the exposures ~~are concentrated~~occur at times of the year when the dispersion is below the annual average, and so the annual average may not be conservative. For these exposures, USEPA's Supplemental ~~SSG~~Guidance for Developing Soil Screening Levels for Superfund Sites (USEPA, 2002b, Sec. 5.3.2~~.1~~, p.5-18) recommends:

"Site managers conducting a detailed site-specific analysis for the construction scenario can develop a site-specific Q/C value by running the SCREEN3 model."

The SCREEN3 model (USEPA 2012c) was run for these exposures using conditions from the Typical Meteorological Year (TMY) data set developed by the National Solar Radiation Database (NREL 2008, NSRDB 2019) for the Newark Liberty International Airport (EWR) station, approximately 5 miles from the Site. A TMY data set is a year of hourly meteorological data constructed by connecting stretches of data from the station in different years so that the long-term seasonal averages reflect median conditions over the time period of record (in this case, 1991-2005) and at the same time, show a typical variability in the day-to-day and hour-to-hour fluctuations. The TMY data set was used to produce conservative estimates of wind speed for time periods shorter than one year, as shown in Appendix D Attachment D.1.4. For exposure of construction workers to soil, this is the average wind speed over the 6-month period with the most conservative (i.e., lowest) average, or 4.11 m/s. For exposure of utility workers to soil and of both utility workers and construction workers to groundwater, this is the lowest average wind speed over the daytime (7 AM to 6 PM) hours on any day of the year, 1.5 m/s. Since, as discussed in Sections 4.4.3 and 4.4.4, utility workers and construction workers ~~and utility workers~~ are assumed to be at the site for ~~26 days and~~ 20 days/year and 130 days, respectively, the worst-case single day is conservative. For exposure of ~~trespassers~~visitors[EPA11], this is the average wind speed, 4.15 m/s, over the May-October period (as discussed in Section 4.4.6).

The stability class (i.e., the classification of the relationship between temperature and elevation which influences vertical air dispersion) in the SCREEN3 modeling was set to class D, the most conservative of the stability classes which can be maintained during the daytime. Although the TMY includes information (including solar irradiance, temperature, and sky cover) which could show when the stability class would show more dispersion, class D was chosen to be conservative and avoid the complication of estimating stability classes and entering many combinations into SCREEN3. [EPA12]

The Q/C values for each exposure scenario are based on the air concentrations at the worst-case location from the SCREEN3 output (which in all cases is at ground level at the downwind edge of the source area). The source area is the lot size of 1.2 acres for the soil source as discussed above, and a 15 ft by 15 ft area for groundwater pooled in an excavation that extends to the water table.

The SCREEN3 result is an air concentration associated with a flux input as 1 g/m^2-s, and the Q/C is calculated as follows:

$$Q/C = \frac{1\,\frac{g}{m^{\sout{3}2} - s}}{C} \cdot 10^9\,\frac{ug}{kg}$$

Where:

Q/C is the dispersion factor in kg/m^2~~/~~-s per kg/m^3, and C is the SCREEN3 output air concentration (ug/m^3) for a flux of 1 g/m^2-s.

The SCREEN3 output files are presented as Appendix D Attachments D.1.5-D.1.8, and the Q/C values are shown in Attachments D.4.1 (utility worker soil), D.4.4 (utility worker groundwater), D.5.1 (construction worker soil), D.5.4 (construction worker groundwater), and D.7.6 (visitor soil).

4.34.4 Exposure Factors

The exposure factors for calculating intakes for each exposure scenario discussed in Section 4.14.1 are presented in Table 4-1 and discussed in this section. In this risk assessment, standard default exposure factors recommended by USEPA for estimating reasonable maximum exposure (RME) are used where available and appropriate. (USEPA, 2014b). Where standard default exposure factors are not available or appropriate for an exposure scenario, similarly health protective exposure factors are developed based on site-specific considerations and professional judgment. For exposure scenarios in which estimates of RME risk exceed USEPA's acceptable limits, central tendency (CT) exposure factors might be developed to provide an additional perspective for informing risk management decisions.

The exposure factors are also presented in RAGS Part D format in Appendix B, Table 4, along with the intake equations in which they are used, as well as their references or rationale. As requested by USEPA Region 2, Ccumulative cancer risk and HI estimates for soil and groundwater are summed to account for potential concurrent exposures to both media (e.g., utility or construction worker exposure to both soil and groundwater during excavations). These exposures to both soil and groundwater are calculated at the magnitudes, frequencies, and durations assumed for each medium to determine the combined cumulative cancer risk and combined HI.

4.3.14.4.1 Outdoor Workers

Soil Ingestion Rate

A soil ingestion rate of 100 mg/day is used for outdoor workers, who are engaged in outdoor commercial/industrial activities. USEPA has recommended the use of this value for evaluating high-end outdoor worker exposures to soil (USEPA, 2002b, 2014b).

Soil Dermal Contact Rate and, Absorption and Event Frequency

The dermal contact rate is the product of the exposed skin surface area and the soil to skin adherence factor. The exposed skin area of 3,527 cm^2 and the soil-to-skin adherence factor of 0.12 mg/cm^2 are the USEPA recommended skin area and adherence factor for evaluating high-end contact with soil by workers in industrial settings. This is the weighted average of mean values for head, hands, and forearms (male and female, 21+ years) (USEPA, 2014b). The absorbed dose from dermal contact with soil is estimated by multiplying the dermal contact rate by USEPA-recommended absorption factors for absorption from soil (USEPA, 2004b). The event frequency for soil dermal contact is assumed to be one event per day, which is the USEPA-recommended value for industrial soil contact (USEPA, 2004b).

Exposure Time

Outdoor workers are assumed to be at the Site and inhale vapors and particulates for 8 hours/day, the USEPA-recommended value for full-time workers (USEPA, 2009, 2014b).

Exposure Frequency and Duration

Outdoor workers are assumed to contact soil for 225 days/year for 25 years. USEPA has recommended the use of these values for evaluating high end worker exposures when regional climate is not a relevant factor (USEPA, 2002b, 2014b). The exposure frequency is conservative and likely tomay overestimate RME given that the climate at the Site is not conducive to year-round outdoor soil contact activities (i.e., winter weather precludes exposure to soil at the Site for extended periods during the year).

Fraction Contacted

A fraction contacted~~ (FC)~~ term of 1 is conservatively used.

Body Weight

The body weight of 80 kg is the standard default body weight USEPA recommends for assessing exposure to adults (USEPA, 2014b).

Averaging Time

The averaging time for evaluating cancer risk is equal to a lifetime of 70 years, and the averaging time for evaluating noncancer ~~risk~~HI is equal to the exposure duration (USEPA, 1989, 2014b).

Although it is recognized that the use of the default exposure factors rather than site-~~-~~specific factors results in overestimation of RME risks, this approach streamlines the risk assessment. The assessment is also streamlined because the added conservatism in these risk estimates allows them to be used as conservative estimates for other receptors. In this risk assessment, the risk estimates for outdoor workers are used to evaluate the lower potential exposure of adult trespassers~~, indoor workers~~ and off-site workers, as discussed in Section ~~4.1.~~4.1.

~~4.3.2~~4.4.2 Indoor Workers

This section summarizes the exposure factors used in the assessment for indoor workers. The factors are categorized by soil, groundwater, and soil and groundwater and activities as indicated below.

Soil Ingestion Rate

A soil ingestion rate of 50 mg/day is used for indoor workers, who are engaged in indoor commercial/industrial non-contact intensive activities. USEPA has recommended the use of this value for evaluating high-end indoor worker exposures to soil/dust (USEPA, 2002b, 2014b).

Potable Groundwater Ingestion Rate

A drinking water ingestion rate of 1.25 L/d is used, which is ½ of the drinking water ingestion rate USEPA recommends for adult residents (USEPA, 2014b). This was used as the indoor worker spends ½ of their waking hours at work (8 hours/16 hours).

Soil and Groundwater Dermal Contact Rate, and Absorption and Event Time

The soil dermal factors are the same as those for outdoor workers, except the soil-to-skin adherence factor of 0.07 mg/cm^2 is used for indoor workers because indoor workers are expected to have less intensive contact with soil/dust than outdoor workers. This is the adherence factor USEPA has recommended for adult residents (USEPA 2014b). The exposed skin surface area for potable groundwater contact while showering or bathing is 20,900 cm^2, which is the weighted average of mean values for adults (male and female, 21+ years) (USEPA, 2014b). The event frequency for both soil dermal contact and groundwater contact while showering or bathing is assumed to be one event per day, as recommended by USEPA (2004b).

Exposure Time

The potable groundwater exposure time for the dermal pathway is 0.71 hours, which is the weighted average of adult (21 to 78 years old) 90th percentile of time spent bathing/showering in a day, divided by mean number of baths/showers taken in a day.

Indoor workers are assumed to be inside on-site buildings and inhale COPCs due to vapor intrusion or potable groundwater use for 8 hours/day, the USEPA-recommended value for full-time workers (USEPA, 2009, 2014b). This potable groundwater exposure time for the inhalation pathway is also assumed to be the 8 hour workday to be consistent with the calculation of the indoor air vapor concentration which is the average concentration in the building from potable use (showers, dishwashers, toilets) over a 24 hour period (USEPA 1991b).

Exposure Frequency and Duration

Indoor workers are assumed to be inside on-site buildings for 250 days/year for 25 years. USEPA has recommended the use of these values for evaluating high-end indoor worker exposures (USEPA, 2002b, 2014b).

In this risk assessment, indoor worker's exposure to ~~soil and~~potable groundwater COPCs ~~via vapor intrusion~~ are also used to conservatively evaluate ~~visitors' indoors~~outdoor workers' and off-site workers' exposures to ~~soil and~~potable groundwater COPCs~~ during brief periods spent indoors~~.

Fraction Contacted

A fraction contacted~~ (FC)~~ term of 1 is conservatively used.

~~4.3.3~~4.4.3 Utility Workers

The exposure factors used for evaluating potential exposure of utility workers to soil and groundwater are the same as those for outdoor workers discussed in Section ~~4.3.1,~~4.4.1, except as follows:

Soil Ingestion Rate

An incidental ingestion rate of 330 mg/day is used for the utility workers, assuming they are engaged in high-intensity soil contact activities ~~similar to~~like construction workers, such as soil excavation (USEPA, 2002b). This value is approximately the 95th percentile of the soil ingestion rates in the study (Stanek et al. 1997) cited by USEPA (2002b), which involved only 10 adults (so the 95th percentile is essentially the highest rate in the study~~, and is likely to overstate the RME). For perspective, the 90th percentile in that study was approximately 200 mg/day.~~). ~~See~~ Section 6.3.3 provides ~~for~~ a discussion on the uncertainties related to th~~eis~~ ingestion rate.

Groundwater Ingestion Rate

A rate of 0.005 L/hour for 2 hours is used for incidental ingestion of groundwater during excavations that extend into the water table. This rate is 10% of the rate that USEPA (1989) recommends for ingestion while swimming (0.05 L/hour~~), and~~) and represents a conservative estimate of incidental groundwater ingestion that could occur during excavation activities. The ingestion rate of 0.05 L/hour is more conservative than the mean ingestion rate of 0.021 L/hour recommended in USEPA's 2011 Exposure Factors Handbook (EFH) for adults while swimming.

Groundwater Dermal Contact

The exposed skin surface area of 3,527 cm^2 is based on the USEPA-recommended exposed skin surface area for evaluating high-end contact with soil by workers in industrial settings. This is the weighted average of mean values for head, hands, and forearms (male and female, 21+ years) (USEPA, 2014b). Workers are conservatively assumed to be covered with groundwater over this same exposed skin surface area for 2 hours/event. The exposure time of 2 hours/event is based on professional judgment that workers are not likely to remain in contact with "fresh" groundwater at the bottom of an excavation pit for more than 2 hours/event.

The absorbed dose for organic chemicals is estimated using a nonsteady state approach (USEPA, 2004b), which is more conservative than the steady state approach (USEPA, 1989), particularly for hydrophobic chemicals. The permeability coefficient (K_p) for dermal absorption from groundwater is estimated following USEPA guidance (USEPA, 2004b).

Exposure Frequency

Utility workers are assumed to excavate soil one week per quarter for a total of 20 ~~work days~~workdays per year. For contact with groundwater during excavations, workers are expected to contact water for only the brief time it would take to dewater the excavation for utility repairs to proceed. ~~Assuming~~While it is assumed dewatering would occur for ~~one day at~~ the ~~start of~~entire week the trench is open (i.e., the pump would run continuously for the entire work week~~ and continue for the remainder of the week,~~), the workers ~~would be expected~~are conservatively assumed to contact water ~~for one day a~~as noted above during the whole week for four quarters (i.e., ~~four~~20 days per year).

Exposure Duration

An exposure duration of 10 years is used for utility worker exposures. The exposure duration is supported by the analysis of Burmaster (2000), using data from the Bureau of Labor Statistics through February 1996, which indicated that 95th and 90th percentile job tenure of workers in construction is approximately 12.48 years and 7.7 years, respectively. An exposure duration of 10 years is protective ~~conservative~~ considering utility workers are not employees at the Site and the median tenure for US workers at a given job is 4.2 years[33] in 2018. ~~USEPA notes T~~there is some uncertainty in this exposure frequency based on the limitations of the available ~~limited~~ data.

Fraction Contacted

A fraction contacted~~ (FC)~~ term of 1 is conservatively used.

~~4.3.4~~4.4.4 Construction Workers

The exposure factors used for evaluating potential exposure of construction workers to soil and groundwater are the same as those for utility workers discussed in Section ~~4.3.3,~~4.4.3, except as follows:

Exposure Frequency and Duration

Construction workers are assumed to contact soil during excavations for 6 months (130 ~~work days~~workdays) ~~in a one~~per year~~ period~~. This exposure frequency and duration are expected to be conservative for the amount of time that workers are ~~actually exposed~~exposed to soil in excavations

[33] Median years of tenure with current employer for employed wage and salary workers by age and sex, selected years, 2008-2018 (https://www.bls.gov/news.release/tenure.t01.htm).

(as opposed to the total time for construction, which typically includes time not associated with soil excavation).

For contact with groundwater, workers would only contact water for the brief time it would take to dewater the excavation for work to proceed. Assuming dewatering would occur at the beginning of each work week and continue for the remainder of that week, (i.e., the pump is placed in the excavation pit at the beginning of the work week and remains in the pit for the entire week), workers would be expected to contact water for one day a week for 6 months (i.e., 26 days per year).), two hours per event.

Fraction Contacted

A fraction contacted (FC) term of 1 is conservatively used.

4.3.54.4.5 Adolescent Trespassers

Trespassers have been frequently observed at the site both in cars and on foot. by USEPA staff and RI contractors. Evidence of trespassing, including extensive graffiti inside and outside of abandoned buildings, frequent extensive illegal dumping and frequent vandalism of property fencing, has also been observed by USEPA staff and RI contractors. The following exposure factors for adolescent trespassers are based on these observations and the assumption that trespassers are 10 to 18 years old, and observations of trespassing or evidence of trespassing activities (under current site conditions) by USEPA staff and others during the RI. .

Soil Ingestion Rate

A soil ingestion rate of 100 mg/day is used for adolescent trespassers. This is the same as the soil ingestion rate used for outdoor workers, and consistent with the EFH, which recommends this value as the upper-percentile for evaluating exposure of adolescents age 12 to adults to soil and dust (Table 5-1, USEPA, 2017d).

Soil Dermal Contact Rate and, Absorption, and Event Frequency

The exposed skin area of 4,220 $cm^2$3,961 is used for 10 to 16 year-old receptorss and 4,998 is used for 16 to 18 year-old receptors. These values are calculated for the face, forearms, lower legs, and hands of adolescents 10 to 18 years old, using the mean values for body surface area from Tables 7-10 and 7-11 and the percent of total body surface area from Table 7-6 in the EFH (USEPA, 2011). 2011a). The soil-to-skin adherence factor of 0.2 mg/cm^2 is the adherence factor for adolescents engaged in high-intensity soil contact activities (USEPA, 2014b, Exhibit 3-3 of USEPA, 2004b). The absorbed dose from dermal contact with soil is estimated by multiplying the dermal contact rate by USEPA-recommended absorption factors for absorption from soil (USEPA, 2004b). The event frequency for soil dermal contact is assumed to be one event per day, which is the USEPA-recommended value for both residential and industrial soil contact (USEPA, 2004b).

Exposure Time, Frequency and Duration

USEPA recommended the following exposure time, frequency and duration for adolescent trespassers, based on observations of trespassing and evidence of trespassing activities at the Site, including graffiti on walls and reports of trespassing by RI contractors. Trespassers are assumed to be at the Site and inhaling vapors and particulates for 4 hours/day while trespassing. This value is conservative and likely tomay overestimate RME. According to the 2011 EFH (Table 16-20, USEPA, 2011), people typically spend no more than 2 hours per day outdoors. RME, as discussed in Section 6.3.3.

Trespassers are assumed to be at the Site for 150 days/year. This value is conservative since the activity in the occupied areas of the Site would likely dissuade trespassers from frequently being outdoors at the unoccupied lots for 4 hours/day. The exposure duration of 8 years is based on the assumed age range of the trespassers. Trespassers present at the site after it has been redeveloped will likely spend less time at the site since the vacant buildings will no longer be present and therefore, the use of these exposure factors to assess exposures for future trespassers likely overestimatesmay overestimate the RME.

Fraction Contacted

A fraction contacted (FC) term of 1 is conservatively used, even though the soil ingestion rate and dermal contact rate are for an entire day and dowhich does not account for the fraction of the day spent on-site (4 hours out of 16 waking hours). This is protective conservative since the ingestion rate and dermal contact rate are for an entire day.

Body Weight

The body weight of 57.4 kg is the A mean body weight of 52.6 kgs is used for 10 to 16 year-old receptorss and 71.6 kgs is used for 16 to 18- year-old receptors (Table 8-1, USEPA, 2011a).

Averaging Time

The averaging time for evaluating cancer risk is equal to a lifetime of 70 years, and the averaging time for evaluating noncancer HI is equal to the exposure duration (USEPA, 1989).

4.4.6 Visitors

The exposure factors used for evaluating potential exposure of visitors to soil and groundwater are the same as those for residents discussed in Section 04.4.7, except as follows:

Exposure Time, Frequency and Duration

Visitors are assumed to be at the Site and inhaling vapors and particulates for 2 hours/day, based on professional judgment.

The exposure frequency of 52 days per year is based on a conservative assumption that visitors come to the Site 2 days/week during the warmer months from May to October). Visitors are assumed to be exposed for 26 years (6 years as children and 20 years as adults) for cancer risk calculations, and 6 years as children only and 20 years as adults only for noncancer risk calculations based on the residential exposure duration in USEPA guidance (USEPA, 2014).

Fraction Contacted

2011).A fraction contacted term of 1 is conservatively used, which does not account for the fraction of the day spent on-site (2 hours out of 16 waking hours). This is protective conservative since the ingestion rate and dermal contact rate are for an entire day.

Averaging Time

The averaging time for evaluating cancer risk is equal to a lifetime of 70 years, and the averaging time for evaluating noncancer riskHI is equal to the exposure duration (USEPA,, 1989). , 2014b).

Visitor noncancer HI are calculated for an exposure duration of 6 years (i.e., child only). Using an exposure duration of 6 years does not account for the lower soil ingestion rate and higher body weight, as well as other differences, over the rest of the exposure duration of 26 years, and therefore, may over estimateoverestimates noncancer HI for this combined child/adult receptor. Therefore, visitor noncancer HI are also calculated separately for an exposure duration of 20 years (i.e., adult only). , as required by USEPA Region 2.

~~4.3.6~~4.4.7 Residents

The exposure factors used for evaluating potential exposure of residents to soil and groundwater are as follows:

Soil Ingestion Rate

A soil ingestion rate of 100 mg/day is used for adult residents and 200 mg/day is used for child (<6 years) residents (USEPA, 2002b, 2014b).

Potable Groundwater Ingestion Rate

A drinking water ingestion rate of 2.5 L/day is used for adult residents and 0.78 L/day is used for child residents (USEPA 2014a).

Soil and Groundwater Dermal Contact Rate ~~and~~, Absorption and Event Frequency

The exposed skin area ~~of~~for soil contact is 2,373 cm^2 and 6,032 cm^2, for the child and adult resident, respectively~~,~~. This is calculated for the head, hands, forearms, lower legs, and ~~feet~~ft. using the mean values for body surface area from USEPA (2014b). The soil-to-skin adherence factor of 0.2 mg/cm^2 is used for child residents and 0.07 mg/cm^2 is used for adult residents. (USEPA, 2002b, 2014b). The absorbed dose from dermal contact with soil is estimated by multiplying the dermal contact rate by USEPA-recommended absorption factors for absorption from soil (USEPA, 2004b). The exposed skin surface area for potable groundwater contact while showering or bathing is 6,378 cm^2 for child residents and 20,900 cm^2 for adult residents. These are the weighted average of mean values for children (~~<~~6 years and younger) and adults (male and female, 21~~+~~ years and older) (USEPA, 2014b). The event frequency for both soil dermal contact and groundwater contact while showering or bathing is assumed to be one event per day, as recommended by USEPA (2004b).

Exposure Time, Frequency and Duration

The potable groundwater exposure time for the dermal pathway is 0.71 hours for adult residents, which is the weighted average of adult (21 to 78) 90th percentile of time spent bathing/showering in a day, divided by mean number of baths/showers taken in a day. For child residents, 0.54 hours is used, which is the weighted average of 90th percentile time spent bathing (birth to less than ~~<~~6 years) (USEPA, 2014b).

Residents are assumed to be at home and inhaling vapors and particulates for 24 hours/day, 350 days/year~~, and 26 years.~~ . The potable groundwater exposure time for the inhalation pathway is also 24 hours/day to be consistent with the calculation of the indoor air vapor concentration which is the average concentration in the house from potable use (showers, dishwashers, toilets) over a ~~24 hour~~24-hour period (USEPA 1991b).

Residents are assumed to be exposed for 26 years (6 years as children and 20 years as adults) for cancer risk calculations, and 6 years as children only for noncancer risk calculations and 20 years as adults only for noncancer risk calculations based on the residential exposure duration in USEPA guidance (USEPA 2014). This combination of exposure frequency and exposure duration is expected to be conservative for the amount of time that residents could ~~actually be~~be exposed to soil at the Site because winter weather in New Jersey would preclude soil contact for extended periods of the year. USEPA has recommended the use of these values for evaluating high-end residential exposures (USEPA, 2014b), assuming local climate is not a significant factor.

The inhalation exposure factors are used to assess inhalation exposures for both current off-site residents that may be exposed to COPCs in on-site soil that migrates off-site as well as future residents. Additionally, in this risk assessment, future residents' exposure to groundwater COPCs via potable use are also used to conservatively evaluate visitors' and off-site residents' exposures to groundwater COPCs.

Fraction Contacted

A fraction contacted (FC) term of 1 is conservatively used.

Body Weight

The body weight of 15 kg for a child and 80 kg for an adult are used for assessing exposure of children and adults (USEPA, 2014b).

Averaging Time

The averaging time for evaluating cancer risk is equal to a lifetime of 70 years, and the averaging time for evaluating noncancer riskHIs is equal to the exposure duration (USEPA, 1989, 2014b).

Residential noncancer risksHIs are calculated for an exposure duration of 6 years (i.e., child only). Using an exposure duration of 6 years does not account for the lower soil ingestion rate and higher body weight, as well as other differences, over the rest of the exposure duration of 26 years, and therefore, over estimatesoverestimates noncancer risk.HIs for this combined child/adult receptor. Therefore, resident noncancer HI are also calculated for an exposure duration of 20 years (i.e., adult only), as required by USEPA Region 2.

Exposure to Lead

Lead was identified as a COPC for each of the 15 lots. Potential exposures to lead in soil are evaluated separately from the assessment for other COPCs because USEPA (2003b) evaluates the significance of lead exposures using blood lead level as an index of exposure, rather than in terms of cancer risk or noncancer riskhazards.

4.3.74.4.8 Soil Lead Screening Levels

USEPA required that the BHHRA follow USEPA Region 2's Lead Strategy, which is included as Appendix C. In the Region 2 Lead Strategy, the soil lead screening levels are as follows:

- Non-residential: 800 mg/kg.
- Residential: 200 mg/kg.

These screening levels utilize a target blood lead level (BLL) of approximately 5 micrograms per deciliter (ug/dL) (as opposed to 10 ug/dL) based on the USEPA Office of Land and Emergency Management (OLEM) Directive 9200.2-167 to reduce BLLs from 10 ug/dl to a BLL within 2 to 8 ug/dL. It should be noted that the current screening levels being used by the OLEM, are still based on a 10 ug/dL target BLL, pending completion of a cross-Agency effort to evaluate whether updated policy recommendations are needed to incorporate the current scientific consensus and national public health recommendations regarding lead exposure into land cleanup programs (USEPA, 2016, 2017b).

Using a target BLL of 10 ug/dL and the inputs from 2017 adult lead model (ALM) update, the soil lead screening level for nonresidential settings is 2,520 mg/kg compared to 1,050 mg/kg screening level at target BLL of 5 ug/dL. These screening levels can be found in Appendix F. The soil lead screening level for residential settings is 400 mg/kg (USEPA, 1994, 2019). When OLEM will eventually incorporate a target blood lead level of 5 ug/dL in the IEUBK model to derive a residential screening level, it may also update other model inputs (e.g., soil ingestion rate, age range) (TRW Lead Committee 2017 Annual Report, USEPA, 2017c) that may counterbalance the impact of lowering the target blood lead level. dL to a BLL within the range of 2 to 8 ug/dL.

4.3.84.4.9 Blood Lead Distribution Calculations

In addition to using the soil lead screening levels from the Region 2 Lead Strategy, blood lead distributions are calculated using USEPA's Integrated Exposure Uptake Biokinetic (IEUBK) model (version 1.1, 2007) for child IEUBK model and Adult Lead Model (ALM) (2003b, 2017b) for all receptors at each lot to reflect the average soil lead concentration on each Lot, per USEPA's request. The blood lead distributions are calculated using the soil EPCs (average concentration) for lead discussed in the Section 4.4.34.4.104.5.3 and central tendency (CT) exposure factors consistent with the model requirements perrequired by USEPA guidance (2003b, 2007)Region 2, which are discussed in Section 4.4.4.4.4.114.5.4.

Per USEPA Region 2's Lead Strategy (Appendix C), the goal is to ensure the 95th percentile of blood lead distributions produced by the ALM and IEUBK model are below the target BLL of 5 ug/dL.

4.3.8.14.4.9.1 -ALM

The ALM is used to assess adolescent and adult exposures (i.e., exposures of outdoor workers, utility workers, trespassers, and construction workers) from ingestion of soil. Exposure from other sources (e.g. food or water is not considered). The methodology focuses on estimating fetal blood lead concentration in women of child-bearing age exposed to lead contaminated soils (USEPA, 2003b). The ALM predicts risk, as a probability, that fetal BLL exceeds the target BLL, and the goal is to limit risks exceeding the target BLL to 5%. Per USEPAConsistent with the Region 2's Lead Strategy (Appendix C), the goal is to limit the estimated portion of the workers' fetal blood lead distribution exceeding the 5 ug/dL level to less than 5%.

4.3.8.24.4.9.2 IEUBK

The IEUBK model is used to assess child (0 to 6 years old) exposure while visiting the site and during hypothetical future residential use of the Site. The model predicts the risk, as a probability, that a typical child will have a BLL greater than the target BLL when exposed to a combination of specified media concentrations of lead. Consistent with Per USEPA Region 2's Lead Strategy (Appendix C), the goal is to limit the estimated portion of the child residents' blood lead distribution exceeding the 5 ug/dL level to less than 5%.

The IEUBK model includes three modules: exposure, uptake, and biokinetic. The exposure module calculates media-specific lead intake rates to estimate how much lead is taken into a child's body from air (indoor and outdoor), soil, dust (indoor), diet, and drinking water. The uptake model incorporates absorption factors to estimate the fraction of lead intake that crosses into the bloodstream from the lungs or gastrointestinal tract. The transfer of lead between blood and other body tissues and through elimination pathways is addressed by the biokinetic module. The mother's blood lead concentration at childbirth is incorporated in the biokinetic module.

IEUBK v1.1 build 11, the version of the model currently available on ~~EPA's~~USEPA's website, was used in this assessment. As discussed below, an analysis using the recommendations from the Lead TRW was also developed. IEUBK v1.1 model defaults were used for all exposure parameters except maternal blood lead because guidance was issued by the USEPA Technical Review Workgroup for Lead (Lead TRW) in 2017 incorporating updated data on maternal blood lead concentrations from the National Health and Nutrition Examination Survey (NHANES). The model was run using batch mode assuming an age of 32 months, as recommended by the Lead TRW. The batch mode approximates the 12- to 72-month average calculated in single run mode and recommended in the November 2017 OLEM Directive 9200.2-1, "Recommendations for Default Age Range in the IEUBK Model", recommends the 12- to 72- month age range for lead risk assessment at Superfund sites. Using the updates to the IEUBK model recommended by the Lead TRW, noted below, for comparison indicates that the USEPA Region 2 soil screening level of 200 mg/kg based on evaluation of the 12-72 month age range (OLEM Directive 9200.2-177), the blood lead distribution does not exceed 5 ug/dL of 5~~17~~%. The implications of the different applications of the IEUBK model are discussed in the Uncertainty Analysis.

Table 4-2 Exposure Parameters in the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK Model)

IEUBK Input Parameters Based on USEPA and Site-Specific Information Based on Consultation with the Lead TRW.

Parameter	Value	Basis
Soil concentration (mg/kg)	C_{soil}	EPC soil concentration
Dust concentration (mg/kg)	$C_{dust} = 0.7 \cdot C_{soil(weighted)} +$ (air concentration • 100)	Indoor dust lead was derived from residential soil data (or weighted soil considering contribution of sediment where track- in is assumed) (EPA, 1994b, 1994c)
Outdoor air concentration (µg per cubic meter [m³])	0.1	(EPA 2016a)
Indoor air concentration (µg/m³)	30% of outdoor air concentration	IEUBK Default (EPA, 1994b, 1994c)
Drinking water concentration (µg per liter [L])	0.9	EPA (2016a)
Maternal PbB at birth (µg/dL)*	0.6	Based on National Health and Nutrition Examination Survey (NHANES) update (2009-2014) (EPA, 2017d)
Absorption fractions† at low intakes: Air Diet Water Soil/dust Sediment and disturbed surface water	 32% 50% 50% DU- or ADA-specific DU- or ADA-specific	 IEUBK Default (EPA, 1994b, 1994c) IEUBK Default (EPA, 1994b, 1994c) IEUBK Default (EPA, 1994b, 1994c) SRC (2017); see Appendix 9 SRC (2017); see Appendix 9
RBA (soil/dust)	DU- or ADA-specific RBA %	SRC (2017); see Appendix 9
Fraction soil	45%	IEUBK Default (EPA, 1994b, 1994c)
GSD	1.6	IEUBK Default (EPA, 1994b, 1994c)
Target PbB	5 µg/dL	Within the risk range of child PbBs associated with adverse health effects from EPA (2016a)

*Maternal PbB at birth does not impact results for the 12-72-month age range.
† Absorption fraction% = RBA% * 0.5.

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~~4.3.9~~4.4.10 Lead Exposure Point Concentration

Unlike the soil EPCs discussed in Section ~~4.2.2,~~4.3.2, the soil EPCs for lead are arithmetic mean concentrations rather than ~~95%~~ 95 % UCL concentrations~~s~~, to be consistent with the principles of the blood lead models and the screening levels derived from those models. The soil lead EPCs for 0 to 2 ~~feet~~ft. bgs~~, (~~ (outdoor worker, indoor worker, trespasser, resident), 0 to 4 ~~feet~~ft. bgs (utility worker), and all depths (outdoor worker, indoor worker, construction worker, trespasser, and resident) at each lot are shown in RAGS Part D Table 3 format in Appendix B.

~~For the child visitor, time-weighted average lead concentrations were calculated using Equation 7 of the USEPA guidance on Assessing Intermittent or Variable Exposures at Lead Sites (USEPA 2003c). Equation 7 of this guidance accounts for time spent at the Site and at another location away from the Site (e.g., their residential yard). The lead concentrations used for the Site are the arithmetic mean for each property, and for the residential yard is 139 mg/kg, which is the arithmetic mean soil lead background concentration for this region of New Jersey (BEM Systems, Inc. 1997 as referenced in NJDEP 2003). The time spent at each property was assumed to be 2 days/week for 2 hours/day,~~

~~which are conservative for a child visitor. According to the 2011 EFH (Table 16-20, USEPA, 2011), people typically spend no more than 2 hours per day outdoors.~~

~~4.3.10~~4.4.11~~Central Tendency~~ Exposure Factors for Lead Assessment

As discussed in the USEPA guidance on the ALM and IEUBK model (USEPA, 2003b, 2007), central tendency exposure factors should be used in the derivation of a lead screening level to achieve the intended degree of protectiveness (e.g., 5 ug/dL PbB at the 95th percentile) or in the estimation of the blood lead distribution of an exposed population. Uncertainties associated with these exposure factors are discussed in Section 6.3.4.2.

~~Outdoor~~Indoor Worker

The default ~~value~~values for daily soil intake and exposure frequency recommended for the ALM for occupational exposures are 50 mg/day and 219 day/year, respectively (USEPA, 2003b).

~~Utility~~Outdoor Worker

~~Exposure to lead in soil~~ ~~As required by USEPA Region 2, A~~an ingestion rate of 67 mg/day for outdoor workers is ~~not calculated for the utility worker because the expected~~ used, which is a theoretical average daily exposure from Hawley, 1985. The exposure frequency is ~~well below~~ the same as for indoor workers.

Utility Worker~~level at which~~

USEPA g~~uidance~~ (2003c) recommends the ALM model be applied ~~(i.e.,~~to "exposures that exceed a minimum frequency of one day per week and duration of 3 consecutive months~~").~~". Since utility workers' expected intermittent exposures (1 week per quarter) are below this level, USEPA Region 2 required the use of the minimum exposure frequency and duration (1 day a week for 3 consecutive months (USEPA 2003c) or 13 days over a ~~91 day~~91-day averaging time).

Construction Workers

~~In the study (Stanek et al. 1997) from which USEPA selected the RME soil ingestion rate of 330 mg/day (the 95th percentile), the mean~~~~As required by USEPA Region 2, A~~an ingestion rate ~~is 6~~of 100 mg/day ~~and the median~~ is ~~11 mg/day. Since these rates are lower than the central tendency ingestion rate of 50 mg/day for outdoor workers (USEPA, 2003b), the outdoor worker central tendency soil ingestion rate is conservatively used for~~used, since construction workers~~. ~~ are expected to perform more contact-intensive activities than that outdoor workers. For exposure frequency, half of the RME exposure frequency of 130 days/year ~~are~~is used (i.e., 65 days/year~~ or 5 days a week for 3 months), based on professional judgment.~~) over the minimum exposure duration (i.e., 91 day averaging time), as required by USEPA Region 2).

Adolescent Trespassers

As required by USEPA Region 2, adolescent trespassers' lead exposure is qualitatively assessed using outdoor workers' exposures. This is health protective ~~conservative~~ as the central tendency exposure frequency and duration of each event for trespassers is expected to be lower than that for outdoor workers.

Child Resident ~~Table 5-1 of the Exposure Factors Handbook (USEPA, 2017d) indicates that the central tendency soil ingestion rate for adolescents age 12 to adults is 30 mg/day (with a range from 4 to 50 mg/day). The upper end of that range is the same as the central tendency soil ingestion rate used in~~

~~the ALM, and is conservatively used for adolescent trespassers. This makes the trespassers' central tendency and RME soil ingestion rates the same as those of the outdoor workers. For exposure frequency, 60 days/year is used, based on a conservative assumption that trespassers come to the Site 2 days/week during the six months of the year when the temperature is above 55 degrees in Newark, NJ.~~

~~***Child Resident and Visitor***~~

The soil ingestion rate recommended by IEUBK is age-dependent, and the full range can be found in Appendix F. For the child aged 32 months, an ingestion rate of 135 mg/day is used.

Child Visitor

The child visitor is potentially exposed to lead while at their primary residence as well as during their limited time at the Site (and at other locations). USEPA's Assessing Intermittent Exposure at Lead Sites (USEPA, 2003c) presents methodologies to account for the child's lead exposure at both locations. When the lead concentrations in soil at the primary residence is unknown, the USEPA guidance recommends using local soil background concentrations for the lead concentration at the primary residence to provide an estimate that reflects no less than what a minimally exposed individual may experience. Background data are limited for the Newark area[1],[2]. Based on the uncertainties associated with establishing the concentration of lead in soil at the child's residence, the ability to predict where the child may live, the limited data on soil lead background concentrations for this area, and the limited exposures compared of the young child future resident and current/future outdoor worker, the child visitors' lead exposure is assessed qualitatively using the child residents' exposure, as required by USEPA Region 2. Subsequent to EPA's discussion with the PRP on October 17, 2019, USEPA determined it is possible to quantitatively evaluate lead exposures on the individual Lots. The lead exposure was calculated based on a time-weighted soil lead concentration assuming the lead EPC on the lot 1 day per week and the local soil lead concentration six days per week. Consistent with USEPA guidance, only the number of days were evaluated and not combined with hours/day for the assessment. As outlined in Section 4.4 and consistent with USEPA's guidance, the child visitors' exposure time, frequency, and duration are assumed to be one day/week for 52 weeks.

As outlined in Section 4.4, the assessment for exposures to other chemicals is conducted assuming the child visitors' exposure time, frequency, and duration of 2 hours/day for 52 days/year (i.e., 2 days/week for 6 months) for 6 years are significantly lower than the child residents' exposure time, frequency and duration of 24 hours/day (16 waking hours) for 350 days/year for 6 years. A comparison of the child visitor exposure intensity relative to the future child resident in a given week (2 hour/day for 2 days/~~7 day~~7-day week for a visitor vs 16 waking hours/day for 7 days/~~7 day~~7-day week for a resident) is 3.6%. The child visitor is also only assumed to be at the site for a half a year compared to a future resident who is assumed to be at the site for the entire year. Therefore, the use of 5% is conservative.

[1] The arithmetic mean soil lead background concentrations for this region of New Jersey is 139 mg/kg (BEM Systems, Inc. 1997 as referenced in NJDEP 2003). NJDEP 2003 shows Newark, NJ in the urban piedmont area of the State, lists urban piedmont as having the highest background lead levels in the State, and references BEM 1997 as the source of the urban piedmont values. In BEM 1997, Table 8 presents summary statistics for the 67 soil lead samples for piedmont soils in NJ, showing an arithmetic average of 139 mg/kg, median of 11 mg/kg and the range of soil lead concentration is 14.9 to 464 mg/kg.

[2] USEPA Region 2 provided an abstract titled: "Heavy Metal Contamination in Urban Soils of Newark, New Jersey", which identifies concentrations of lead in the soils from Newark area gardens ranging from 72-830 mg/kg. The abstract is available at: https://scisoc.confex.com/crops/2017am/webprogram/Paper108085.html

5. TOXICITY ASSESSMENT

This section presents the toxicity assessment, which describes the potential adverse health effects that are associated with exposure to ~~chemicals, and~~chemicals and summarizes the toxicity values for characterizing the dose-response relationship between exposure and the occurrence of adverse health effects. The following subsections describe the sources used to compile toxicity values (Section ~~5.1),~~ ~~non-cancer~~5.1), noncancer toxicity values (Section ~~5.2),~~5.2), cancer toxicity values (Section ~~5.3),~~5.3), and the extrapolation of toxicity values (Section ~~5.4).~~5.4).

5.1 Source Hierarchy

The toxicity values used in the BHHRA are compiled from the hierarchy of sources recommended in OSWER Directive 9285.7-53 (USEPA, 2003a), as follows:

- Integrated Risk Information System (IRIS);
- Provisional Peer Reviewed Toxicity Values (PPRTV); and
- Other Toxicity Values.

When a toxicity value is not available from the first two tiers of the hierarchy, other USEPA and non-USEPA sources ~~(e.g., Agency for Toxic Substances and Disease Registry (ATSDR))~~ of toxicity values are used~~.~~ as listed below. The values are reviewed by USEPA Region 2 before use.

- Agency for Toxic Substances and Disease Registry (ATSDR)
- National Center for Environmental Assessment (NCEA)
- California EPA
  - Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values
  - OEHHA Toxicity Criteria Database http://www.oehha.ca.gov/risk/ChemicalDB/index.asp
- Health Effects Assessment Summary Table (HEAST 1997)

NCEA assessments are used for the reference concentrations (RfCs) for iron (NCEA 2001), RfCs for chloroform (NCEA 2003), and the subchronic RfC for cadmium (NCEA 1998). The subchronic reference dose (RfD) for arsenic is from a USEPA Region 8 derivation (USEPA Region 8, 2002). Since these assessments are not available on-line, they have been included in Appendix J.

Cancer toxicity values for the carcinogenic PAHs are based on the potency relative to benzo(a)pyrene as described in USEPA's 1993 "Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons (PAH)".

For arsenic, the IRIS cancer and noncancer oral toxicity values are based on exposure to arsenic in water. To account for the lower bioavailability of arsenic in soil relative to water, USEPA (2012) recommends using a default RBA of 0.6 in evaluating exposure from ingestion of arsenic in soil. According to USEPA, less than 5% of measured RBAs are expected to exceed the default RBA of 0.6.

For COPCs without toxicity values, toxicity values from chemicals with structural similarity are used as a surrogate, and are noted in RAGS Part D format, Tables 5 and 6, in Appendix ~~B~~A. The Superfund Technical Support Center (STSC) recommended the following surrogates, which USEPA transmitted to PPG on September 18, 2018: fluorene ~~(noncancer)~~ as a surrogate for carbazole; diethylphthalate as a surrogate for dimethylphthalate; and cyclohexane as a surrogate for methylcyclohexane. Four additional surrogates are used, as listed below and confirmed by STSC, which ~~USEPA's~~USEPA transmitted to PPG on April 16, 2019 (Appendix ~~A~~B):

- Mercuric Chloride ~~non-cancer reference dose (~~noncancer RfD~~)~~ is used as a surrogate for the total mercury RfD. This surrogate is used because the mercury analytical method measures total mercury concentration, which could consist of various forms of inorganic mercury including elemental mercury and mercuric chloride~~.~~, and the type of mercury present in the fill or used at the site is unknown. Using the mercuric chloride RfD is conservative since there is no RfD for total mercury. The RfC for elemental mercury is used to assess total mercury.
- Hydrogen Cyanide RfD and ~~non-cancer reference concentration (~~noncancer RfC~~)~~ are used as surrogates for both the RfD and RfC of total cyanide. These surrogates are used because the analytical method measures total cyanide concentration, which could include various forms of cyanide. This is also consistent with the toxicity values for cyanide (CN-) in the RSL table. The use of the RfC is explained in Section 5.20 of the RSL User's Guide (USEPA, 2019).
- Aroclor 1254 [CASRN 11097-69-1] RfD is used as a surrogate for PCBs [CASRN 1336-36-3]. This surrogate is used because it is conservative for the Aroclors detected at the Site, since Aroclor 1254 has the most stringent IRIS RfD among the Aroclors.
- Copper intermediate minimal risk level (MRL) (0.01 mg/kg/day) from ATSDR with a subchronic to chronic uncertainty factor of 10, per USEPA Region 2, is used as the chronic RfD.

5.2 ~~Non-Cancer~~Non~~C~~cancer Toxicity Values

Oral RfDs and inhalation RfCs are presented in RAGS Part D Table 5.01 and Table 5.02, respectively, in Appendix ~~B~~A. Constituents designated by USEPA as belonging to the cancer weight-of-evidence Group D (Not Classifiable as to Human Carcinogenicity) are considered noncarcinogens. Constituents not designated as belonging to any cancer group are also treated as noncarcinogens. Additionally, chemicals classified as carcinogens may also have ~~non-cancer~~noncancer health effects (and have an RfD and/or RfC). In those cases, noncancer hazards are evaluated in addition to cancer risks.

The oral RfDs and inhalation RfCs represent conservative estimates of the daily exposure to the human population, including sensitive subpopulations (e.g., children), which are likely to be without an appreciable risk of deleterious effects. These RfDs and RfCs typically incorporate several uncertainty factors to account for uncertainties in their derivation, which in combination result in overall uncertainty factors ranging from 1 to 3,000 for the COPCs.

According to RAGS Part A (USEPA, 1989, Section 7.2), subchronic RfDs and RfCs should be used to characterize potential non-cancer effects associated with shorter-term exposure periods from two weeks to seven years. Subchronic toxicity values were used to evaluate construction workers, whose exposure period falls in this category, as discussed in Section ~~4.3.4.~~4.4.4. As discussed in ~~Section 4.3.6,~~Sections 0~~4.4.7~~ and 4.4.6, residential and visitor noncancer ~~risks~~HIs are calculated for an exposure duration of 6 years (i.e., child only). However, as required by USEPA Region 2, chronic noncancer toxicity values are used to calculate ~~risk~~HI estimates for the ~~future~~child only resident and visitor~~ even though the 6-year period is considered subchronic.~~. ~~According to USEPA (1996, Section~~Region ~~2.2), this can~~, T~~ t~~he use of chronic values for a young child is designed to be ~~overly conservative depending on the chemical~~protective for potential developmental effects.

5.3 Cancer Toxicity Values

Oral slope factors (SFs) and inhalation unit risk factors (URFs) are presented in RAGS Part D Table 6.01 and Table 6.02, respectively, in Appendix ~~B~~A. For chemicals that USEPA assessed ~~prior to~~using the ~~2005~~1986 Guidelines for Carcinogen Risk Assessment~~ (USEPA, 2005a),~~, USEPA considers chemicals belonging to the following cancer weight of evidence groups as human carcinogens:

- Group A - Known Human Carcinogen: Sufficient evidence of carcinogenicity in humans;
- Group B1 - Probable Human Carcinogen: Limited evidence of carcinogenicity in humans;
- Group B2 - Probable Human Carcinogen: Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans; and
- Group C - Possible Human Carcinogen: Limited evidence of carcinogenicity in animals and inadequate or lack of evidence in humans.

For chemicals that USEPA assessed ~~after~~using the 2005 Guidelines for Carcinogen Risk Assessment (USEPA, 2005a), USEPA uses the following cancer weight of evidence groups for human carcinogens:

- Carcinogenic to Humans.
- Likely to be Carcinogenic to Humans.
- Suggestive Evidence of Carcinogenic Potential.

~~Many of the constituents that will be evaluated as carcinogens are not designated as Group A or as being "Carcinogenic to Humans", which means USEPA acknowledges that there is either inadequate evidence or a lack of evidence that these constituents cause cancer in humans.~~

The weight of evidence classification under USEPA 2005 includes a written narrative describing the data used to determine the classification.

USEPA published "Proposed" Guidelines for Carcinogen Risk Assessment in 1996 and "Revised Draft" Guidelines for Carcinogen Risk Assessment in 1999 and these documents including response to comments and external peer review were included in the 2005 Cancer Guidelines. ~~While USEPA Region 2 considers these sources to be superseded by the 2005 Guidelines, A~~a weight of evidence classification from the 1999 Guidelines is still available in the IRIS file ~~used~~ for three COPCs (acetone, 4-methyl-2-pentanone, and xylenes (total)) since ~~that is the only available weight of evidence from USEPA for these COPCs~~the IRIS has not updated the file since it was initially placed on IRIS. .

~~A weight of evidence classification derived by USEPA is preferred over other sources.~~ A cancer weight of evidence classification was not derived by the IRIS program. Consistent with the toxicity hierarchy, the ~~USEPA for one COPC (methyl tert-butyl ether). A cancer class of C derived by~~ California EPA's ~~in the 1999~~ Public Health Goal for Methyl Tertiary Butyl Ether (MTBE) in Drinking Water was evaluated. CalEPA identified MTBE as a Class C carcinogen and cancer risks were calculated using the cancer slope factor and the results indicated that the risks are below the risk range for cancer and the goal of protection for groundwater and air. ~~is therefore used.~~

The oral SFs and inhalation URFs represent 95% upper confidence bounds on the probability of getting cancer over a lifetime per unit dose (USEPA, 2005a).

USEPA (2005b) indicates that early-life exposure to carcinogenic chemicals with a mutagenic mode of action can result in a greater contribution to cancers appearing later in life. To account for this, age-dependent adjustment factors (ADAFs) are used to adjust toxicity values for carcinogenic ~~COPC~~COPCs with a mutagenic mode of action to assess potential exposures of trespassers, visitors, and future residents. Cancer risk for exposures from 0 to 2 years of age, and from 2 to 16 years of age are multiplied by the USEPA-recommended ADAFs of 10 and 3, respectively. The following COPCs have a mutagenic mode of action that requires the application of the ADAF, as noted in Table 3-1: 1,2-dibromo-3-chloropropane, trichloroethene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene.

~~An oral slope factor~~While TCE is a mutagen and the ADAF approach is applied, the TCE cancer toxicity values from IRIS (USEPA 2011b) are based on the same three studies, only one of which was mutagenic. The ADAF adjustment therefore is only required for the portion of oral and inhalation cancer toxicity value that was derived from the study that showed a mutagenic mode of action (i.e., the study that showed a kidney cancer risk). The cancer toxicity values are adjusted by a factor for cancer (i.e., non-mutagen portion) and mutagen portions. For the mutagen portion that requires the application of the ADAF, the SF is adjusted by 0.202 and the URF is adjusted by 0.244. For the cancer portion that does not require the application of the ADAF, the SF is adjusted by 1-0.202 and the URF is adjusted by 1-0.244.

While vinyl chloride is a mutagen, cancer risk estimates are not calculated using the ADAF approach. Instead, cancer risk is evaluated for early-life exposures (defined in the vinyl chloride 2000 IRIS assessment as "much shorter in duration than 10 years") by calculating an early-life exposure that is not prorated (i.e., averaging time equals exposure duration instead of 70 years) and adding it to the pro-rated exposure from 0 to 26 years. Both the pro-rated cancer risk for early-life exposures and non-pro-rated cancer risks are calculated using the lower SF and URF (i.e., continuous lifetime exposure during adulthood), as outlined in Section 5.3.5.1 of the IRIS assessment (USEPA 2000). Early-life risk estimates are calculated for visitors and future residents since these receptors include a child.

The URF for PCBs (total) is calculated from the inhalation slope factor listed in IRIS using standard methodology, as outlined in USEPA's RSL Frequently Asked Question #47 (USEPA 2019). The calculated URF from IRIS methodology is equal to the URF from CalEPA.

An oral SF is not used to assess hexavalent chromium since IRIS has designated hexavalent chromium as Group D (Not Classifiable as to Human Carcinogenicity) by the oral route and Group A (Carcinogenic to Humans) by the inhalation route. According to IRIS, carcinogenicity by the oral route of exposure cannot be determined at this time. Therefore, the assessment of hexavalent chromium by the oral route of exposure will be evaluated based on non-cancer health effects.

Cancer toxicity values and the cancer weight of evidence for nickel refinery dust are conservatively used to assess nickel since the type of nickel present in the fill or used at the site is unknown.

5.4 Extrapolation of Toxicity Values

The USEPA sources of toxicity values listed above do not provide dermal toxicity values for any of the COPCs. Therefore, oral toxicity values (i.e., oral SFs and RfDs) are used as dermal toxicity values. Adjustments to the oral toxicity values to reflect absorbed dose, where appropriate, are made in this route-to-route extrapolation following USEPA guidance (USEPA, 2004b).

The USEPA sources of toxicity values listed above do not provide inhalation toxicity values (URFs and RfCs) for every COPC. Route-to-route extrapolation from oral toxicity values is not performed to obtain inhalation toxicity values for COPCs that lack inhalation toxicity values, consistent with USEPA guidance on performing inhalation risk assessments (USEPA, 2009).

6. RISK CHARACTERIZATION

This section presents the estimates of RME risk for the potential exposures described in Section 4.1.4.1. The following subsections describe: the methods for quantifying cancer risks and noncancer hazard indices (Section 6.1);6.1); the RME risk estimates and their significance relative to USEPA's risk management goals (Section 6.2);6.2); and uncertainties in the risk estimates (Section 6.3).6.3).

6.1 Cancer Risks and Noncancer RisksHazards

According to RAGS Part A (USEPA 1989), the risks from COPCs other than lead are characterized by cancer risk and noncancer riskHI estimates, as described below. Background on lead exposure assessment is discussed in Section 4.404.5. Cancer risks and noncancer health effects are evaluated separately because of fundamental differences in their critical toxicity values.

Cancer risks are estimated as the incremental probability of an individual to develop cancer over a lifetime as a result of exposure to a potential carcinogen. The excess lifetime cancer risk is estimated by multiplying the lifetime exposure estimated in the exposure assessment (Section 4) by the slope factor or inhalation unit risk factor (URF) identified in the toxicity assessment (Section 5). Excess lifetime cancer risks generally are expressed in scientific notation and are probabilities. The cancer risk associated with potential exposure to a carcinogenic chemical via ingestion and dermal contact is calculated by multiplying an estimate of the lifetime average daily dose (*LADD*) for a particular exposure scenario by the cancer oral slope factor (*SF*) for the chemical, as follows:

$$Risk = LADD \cdot SF$$

To assess ingestion exposures, the oral cancer slope factor is used. To assess dermal exposures, the oral slope factor adjusted for the orally absorbed dose (as described in Section 5.4) is used.

For the inhalation route, the cancer risk is calculated using the chemical concentration in air (C_{air}) and the cancer inhalation unit risk factor (*URF*),URF, as follows:

$$Risk = C_{air} \cdot URF \cdot \frac{ET \cdot EF \cdot ED}{AT_c}$$

Where:

ET is exposure time, *EF* is exposure frequency, *ED* is exposure duration, and AT_c is the averaging time for carcinogens.

The noncancer hazard quotient (HQ)The potential for noncancer health effects is evaluated by comparing an exposure level over a specified time period with an oral reference dose (RfD) or an inhalation (RfC) derived for a similar exposure period. This ratio of exposure to toxicity for a COPC is referred to as a hazard quotient (HQ).

The noncancer HQ associated with potential exposure via ingestion and dermal contact is calculated by dividing an estimate of the average daily dose (*ADD*) for a particular exposure scenario by the *RfD* for the chemical, as follows:

$$HQ = \frac{ADD}{RfD}$$

To assess ingestion exposures, the oral RfD is used. To assess dermal exposures, the oral RfD adjusted for the orally absorbed dose (as described in Section 5.4) is used.

For the inhalation route, the HQ is calculated using C_{air} and the RfC, as follows:

$$HQ = \frac{C_{air}}{RfC} \cdot \frac{ET \cdot EF \cdot ED}{AT_{nc}}$$

Where:

AT_{nc} is the averaging time for non-carcinogens.

The equations and exposure factors for calculating the LADDs and ADDs are summarized in Section 4 and RAGS Part D Table 4 (Appendix BA). The noncancer and cancer toxicity values are summarized in RAGS Part D Tables 5 and 6, respectively, in Appendix BA. The calculation of single-chemical cancer risks and noncancer HQs are presented in RAGS Part D Table 7 format in Appendix B.A. Per USEPA Region 2, COPCs identified as single-chemical cancer risks above the lower end of NCP's risk range (1 x 10^{-6}) and HQ above 1 are discussed in Section 6.2. ADAFs are used to adjust toxicity values for carcinogenic COPCs with a mutagenic mode of action to assess potential exposures of trespassers, visitors, and future residents. Cancer risk for exposures from 0 to 2 years of age, and from 2 to 16 years of age are multiplied by the USEPA-recommended ADAFs of 10 and 3, respectively.

The cumulative cancer risk and noncancer hazard index (HI) that may result from exposure to the combination of chemicals at an exposure unit are estimated following USEPA guidance (USEPA, 1989), as follows:

$$Cumulative\ Risk = \sum_i Risk_i$$

$$Hazard\ Index = \sum_i HQ_i$$

Where:

$Risk_i$ = Estimated cancer risk for the i^{th} constituent
HQ_i = Hazard quotient for the i^{th} constituent

That is, the single-chemical cancer risk and non-cancer risksnoncancer hazards (i.e., hazard quotientsHQs) for each COPC are summed for an exposure pathway (e.g., dermal contact with soil) and then each of the pathway specific risks for a receptor are summed to calculate a "total" (i.e., cumulative) cancer risk and noncancer riskHI for each receptor and mediamedium[EPA13]. This approach that is based on simple additivity -which may result in estimates of cumulative cancer risk and noncancer HI that are likely to overestimate RME. For example, since different chemicals may cause different and unrelated non-cancernoncancer health effects, so summing the HQs for their individual effects would overestimate the significance of their combined effects. Whether this added conservatism materially affects the risk assessment results isas discussed in Section 6.3. Toxic-endpoint specific HI estimates were calculated for off-site residential exposure (Section 6.2.1.8).6.3. Toxic-endpoint specific HI estimates are determined by identifying the COPCs and pathway (oral or inhalation) that contribute the most to the HI, determining the toxic-endpoint for these COPCs and pathways, and if the toxic-endpoints are different,for HIs above one by summing the HQ estimates with the same toxic-endpoints[34]. The ~~HQ estimates for the COPCs that do not contribute significantly to the HI (i.e., "remaining COPCs") are conservatively added to each toxic-endpoint specific HI. The toxic-endpoint specific HI~~toxic-endpoint specific HIs are compared to USEPA's ~~limit for~~ RME ~~risk.~~ protection goal, as discussed below.

As requested by USEPA Region 2, cumulative cancer risk and HI estimates for soil and groundwater are summed to account for potential concurrent exposures to both media (e.g., utility or construction worker exposure to both soil and groundwater during excavations).

~~The cumulative cancer risk and HI estimates~~ For known or suspected carcinogens, the National Contingency Plan (NCP) established that acceptable exposure levels are generally concentration levels that represent an incremental upper-bound lifetime cancer risk in the range from 10^{-4} to 10^{-6} or less (29 CFR 1910.120, 40 CFR 300.430, USEPA, 1991a). Therefore, the cumulative cancer risk estimates for each receptor population are identified as below, above or within the NCP's cancer risk range of 10^{-4} to 10^{-6}. For systemic toxicants, the NCP established that acceptable exposure levels shall represent concentration levels to which the human population, including sensitive subgroups, may be exposed without adverse effect during a lifetime or part of a lifetime, incorporating an adequate margin of safety. Therefore, noncancer hazards are compared ~~with USEPA's site-related cancer risk limit of 10^{-4} and HI limit~~to a protection goal of 1~~, respectively (40 CFR 300.430, USEPA, 1991).~~ .

The RME cumulative cancer risk and HI estimates and results of ~~the comparison to the USEPA's limits for RME risk~~these comparisons are discussed in Section ~~6.2,~~6.2, and are presented in RAGS D Table 9 and 10 formats in Appendix ~~B.~~ A. RME cumulative cancer risk and HI estimates for each EPC and receptor combination are presented as a range followed by an imbedded table which presents the estimates by Lot. The cumulative cancer risk estimates above NCP's risk range (i.e., above 1 x 10^{-4}) are shaded and bolded, and risk estimates within the range (i.e., above 1 x 10^{-6} and less than or equal to 1 x 10^{-4}) are only bolded. The HI estimates above NCP's protection goal of 1 are shaded and bolded.

6.2 Results

The health significance of the potential exposures described in Section ~~4.1~~4.1 is discussed in the following subsections. The risk calculation results and lead analyses are discussed in Section ~~6.2.1~~6.2.1 for current receptors and in Section ~~6.2.2~~6.2.2 for potential future receptors. Uncertainties in the risk characterization are discussed in Section ~~6.3.~~6.3.

The Introduction to Appendix A provides an overview and map for locating the RAGS Part D tables in Appendix A for information used in this assessment. The content and organization of the tables are described, including the nomenclature for the tables, bookmarks, and nested bookmarks to facilitate access to the individual tables

[34] The toxic-endpoints, which are listed under "primary target organ" on RAGS D Table5 in Appendix A, were selected based on IRIS descriptions of Organs/Systems (https://www.epa.gov/iris/iris-descriptions-organssystems). ~~Toxic-endpoints~~Toxic endpoints that are not associated with a specific organ system, such as decreased body weight and selenosis, were assigned to the "Other" category.

6.2.1 Current Receptors

Risk estimates for the receptors at and around the Site under current land use are discussed in this section. As discussed in Section 4.1.1,4.1.1, receptors under current land use are:

- Outdoor Workers (only at occupied lots);
- Indoor Workers (only at occupied lots);
- Utility Workers;
- Construction Workers;
- Trespassers; (adolescents and adults);
- Visitors (children and adults; only at occupied lots);
- Off-Site Workers and Residents (children and adults; via wind transport).

6.2.1.1 -Outdoor Workers

Outdoor workers are employees at the Site who spend most of the work dayworkday conducting maintenance activities outdoors (e.g., moderate digging, landscaping) which may result in exposure to contaminants in: surface soil via incidental ingestion, dermal contact, and particulate inhalation; and surface and subsurface soil via vapor inhalation. Currently, outdoor workers are present at only the occupied properties (i.e., Lots 1, 57, 59, 60, 62, 69, and 70). The cancer risk, HI, and lead modeling are calculated assuming the absence of protective measures, such as existing pavement. or capping.

Cancer Risks and Noncancer Hazards. The outdoor workers' cumulative cancer risk and HI estimates summarized on Table 6-1 are the sum of the estimates for ingestion, dermal contact, and particulate inhalation calculated using soil data from the 0 to 2 ft. depth interval, and the estimate for vapor inhalation calculated using soil data from all sampled depths. As shown on Table 6-1, these cumulative risk estimatesbelow for each occupied property, the cumulative cancer risk estimates range from 2 x 10^{-6} to 2 x 10^{-5}, which are all within USEPA's limits for RMENCP's risk range. The noncancer HIs range from 0.09 to 0.7 and are all below the protection goal of 1. The single-chemical cancer risks. above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are arsenic (Lots 1, 59, 60, 62, 69 and 70), benzo(a)pyrene (Lots 57 and 69), naphthalene (Lot 62), PCBs (Lot 57), and 2,3,7,8-tetrachlorodibenzo-p-dioxin (Lot 70) (see RAGS D Table 7).

Table 6-1 . Current Outdoor Worker Cancer Risks and Noncancer HIsazard Indices from Exposure through Ingestion, Dermal Contact, and Particulate Inhalation of Surface Soil (0 to 2 Ft.) and Vapor Inhalation from Calculated Using Soil Data from All Sampled Depths. Cancer Risks are Within the NCP Risk range and Bdlow the Protection Goal of 1.

(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded).

Lot	Risk	HI
Lot 1	**6×10^{-6}**	0.1
Lot 57	**8×10^{-6}**	0.4
Lot 59	**2×10^{-6}**	0.09
Lot 60	**6×10^{-6}**	0.2
Lot 62	**1×10^{-5}**	0.3
Lot 69	**7×10^{-6}**	0.4
Lot 70	**2×10^{-5}**	0.7

Lead. As discussed in Section ~~4.4~~4.4.8~~, outdoor~~4.5.1, worker exposure to lead in soil may be assessed by comparing the average lead concentration at each property to the USEPA Region 2 nonresidential lead screening level of 800 mg/kg. As shown ~~on Table 6-2~~below ~~,~~, the average lead concentration in the 0 to 2 ~~foot~~ft. depth interval is below 800 mg/kg at each occupied property except for Lot 70. ~~The average lead concentration in surface soil at Lot 70 is 934 mg/kg, which is slightly above the screening level. However, outdoor workers are not expected to contact soil at Lot 70 currently, because Lot 70 is paved and partly capped (Figure 6-1).~~

Lead exposure also may be assessed by using the average lead concentration to estimate whether the portion of the fetal blood lead distribution exceeding the USEPA Region 2 blood lead level goal of no more than 5% of the population with BLLs greater ~~5 ug/dL is greater~~ than 5~~%,~~ ug/dL using the current version of USEPA's Adult Lead Model (USEPA 2017b). As also shown below ~~in Table 6-3A~~, the estimated portion of the outdoor worker's fetal blood lead distribution that exceeds ~~USEPA Region 2's lead goal of~~ 5 ug/~~dl~~dL for the 0 to 2 ~~foot~~ft. depth interval is less than 5% at each ~~currently~~ occupied property ~~(including Lot 70) is less than 5%.~~except for Lot 70. However, outdoor workers are not expected to contact soil at Lot 70 currently, because Lot 70 is paved and partly capped. T~~-~~his exposure pathway will be evaluated under a future scenario (Figure 6-1).

Table 6-2. Current Outdoor Worker Exposure to Pb Concentrations in Soils at Depths of 0 to 2 Ft. On Individual Lots. The Table includes Highlights for Lead Concentrations Greater than the Screening Level of 800 mg/kg and the Percent of BLLs Greater Than 5 ug/dl.Average Lead Concentrations in Surface Soil (PbS) and ALM Estimated Probabilities (P) that PbB_{fetal} > PbB_t for Current Outdoor Workers Exposed to the PbS Concentrations (PbS > 800 mg/kg and P >5% are bolded and shaded)

Lot	PbS (mg/kg)	P(PbB_{fetal} > PbB_t) (%)
Lot 1	580	2.3%
Lot 57	305	0.44%
Lot 59	240	0.24%
Lot 60	185	0.14%
Lot 62	567	2.2%
Lot 69	343	0.58%
Lot 70	**934**	**7.7%**

Groundwater. Shallow and deep groundwater are not currently used for potable purposes at or around the Site. Water is supplied by the City of Newark. In addition, Lots 67, 68 and 69 have restrictions in place against groundwater use established by NJDEP. Future use of groundwater is evaluated in Section 6.2.2.1 to support decisions regarding ICs.

6.2.1.2 Indoor Workers

Indoor workers are employees at the Site who spend most of the work dayworkday indoors. Potential inhalation exposures to surface and subsurface soil vapors or shallow groundwater vapors may occur indoors if vapors migrate through building foundations. During brief periods outdoors,While an indoor workersworker has no direct contact with outdoor soils, this worker may have exposurebe exposed to contaminants in surface soil in unpaved areas via incidentalthrough ingestion, dermal contact, vapor and particulate inhalation, as discussed in Section 6.2.1.1 for outdoor workers. They may also have incidental ingestion of and dermal contact exposures indoors, towith outdoor surface soils that have been incorporated into indoor dust. The cancer risk, HI, and lead modeling are calculated assuming the extentabsence of protective measures, such soil is tracked indoorsas existing pavement or capping.

Cancer Risks and Noncancer Hazards. Currently, indoor workers are present only in the occupied buildings, which are located on Lots 1, 57, 59, 60, 62, and 70. As discussed in Section 4.2.2.6,4.3.2.6, an indoor air sample was collected at each of the currently occupied buildings. TheseWhile Lot 69 is currently occupied, no active operations are conducted in either building so no indoor air sample was collected at this building. These indoor air samples represent the current indoor air EPCs, which may include contributions from soil and/or groundwater vapor intrusion. The cumulative cancer risk and HI estimates associated with these indoor air EPCs are summarized for each building on Table 6-4below. These risk estimates assume the EPCs are entirely due to vapor intrusion, and indoor workers are exposed to the EPCs for the entire work dayworkday (8 hours). As shown on Table 6-4, thesebelow, the cumulative cancer risk estimates are within USEPA's limits for RME risks. range from 8 x 10^{-7} to 4 x 10^{-5}, which are within NCP's risk range, for Building 2 on Lot 1 and the building on Lots 57, 59, 60 and 70, and are at or below the lower end of NCP's risk range for Building 3 on Lot 1 and the building on Lot 62. Noncancer HIs range from 0.02 to 0.4, which are all below the protection goal of 1. The single-chemical cancer risks above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are chloroform (Lot 1, Building 2, Lot 57, 59, and 70) and benzene (Lots 57 and 70) (see RAGS D Table 7).

Table 6-3. -Current Indoor Worker Cancer Risks and Noncancer HIsazard Indices from Inhalation of Exposures to Indoor Air -Sampled for Indoor Vapors from Surface and Subsurface Soil and/or Groundwater via Vapor Intrusion.

(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded).

Lot	**Location**	**Risk**	**HI**
Lot 1	BLDGuilding 2	**2 x 10^{-6}**	0.03
	BLDGuilding 3	8 x 10^{-7}	0.02
Lot 57	BLDGuilding 10	**4 x 10^{-5}**	0.1
Lot 59	BLDGuilding 14	**4 x 10^{-6}**	0.07
Lot 60	BLDGuilding 1	**2 x 10^{-6}**	0.3
Lot 62	BLDGuilding 9	1 x 10^{-6}	0.02
Lot 70	BLDGuilding 16	**3 x 10^{-5}**	0.4
Note: These cumulative cancer risks and HI estimates are based on measured indoor air concentrations.			

Potential exposure of indoor workers to COPCs in surface soil incorporated into indoor dust are shown below for the currently occupied properties (i.e., Lots 1, 57, 59, 60, 62, 69, and 70). As shown below for each occupied property, the cumulative cancer risk estimates range from 1 x 10^{-6} to 1 x 10^{-5}, which are all within NCP's risk range except for Lot 59 which is at the lower end of the risk range. The noncancer HIs range from 0.05 to 0.4, which are all below the protection goal of 1. The single-chemical cancer risks above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are arsenic (Lots 1, 62 and 70), benzo(a)pyrene (Lot 69), naphthalene (Lot 62), PCBs (Lot 57), and 2,3,7,8-tetrachlorodibenzo-p-dioxin (Lot 70) (see RAGS D Table 7).).

Table 6-4. Current Indoor Worker Cancer Risks and Noncancer HIsazards Indices Ffrom Inhalation Exposures Toto Surface Soil Incorporated Iinto Indoor Dust (Risks > $1x10^{-6}$ are bolded. Risks > $1x10^{-4}$ and HIs >1 are bolded and shaded).

Lot	Risk	HI
Lot 1	**3 x 10^{-6}**	0.05
Lot 57	**4 x 10^{-6}**	0.2
Lot 59	1 x 10^{-6}	0.05
Lot 60	**4 x 10^{-6}**	0.08
Lot 62	**6 x 10^{-6}**	0.07
Lot 69	**4 x 10^{-6}**	0.2
Lot 70	**1 x 10^{-5}**	0.4

Exposure of indoor workers to lead in surface soil incorporated into indoor dust are shown below for the currently occupied properties. The average lead concentration in the 0 to 2 ft. depth interval is below 800 mg/kg at each currently occupied property except for Lot 70. However, the estimated portion of the indoor workers' fetal blood lead distribution exceeding the 5 ug/dL level is less than 5% for Lot 70 (and all other properties).

Lot	PbS (mg/kg)	$P(PbB_{fetal} > PbB_t)$ (%)
Lot 1	580	1.1%
Lot 57	305	0.22%
Lot 59	240	0.13%
Lot 60	185	0.08%
Lot 62	567	1.0%
Lot 69	343	0.28%
Lot 70	**934**	3.7%

The combined cumulative cancer risks and HIs from indoor air[35] and indoor dust exposures are shown below. The cumulative cancer risk estimates range from 5 x 10^{-6} to 5 x 10^{-5}, which are all within NCP's risk range. The combined noncancer HIs range from 0.08 to 0.8, which are all below the protection goal of 1.

Table 6-5. Current Indoor Worker Cancer Risks and Noncancer HIsazard Indices Ffrom Inhalation Exposures Tto Indoor Air and Indoor Dust by Lot.
(Risks > $1x10^{-6}$ are bolded. Risks > $1x10^{-4}$ and HIs >1 are bolded and shaded)

[35] Since there are two buildings on Lot 1, the higher cumulative cancer risk and HI estimates (Building 2) are included in the combined estimates.

Lot	Risk	HI
Lot 1	**6 x 10^{-6}**	0.08
Lot 57	**5 x 10^{-5}**	0.3
Lot 59	**5 x 10^{-6}**	0.1
Lot 60	**5 x 10^{-6}**	0.3
Lot 62	**7 x 10^{-6}**	0.09
Lot 69	**4 x 10^{-6}**	0.2
Lot 70	**4 x 10^{-5}**	0.8

Lead. Exposure of indoor workers to lead in surface soil incorporated into indoor dust are shown below for the currently occupied properties. The average lead concentration in the 0 to 2 ft. depth interval is below 800 mg/kg at each currently occupied property except for Lot 70. However, the estimated portion of the indoor workers' fetal blood lead distribution exceeding the 5 ug/dL level is less than 5% for Lot 70 (and all other properties).

Table 6-6. Average Lead Concentrations in Surface Soil (PbS) and ALM Estimated Probabilities (P) that PbB_{fetal} > PbB_t for Current Outdoor Workers Exposed to the PbS Concentrations (PbS > 800 mg/kg and P >5% are bolded and shaded)
~~Current Lot Specific Average Soil Lead Concentration Highlighting Industrial Screening Levels Greater than 800 mg/kg and BLLs Greater Than 5 ug/dl Based On Indoor Worker Exposures To Surface Soil Incorporated Into Indoor Dust.~~

Lot	**PbS (mg/kg)**	**P(PbB_{fetal} > PbB_t) (%)**
Lot 1	580	1.1%
Lot 57	305	0.22%
Lot 59	240	0.13%
Lot 60	185	0.08%
Lot 62	567	1.0%
Lot 69	343	0.28%
Lot 70	**934**	3.7%

Groundwater. Shallow and deep groundwater are not currently used for potable purposes at or around the Site. Water is supplied by the City of Newark. In addition, Lots 67, 68 and 69 have restrictions in place against groundwater use established by NJDEP. However, consistent with EPA guidance, since the groundwater is classified as Class II A the risk assessment evaluates cancer risks and noncancer hazards in the absence of ICs such as the NJDEP Classification of Class 2A. ~~Potential exposure of indoor workers to COPCs in soil while outdoors is evaluated indirectly in this risk assessment by using the risk estimates for outdoor workers, as explained in Section 4.1.1. Specifically, the risk estimates for such outdoor exposure of indoor worker are expected to be no higher than the outdoor workers' cumulative cancer risk and HI estimates discussed in Section 6.2.1.1, which are within USEPA's limits for RME risks.~~

6.2.1.3 Utility Workers

Currently, utility workers may be present at any of the 15 properties at the Site (i.e., occupied or unoccupied). They are not employees at the Site~~,~~ but may be on-site occasionally to repair underground utilities. During such activities, they may contact contaminants in surface and subsurface soil to the depth of utilities (0-4 ~~feet~~ft. bgs) via incidental ingestion, dermal contact, and particulate inhalation. They also may be exposed to contaminants in surface and subsurface soil (0-13 ~~feet~~ft. bgs) via vapor inhalation~~.~~ assuming flux of volatiles from these soils into a trench or excavation. The cancer risk ~~estimates~~, noncancer HI, and lead modeling are calculated assuming the absence of protective measures, such as the use of personal protective equipment.

Cancer Risks and Noncancer Hazards. The utility workers' cumulative cancer risk and HI estimates summarized ~~on Table 6-1~~below are the sum of the estimates for ingestion, dermal contact, and particulate inhalation calculated using soil data from the 0 to 4 ft. depth interval, and the estimate for vapor inhalation calculated using soil data from all sampled depths. As shown on Table 6-1, thesebelow, the cumulative cancer risk estimates range from 3 x 10^{-7} to 3 x 10^{-6}, which are below NCP's risk range except for each propertyLots 61, 62, 63, 67 and 70 which are within USEPA's limits for RMENCP's risk range. The noncancer HIs range from 0.04 to 0.3, which are all below the protection goal of 1. The single-chemical cancer risks. above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are arsenic (Lot 61) and 2,3,7,8-tetrachlorodibenzo-p-dioxin (Lot 70) (see RAGS D Table 7).

Table 6-7. Current Utility Worker Cancer Risks and Noncancer HIazard Indices from Exposures to Soil and Particulate Inhalation from Soils Depths of 0 to 4 Ft. and Basedfrom on Exposures Through Vapor Inhalation Calculated Based on Soil Data from All Sampled Depths
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded).

As discussed in Section 4.4.4, utility workers' exposure to lead in soil is not calculated, because the expected exposure frequency is well below the level at which USEPA guidance (2003c) recommends the ALM model be applied.

Lot	**Risk**	**HI**
Lot 1	5 x 10^{-7}	0.06
Lot 57	9 x 10^{-7}	0.2
Lot 58	4 x 10^{-7}	0.2
Lot 59	3 x 10^{-7}	0.04
Lot 60	7 x 10^{-7}	0.08
Lot 61	**2 x 10^{-6}**	0.1
Lot 62	**2 x 10^{-6}**	0.1
Lot 63	**2 x 10^{-6}**	0.3
Lot 64	8 x 10^{-7}	0.2
Lot 65	1 x 10^{-6}	0.1
Lot 66	4 x 10^{-7}	0.08
Lot 67	**2 x 10^{-6}**	0.2
Lot 68	7 x 10^{-7}	0.2
Lot 69	7 x 10^{-7}	0.1
Lot 70	**3 x 10^{-6}**	0.3

Lead. As discussed in Section 4.5.14.4.8, worker exposure to lead in soil may be assessed by comparing the average lead concentration at each propertylot to the USEPA Region 2 nonresidential lead screening level of 800 mg/kg. As shown below, the average lead concentration in the 0 to 4 ft. depth interval is below 800 mg/kg except for Lots 63 and 70. However, as also shown below, the estimated portion of the utility workers' fetal blood lead distribution exceeding the 5 ug/dL level is less than 5% for both of these properties (as well as the rest of the 15 properties at the Site).

Table 6-8~~.~~ Average Soil Lead Concentration in the 0 to 4 ft. Depth Interval (PbS) and ALM Estimated Probabilities (P) that PbB_{fetal} > PbB_t for Current Utility Workers Exposed to the PbS Concentrations
(PbS > 800 mg/kg and P > 5% are bolded and shaded)~~Current Lot Specific Average Lead Concentration in Soils from Depths of 0 to 4 Ft. with Lots Highlighted with Blood Lead Concentrations Exceeding the Industrial Screening Level for Lead of 800 mg/kg and Associated Percentage of BLLs Greater than 5 ug/dl Highlighted.~~

Lot	**PbS (mg/kg)**	**P(PbB_{fetal} > PbB_t) (%)**
Lot 1	509	0.06%
Lot 57	246	0.02%
Lot 58	466	0.05%
Lot 59	240	0.02%
Lot 60	197	0.02%
Lot 61	505	0.06%
Lot 62	493	0.06%
Lot 63	**2,420**	2.2%
Lot 64	681	0.11%
Lot 65	619	0.09%
Lot 66	104	0.01%
Lot 67	431	0.05%
Lot 68	671	0.10%
Lot 69	343	0.03%
Lot 70	**1,040**	0.26%

Groundwater. Utility workers may contact ~~contaminates~~contaminants in shallow groundwater during some utility repairs~~.~~ if the depth to groundwater is less than 4 feet. The utility workers' cumulative cancer risk and HI estimates summarized on ~~Table 6-5~~below are the sum of the estimates for ingestion, dermal contact, and vapor inhalation calculated using the EPCs for shallow groundwater for each property. Because Lot 59 and Lot 61 do not have shallow monitoring wells, the cancer risk and HI estimates ~~on Table 6-5~~ for these two properties are the highest risk estimates among adjacent properties; the Lot 59 the cancer risk and HI estimates are from Lot 58 and the Lot 61 the cancer risk and HI estimates are from Lot 64. As shown ~~on Table 6-5, these~~below, the cumulative cancer risk estimates ~~meet USEPA's limits for RME risks.~~range from 5 x 10^{-7} to 5 x 10^{-6}, which are below NCP's risk range except for Lots 57, 58, 59, 60, 65, and 69 which are within NCP's risk range. The noncancer HIs range from 0.02 to 0.9, which are all below the protection goal of 1. The single-chemical cancer risks above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are pentachlorophenol (Lots 57, 58, and 59) and dibenz(a,h)anthracene (Lot 65) (see RAGS D Table 7).

Table 6-9. Current Utility Worker Cancer Risks and Noncancer HIs from Exposure to Shallow Groundwater (less than 4 ft.) Through Ingestion, Dermal Contact, and Vapor Inhalation
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Current Lot Specific Utility Worker Cancer Risks and Noncancer Hazard Indices from Exposures Based on Estimates of Ingestion, Dermal Contact, and Vapor Inhalation to Shallow Groundwater (less than 4 ft.).

Lot	**Risk**	**HI**
Lot 1	7 x 10^{-7}	0.02
Lot 57	**4 x 10^{-6}**	0.1
Lot 58	**5 x 10^{-6}**	0.9
Lot 59	**5 x 10^{-6}**	0.9
Lot 60	**2 x 10^{-6}**	0.02
Lot 61	1 x 10^{-6}	0.2
Lot 62	5 x 10^{-7}	0.01
Lot 63	9 x 10^{-7}	0.05
Lot 64	1 x 10^{-6}	0.2
Lot 65	**2 x 10^{-6}**	0.02
Lot 66	7 x 10^{-7}	0.02
Lot 67	5 x 10^{-7}	0.01
Lot 68	5 x 10^{-7}	0.02
Lot 69	**2 x 10^{-6}**	0.1
Lot 70	5 x 10^{-7}	0.02

If utility workers were to have exposure to both soil and groundwater at the magnitudes, frequencies, and durations assumed for each medium, the combined risk from these exposures would meet USEPA's limits for RME risk, as shown on Table 6-6cumulative cancer risk estimates range from 1 x 10^{-6} to 5 x 10^{-6}, which are within the NCP's risk range except for Lots 1, 66, and 68 which are at the lower end of NCP's risk range, as shown below. The combined noncancer HIs range from 0.07 to 1, which are at or below the protection goal of 1.

Table 6-10. Current Utility Worker Cancer Risks and Noncancer HI from Exposure to Shallow Groundwater and Soil
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Current Utility Worker Lot Specific Cancer Risks and Noncancer Hazard Indices from Exposure to Shallow Groundwater and Soil.

Lot	**Risk**	**HI**
Lot 1	1 x 10^{-6}	0.07
Lot 57	**5 x 10^{-6}**	0.3
Lot 58	**5 x 10^{-6}**	1
Lot 59	**5 x 10^{-6}**	0.9
Lot 60	**2 x 10^{-6}**	0.1
Lot 61	**3 x 10^{-6}**	0.3
Lot 62	**2 x 10^{-6}**	0.1
Lot 63	**2 x 10^{-6}**	0.4
Lot 64	**2 x 10^{-6}**	0.3
Lot 65	**4 x 10^{-6}**	0.2
Lot 66	1 x 10^{-6}	0.1
Lot 67	**2 x 10^{-6}**	0.2
Lot 68	1 x 10^{-6}	0.2
Lot 69	**2 x 10^{-6}**	0.3
Lot 70	**3 x 10^{-6}**	0.3

6.2.1.4 Construction Workers

Lots 57, 58, 61, 63, 64, 68, and 70 may be redeveloped in the near future, as discussed in Section 2.42.5 and Table 2-1, and therefore, construction workers would be present at those properties. Construction workers may conduct site redevelopment or renovation, and are at the Site for a short period (several months). They may contact contaminants in surface and subsurface soil (0-13 feetft. bgs) via incidental ingestion, dermal contact, inhalation of vapor and particulate during construction activities (e.g., as part of site redevelopment). The cancer risk estimates, HI, and lead modeling for such activities are calculated assuming the absence of protective measures, such as the use of personal protective equipment.

Cancer Risks and Noncancer Hazards. The construction workers' cumulative cancer risk and HI estimates for soil summarized on Table 6-1below are the sum of the estimates for ingestion, dermal contact, vapor and particulate inhalation calculated using soil data from all depths (i.e., ground surface to maximum sampled depth of approximately 13 feet).ft.). As shown on Table 6-1, thesebelow, the cumulative cancer risk estimates range from 2 x 10^{-7} to 2 x 10^{-6}, which are at or below the lower end of NCP's risk range except for each property do not exceed USEPA's limitsLot 70 which is within the NCP risk range. The noncancer HIs range from 0.8 to 2, which are at or below the protection goal of 1 except for RME risks (including those for Lots 57, 58, 61, 63, 64,Lot 68, which has an HI of 2. No single-chemical cancer risk is above the lower end of NCP's risk range (10^{-6}) and 70). no single-chemical HQ estimates are above the protection goal of 1 (see RAGS D Table 7).

Table 6-11.~~,~~ Current Construction Worker Cancer Risks and Noncancer HIs from Exposure to Soil Through Ingestion, Dermal Contact, Vapor and Particulate Inhalation Calculated Using Soil Data from All Depths
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)~~Current Construction Worker Lot Specific Cancer Risks and Noncancer Hazard Indices from Exposure to Soil Through Ingestion, Dermal Contact, Vapor and Particulate Inhalation Calculated Using Soil Data from All Depths (Maximum Soil Depth Approximately 13 Ft.).~~

Lot	**Risk**	**HI**
Lot 57	8 x 10^{-7}	1
Lot 58	2 x 10^{-7}	0.8
Lot 61	1 x 10^{-6}	0.8
Lot 63	1 x 10^{-6}	1
Lot 64	1 x 10^{-6}	0.9
Lot 68	5 x 10^{-7}	**2**
Lot 70	**2 x 10^{-6}**	0.8

Since the HI for soil exposure at Lot 68 is above the protection goal of 1, the toxic~~arget~~ endpoint-specific ~~toxic~~ HIs for construction worker exposure at Lot 68 are listed below. All toxic endpoint specific HI estimates are below the protection goal of 1.

Table 6-12. Noncancer Toxic~~arge~~ Endpoint-~~t Organ~~ Specific HIs for Lot 68 for Current Construction Worker Exposed to Soils at All Depths
(HIs > 1 are bolded and shaded)~~Target Organ Specific Hazard Indices for Lot 68 for Current Construction Worker Exposed to Soils at All Depths with All Target Organ Hazard Indices Less than 1.~~

Toxic Endpoint	HI
Cardiovascular	0.8
Dermal	0.02
Developmental/Reproductive	0.8
Ear	0.00007
Endocrine	0.004
Gastrointestinal	0.1
Hematologic	0.02
Hepatic	0.002
Immune	0.8
Nervous	0.7
Ocular	0.1
Other	0.01
Respiratory	0.03
Urinary	0.02

Lead. As shown ~~on Table 6-2~~below, the average lead concentration calculated using soil data from all sampled depths is below the USEPA Region 2 nonresidential screening level of 800 mg/kg at each property except for Lot 63 and Lot 70. As also shown below, ~~The average lead concentration at Lot 63 is 2,290 mg/kg, and the average lead concentration at Lot 70 is 970 mg/kg. However, as shown in Table 6-3B, the~~~~T~~the estimated portion of the construction workers' fetal blood lead distribution exceeding the 5 ug/~~dl~~dL level is ~~less~~more than 5% for ~~both of these properties (as well as the rest of the 15 properties at the Site).~~ Lots 61, 63, 64~~3~~, 68 and 70. The average lead concentrations~~As shown below, the EPCs~~ for Lots 61, 64 and 68 do not exceed the 800 mg/kg screening level for workers but result in ~~exceed~~ the blood lead goal being exceeded becaus~~e~~~~as a result~~ of more conservative assumptions for the incidental ingestion rate and averaging time for the construction worker relative to the outdoor worker (see Section 6.3.4.2).

Table 6-13~~.~~ Average Soil Lead Concentration from All Sampled Depths (PbS) and ALM Estimated Probabilities (P) that PbB_{fetal} > PbB_t for Current Construction Workers Exposed to the PbS Concentrations
(PbS > 800 mg/kg and P > 5% are bolded and shaded)~~Current Lot Specific Lead Average Concentration Highlighting Lots with Concentrations Greater than the Industrial Screening Level of 800 mg/kg. The Percentage of Construction Workers with BLLs Greater Than 5 ug/dl are Highlighted.~~

Lot	PbS (mg/kg)	$P(PbB_{fetal} > PbB_t)$ (%)
Lot 57	272	1.4%
Lot 58	318	2.1%
Lot 61	500	**6.8%**
Lot 63	**2,530**	**81%**
Lot 64	688	**14%**
Lot 68	586	**9.9%**
Lot 70	**970**	**28%**

Groundwater. Construction workers may contact ~~contaminates~~contaminants in shallow groundwater during future ~~some site~~ redevelopment activities. The construction workers' cumulative cancer risk and HI estimates summarized ~~on Table 6-5~~below are the sum of the estimates for ingestion, dermal contact, and vapor inhalation calculated using the EPCs for shallow groundwater at each property~~, except for the two properties with no shallow wells as discussed in Section 6.2.1.3. As shown on Table 6-5, these~~. The cumulative cancer risk estimates ~~are within USEPA's limits for RME risks~~range from 6 x 10^{-8} to 6 x 10^{-7}, which are all below the lower end of NCP's risk range. Noncancer HIs range from 0.02 to 0.4, which are all below the protection goal of 1.

Table 6-14. Cancer Risks and Noncancer HIs for the Construction Workers Exposed to Shallow Groundwater During Construction Activities
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Lot Specific Cancer Risks and Noncancer Hazard Indices for the Construction Worker Exposed to Shallow Groundwater During Construction Activities. All Cancer Risks are below 1 x 10^{-6} and the HI is Less than the Goal of Protection of 1.

Lot	**Risk**	**HI**
Lot 57	5 x 10^{-7}	0.1
Lot 58	6 x 10^{-7}	0.4
Lot 61	2 x 10^{-7}	0.1
Lot 63	1 x 10^{-7}	0.05
Lot 64	2 x 10^{-7}	0.1
Lot 68	6 x 10^{-8}	0.02
Lot 70	7 x 10^{-8}	0.02

Soil and Groundwater. If construction workers were to have exposure to both soil and groundwater at the magnitudes, frequencies, and durations assumed for each medium, the combined risk from these exposures would not exceed USEPA's limits for RMEcumulative cancer risk, as shown on Table 6-6 estimates range from 5 x 10^{-7} to 2 x 10^{-6}, which are at or below the lower end of NCP's risk range except for Lots 64 and 70 which are within the NCP risk range, as shown below. The noncancer HIs range from 0.8 to 2, which are at or below the protection goal of 1 except for Lot 68 which has an HI of 2.

Table 6-15. Cancer Risks and Noncancer HIs for Construction Workers Exposed to Soil and Groundwater
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Lot Specific Cancer Risks and Noncancer Hazard Indices for Construction Workers Exposed to Soil and Groundwater. Cancer Risks Are Within the Risk Range or Below and Hazard Indices Greater than 1 are Highlighted.

Lot	**Risk**	**HI**
Lot 57	1 x 10^{-6}	1
Lot 58	8 x 10^{-7}	1
Lot 61	1 x 10^{-6}	0.9
Lot 63	1 x 10^{-6}	1
Lot 64	**2 x 10^{-6}**	1
Lot 68	5 x 10^{-7}	**2**
Lot 70	**2 x 10^{-6}**	0.8

Since the HI for Lot 68 is above the protection goal of 1, the toxicarget endpoint-specific HI toxic endpoint specific HIs for the construction worker exposure at Lot 68 are shown on RAGS D Table 9. All toxic endpoint specific HI estimates are at or below the protection goal of 1.

6.2.1.5 Trespassers

Trespassers are potentially present at any property (i.e., occupied or unoccupied). As discussed in Section 4.1.1,4.1.1, adolescent trespasser trespassers (age 10 to 18) and adult trespassers are evaluated for exposure to contaminants in unpaved areas of the Site for: surface soil via incidental ingestion, dermal contact, and particulate inhalation; and surface and subsurface soil via vapor inhalation. Potential exposure of adult trespassers to constituents in soil is evaluated by using risk estimates for outdoor workers, as explained in Section 4.1. The cancer risk, HI, and lead modeling are calculated assuming the absence of protective measures, such as existing pavement or capping.

Cancer Risks and Noncancer Hazards. The adolescent and- adult trespasser cumulative cancer risk and HI estimates summarized on Table 6-1below are the sum of the estimates for ingestion, dermal contact, and particulate inhalation calculated using soil data from the 0 to 2 ft. depth interval, and the estimate for vapor inhalation calculated using soil data from all sampled depths. As shown on Table 6-1, thesebelow for the adolescent trespasser, the cumulative cancer risk estimates for each property are within USEPA's limits for RME risks.range from 1 x 10^{-6} to 1 x 10^{-5}, which are within NCP's risk range except for Lots 58, 59 and 66 which are at the lower end of NCP's risk range. Noncancer HIs range from 0.09 to 1, which are all at or below the protection goal of 1. The single-chemical cancer risks above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are arsenic (Lots 61 and 63), benzo(a)pyrene (Lots 57, 62, 63, 65, 67 and 69), naphthalene (Lot 62), PCBs (Lot 57) and 2,3,7,8-tetrachlorodibenzo-p-dioxin (Lots 70) (see RAGS D Table 7).

As shown on Table 6-2below for the adult trespasser, the cumulative cancer risk estimates range from 2 x 10^{-6} to 2 x 10^{-5}, which are within NCP's risk range. Noncancer HIs range from 0.09 to 1, which are all at or below the protection goal of 1. The single-chemical cancer risks above the lower-end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are arsenic (Lots 1, 58, 59, 60, 61, 62, 63, 65, 67, 68, 69 and 70), benzo(a)pyrene (Lots 57, 62, 63, 65, 67 and 69), naphthalene (Lot 62), PCBs (Lots 57 and 67), and 2,3,7,8-tetrachlorodibenzo-p-dioxin (Lots 60, 64 and 70) (see RAGS D Table 7).

Table 6-16. Cancer Risks and Noncancer HI for Trespasser Exposures from Ingestion, Dermal Contact, and Particulate Inhalation of Soil from the 0 to 2 Ft. Depth Interval, and Vapor Inhalation Calculated Based on Soil data from All Sampled Depths (Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Lot Specific Cancer Risks and Noncancer Hazard Indices for Adolescent and Adult Trespassers. Exposures Estimates for Ingestion, Dermal Contact, and Particulate Inhalation Calculated Using Soil Data from the 0 to 2 Ft. Depth Interval, and the Estimate for Vapor Inhalation Calculated Based on Soil data from All Sampled Depths. The Cancer Risks Are Within the Risk Range and the Noncancer Hazard Indices are At or Below the Protection Goal of 1.

Lot	Adolescent Trespasser		Adult Trespasser	
	Risk	HI	Risk	HI
Lot 1	**3 x 10^{-6}**	0.1	**6 x 10^{-6}**	0.1
Lot 57	**5 x 10^{-6}**	0.4	**8 x 10^{-6}**	0.4
Lot 58	1 x 10^{-6}	0.5	**3 x 10^{-6}**	0.5
Lot 59	1 x 10^{-6}	0.09	**2 x 10^{-6}**	0.09
Lot 60	**4 x 10^{-6}**	0.2	**6 x 10^{-6}**	0.2
Lot 61	**8 x 10^{-6}**	0.3	**2 x 10^{-5}**	0.3
Lot 62	**6 x 10^{-6}**	0.2	**1 x 10^{-5}**	0.3
Lot 63	**5 x 10^{-6}**	1	**1 x 10^{-5}**	1
Lot 64	**2 x 10^{-6}**	0.2	**5 x 10^{-6}**	0.2
Lot 65	**4 x 10^{-6}**	0.4	**6 x 10^{-6}**	0.4
Lot 66	1 x 10^{-6}	0.1	**2 x 10^{-6}**	0.1
Lot 67	**1 x 10^{-5}**	0.8	**2 x 10^{-5}**	0.7
Lot 68	**2 x 10^{-6}**	0.5	**5 x 10^{-6}**	0.5
Lot 69	**6 x 10^{-6}**	0.4	**7 x 10^{-6}**	0.4
Lot 70	**8 x 10^{-6}**	0.8	**2 x 10^{-5}**	0.7
Note: The cumulative cancer risk and HI estimates for the adult trespasser are those presented for the outdoor worker, as discussed in Section 4.1. The outdoor worker is assumed to be on-site for a longer period (8 hours/day for 225 days/year for 25 years) compared to the adolescent trespasser (4 hours/day for 150 days/year for 8 years).				

Lead. As discussed in Section 4.4.114.5.4, trespassers' exposure to lead in soil is evaluated using the outdoor workers' exposure to lead, as required by USEPA Region 2. As shown below, the average lead concentration in the 0 to 2 footft. depth interval is below 800 mg/kg at each property except Lots 63 and 70. The average lead concentration at Lot 63 is 1,860 mg/kg, and the average lead concentration at Lot 70 is 934 mg/kg. However, as shown on Table 6-3C, the for Lots 63 and 70. As also shown below, tThe estimated portion of the trespassers' outdoor workers' fetal blood lead distribution (which is used to assess trespassers) that exceeds the 5 ug/dL level is less than 5% at both of these properties (as well as the rest of the properties). As shown on Figure 6-1,each property except for

Lots 63 and ~~70~~ 60. Trespassers are not expected to contact soil at Lot 70 currently, because Lot 70 is paved and ~~are~~ partly capped~~.~~ (Figure 6-1).

Table 6-17. Average Lead Concentrations in Surface Soil and ALM Estimated Probabilities (P) that PbB_{fetal} > PbB_t for Current Trespassers Exposed to the PbS Concentrations (PbS > 800 mg/kg and P > 5% are bolded and shaded)Lot Specific Average Lead Concentrations Greater than the Industrial Screening Level of 800 mg/kg Highlighted. BLLs Greater than 5% of the Exposed Individuals with 5 ug/dl from Exposure to Soils at Depths of 0 to 2 Ft. Are Also Highlighted.

Potential exposure of adult trespassers to constituents in soil is evaluated indirectly in this risk assessment by using risk estimates for outdoor workers, as explained in Section 4.1. Specifically, the risk estimates for adult trespassers are expected to be no higher than the outdoor workers' cumulative cancer risk and HI estimates discussed in Section 6.2.1.1, which are within USEPA's limits for RME risks.

Lot	**PbS (mg/kg)**	**P(PbB_{fetal} > PbB_t) (%)**
Lot 1	580	2.3%
Lot 57	305	0.44%
Lot 58	466	1.3%
Lot 59	240	0.24%
Lot 60	185	0.14%
Lot 61	505	1.6%
Lot 62	567	2.2%
Lot 63	**2,090**	**38%**
Lot 64	616	2.7%
Lot 65	619	2.7%
Lot 66	129	0.07%
Lot 67	429	1.0%
Lot 68	510	1.6%
Lot 69	343	0.58%
Lot 70	**934**	**7.7%**

6.2.1.6 Visitors

Currently, visitors are assumed to be present at only the occupied properties (i.e., Lots 1, 57, 59, 60, 62, 69, and 70). Visitors are children and adults who are on-site occasionally and for short periods which may result in exposure to contaminants in unpaved areas of the site for: surface soil via incidental ingestion, dermal contact, and particulate inhalation; and surface and subsurface soil via vapor inhalation. While indoors, potential inhalation exposure to surface and subsurface soil vapors or shallow groundwater vapors may occur if vapors migrate through building foundations. The cancer risk, HI, and lead modeling are calculated assuming the absence of protective measures, such as existing pavement or capping.

Cancer Risks and Noncancer Hazards. While outdoors at the Site, the visitors' potential exposures to soil may conservatively be assessed by considering the risk estimates discussed in Section 6.2.2.9 for hypothetical future on-site residents. Specifically, the visitors' cumulative cancer risk or HI at a property must be acceptable if the residents' cumulative cancer risk or HI estimates for outdoor soil exposures are within USEPA's limits for RME risks. Where the residents' risk estimates exceed USEPA's

~~limits, the visitors' risks still may be acceptable if their exposure frequency and exposure time are low enough. The allowable exposure frequency for visitors at a particular property was determined by scaling from the residents' cumulative cancer risk and HI estimates for that property and assuming visitors are on-site for 2 hours/day. The allowable exposure frequency calculated for the 0 to 2 foot depth interval is summarized on Table 6-7. For the currently occupied properties, the allowable exposure frequency ranges from 48 days/year (Lot 70) to 349 days/year (Lot 1).~~

~~Since the visitor population could potentially include children under 6 years old, the exposure to lead in soil may be assessed by comparing the average lead concentration at each property to the USEPA Region 2 residential lead screening level of 200 mg/kg. Since child visitors are expected to be at the Site much less than the hypothetical child resident, time-weighted average lead concentrations were calculated using Equation 7 of the USEPA guidance on Assessing Intermittent or Variable Exposures at Lead Sites (USEPA 2003c), as discussed in Section 4.4.3. The time-weighted average concentrations for each currently occupied property for the 0 to 2 foot interval are below the USEPA Region 2 residential screening level for the currently occupied properties, as shown on Table 6-8.~~

~~Potential visitor exposures via vapor intrusion are evaluated indirectly in this risk assessment by using risk estimates for indoor workers. This approach is valid since inhalation risk estimates do not depend on breathing rate or body weight (only exposure time, frequency, and duration). It is also highly conservative since visitors are expected to be in the existing buildings far less than the indoor workers. Specifically, the vapor intrusion risk estimates for visitors are expected to be far lower than the cumulative cancer risk and HI estimates for indoor workers discussed in Section 6.2.1.2, which are within USEPA's limits for RME risks.~~

The visitors' cumulative cancer risk and HI estimates are the sum of the estimates for ingestion, dermal contact, and particulate inhalation calculated using soil data from the 0 to 2 ft. depth interval, and the estimate for vapor inhalation calculated using soil data from all sampled depths, as shown below for each occupied property.

- The cumulative cancer risk estimates range from 3 x 10^{-6} to 2 x 10^{-5}, which are all within NCP's risk range. The single-chemical cancer risks above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are arsenic (Lots 1, 60, 62, and 70), benzo(a)pyrene (Lots 1, 57, 60, 62 and 69), dibenz(a,h)anthracene (Lot 69), naphthalene (Lot 62), PCBs (Lot 57), and 2,3,7,8-tetrachlorodibenzo-p-dioxin (Lots 60 and 70) (see RAGS D Table 7).

- For adults, noncancer HIs range from 0.02 to 0.2, which are all below the protection goal of 1.

- For children, noncancer HIs range from 0.2 to 2, which are all below the protection goal of 1 except for Lot 70 which is above the protection goal. No single-chemical HQ are above the protection goal of 1.

Table 6-18~~.~~ Cancer Risks and Noncancer HIs for Current Visitor Exposure to Soils at Depths of 0 to 2 ft.
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)~~Current Adult and Child Visitor Cancer Risks and Noncancer Hazard Indices Based on Exposures to Soils at Depths of 0 to 2 ft. Cancer Risks Are Within the Risk Range for all Receptors and Noncancer Hazards Are Less than the Protection Goal of 1 Except for the Child Exposed at Lot 70.~~

Lot	Adult/Child Risk	Adult HI	Child HI
Lot 1	**8×10^{-6}**	0.02	0.2
Lot 57	**1×10^{-5}**	0.08	0.7
Lot 59	**3×10^{-6}**	0.02	0.2
Lot 60	**9×10^{-6}**	0.03	0.3
Lot 62	**1×10^{-5}**	0.04	0.3
Lot 69	**2×10^{-5}**	0.09	0.9
Lot 70	**2×10^{-5}**	0.2	**2**

Since the child visitor HI for soil exposure at Lot 70 is above the protection goal of 1, the toxic endpoint specific HIs for child visitor exposure at Lot 70 are listed below. All toxic endpoint specific child visitor HI estimates for soil are at or below the protection goal of 1.

Table 6-19. Noncancer Toxicarget Endpoint-Specific HIs for Child Visitor Exposed at Lot 70 (HIs > 1 are bolded and shaded)

Toxic Endpoint	**HI**
Cardiovascular	0.04
Dermal	0.2
Developmental/Reproductive	1
Endocrine	0.06
Gastrointestinal	0.05
Hematologic	0.02
Immune	0.2
Nervous	0.02
Ocular	0.15
Other	0.02
Respiratory	0.001
Urinary	0.01

As shown below, all average surface lead concentrations are above the residential screening level except for Lot 60. As discussed in Section , the child visitor's exposure to lead would be approximately 5% of the future child resident's exposure to lead based on the differences in exposure time, frequency and duration. Using the percentage, the estimated portion of the child visitor's blood lead distribution that exceeds USEPA Region 2's lead goal of 5 ug/dL for the 0 to 2 ft. depth interval is less than 5% at each occupied property.

Lot	**PbS** (mg/kg)	**Child Res P(PbB> PbB_t)** (%)	**5% of Child Res P(PbB> PbB_t)** (%)
Lot 1	**580**	**76**	3.8
Lot 57	**305**	**37**	1.9
Lot 59	**240**	**24**	1.2
Lot 60	185	**14**	0.71
Lot 62	**567**	**75**	3.8
Lot 69	**343**	**45**	2.2
Lot 70	**934**	**93**	4.7

Currently, visitors are potentially present only in the occupied buildings, which are located on Lots 1, 57, 59, 60, 62, and 70. As discussed in Section 4.3.2.6, an indoor air sample was collected at each of the currently occupied buildings. While Lot 69 is currently occupied, no active operations are conducted in either building so no indoor air sample was collected at this building. These samples represent the current indoor air EPCs, which may include contributions from soil and/or groundwater vapor intrusion. The cumulative cancer risk and HI estimates associated with these indoor air EPCs are summarized for each building below. These risk estimates assume the EPCs are entirely due to vapor intrusion, and visitors are exposed to the EPCs for the entire time on-site (2 hours). As shown below for each occupied property, the cumulative cancer risk estimates range from 4 x 10^{-8} to 2 x 10^{-6}, which are below NCP's risk range except for Lots 57 and 70 which are within NCP risk range. The single-chemical cancer risk above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), is chloroform (Lot 57) (see RAGS D Table 7). For adult and child noncancer HI[36], noncancer HIs range from 0.001 to 0.02, which are all below the protection goal of 1.

[36] The child and adult indoor air HI estimates are the same since the EPCs are the same (i.e., the indoor air results) and the exposure time and frequency are the same (i.e., 2 hours day for 52 days a years).

Table 6-21. Cancer Risks and Noncancer HIs for Current Visitors Based on Inhalation Exposures to Indoor Air in Occupied Buildings Based on Indoor Air Samples (Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Current Adult and Child Visitor Cancer Risks and Noncancer Hazard Indices Based on Exposures to Occupied Buildings Based on Indoor Air Samples Based on Contributions from Soil and/or Groundwater Via Vapor Intrusion. The Cancer Risks to the Adult/Child are Within and Below the NCP Risk Range and the Noncancer Hazard Indices are Below the Protection Goal of 1.

Lot	**Location**	**Adult/Child Risk**	**Adult HI**	**Child HI**
Lot 1	BLDGuilding 2	1 x 10^{-7}	0.002	0.002
	BLDGuilding 3	4 x 10^{-8}	0.001	0.001
Lot 57	BLDGuilding 10	**2 x 10^{-6}**	0.007	0.007
Lot 59	BLDGuilding 14	2 x 10^{-7}	0.004	0.004
Lot 60	Building LDG1	1 x 10^{-7}	0.01	0.01
Lot 62	BLDGuilding 9	7 x 10^{-8}	0.001	0.001
Lot 70	BLDGuilding 16	**2 x 10^{-6}**	0.02	0.02

The combined cumulative cancer risk and HI estimates from indoor air[37] and outdoor soil contact exposures for each currently occupied property are all within the NCP's risk range. The combined adult noncancer hazards are all below the protection goal of 1 and the combined child noncancer hazards are below the protection goal of 1 except Lot 70 which has an HI of 2, as shown below.

Table 6-22. Cancer Risks and Noncancer HIs for Current Visitor Exposures to Indoor Air and Outdoor Soil at Currently Occupied Properties (Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Current Cancer Risks and Noncancer Hazard Indices for Indoor Air and Outdoor Soil Contact Exposures for Currently Occupied Properties. The Cancer Risks are within the NCP Risk Range and Noncancer Hazard Indices are Below the Protection Goal of 1 for All Properties Except Lot 70 Where the Child Hazard Index = 2.

[37] Since there are two buildings on Lot 1, the higher cumulative cancer risk and HI estimates (Building 2) are included in the combined estimates.

Lot	Adult/Child Risk	Adult HI	Child HI
Lot 1	**8 x 10^{-6}**	0.02	0.2
Lot 57	**1 x 10^{-5}**	0.08	0.7
Lot 59	**3 x 10^{-6}**	0.02	0.2
Lot 60	**9 x 10^{-6}**	0.05	0.3
Lot 62	**1 x 10^{-5}**	0.04	0.3
Lot 69	**2 x 10^{-5}**	0.09	0.9
Lot 70	**2 x 10^{-5}**	0.2	**2**

Since the HI for Lot 70 is above the protection goal of 1, the toxic organ endpoint specific HIs for child visitor exposure at Lot 70 are shown on RAGS D Table 9. All toxic endpoint specific HI estimates are at or below the protection goal of 1.

Lead. As shown below, all average soil surface lead concentrations in surface soil from the 0 to 2 ft. depth interval are above the residential screening level of 200 mg/kg at all currently occupied properties except for Lot 60. As discussed in Section 4.5.4, the child visitor's exposure to lead would be approximately 5% of the future child resident's exposure to lead based on the differences in exposure time, frequency and duration. Using theis percentage, as shown below, t. The estimated portion of the child visitor's blood lead distribution that exceeds USEPA Region 2's lead goal of 5 ug/dL for the 0 to 2 ft. depth interval is greaterless than 5% at Lot 1, Lot 62, and Lot 70each occupied propertylot.

The child visitor's exposure to lead was calculated consistent with USEPA's Assessing Intermittent or Variable Exposures at Lead Sites (USEPA, 2003c) as discussed in Section 4.4.11.

Table 6-20. Average Lead Concentrations in Surface Soil (PbS) and IEUBK Model Estimated Probabilities (P) that PbB_{fetal} > PbB_t for Current Child Visitors Exposed to the PbS Concentrations
(PbS > 200 mg/kg and P > 5% are bolded and shaded)Average Surface Lead Concentrations for Current Child Visitors Exposure on Individual Lots Exposed to Soils at Depths of 0 to 2 Ft. Soil Concentrations Greater than the Residential Value of 200 mg/kg are Highlighted Along with Percentage of Child Visitors with BLLs Greater Than 5% with 5 ug/dl.

Lot	PbS (mg/kg)	Time-Weighted PbS* (mg/kg)	5% of Child Res $P(PbB > PbB_t)$ (%)
Lot 1	580	199202	4.785.19
Lot 57	305	159163	2.943.21
Lot 59	240	150153	2.582.79
Lot 60	185	142145	2.292.48
Lot 62	567	197200	4.685.08
Lot 69	343	165168	4.263.43
Lot 70	934	249252.6	8.278.54

* -Time-Wweighted soil lead cConcentration of lead in soil was calculated assuming 1/7 of the soil lead EPC (PbS) in surface soil during exposure and at the lot and 6/7 of the average lead concentration (1395 mg/kg) at an offsite residential property concentration of 135 mg/kg as discussed in Section 4.4.111.

6.2.1.7 Off-Site Workers

Adjacent to the Site, east of McCarter Highway, are other industrial properties. While no site-related contamination is known to extend off-site, off-site workers may be exposed to COPCs in on-site soil that migrate off-site via windblown soil vapor and particulates emanating from areas without groundcover. The cancer risk and are calculated assuming there is no pavement or building covering the soil, and no air dispersion from the Site to the off-site workers (i.e., as though the off-site workers are at the downwind edge of the Site).

Cancer Risks and Noncancer Hazards. Potential exposure of off-site workers to COPCs in on-site soil that migrate off-site via windblown soil vapor and particulates are evaluated indirectly in this risk assessment using risk estimates for on-site outdoor workers, as explained in Section 4.1. This is conservative since the outdoor worker risk estimates include incidental ingestion and dermal contact pathways in addition to inhalation. Specifically, the risk estimates for off-site workers are expected to be no higher than the cumulative cancer risk and HI estimates for on-site outdoor workers discussed in Section 6.2.1.1, which are within USEPA's limits for RME risks.

-The off-site workers' cumulative cancer risk and HI estimates summarized below are the sum of the estimates for particulate inhalation calculated using soil data from the 0 to 2 ft. depth interval, and the estimates for vapor inhalation calculated using soil data from all sampled depths. These risk estimates are calculated assuming there is no pavement or building covering the soil, and no air dispersion from the Site to the off-site property (i.e., as though the off-site workers are at the downwind edge of the Site). As shown below, the cumulative cancer risk estimates range from 2×10^{-8} to 5×10^{-6}, which are at or below NCP's risk range except for Lot 62 which is within NCP's risk range. The noncancer HIs range from 0.002 to 0.2, which are all below the protection goal of 1. The single-chemical cancer risk above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), is naphthalene (Lot 62) (see RAGS D Table 7).

Table 6-23. Cancer Risks and Noncancer HIs for Current Off-Site Workers Exposed to On-Site Soil That Migrates Off-Site Via Windblown Soil Vapor and Particulates Emanating from Lots Without Groundcover
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Current Cancer Risks and Noncancer Hazard Indices for Off-Site Workers Exposed
to On-Site Soil That Migrates Off-Site Via Windblown Soil Vapor and Particulates Emanating from Lots Without Groundcover. The Cancer Risks Are Within or Below the NCP Risk Range and the Noncancer HI Is Below the Protection Goal of 1.

Lot	Risk	HI
Lot 1	3 x 10^{-7}	0.02
Lot 57	7 x 10^{-7}	0.09
Lot 58	6 x 10^{-8}	0.04
Lot 59	2 x 10^{-8}	0.002
Lot 60	6 x 10^{-8}	0.01
Lot 61	4 x 10^{-8}	0.05
Lot 62	**5 x 10^{-6}**	0.2
Lot 63	6 x 10^{-8}	0.07
Lot 64	1 x 10^{-6}	0.05
Lot 65	1 x 10^{-7}	0.1
Lot 66	3 x 10^{-8}	0.05
Lot 67	4 x 10^{-7}	0.06
Lot 68	2 x 10^{-7}	0.1
Lot 69	4 x 10^{-8}	0.01
Lot 70	9 x 10^{-7}	0.03

Groundwater. Shallow and deep groundwater are not currently used for potable purposes at or around the Site. Water is supplied by the City of Newark. Future use of groundwater for potable uses is evaluated and discussed in Section 6.2.2.9.

6.2.1.8 Off-Site Residents

West of McCarter Highway are residential properties with medium-density residential units. While no site-related contamination is known to extend off-site, off-site residents may be exposed to COPCs in on-site soil that migrate off-site via windblown soil vapor and particulates emanating from areas without groundcover.

The off-site resident cumulative cancer risk and HI estimates summarized on Table 6-1 are the sum of the estimates for particulate inhalation calculated using soil data from the 0 to 2 foot depth interval, and the estimate for vapor inhalation calculated using soil data from all sampled depths. These risk estimatesThe cancer risk and are calculated assuming there is no pavement or building covering the soil, and no air dispersion from the Site to the off-site residents (i.e., as though the off-site residents are at the downwind edge of the Site). As shown on Table 6-1, these cumulative risk estimates for each property are within USEPA's limits for RME risks except at Lot 62.

Cancer Risks and Noncancer Hazards. The HI at Lot 62 of 2 is primarily from naphthalene (hazard quotient of 1.3) and benzo(a)pyrene (hazard quotient of 0.13). The naphthalene EPC for Lot 62 is based on the maximum detected concentration since the UCL was greater than the maximum concentration. This maximum detected naphthalene concentration (68 mg/kg) is from the 1 to 2 foot sample at boring B-93. The naphthalene concentration in the 2 to 3 foot sample at B-93 is 53 mg/kg. As shown on Figure 3-1, B-93 is bounded by nearby borings B-29, B-36, B-34, and B-75, which are approximately 50 feet from B93 in each direction and all of which have much lower naphthalene concentrations (0.65 mg/kg or less). Also shown on Figure 3-1, the area represented by B-93 is currently paved, preventing off-site particulate and vapor migration.

As shown in RAGS Part D Table 5.02 in Appendix B, the target organ/effect for the chronic RfC for naphthalene is respiratory/nervous system and for benzo(a)pyrene is developmental. The HI for the remaining COPCs is 0.045. Therefore, by segregating the HQs of naphthalene and benzo(a)pyrene by target organ/effect, the toxic-endpoint specific HI for respiratory/nervous system is no higher than 1.4 (naphthalene plus the remaining COPCs), which rounds to 1, and the toxic-endpoint specific HI for developmental is no higher than 0.17 (benzo(a)pyrene plus the remaining COPCs), which rounds to 0.2, as shown on Table 6-1. Neither toxic-endpoint specific HI estimate exceeds USEPA's limit for RME risk.

The off-site resident cumulative cancer risk and HI estimates summarized below are the sum of the estimates for particulate inhalation calculated using soil data from the 0 to 2 ft. depth interval, and the estimate for vapor inhalation calculated using soil data from all sampled depths. As shown below, the cumulative cancer risk estimates range from 1 x 10^{-7} to 2 x 10^{-5}, which are at or below NCP's risk range except for Lots 57, 62, 64, 67, and 70 which are within NCP's risk range. The single-chemical cancer risks above the lower-end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are naphthalene (Lots 57 and 62) and benzene (Lot 64) (see RAGS D Table 7). For adults, noncancer HIs range from 0.01 to 0.8, which are all below the protection goal of 1. For children, noncancer HIs range from 0.02 to 2, which are at or below the protection goal of 1 except for Lots 62 and 68 which have HIs of 2. No single-chemical HQs are above the protection goal of 1.

Table 6-24. Current Off-Site Resident Cancer Risks and Noncancer HIs from Exposure to COPCs in On-Site Soil That May Migrate Off-Site Via Windblown Soil Vapor and Particulates (Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Summary Table of Off-Site Resident Cancer Risks and Noncancer Hazards Indices

From Exposure to Chemicals of Potential Concern in On-Site Soil That May Migrate Off-Site Via Windblown Soil Vapor and Particulates from Areas Without Groundwater. The Cancer Risks Are Within or Below the NCP Risk Range and the Noncancer HI is Below the Protection Goal of 1 for the Adult. The Noncancer Hi for the Child is Below the Goal of Protection of 1 At All Lots Except Lot 62 and Lot 68 where the Goal of 1 is Exceeded (e.g., HI = 2).

Lot	Adult/Child Risk	Adult HI	Child HI
Lot 1	1×10^{-6}	0.08	0.2
Lot 57	**4×10^{-6}**	0.5	0.9
Lot 58	4×10^{-7}	0.2	0.7
Lot 59	1×10^{-7}	0.01	0.02
Lot 60	4×10^{-7}	0.07	0.2
Lot 61	3×10^{-7}	0.3	0.5
Lot 62	**2×10^{-5}**	0.8	**2**
Lot 63	5×10^{-7}	0.4	0.6
Lot 64	**5×10^{-6}**	0.3	0.6
Lot 65	7×10^{-7}	0.6	1
Lot 66	2×10^{-7}	0.2	0.4
Lot 67	**2×10^{-6}**	0.3	0.6
Lot 68	1×10^{-6}	0.7	**2**
Lot 69	3×10^{-7}	0.07	0.1
Lot 70	**4×10^{-6}**	0.2	0.3

Since the off-site child ~~resident~~resident, HIs from ~~or~~ soil exposure at Lot 62 and Lot 68 are above the protection goal of 1, the toxic endpoint specific HIs for off-site child resident exposure at Lots 62 and 68 are listed below. All toxic endpoint specific off-site child resident HI estimates for soil are at or below the protection goal of 1.

Table 6-245. Noncancer Toxic Endpoint-Specific HIs for Current Off-Site Resident Children Exposed at Lot 62 and Lot 68
(HIs > 1 are bolded and shaded)
Noncancer Toxic Endpoints for Hazard Indices for Children Exposed at Lot 62.
and Lot 68. All Hazard Indices are At or Below the Protection Goal of 1.

Lot	Toxic Endpoint	HI
Lot 62	Cardiovascular	0.0002
	Dermal	0.0002
	Developmental/Reproductive	0.1
	Nervous	1
	Respiratory	1
Lot 68	Cardiovascular	0.7
	Dermal	0.0002
	Developmental/Reproductive	0.7
	Hepatic	0.002
	Immune	0.7
	Nervous	1
	Ocular	0.1
	Respiratory	0.0007

Additionally, the dispersion factor (Q/C) used to calculate the HI estimate for each property is based on an emission source area of 1.2 acres, which is the size of the largest property, as discussed in Section 4.2.3.5.4.3.3.5. However, the area of LotLots 62 isand 68 are each actually 0.50.5 acre, as shown on Table 2-1. TheUse of a smaller area (i.e., more than half the area) to calculate the HI estimates would result in a lower HI estimate calculated using this property-specific area is 1 (without segregating HQs), which meets USEPA's limits for RME risk, as shown in Appendix D..

6.2.2 Future Receptors

Potential future exposures are evaluated for every receptor at each of the 15 Lots ~~properties~~ at the Site (i.e., each property is assessed assuming future ~~re~~development under both industrial land use and ~~Potential future exposures are evaluated for every receptor at each of the 15 properties at the Site (i.e., each property is assessed assuming future redevelopment under both industrial land use and~~ hypothetical residential land use). The cancer risk, HI, and lead modeling are calculated assuming the absence of protective measures, such as existing pavement or capping.

Under future industrial land use, the potentially exposed populations at and around the Site are ~~conservatively~~ assumed to include all the following:

- Outdoor Workers;
- Indoor Workers;
- Utility Workers;
- Construction Workers;
- ~~As shown~~ Trespassers (adolescents and adults);
- Visitors (children and adults);
- Off-Site Workers (via wind transport of on ~~Table 6-9, none~~-site soil and migration of shallow and deep groundwater);
- Off-Site Residents (children and adults; via wind transport of on-site soil and migration of deep groundwater).

Additionally, hypothetical future residential land use was evaluated.

6.2.2.1 Outdoor Workers~~the 15 properties have~~

The outdoor ~~worker~~workers' cumulative cancer ~~or~~risk and HI estimates are the sum of the estimates for ingestion, dermal contact, and particulate inhalation calculated using soil data from the 0 to 2 ~~foot~~ft. depth interval ~~that exceed USEPA's limits~~, and the estimate for ~~RME risks. Table 6-17 shows the cumulative risk estimates~~vapor inhalation calculated using soil data from all sampled depths ~~for all routes of exposure, to~~.

Cancer Risks and Noncancer Hazards. The cumulative cancer risk estimates range from 2 x 10^{-6} to 2 x 10^{-5}, which are all within NCP's risk range. The noncancer HIs range from 0.09 to 1, which are at or below the protection goal of 1. The single-chemical cancer risks above the lower-end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are arsenic (Lots 1, 58, 59, 60, 61, 62, 63, 65, 67, 68, 69 and 70), benzo(a)pyrene (Lots 57, 62, 63, 65, 67 and 69), naphthalene (Lot 62), PCBs (Lots 57 and 67), and 2,3,7,8-tetrachlorodibenzo-p-dioxin (Lots 60, 64, and 70) (see RAGS D Table 7).

Table 6-256. Cancer Risks and Noncancer HIs for Future Outdoor Workers from Exposure through Ingestion, Dermal Contact, and Particulate Inhalation of Surface Soil (0 to 2 ft.) and Vapor Inhalation Calculated Using Soil Data from All Sampled Depths (Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Future Outdoor Worker Cancer Risks and Noncancer Hazard Indices from Exposure through Ingestion, Dermal Contact, and Particulate Inhalation of Surface Soil (0 to 2 Ft.) and Vapor Inhalation Calculated Using Soil Data from All Sampled Depths. Cancer Risks are Within the NCP Risk range and At or Below the Protection Goal of 1.

Lot	**Risk**	**HI**
Lot 1	**6 x 10^{-6}**	0.1
Lot 57	**8 x 10^{-6}**	0.4
Lot 58	**3 x 10^{-6}**	0.5
Lot 59	**2 x 10^{-6}**	0.09
Lot 60	**6 x 10^{-6}**	0.2
Lot 61	**2 x 10^{-5}**	0.3
Lot 62	**1 x 10^{-5}**	0.3
Lot 63	**1 x 10^{-5}**	1
Lot 64	**5 x 10^{-6}**	0.2
Lot 65	**6 x 10^{-6}**	0.4
Lot 66	**2 x 10^{-6}**	0.1
Lot 67	**2 x 10^{-5}**	0.7
Lot 68	**5 x 10^{-6}**	0.5
Lot 69	**7 x 10^{-6}**	0.4
Lot 70	**2 x 10^{-5}**	0.7

To evaluate the scenario in which soil below the 0 to 2 footft. depth interval is brought to the surface in the course of site future redevelopment. The , the outdoor workers' cumulative risk estimates for that scenario at each property are also within USEPA's limits for RME risks. cancer risk and HI estimates are the sum of the estimates for ingestion, dermal contact, vapor and particulate inhalation calculated using soil data from all sampled depths. The cumulative cancer risk estimates range from 2 x 10^{-6} to 3 x 10^{-5}, which are all within NCP's risk range. The noncancer HIs range from 0.06 to 1, which are at or below the protection goal of 1. The single-chemical cancer risks above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are arsenic (Lots 1, 58, 60, 61, 62, 63, 65, 67, 68, 69 and 70), benzo(a)pyrene (Lots 57, 61, 62, 63, and 67), naphthalene (Lot 62), PCBs (Lots 57, 65, 67 and 70), 2,3,7,8-tetrachlorodibenzo-p-dioxinTCDD (Lots 60, 64, and 70) (see RAGS D Table 7).

Table 6-2~~6~~7~~.~~ Cancer Risks and Noncancer HIs for Future Outdoor Workers from Exposure through Ingestion, Dermal Contact, Vapor and Particulate Inhalation to Soils at Depth Brought to the Surface During Future Development
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)~~Future Outdoor Worker Cancer Risks and Noncancer Hazard Indices from Exposure to Soils at Depths of 0 to 2 Ft. Brought to the Surface During Future Development. Exposures are for Ingestion, Dermal Contact, Vapor and Particulate Inhalation Calculated Using Soil Data from All Samples Depths. Cancer Risks are Within the NCP Risk Range and At or Below the Protection Goal of 1.~~

~~As shown on Table 6-10, the~~

Lot	Risk	HI
Lot 1	**4 x 10^{-6}**	0.09
Lot 57	**1 x 10^{-5}**	0.5
Lot 58	**3 x 10^{-6}**	0.3
Lot 59	**2 x 10^{-6}**	0.06
Lot 60	**5 x 10^{-6}**	0.2
Lot 61	**2 x 10^{-5}**	0.3
Lot 62	**1 x 10^{-5}**	0.3
Lot 63	**1 x 10^{-5}**	0.8
Lot 64	**6 x 10^{-6}**	0.2
Lot 65	**6 x 10^{-6}**	0.4
Lot 66	**5 x 10^{-6}**	0.2
Lot 67	**1 x 10^{-5}**	0.6
Lot 68	**5 x 10^{-6}**	0.5
Lot 69	**4 x 10^{-6}**	0.2
Lot 70	**3 x 10^{-5}**	1

Lead. The average lead concentration for the 0 to 2 ~~foot~~ft. Soil depth interval is below the USEPA Region 2 nonresidential screening level of 800 mg/kg at each property except for Lots 63 and 70~~. The average lead concentration at Lot 63 is 1,860 mg/kg, and the average lead concentration at Lot 70 is 934 mg/kg. As shown on Table 6-11A, as shown below.~~ As also shown below, the estimated portion of the outdoor workers' fetal blood lead distribution exceeding the 5 ug/~~dl~~dL level target PbB is less than 5% at each property except ~~Lot 63. For Lot 63, 18% of the estimated fetal blood lead distribution exceeds 5 ug/dL. Lots 63 and 70 are currently paved and are partly capped (Figure 6-1).~~ for Lots 63 and 70.

Table 6-278. Average Lead Concentrations in Surface Soil (PbS) and ALM Estimated Probabilities (P) that PbB_{fetal} > PbB_t for Future Outdoor Workers Exposed to the PbS Concentrations (PbS > 800 mg/kg and P > 5% are bolded and shaded)Future Outdoor Worker Exposure to Lead (Pb) Concentrations in Soils at Depths of 0 to 2 Ft. By Lot. The Table Highlights Pb Concentrations Greater than the Screening Level for Industrial Soils of 800 mg/kg (bold) and the Percent of BLLs Greater Than 5 ug/dl.

LLot	**PbS (mg/kg)**	**P(PbB_{fetal} > PbB_t) (%)**
Lot 1	580	2.3%
Lot 57	305	0.44%
Lot 58	466	1.3%
Lot 59	240	0.24%
Lot 60	185	0.14%
Lot 61	505	1.6%
Lot 62	567	2.2%
Lot 63	**2,090**	**38%**
Lot 64	616	2.7%
Lot 65	619	2.7%
Lot 66	129	0.07%
Lot 67	429	1.0%
Lot 68	510	1.6%
Lot 69	343	0.58%
Lot 70	**934**	**7.7%**

As shown on Table 6-10below, the average lead concentration calculated using soil data from all sampled depths (in case subsurface soil is moved to the surface during future site- reddevelopment) is below the USEPA Region 2 nonresidential screening level of 800 mg/kg at each property except for Lot 63 and Lot 70. The average lead concentration at Lot 63 is 2,290 mg/kg, and the average lead concentration at Lot 70 is 970 mg/kg. As shown on Table 6-11A, theThe estimated portion of the outdoor workers' fetal blood lead distribution exceeding the 5 ug/dldL level is less than 5% -for each property except Lot 63. For Lot 63, 27% of the estimated fetal blood lead distribution exceeds 5 ug/dL. As an additional comparison, the lead EPCs in Lot 63 are below the nonresidential screening level calculated using a target blood lead level of 10 ug/dL is 2,520 mg/kg. for Lots 63 and 70.

Table 6-289. Average Lead Concentrations in Soil from All Sample Depths (PbS) and ALM Estimated Probabilities (P) that $PbB_{fetal} > PbB_t$ for Future Outdoor Workers Exposed to the PbS Concentrations (PbS > 800 mg/kg and P > 5% are bolded and shaded)Future Outdoor Worker Exposure to Lead (Pb) Concentrations in Soils from All Sampled Depths in the Event that Subsurface Soil is Moved to the Surface During Future Site Development by Lot. The Table Highlights Pb Concentrations Greater than the Screening Level for Industrial Soils of 800 mg/kg (bold) and the Percent of BLLs Greater Than 5 ug/dl (bold).

Risk

Lot	PbS (mg/kg)	$P(PbB_{fetal} > PbB_t)$ (%)
Lot 1	426	1.0%
Lot 57	272	0.33%
Lot 58	318	0.48%
Lot 59	153	0.10%
Lot 60	171	0.12%
Lot 61	500	1.6%
Lot 62	493	1.5%
Lot 63	**2,530**	**49%**
Lot 64	688	3.6%
Lot 65	510	1.6%
Lot 66	206	0.17%
Lot 67	395	0.84%
Lot 68	586	2.4%
Lot 69	241	0.25%
Lot 70	**970**	**8.4%**

Groundwater. Risks from potable and nonpotable groundwater[38] use by outdoor workers (as well as other receptors) is are evaluated by comparing the for shallow and deep groundwater EPCs to the tap water RSLs (USEPA 2019) to facilitate development of appropriate ICs institutional controls for the Site. As If shallow or deep groundwater is used in the future, outdoor workers could be exposed through ingestion, dermal contact, and inhalation of vapors during potable use.

For shallow groundwater potable use, the cumulative cancer risk estimates range from 1 x 10^{-4} to 7 x 10^{-4}, which are above NCP's risk range except for Lots 62, 67, 68 and 70 which are at the upper-end of NCP's risk range, as shown in Table 6-18, shallow groundwater EPCs exceed the tap water RSLsbelow. The single-chemical cancer risks are above the lower end of NCP's risk range (10^{-6}) for a number of VOCs, SVOCs, PCBs, and metals at each of the 15 properties at the Site. Similarly, (see RAGS D Table 7). The highest risks (i.e., above the upper end of NCP's range) are for 1,2-dibromo-3-chloropropane, pentachlorophenol, dibenz(a,h)anthracene, and arsenic.

[38] Hypothetical future nonpotable groundwater use is conservatively evaluated using USEPA's RSLs for tap water (i.e., potable use).

The noncancer HIs range from 2 to 50, which are above the protection goal of 1. The single-chemical HQs are above the protection goal of 1 for ~~a number of~~several VOCs, SVOCs, and metals at each of the 15 properties at the Site (see RAGS D Table 7). The highest HQ (i.e., HI above 10) is for xylene at Lots 58 and 59.

Table 6-2930. Cancer Risks and Noncancer HIs for Future Outdoor Workers from Exposure to Groundwater (shallow and deep) Through Ingestion, Dermal Contact and Inhalation of Vapors During Potable Use
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Future Outdoor Worker Cancer Risks and Noncancer Hazard Indices from Exposure to Groundwater (shallow and deep) Through Ingestion, Dermal Contact and Inhalation of Vapors During Potable Use. Lots Exceeding the Risk Range and/or the Protection Goal of 1 Are Highlighted.

Lot	Risk	HI
Lot 1	**2 x 10^{-4}**	**3**
Lot 57	**7 x 10^{-4}**	**20**
Lot 58	**7 x 10^{-4}**	**50**
Lot 59	**7 x 10^{-4}**	**50**
Lot 60	**3 x 10^{-4}**	**3**
Lot 61	**6 x 10^{-4}**	**20**
Lot 62	**1 x 10^{-4}**	**2**
Lot 63	**3 x 10^{-4}**	**10**
Lot 64	**6 x 10^{-4}**	**20**
Lot 65	**4 x 10^{-4}**	**3**
Lot 66	**2 x 10^{-4}**	**3**
Lot 67	**1 x 10^{-4}**	**2**
Lot 68	**1 x 10^{-4}**	**3**
Lot 69	**4 x 10^{-4}**	**20**
Lot 70	**1 x 10^{-4}**	**2**

The maximum lead concentration for shallow groundwater is below the federal action limit of 0.015 mg/L at seven properties and above at Lots 57, 60, 63, 64, 67, and 69, as shown below.

Table 6-2931. Future Outdoor Worker Exposure to Lead in Shallow and Deep Groundwater (PbGW) Through Ingestion, Dermal Contact and Inhalation of Vapors During Potable Use (PbGW > the Pb Action Level of 0.015 mg/L are bolded and shaded)Future Outdoor Worker Exposure to Groundwater (shallow and deep) Through Ingestion, Dermal Contact and Inhalation of Vapors During Potable Use. Lots Exceeding the Pb Action Level (0.015 mg/L are Highlighted.

Lot	**PbGW** (mg/L)
Lot 1	0.0033
Lot 57	**0.57**
Lot 58	0.00028
Lot 60	**0.018**
Lot 62	0.0074
Lot 63	**0.11**
Lot 64	**0.045**
Lot 65	ND
Lot 66	0.013
Lot 67	**0.019**
Lot 68	0.0013
Lot 69	**0.025**
Lot 70	0.0079

For deep groundwater EPCspotable use (site-wide) exceed for several VOCs, SVOCs, PCBs, and metals.), the cumulative cancer risk estimate is 2 x 10^{-4}, which is above NCP's risk range, and the noncancer HI is 4, which is above the protection goal of 1. The single-chemical cancer risks are above the lower end of NCP's risk range (10^{-6}) for benzene, chloroform, 1,4-dioxane, 1,1,2-trichloroethane, benzo(a)pyrene, naphthalene, and arsenic. No single-chemical HQ exceeds the protection goal and the toxic endpoint specific HI estimates are at or below the protection goal of 1 as shown on RAGS D Table 9.

Therefore, cancer risk and noncancer hazards from potable and nonpotable use of the shallow and the risk from potable use of the deep groundwater, if to occur in the future, would be unacceptable. However, such future groundwater use at the Site is unlikely since site-specific conductivity readings of the shallow groundwater indicate possible brackish conditions, and the Site and surrounding area are served by the City of Newark's potable water system. In addition, Lots 67, 68 and 69 have restrictions in place against groundwater use.

If outdoor workers were to have exposure to both soil (0 to 2 footft. interval and) and shallow groundwater (from potable use) in the future, the combined cumulative cancer risk estimates range from 2 x 10^{-4} to 7 x 10^{-4}, which are all above NCP's risk range, as shown below. The combined noncancer HIs range from 2 to 50, which are above the protection goal of 1. The toxic endpoint specific HI estimates are also above the protection goal of 1 except for Lots 1, 60, 62, 65, 66, 67, 68 and 70, which are at or below the protection goal, as shown on RAGS D Table 9.

Table 6-3~~0~~2~~.~~ Cancer Risks and Noncancer HIs for Future Outdoor Worker Exposure to Soil (depth of 0 to 2 ft) and Shallow Groundwater During Potable Use (Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)~~Future Outdoor Worker Exposure to Soil (depth of 0 to 2 ft) and Shallow Groundwater (potable use) in the Future. Cancer Risks Greater than the Risk Range and Noncancer Hazard Indices Greater than the Protection Goal of 1 Are Highlighted by Low.~~

Lot	**Risk**	**HI**
Lot 1	**2 x 10^{-4}**	**3**
Lot 57	**7 x 10^{-4}**	**20**
Lot 58	**7 x 10^{-4}**	**50**
Lot 59	**7 x 10^{-4}**	**50**
Lot 60	**3 x 10^{-4}**	**3**
Lot 61	**6 x 10^{-4}**	**20**
Lot 62	**2 x 10^{-4}**	**2**
Lot 63	**3 x 10^{-4}**	**10**
Lot 64	**6 x 10^{-4}**	**20**
Lot 65	**4 x 10^{-4}**	**4**
Lot 66	**2 x 10^{-4}**	**3**
Lot 67	**2 x 10^{-4}**	**2**
Lot 68	**2 x 10^{-4}**	**3**
Lot 69	**4 x 10^{-4}**	**20**
Lot 70	**2 x 10^{-4}**	**3**

If outdoor workers were to have exposure to both soil from all depths (in case subsurface soil is moved to the surface during site redevelopment) and ~~groundwater in the future, the combined risk from these exposures would be unacceptable, and would be driven by risks from the use of groundwater (as indicated by Table 6-18).~~ shallow groundwater (from potable use) in the future, the combined cumulative cancer risk estimates range from 2 x 10^{-4} to 7 x 10^{-4}, which are all above NCP's risk range, as shown below. The combined noncancer HIs range from 2 to 50, which are above the protection goal of 1. The toxic endpoint specific HI estimates are also above the protection goal of 1 except for Lots 1, 60, 62, 65, 66, 67, 68 and 70, which are at or below the protection goal, as shown on RAGS D Table 9.

Lot	Risk	HI
Lot 1	2×10^{-4}	3
Lot 57	7×10^{-4}	20
Lot 58	7×10^{-4}	50
Lot 59	7×10^{-4}	50
Lot 60	3×10^{-4}	3
Lot 61	6×10^{-4}	20
Lot 62	2×10^{-4}	2
Lot 63	3×10^{-4}	10
Lot 64	6×10^{-4}	20
Lot 65	4×10^{-4}	4
Lot 66	2×10^{-4}	3
Lot 67	2×10^{-4}	2
Lot 68	2×10^{-4}	3
Lot 69	4×10^{-4}	20
Lot 70	2×10^{-4}	3

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6.2.2.16.2.2.2 Indoor Workers

Potential inhalation exposures to surface and subsurface soil vapors or shallow groundwater vapors may occur indoors if vapors migrate through building foundations.

Cancer Risk and Noncancer Hazards. The indoor worker cumulative cancer risk and HI estimates for vapor intrusion exposure assuming a hypothetical future commercial/industrial building are summarized on Table 6-9below for soil data from all sampled depths and Table 6-12 for shallow groundwater data. As shown on Table 6-9, the soil. The cumulative cancer risk estimates for each propertyrange from 4 x 10^{-8} to 1 x 10^{-4}, which are within USEPA's limits for RME risks except for Lots 58, 62, 64, and 68. or at the upper end of NCP's risk range except for Lots 59, 63, 65, 66, 69, 70 which are below NCP's risk range. The noncancer HIs range from 0.0004 to 4, which are below the protection goal of 1 except for Lots 58, 62, 64, and 68 which are above the protection goal of 1. The single-chemical cancer risks above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are benzene (Lots 1, 57, and 64), chloroform (Lot 64), naphthalene (Lots 1, 57, 62, 67 and 70), tetrachloroethene (Lot 68), and trichloroethene (Lots 58, 60, 61, and 68) (see RAGS D Table 7). The single-chemical HQs above the protection goal of 1 are trichloroethene (Lots 58 and 68), xylenes (Lot 58), naphthalene (Lots 62), and benzene (Lot 64) (see RAGS D Table 7).

Table 6-313. Cancer Risks and Noncancer HIs for Future Indoor Workers from Inhalation Exposure of Indoor Vapors from Vapor Intrusion Based on Soil Data from All Sampled Depths Assuming a Future Commercial/Industrial Building
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Cancer Risks and Noncancer Hazard Indices to Future Indoor Workers Exposed Through Vapor Intrusion Assuming a Future Commercial/Industrial Buildings On Individual Lots and Exposures Are from All Soils. The Cancer Risks are Within the NCP Risk Range and the Protection Goal of 1 at Lot 58, Lot 62, Lot 64, and Lot 68.

Lot	Risk	HI
Lot 1	**1 x 10^{-5}**	0.2
Lot 57	**1 x 10^{-5}**	0.7
Lot 58	**5 x 10^{-6}**	**4**
Lot 59	2 x 10^{-7}	0.002
Lot 60	**2 x 10^{-6}**	0.6
Lot 61	**2 x 10^{-6}**	0.8
Lot 62	**1 x 10^{-4}**	**3**
Lot 63	3 x 10^{-7}	0.2
Lot 64	**1 x 10^{-4}**	**2**
Lot 65	2 x 10^{-7}	0.5
Lot 66	6 x 10^{-8}	0.3
Lot 67	**4 x 10^{-6}**	0.3
Lot 68	**1 x 10^{-5}**	**5**
Lot 69	4 x 10^{-8}	0.0004
Lot 70	8 x 10^{-6}	0.3

The HI estimates above USEPA's limit of 1 are primarily from the following COPCsCOPCs detected at the specified location:

- Lot 58: trichloroethene (B-16) and xylene. (B-13)
- Lot 62: naphthalene. (B-93)
- Lot 64: benzene (B-74) and xylenes.xylene (B-34)
- Lot 68: trichloroethene and xylenes.(B-56)

As shown on Figure 3-1, the soil borings are not located under existing buildings in Lots 58, 62, 64 and 68. The naphthalene concentration at Lot 62 is limited to a small area, as discussed in Section 6.2.1.8, which is not located under an existing building. The HI at Lot 64 of 2 is primarily from benzene (hazard quotient of 1.2) and xylenes (hazard quotient of 0.57). As shown in RAGS Part D Table 5.02 in Appendix B,Since the target organ/effectHIs for the chronic RfC for benzene is immune system and for xylene is nervous system. The HI for the remaining COPCs is 0.13. Therefore, by segregating the HQs of benzene and xylene by target organ/effect, the toxic-endpoint specific HI for immune system is no higher than 1.4 (benzene plus the remaining COPCs), which rounds to 1, and the toxic-endpoint specific HI for nervous system is no higher than 0.71 (xylene plus the remaining COPCs), which rounds to 0.7, as shown on Table 6-9. Neither toxic-endpoint specific HI estimate for Lot 64 exceeds USEPA's limit for RME risk.

As shown on Table 6-12, the shallow groundwater cumulative risk estimates are within USEPA's limits for RME risks.

If indoor workers were to have exposure to both soil and groundwater via vapor intrusion, the combined risk from these exposures would be within USEPA's limits for RME risk except for Lots exposure at Lots 58, 62, 64, and 68, as shown on Tables 6-13, which are the properties where the are above the protection goal of 1, the toxic endpoint specific HIs at these Lots are listed below. The toxic endpoint specific soil vapor intrusion HI estimates for soil exceed USEPA's limit.

As discussed in Section 6.2.2.1, risk from potable and nonpotable use of the shallow and deep groundwater, if to occur in the future, would be unacceptable. However, such groundwater use at the Site is unlikely since the shallow groundwater is brackish and the Site and surrounding area are served by the City of Newark's potable water system. In addition, Lots 67, 68 and 69 have restrictions in place against groundwater use. at or below the protection goal of 1 for Lot 64. The toxic endpoint specific HI estimates are above the protection goal of 1 for Lots 58, 62 and 68.

Table 6-324. Noncancer Toxicarget Endpoint-Specific HIs for Future Indoor Workers from Inhalation Exposure of Indoor Vapors from Vapor Intrusion Based on Soil Data from All Sampled Depths Assuming a Future Commercial/Industrial Building for Lot 58, Lot 62, Lot 64, and Lot 68
(HIs > 1 are bolded and shaded)Target Organ Specific Hazard Indices for Lots 58, Lot 62, Lot 64, and Lot 68 for Future Indoor Workers Exposed to Vapor Intrusion Assuming a Future Commercial/Industrial Building Based on Soil Data from All Sampled Depths. All Target Organ Hazard Indices Less than the Protection Goal on Lot 64 and Lot 68. The Goal of Protection of 1 Was Exceeded on Lot 58, Lot 62, and Lot 68.

If indoor workers were to have exposure to both soil and groundwater via vapor intrusion and potable and nonpotable use of groundwater in the future, the combined risk from these exposures would be unacceptable, and would be driven by risks from the use of groundwater (as indicated by Table 6-18).

Potential exposures of indoor workers to COPCs in soil while outdoors are evaluated indirectly in this risk assessment by using the risk estimates for outdoor workers, as explained in Section 4.1. Specifically, the risk estimates for such outdoor exposure of indoor workers are expected to be no higher than the outdoor workers cumulative cancer risk and HI estimates discussed in Section 6.2.2.1, which are within USEPA's limits for RME risks.

6.2.2.2 Utility Workers

As shown on Table 6-9, none of the 15 properties have utility

Lot	Toxic Endpoint	HI
Lot 58	Cardiovascular	2
	Developmental/Reproductive	2
	Immune	2
	Nervous	2
Lot 62	Developmental/Reproductive	0.0004
	Nervous	3
	Respiratory	3
Lot 64	Cardiovascular	0.01
	Developmental/Reproductive	0.01
	Endocrine	0.00001
	Gastrointestinal	0.00001
	Hematologic	0.00001
	Immune	1
	Nasal Epithelium	0.01
	Nervous	0.8
	Respiratory	0.00001
Lot 68	Cardiovascular	4
	Developmental/Reproductive	4
	Hepatic	0.01
	Immune	4
	Nervous	2
	Ocular	0.5

The indoor worker cumulative cancer ~~or~~risk and HI estimates for ~~the 0 to 4 foot depth interval that exceeds USEPA's limits~~vapor intrusion exposure assuming a hypothetical future commercial/industrial building are summarized below for ~~RME risks. Table 6-17 shows the cumulative risk estimates calculated using soil~~shallow groundwater data ~~from all sampled depths for all routes of exposure, to~~. The cumulative cancer risk estimates range from 4 x 10^{-8} to 2 x 10^{-7}, which are all below NCP's risk range. The noncancer HIs range from 0.0004 to 0.1, which are all below the protection goal of 1.

Table 6-335. Cancer Risks and Noncancer HIs for Future Indoor Workers from Inhalation Exposure to Indoor Vapors from Vapor Intrusion from Shallow Groundwater Assuming a Future Commercial/Industrial Building
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Cancer Risks and Noncancer Hazard Indices to Future Indoor Workers Exposed

Through Vapor Intrusion Assuming a Future Commercial/Industrial Buildings
On Individual Lots and Exposures Are from Shallow Groundwater. The Cancer Risks are Within or Below the NCP Risk Range and Hazard Indices are At or Below the Goal of Protection of 1.

Lot	Risk	HI
Lot 1	4 x 10^{-8}	0.0004
Lot 57	2 x 10^{-7}	0.01
Lot 58	1 x 10^{-7}	0.1
Lot 59	1 x 10^{-7}	0.1
Lot 60	5 x 10^{-8}	0.0006
Lot 61	2 x 10^{-7}	0.02
Lot 62	4 x 10^{-8}	0.0004
Lot 63	7 x 10^{-8}	0.002
Lot 64	2 x 10^{-7}	0.02
Lot 65	4 x 10^{-8}	0.0007
Lot 66	4 x 10^{-8}	0.0004
Lot 67	4 x 10^{-8}	0.0004
Lot 68	4 x 10^{-8}	0.0006
Lot 69	2 x 10^{-7}	0.01
Lot 70	4 x 10^{-8}	0.0005

Potential exposure of indoor workers to COPCs in surface soil incorporated into dust are shown below. The cumulative cancer risk estimates range from 1 x 10^{-6} to 1 x 10^{-5}, which are within NCP's risk range except for Lots 59 and 66 which are at the lower end of NCP's risk range. The noncancer HIs range from 0.05 to 0.7, which are below the protection goal of 1. The single-chemical cancer risks above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are arsenic (Lots 1, 61, 62, 63, 67, 68 and 70), benzo(a)pyrene (Lots 67 and 69), naphthalene (Lots 62), PCBs (Lots 57 and 67), and 2,3,7,8-TCDDtetrachlorodibenzo-p-dioxin (Lot 70) (see RAGS D Table 7).

Table 6-346. Cancer Risks and Noncancer HIs for Future Indoor Workers from Inhalation Exposures to Surface Soil Incorporated into Indoor Dust
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Future Indoor Worker Cancer Risks and Noncancer Hazards Indices from Inhalation Exposures to Surface Soil Incorporated into Dust. The Cancer Risks are Within or Below the NCP Risk Range and Hazard Indices are At or Below the Goal of Protection of 1.

Lot	Risk	HI
Lot 1	**3 x 10^{-6}**	0.05
Lot 57	**4 x 10^{-6}**	0.2
Lot 58	**2 x 10^{-6}**	0.2
Lot 59	1 x 10^{-6}	0.05
Lot 60	**4 x 10^{-6}**	0.08
Lot 61	**1 x 10^{-5}**	0.1
Lot 62	**6 x 10^{-6}**	0.07
Lot 63	**6 x 10^{-6}**	0.7
Lot 64	**2 x 10^{-6}**	0.1
Lot 65	**4 x 10^{-6}**	0.2
Lot 66	1 x 10^{-6}	0.05
Lot 67	**1 x 10^{-5}**	0.4
Lot 68	**3 x 10^{-6}**	0.2
Lot 69	**4 x 10^{-6}**	0.2
Lot 70	**1 x 10^{-5}**	0.4

To evaluate the scenario in which soil below the 0 to 4 foot2 ft. depth interval is brought to the surface in the course of site future redevelopment., the indoor workers' cumulative cancer risk and HI estimates are calculated for the exposure to COPCs in soil from all sampled depths incorporated into dust. The cumulative risk estimates for that scenario at each property are also within USEPA's limits for RME risks. cancer risk estimates range from 1 x 10^{-6} to 1 x 10^{-5}, which are all within NCP's risk range except for Lot 59 which is at the lower end of NCP's risk range. The noncancer HIs range from 0.04 to 0.6, which are all below the protection goal of 1. The single-chemical cancer risks above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are arsenic (Lots 61, 62, 63, 67 and 68), benzo(a)pyrene (Lots 57, 63, and 67), naphthalene (Lot 62), PCBs (Lots 57, 67 and 70), and 2,3,7,8-tetrachlorodibenzo-p-dioxin (Lot 70) (see RAGS D Table 7).

Table 6-357. Cancer Risks and Noncancer HIs for Future Indoor Workers from Inhalation Exposure to Soil from All Sampled Depths
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Future Indoor Worker Cancer Risks and Noncancer Hazards Indices from Inhalation Exposures from Soil below the 0 to 2 ft. depth interval brought to the surface in the course of future Site Development. Cancer Risks are Within or Below the NCP Risk Range and Hazard Indices are At or Below the Goal of Protection of 1.

As discussed in Section 4.4.4, utility workers' exposure to lead in soil is not calculated, because the expected exposure frequency is well below the level at which USEPA guidance (2003c) recommends the ALM model be applied (i.e., "exposures that exceed a minimum frequency of one day per week and duration of 3 consecutive months").

Utility workers may contact contaminates in shallow groundwater during some utility repairs. As shown on Table 6-12, the utility worker cumulative risk estimates are within USEPA's limits for RME risks.

If utility workers were to have exposure to both soil (0 to 4 foot interval and in case subsurface soil is moved to the surface during site redevelopment) and groundwater, the combined risk from these exposures would be within USEPA's limits for RME risk, as shown on Tables 6-13 and 6-19.

6.2.2.3 Construction Workers

As shown on Table 6-9, none of the 15 properties have construction worker cumulative cancer risk or HI estimates for the "all depths" interval that exceeds USEPA's limits for RME risks.

The

Lot	**Risk**	**HI**
Lot 1	**2 x 10^{-6}**	0.04
Lot 57	**6 x 10^{-6}**	0.2
Lot 58	**2 x 10^{-6}**	0.1
Lot 59	1 x 10^{-6}	0.04
Lot 60	**3 x 10^{-6}**	0.08
Lot 61	**1 x 10^{-5}**	0.2
Lot 62	**5 x 10^{-6}**	0.07
Lot 63	**8 x 10^{-6}**	0.4
Lot 64	**3 x 10^{-6}**	0.1
Lot 65	**4 x 10^{-6}**	0.2
Lot 66	**3 x 10^{-6}**	0.08
Lot 67	**7 x 10^{-6}**	0.3
Lot 68	**3 x 10^{-6}**	0.2
Lot 69	**2 x 10^{-6}**	0.1
Lot 70	**1 x 10^{-5}**	0.6

Lead. Potential exposure of indoor workers to lead in surface soil incorporated into indoor dust are shown below. As discussed in Section 4.4.8, worker exposure to lead in soil may be assessed by comparing the average lead concentration ~~calculated using soil data from all sampled depths is below~~at each property to the USEPA Region 2 nonresidential lead screening level of 800 mg/kg~~ at each property~~. As shown below, the average lead concentration in the 0 to 2 ft. depth interval is below 800 mg/kg except ~~Lot~~for Lots 63 and ~~Lot~~ 70~~, as shown on Table 6-10. As shown on Table 6-11B~~. However, the estimated portion of the ~~construction~~indoor workers' fetal blood lead distribution exceeding the 5 ug/~~dl~~dL level is less than 5% for ~~each property (including~~all properties except Lot 63 ~~and Lot 70).~~ .

Table 6-36~~8.~~ Average Lead Concentrations in Surface Soil (PbS) and ALM Estimated Probabilities (P) that PbB_{fetal} > PbB_t for Future Indoor Workers Exposed to the PbS Concentrations (PbS > 800 mg/kg and P > 5% are bolded and shaded)~~Future Indoor Worker Exposure to Lead (Pb) Concentrations in Surface Soils Incorporated into Indoor Dust. The Table Highlights Pb Concentrations Greater than the Screening Level for Industrial Soils of 800 mg/kg (bold) and the Percent of BLLs Greater Than 5 ug/dl.~~

~~Construction workers may contact contaminates in shallow groundwater during some site redevelopment activities. As shown on Table 6-12, the cumulative risk estimates for each of the 15 properties are within USEPA's limits for RME risks.~~

~~If construction workers were to have exposure to both soil and groundwater, the combined risk from these exposures would be within USEPA's limits for RME risk, as shown on Table 6-13.~~

~~6.2.2.4 Trespassers~~

~~As shown on Table 6-9, none of the 15 properties have adolescent trespasser cumulative cancer or HI estimates for soil in the 0 to 2 foot depth interval that exceeds USEPA's limits for RME risks. Table 6-17 shows the cumulative risk estimates calculated using soil data from all sampled depths for all routes of exposure, to evaluate the scenario in which soil below the 0 to 2 foot~~

Lot	**PbS (mg/kg)**	**$P(PbB_{fetal} > PbB_t)$ (%)**
Lot 1	580	1.1%
Lot 57	305	0.22%
Lot 58	466	0.61%
Lot 59	240	0.13%
Lot 60	185	0.08%
Lot 61	505	0.74%
Lot 62	567	1.0%
Lot 63	**2,090**	**23%**
Lot 64	616	1.2%
Lot 65	619	1.3%
Lot 66	129	0.04%
Lot 67	429	0.49%
Lot 68	510	0.76%
Lot 69	343	0.28%
Lot 70	**934**	3.7%

As shown below~~depth interval is brought to the surface in the course of site redevelopment. The cumulative risk estimates for that scenario at each property are also within USEPA's limits for RME risks.~~

~~As shown on Table 6-10, the average lead concentration in the 0 to 2 foot depth interval is below 800 mg/kg at each property except Lots 63 and 70. However, as shown on Table 6-11C, the estimated portion of the adolescent trespassers' fetal blood lead distribution exceeding the 5 ug/dl level is less~~

~~than 5% at each property (including Lot 63 and Lot 70). As shown on Figure 6-1, Lots 63 and 70 are currently paved and are partly capped.~~

~~As shown on Table 6-10~~, the average lead concentration calculated using soil data from all sampled depths (in case subsurface soil is moved to the surface during site redevelopment) is below the USEPA Region 2 nonresidential screening level of 800 mg/kg at each property except for Lot 63 and Lot 70. ~~The average lead concentration at Lot 63 is 2,290 mg/kg, and the average lead concentration at Lot 70 is 970 mg/kg. However, as~~As shown ~~on Table 6-11C~~below, the estimated portion of the ~~adolescent trespassers'~~indoor workers' fetal blood lead distribution exceeding the 5 ug/~~dl~~dL level is less than 5% for each property ~~(including~~except for Lot 63~~ and Lot 70). ~~.

Table 6-379. Average Lead Concentrations in Soil from All Sample Depths (PbS) and ALM Estimated Probabilities (P) that PbB_{fetal} > PbB_t for Future Indoor Workers Exposed to the PbS Concentrations (PbS > 800 mg/kg and P > 5% are bolded and shaded)Future Indoor Worker Exposure to Lead (Pb) Concentrations Using Soil Data from All Samples Depths Moved to the Surface During Future Site Development. The Table Highlights Pb Concentrations Greater than the Screening Level for Industrial Soils of 800 mg/kg (bold) and the Percent of BLLs Greater Than 5 ug/dl.

6.2.2.5 Visitors

As discussed in Section 6.2.1.6, the allowable exposure frequency

Lot	PbS (mg/kg)	P(PbB_{fetal} > PbB_t) (%)
Lot 1	426	0.48%
Lot 57	272	0.17%
Lot 58	318	0.24%
Lot 59	153	0.06%
Lot 60	171	0.07%
Lot 61	500	0.72%
Lot 62	493	0.70%
Lot 63	**2,530**	**32%**
Lot 64	688	1.7%
Lot 65	510	0.76%
Lot 66	206	0.10%
Lot 67	395	0.40%
Lot 68	586	1.1%
Lot 69	241	0.13%
Lot 70	**970**	4.1%

Groundwater. Risks from potable groundwater use by indoor workers are evaluated for visitors at a particular property was determined by scaling from the residents' shallow and deep groundwater to facilitate development of appropriate ICs institutional controls for the Site. If shallow or deep groundwater is used in the future, indoor workers could be exposed through ingestion, dermal contact, and inhalation of vapors during potable use.

For shallow groundwater potable use, the cumulative cancer risk and HI estimates for that property and assuming visitors are on estimates range from 1 x 10^{-4} to 7 x 10^{-4}, which are above NCP's risk range except for Lots 62, 67, 68 and 70 which are at the upper-end of NCP's risk range, as shown below. The single-chemical cancer risks are above the lower end of NCP's risk range (10^{-6}) for a number of several VOCs, SVOCs, PCBs, and metals at each of the 15 properties at the Site (see RAGS D Table 7). The highest risks (i.e., above the upper end of NCP's range) are for 1,2-dibromo-3-chloropropane, pentachlorophenol, dibenz(a,h)anthracene, and arsenic.

The noncancer HIs range from 2 to 50, which are above the protection goal of 1. The single-chemical HQs are above the protection goal of 1 for a number of several VOCs, SVOCs, and metals at each of the 15 properties at the Site (see RAGS D Table 7). The highest HQ (i.e., HI above 10) is for xylene at Lots 58 and 59.

Table 6-~~38~~40~~.~~ Cancer Risks and Noncancer HIs for Future Indoor Worker Exposures to Shallow and Deep Groundwater through Ingestion, Dermal Contact, and Inhalation of Vapors (Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)~~Future Indoor Worker Exposures to Shallow and Deep Groundwater Exposed through Ingestion, Dermal Contact, and Inhalation of vapors. Cancer risks greater than the NCP Risk Range and the Protection Goal of 1 are Highlighted below.~~

Lot	Risk	HI
Lot 1	**2 x 10^{-4}**	**3**
Lot 57	**7 x 10^{-4}**	**20**
Lot 58	**7 x 10^{-4}**	**50**
Lot 59	**7 x 10^{-4}**	**50**
Lot 60	**3 x 10^{-4}**	**3**
Lot 61	**6 x 10^{-4}**	**20**
Lot 62	**1 x 10^{-4}**	**2**
Lot 63	**3 x 10^{-4}**	**10**
Lot 64	**6 x 10^{-4}**	**20**
Lot 65	**4 x 10^{-4}**	**3**
Lot 66	**2 x 10^{-4}**	**3**
Lot 67	**1 x 10^{-4}**	**2**
Lot 68	**1 x 10^{-4}**	**3**
Lot 69	**4 x 10^{-4}**	**20**
Lot 70	**1 x 10^{-4}**	**2**

Lead. For shallow groundwater exposure to lead, the maximum lead concentration for shallow groundwater is below the federal action limit of 0.015 mg/L at seven properties and above at Lots 57, 60, 63, 64, 67, and 69, as shown in Section 6.2.2.1.

For deep groundwater potable use (site~~ for 2 hours/day. The allowable~~-wide), the cumulative cancer risk estimate is 2 x 10^{-4}, which is above NCP's risk range and the noncancer HI is 4, which is above the protection goal of 1. The single-chemical cancer risks are above the lower end of NCP's risk range (10^{-6}) for benzene, chloroform, 1,4-dioxane, 1,1,2-trichloroethane, benzo(a)pyrene, naphthalene, and arsenic. No single-chemical HQ exceeds the protection goal and the toxic endpoint specific HI estimates are at or below the protection goal of 1 as shown on RAGS D Table 9.

Therefore, risk and hazards from potable use of the shallow and the risk from potable use of deep groundwater, if to occur in the future, would be unacceptable. However, such future groundwater use at the Site is unlikely since site-specific conductivity readings of the shallow groundwater indicate possible brackish conditions, and the Site and surrounding area are served by the City of Newark's potable water system.

If indoor workers were to have exposure ~~frequency calculated for the~~ to both soil (0 to 2 ~~foot depth~~ft. interval~~ and for the scenario that subsurface soil is moved to the surface during site redevelopment are summarized~~) and shallow groundwater (from vapor intrusion and potable use) in the future, the combined cumulative cancer risk estimates range from 1 x 10^{-4} to 7 x 10^{-4}, which are above NCP's risk range except for Lot 70 which is at the lower end of NCP's risk range. The combined noncancer HIs range from 2 to 50, which are above the protection goal of 1. The toxic endpoint specific HI estimates are also above the protection goal of 1 except for Lots 1, 60, 66, 67, and 70, which are at or below the protection goal, as shown on RAGS D Table 6-14. The allowable9.

Table 6-3941. Cancer Risks and Noncancer HIs for Future Indoor Workers from Exposures to Soil (0 to 2 ft.) and Shallow Groundwater (Vapor Intrusion) (Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Future Indoor Worker Cancer Risks and Noncancer Hazard Indices from Exposures to

Soil (0 to 2 ft.) and Shallow Groundwater (Vapor Intrusion). Cancer Risks and Noncancer Hazard Indices Greater than the NCP Risk Range and the Protection Goal of 1 are Highlighted.

Lot	Risk	HI
Lot 1	**2 x 10^{-4}**	**3**
Lot 57	**7 x 10^{-4}**	**20**
Lot 58	**7 x 10^{-4}**	**50**
Lot 59	**7 x 10^{-4}**	**50**
Lot 60	**3 x 10^{-4}**	**3**
Lot 61	**6 x 10^{-4}**	**20**
Lot 62	**3 x 10^{-4}**	**5**
Lot 63	**3 x 10^{-4}**	**10**
Lot 64	**7 x 10^{-4}**	**20**
Lot 65	**4 x 10^{-4}**	**4**
Lot 66	**2 x 10^{-4}**	**3**
Lot 67	**2 x 10^{-4}**	**2**
Lot 68	**2 x 10^{-4}**	**8**
Lot 69	**4 x 10^{-4}**	**20**
Lot 70	1 x 10^{-4}	**3**

If indoor workers were to have exposure frequency ranges from 48 for the 0 to 2 foot depth interval ranges from 36 (Lot 63) to 349 (Lot 1) and for scenario thatto both soil from all depths (in case subsurface soil is moved to the surface during site future redevelopment ranges from 35 (Lot 70) to 267 (Lot 60).) and shallow groundwater (from vapor intrusion and potable use) in the future, the combined cumulative cancer risk estimates range from 1 x 10^{-4} to 7 x 10^{-4}, which are above NCP's risk range except for Lot 67 which is at the lower end of NCP's risk range. The combined noncancer HIs range from 2 to 50, which are above the protection goal of 1. The toxic organ endpoint specific HI estimates are also above the protection goal of 1 except for Lots 1, 60, 66, 67, and 70, which are at or below the protection goal, as shown inon RAGS D Table 9.

Table 6-402. Cancer Risks and Noncancer HIs for Future Indoor Workers from Exposures to Soil (All Depths) and Shallow Groundwater (Vapor Intrusion)
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Future Indoor Worker Cancer Risks and Noncancer Hazard Indices from Exposures to

Soil (All Depths) and Shallow Groundwater (Vapor Intrusion). Cancer Risks and Noncancer Hazard Indices Greater than the NCP Risk Range and the Protection Goal of 1 are Highlighted.

Lot	**Risk**	**HI**
Lot 1	**2 x 10^{-4}**	**3**
Lot 57	**7 x 10^{-4}**	**20**
Lot 58	**7 x 10^{-4}**	**50**
Lot 59	**7 x 10^{-4}**	**50**
Lot 60	**3 x 10^{-4}**	**3**
Lot 61	**6 x 10^{-4}**	**20**
Lot 62	**3 x 10^{-4}**	**5**
Lot 63	**3 x 10^{-4}**	**10**
Lot 64	**7 x 10^{-4}**	**20**
Lot 65	**4 x 10^{-4}**	**4**
Lot 66	**2 x 10^{-4}**	**3**
Lot 67	1 x 10^{-4}	**2**
Lot 68	**2 x 10^{-4}**	**8**
Lot 69	**4 x 10^{-4}**	**20**
Lot 70	**2 x 10^{-4}**	**3**

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6.2.2.3 Utility Workers

The utility workers' cumulative cancer risk and HI estimates summarized below are the sum of the estimates for ingestion, dermal contact, and particulate inhalation calculated using soil data from the 0 to 4 ft. depth interval, and the estimate for vapor inhalation calculated using soil data from all sampled depths.

Cancer Risk and Noncancer HI. As shown below, the cumulative cancer risk estimates range from 3 x 10^{-7} to 3 x 10^{-6}, which are below NCP's risk range except for Lots 61, 62, 63, 67, and 70 which are within NCP's risk range. The noncancer HIs range from 0.04 to 0.3, which are all below the protection goal of 1. The single-chemical cancer risks above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are arsenic (Lot 61) and 2,3,7,8-tetrachlorodibenzo-p-dioxin (Lot 70) (see RAGS D Table 7).

Table 6-413. Cancer Risk and Noncancer HIs for Future Utility Workers Exposed to Soil (0 to 4 ft.) and Vapor Intrusion Based from Soil (All Sampled Depths) (Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Future Utility Worker Cancer Risk and Noncancer Hazard Indices Exposed to Soil (Depth of 0 to 4 Ft.) and Vapor Intrusion Based on Data from All Sample Depths. The Cancer Risks Are Within or Below the NCP Risk Range and the Noncancer Hazard Indices are Below the Protection Goal of 1.

Lot	Risk	HI
Lot 1	5 x 10^{-7}	0.06
Lot 57	9 x 10^{-7}	0.2
Lot 58	4 x 10^{-7}	0.2
Lot 59	3 x 10^{-7}	0.04
Lot 60	7 x 10^{-7}	0.08
Lot 61	**2 x 10^{-6}**	0.1
Lot 62	**2 x 10^{-6}**	0.1
Lot 63	**2 x 10^{-6}**	0.3
Lot 64	8 x 10^{-7}	0.2
Lot 65	1 x 10^{-6}	0.1
Lot 66	4 x 10^{-7}	0.08
Lot 67	**2 x 10^{-6}**	0.2
Lot 68	7 x 10^{-7}	0.2
Lot 69	7 x 10^{-7}	0.1
Lot 70	**3 x 10^{-6}**	0.3

To evaluate the scenario in which soil below the 0 to 2 ft. depth interval is brought to the surface in the course of future Site site redevelopment, the utility workers' cumulative cancer risk and HI estimates are the sum of the estimates for ingestion, dermal contact, vapor and particulate inhalation calculated using soil data from all sampled depths. The cumulative cancer risk estimates range from 2 x 10^{-7} to 3 x 10^{-6}, which are at or below NCP's risk range except for Lots 61, 62, and 70 which are within NCP's risk range. The noncancer HIs range from 0.04 to 0.3, which are all below the protection goal of 1. The single-chemical cancer risks above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are arsenic (Lot 61) and 2,3,7,8-tetrachlorodibenzo-p-dioxin (Lot 70) (see RAGS D Table 7).

Table 6-424. Cancer Risks and Noncancer HIs for Future Utility Workers Exposed to Soil Brought to the Surface During Future Development through Ingestion, Dermal Contact, and Inhalation of Particulates and Vapors Released from Soil
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Future Utility Worker Cancer Risk and Noncancer Hazard Indices Exposed to Soil Brought to the Surface During Future Development. Exposures Are from Ingestion, Dermal Contact, Vapor and Particulate Inhalation Calculated Using Soil Data from all Sampled Depths. The Cancer Risks Are Within or Below the NCP Risk Range and the Noncancer Hazard Indices are Below the Protection Goal of 1.

Lot	Risk	HI
Lot 1	5 x 10^{-7}	0.06
Lot 57	1 x 10^{-6}	0.2
Lot 58	3 x 10^{-7}	0.1
Lot 59	2 x 10^{-7}	0.04
Lot 60	6 x 10^{-7}	0.09
Lot 61	**2 x 10^{-6}**	0.1
Lot 62	**2 x 10^{-6}**	0.1
Lot 63	1 x 10^{-6}	0.3
Lot 64	8 x 10^{-7}	0.2
Lot 65	1 x 10^{-6}	0.1
Lot 66	5 x 10^{-7}	0.09
Lot 67	1 x 10^{-6}	0.2
Lot 68	5 x 10^{-7}	0.2
Lot 69	5 x 10^{-7}	0.1
Lot 70	**3 x 10^{-6}**	0.3

Lead. As shown below, the average lead concentration in the 0 to 4 ft. depth interval is below 800 mg/kg except for Lots 63 and 70. However, the estimated portion of the utility workers' fetal blood lead distribution exceeding the 5 ug/dL level is less than 5% for both of these properties (as well as the rest of the 15 properties at the Site).

Table 6-435. Average Lead Concentrations in Soil from the 0 to 4 ft. Depth Interval (PbS) and ALM Estimated Probabilities (P) that PbB_{fetal} > PbB_t for Future Utility Workers Exposed to the PbS Concentrations
(PbS > 800 mg/kg and P > 5% are bolded and shaded)Future Utility Worker Lot Specific Average Lead Concentration in the 0 to 4 Ft. Depth Interval. Lead Concentrations Greater than the Region 2 Screening Level of 800 mg/kg for Nonresidential Exposures and Where Appropriate BLLs Greater than 5 ug/dl Are Highlighted.

Lot	**PbS (mg/kg)**	**P(PbB_{fetal} > PbB_t) (%)**
Lot 1	509	0.06%
Lot 57	246	0.02%
Lot 58	466	0.05%
Lot 59	240	0.02%
Lot 60	197	0.02%
Lot 61	505	0.06%
Lot 62	493	0.06%
Lot 63	**2,420**	2.2%
Lot 64	681	0.11%
Lot 65	619	0.09%
Lot 66	104	0.01%
Lot 67	431	0.05%
Lot 68	671	0.10%
Lot 69	343	0.03%
Lot 70	**1,040**	0.26%

As shown below, the average lead concentration calculated using soil data from all sampled depths (in case subsurface soil is moved to the surface during future Site site redevelopment) is below the USEPA Region 2 nonresidential screening level of 800 mg/kg at each property except for Lot 63 and Lot 70. The estimated portion of the utility workers' fetal blood lead distribution exceeding the 5 ug/dL level is less than 5% for each property.

Table 6-446. Average Lead Concentrations in Soil from All Sample Depths (PbS) and ALM Estimated Probabilities (P) that PbB_{fetal} > PbB_t for Future Utility Workers Exposed to the PbS Concentrations (PbS > 800 mg/kg and P > 5% are bolded and shaded)~~Future Utility Worker Lot Specific Average Lead Concentration Using Soil Data from All Depths. Lead Concentrations Greater than the Region 2 Screening Level of 800 mg/kg for Nonresidential Exposures and BLLs Greater than 5 ug/dl Are Highlighted.~~

Lot	PbS (mg/kg)	$P(PbB_{fetal} > PbB_t)$ (%)
Lot 1	426	0.05%
Lot 57	272	0.03%
Lot 58	318	0.03%
Lot 59	153	0.02%
Lot 60	171	0.02%
Lot 61	500	0.06%
Lot 62	493	0.06%
Lot 63	**2,530**	2.5%
Lot 64	688	0.11%
Lot 65	510	0.06%
Lot 66	206	0.02%
Lot 67	395	0.04%
Lot 68	586	0.08%
Lot 69	241	0.02%
Lot 70	**970**	0.22%

Utility workers may contact contaminants in shallow groundwater during some utility repairs. The utility workers' cumulative cancer risk and HI estimates summarized below are the sum of the estimates for ingestion, dermal contact, and vapor inhalation calculated using the EPCs for shallow groundwater for each property. As shown below, the cumulative cancer risk estimates range from 5×10^{-7} to 5×10^{-6}, which are at the lower end of or below NCP's risk range except for Lots 57, 58, 59, 60, 65, and 69 which are within NCP's risk range. The noncancer HIs range from 0.04 to 0.3, which are all below the protection goal of 1. The single-chemical cancer risks above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are pentachlorophenol (Lots 57, 58, and 59) and dibenz(a,h)anthracene (Lot 65) (see RAGS D Table 7).

Table 6-457. Cancer Risks and Noncancer HIs for Future Utility Worker Exposures to Shallow Groundwater During Utility Repairs through Ingestion, Dermal Contact, And Vapor Inhalation
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Utility Workers Exposures to Shallow Groundwater During Utility Repairs. The Utility Workers' Cumulative Cancer Risk and HI Estimates Summarized Below Are the Sum Of the Estimates for Ingestion, Dermal Contact, And Vapor Inhalation Calculated Using the EPCs For Shallow Groundwater For Each Property. The Cancer Risks are Within or Below the NCP Risk Range and the Noncancer Hazard Indices are Below the Protection Goal of 1.

Lot	**Risk**	**HI**
Lot 1	7 x 10^{-7}	0.02
Lot 57	**4 x 10^{-6}**	0.1
Lot 58	**5 x 10^{-6}**	0.9
Lot 59	**5 x 10^{-6}**	0.9
Lot 60	**2 x 10^{-6}**	0.02
Lot 61	1 x 10^{-6}	0.2
Lot 62	5 x 10^{-7}	0.01
Lot 63	9 x 10^{-7}	0.05
Lot 64	1 x 10^{-6}	0.2
Lot 65	**2 x 10^{-6}**	0.02
Lot 66	7 x 10^{-7}	0.02
Lot 67	5 x 10^{-7}	0.01
Lot 68	5 x 10^{-7}	0.02
Lot 69	**2 x 10^{-6}**	0.1
Lot 70	5 x 10^{-7}	0.02

If utility workers were to have exposure to both soil (0 to 4 ft.) and groundwater at the magnitudes, frequencies, and durations assumed for each medium, the combined cumulative cancer risk estimates range from 1 x 10^{-6} to 5 x 10^{-6}, which are within the NCP's risk range except for Lots 1, 66, and 68 which are at the lower end of NCP's risk range. The combined noncancer HIs range from 0.07 to 1, which are at or below the protection goal of 1.

Table 6-468. Cancer Risks and Noncancer HIs for Future Utility Workers Exposures to Both Soil (0 to 4 ft.) and Groundwater
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Utility Workers Exposures to Both Soil (0 to 4 ft.) and Groundwater. The Utility Workers' Cumulative Cancer Risk and HI Estimates Are Within or Below the NCP Risk Range and the Noncancer Hazard Indices are At or Below the Protection Goal of 1.

Lot	**Risk**	**HI**
Lot 1	1 x 10^{-6}	0.07
Lot 57	**5 x 10^{-6}**	0.3
Lot 58	**5 x 10^{-6}**	1
Lot 59	**5 x 10^{-6}**	0.9
Lot 60	**2 x 10^{-6}**	0.1
Lot 61	**3 x 10^{-6}**	0.3
Lot 62	**2 x 10^{-6}**	0.1
Lot 63	**2 x 10^{-6}**	0.4
Lot 64	**2 x 10^{-6}**	0.3
Lot 65	**4 x 10^{-6}**	0.2
Lot 66	1 x 10^{-6}	0.1
Lot 67	**2 x 10^{-6}**	0.2
Lot 68	1 x 10^{-6}	0.2
Lot 69	**2 x 10^{-6}**	0.3
Lot 70	**3 x 10^{-6}**	0.3

If utility workers were to have exposure to both soil for all depths (in case subsurface soil is moved to the surface during site reddevelopment) and shallow groundwater at the magnitudes, frequencies, and durations assumed for each medium, the combined cumulative cancer risk estimates range from 1 x 10^{-6} to 5 x 10^{-6}, which are within the NCP's risk range except for Lots 1, 66, and 68 which are at the lower end of NCP's risk range. The combined noncancer HIs range from 0.07 to 1, which are at or below the protection goal of 1.

Table 6-479. Cancer Risks and Noncancer HIs for Future Utility Worker Exposures to Both Soil (All Sampled Depths Assuming Soils are Moved to the Surface During Future Development) and Shallow Groundwater
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Utility Workers Exposures to Both Soil (all Depths if Subsurface Soils it Moved to the Surface During Future Development) and Shallow Groundwater. The Utility Workers' Cumulative Cancer Risk and HI Estimates Are Within or Below the NCP Risk Range and the Noncancer Hazard Indices are At or Below the Protection Goal of 1.

Lot	**Risk**	**HI**
Lot 1	1 x 10^{-6}	0.07
Lot 57	**5 x 10^{-6}**	0.3
Lot 58	**5 x 10^{-6}**	1
Lot 59	**5 x 10^{-6}**	0.9
Lot 60	**2 x 10^{-6}**	0.1
Lot 61	**3 x 10^{-6}**	0.3
Lot 62	**2 x 10^{-6}**	0.1
Lot 63	**2 x 10^{-6}**	0.4
Lot 64	**2 x 10^{-6}**	0.3
Lot 65	**3 x 10^{-6}**	0.2
Lot 66	1 x 10^{-6}	0.1
Lot 67	**2 x 10^{-6}**	0.2
Lot 68	1 x 10^{-6}	0.2
Lot 69	**2 x 10^{-6}**	0.2
Lot 70	**3 x 10^{-6}**	0.3

6.2.2.4 Construction Workers

The construction workers' cumulative cancer risk and HI estimates for soil summarized below are the sum of the estimates for ingestion, dermal contact, vapor and particulate inhalation calculated using soil data from all depths (i.e., ground surface to maximum sampled depth of approximately 13 ft.).

Cancer Risks and Noncancer Hazards. As shown below, the cumulative cancer risk estimates range from 1 x 10^{-7} to 2 x 10^{-6}, which are at or below the lower end of NCP's risk range except for Lot 70 which is within the NCP risk range. The noncancer HIs range from 0.2 to 2, which are at or below the protection goal of 1 except for Lot 68 which has an HI of 2. No single-chemical cancer risks are above the lower end of NCP's risk range (10^{-6}) and no single-chemical HQ estimates are above the protection goal of 1 (see RAGS D Table 7).

Table 6-4850. Cancer Risks and Noncancer HIs for Future Construction Worker Exposures to Soil from All Sampled Depths
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Construction Worker Exposures to Both Soil (all Depths). The Construction Workers' Cumulative Cancer Risk and HI Estimates Are Within or Below the NCP Risk Range and the Noncancer Hazard Indices are At or Below the Protection Goal of 1 Except Lot 68 Where the Noncancer Hazard Indices = 2.

Lot	**Risk**	**HI**
Lot 1	4 x 10^{-7}	0.3
Lot 57	8 x 10^{-7}	1
Lot 58	2 x 10^{-7}	0.8
Lot 59	1 x 10^{-7}	0.2
Lot 60	4 x 10^{-7}	0.5
Lot 61	1 x 10^{-6}	0.8
Lot 62	1 x 10^{-6}	0.9
Lot 63	1 x 10^{-6}	1
Lot 64	1 x 10^{-6}	0.9
Lot 65	6 x 10^{-7}	0.9
Lot 66	3 x 10^{-7}	0.5
Lot 67	9 x 10^{-7}	0.9
Lot 68	5 x 10^{-7}	**2**
Lot 69	3 x 10^{-7}	0.4
Lot 70	**2 x 10^{-6}**	0.8

Since the HI for soil exposure at Lot 68 is above the protection goal of 1, the toxic organ endpoint specific HIs for construction worker exposure at Lot 68 are listed below. All toxic endpoint specific HI estimates are below the protection goal of 1.

Table 6-~~49~~51~~.~~ Noncancer Toxic Endpoint-Specific HIs for Future Construction Worker Exposures to Soil from All Sampled Depths
(HIs > 1 are bolded and shaded)~~Construction Worker Exposures to Both Soil (all Depths). The Construction Workers' Noncancer Toxic Organ Specific HIs for Lot 68 are Below The Noncancer Protection Goal of 1.~~

Toxic Endpoint	**HI**
Cardiovascular	0.8
Dermal	0.02
Developmental/Reproductive	0.8
Ear	0.00007
Endocrine	0.004
Gastrointestinal	0.1
Hematologic	0.02
Hepatic	0.002
Immune	0.8
Nervous	0.7
Ocular	0.1
Other	0.01
Respiratory	0.03
Urinary	0.02

Lead. As shown below, the average lead concentration calculated using soil data from all sampled depths is below the USEPA Region 2 nonresidential screening level of 800 mg/kg at each property except for Lots 63 and Lot 70. The estimated portion of the construction workers' fetal blood lead distribution exceeding the 5 ug/dL level is more than 5% for Lots 61, 62, 63, 64, 65, 68 and 70. As shown below, the EPCs for Lots 61, 62, 64, 65 and 68 do not exceed the 800 mg/kg screening level for workers but exceed the blood lead goal as a result of more conservative assumptions for the incidental ingestion rate and averaging time for the construction worker relative to the outdoor worker (see Sections ~~6.3.4.2~~4.4.4 and 4.4.1, respectively).

Table 6-502. Average Lead Concentrations in Soil from All Sample Depths (PbS) and ALM Estimated Probabilities (P) that $PbB_{fetal} > PbB_t$ for Future Construction Workers Exposed to the PbS Concentrations (PbS > 800 mg/kg and P > 5% are bolded and shaded)Average Lead Concentration Calculated Using Soil Data from All Sampled Depths For the Future Construction Worker Are Below the USEPA Region 2 Nonresidential Screening Level Of 800 mg/kg At Each Property Except For Lots 63 And Lot 70 Highlighted Below. The Construction Workers' Fetal Blood Lead Distribution Exceeding the 5 ug/dl Level Is More Than 5% For Lots 61, 62, 63, 64, 65, 68 and 70.

Lot	PbS (mg/kg)	$P(PbB_{fetal} > PbB_t)$ (%)
Lot 1	426	4.6%
Lot 57	272	1.4%
Lot 58	318	2.1%
Lot 59	153	0.33%
Lot 60	171	0.43%
Lot 61	500	**6.8%**
Lot 62	493	**6.6%**
Lot 63	**2,530**	**81%**
Lot 64	688	**14%**
Lot 65	510	**7.2%**
Lot 66	206	0.69%
Lot 67	395	3.8%
Lot 68	586	**9.9%**
Lot 69	241	1.0%
Lot 70	**970**	**28%**

Groundwater. Construction As discussed in Section 6.2.1.6 and Section 4.4.3, time-weighted average lead soil concentrations were compared to the USEPA Region 2 residential screening level of 200 mg/kg. The time-weighted average concentrations for each property for the 0 to 2 foot interval are below the residential screening level, as shown on Table 6-15. The time-weighted average concentrations for the scenario in which subsurface soil is moved to the surface during site redevelopment are below the residential screening level except at Lot 63, as shown on Table 6-15. The time-weighted average lead concentration at Lot 63 is 216 mg/kg, which is slightly above the screening level.

As discussed in Section 6.2.1.6, potential visitor exposures via vapor intrusion are evaluated indirectly in this risk assessment using risk estimates for indoor workers. This approach is valid since inhalation risk estimates do not depend on breathing rate or body weight (only exposure time, frequency, and duration). It is also highly conservative since visitors are expected to be in the existing buildings far less than the indoor workers. Specifically, the vapor intrusion risk estimates for visitors are expected to be far lower than the cumulative cancer risk and HI estimates for indoor workers discussed in Section 6.2.2.2, which are within USEPA's limits for RME risks except Lot 58, 62, 64 and 68.

workers may contact contaminants in shallow groundwater during some site future redevelopment activities. The construction workers' cumulative cancer risk and HI estimates summarized below are the sum of the estimates for ingestion, dermal contact, and vapor inhalation calculated using the EPCs for shallow groundwater at each property. The cumulative cancer risk estimates range from 6×10^{-8} to 6×10^{-7}, which are all below the lower end of NCP's risk range. Noncancer HIs range from 0.01 to 0.4, which are all below the protection goal of 1.

Table 6-5~~13.~~ Cancer Risks and Noncancer HIs for Future Construction Worker Exposures to Shallow Groundwater through Ingestion, Dermal Contact, and Vapor Inhalation During Future Site Development
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)~~Future Construction Worker Cancer Risks and Noncancer HI From Contact with Contaminants in Shallow Groundwater During Future Site Development. The Construction Workers' Cancer Risk and HI Estimates from Exposures Through Ingestion, Dermal Contact, And Vapor Inhalation Calculated Using the EPCs For Shallow Groundwater at Each Lot. Cancer Risks Are Below or Within the NCP Risk Range and Noncancer Hazard Indices Are Below the Protection Goal Of 1.~~

Lot	**Risk**	**HI**
Lot 1	9 x 10^{-8}	0.02
Lot 57	5 x 10^{-7}	0.1
Lot 58	6 x 10^{-7}	0.4
Lot 59	6 x 10^{-7}	0.4
Lot 60	2 x 10^{-7}	0.03
Lot 61	2 x 10^{-7}	0.1
Lot 62	7 x 10^{-8}	0.01
Lot 63	1 x 10^{-7}	0.05
Lot 64	2 x 10^{-7}	0.1
Lot 65	3 x 10^{-7}	0.03
Lot 66	9 x 10^{-8}	0.02
Lot 67	7 x 10^{-8}	0.01
Lot 68	6 x 10^{-8}	0.02
Lot 69	2 x 10^{-7}	0.1
Lot 70	7 x 10^{-8}	0.02

If construction workers were to have exposure to both soil and shallow groundwater at the magnitudes, frequencies, and durations assumed for each medium, the combined cumulative cancer risk estimates range from 4 x 10^{-7} to 2 x 10^{-6}, which are at or below the lower end of NCP's risk range except for Lot 62, 64, and 70 which is within the NCP risk range. The noncancer HIs range from 0.3 to 2, which are at or below the protection goal of 1 except for Lot 68 which has an HI of 2.

Table 6-524. Cancer Risks and Noncancer HIs for Future Construction Worker Exposure to Shallow Groundwater and Soil through Ingestion, Dermal Contact, and Vapor Inhalation During Future Site Development
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Future Construction Worker Cancer Risks and Noncancer HI From Contact with Contaminants in Shallow Groundwater and Soil During Future Site Development. The Construction Workers' Cancer Risk and HI Estimates from Exposures. Cancer Risks Are Below or Within the NCP Risk Range and Noncancer Hazard Indices Are Below the Protection Goal Of 1 at All lots Except Lot 68 Where the HI = 2.

Lot	Risk	HI
Lot 1	4 x 10^{-7}	0.3
Lot 57	1 x 10^{-6}	1
Lot 58	8 x 10^{-7}	1
Lot 59	7 x 10^{-7}	0.6
Lot 60	6 x 10^{-7}	0.5
Lot 61	1 x 10^{-6}	0.9
Lot 62	**2 x 10^{-6}**	0.9
Lot 63	1 x 10^{-6}	1
Lot 64	**2 x 10^{-6}**	1
Lot 65	1 x 10^{-6}	1
Lot 66	4 x 10^{-7}	0.5
Lot 67	9 x 10^{-7}	0.9
Lot 68	5 x 10^{-7}	**2**
Lot 69	5 x 10^{-7}	0.5
Lot 70	**2 x 10^{-6}**	0.8

Since the HI for Lot 68 is above the protection goal of 1, the toxic endpoint specific HIs for construction worker exposure at Lot 68 are shown on RAGS D Table 9. The toxicarget endpoint-specific HIs toxare at or below the protection goal of 1.

6.2.2.5 Trespassers

Cancer Risks and Noncancer HI. The adolescent and adult trespasser cumulative cancer risk and HI estimates summarized below are the sum of the estimates for ingestion, dermal contact, and particulate inhalation calculated using soil data from the 0 to 2 ft. depth interval, and the estimate for vapor inhalation calculated using soil data from all sampled depths. As shown below for the adolescent trespasser, the cumulative cancer risk estimates range from 1 x 10^{-6} to 1 x 10^{-5}, which are within NCP's risk range except for Lots 58, 59 and 66 which are at the lower end of NCP's risk range. Noncancer HIs range from 0.09 to 1, which are all at or below the protection goal of 1. The single-chemical cancer risks above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are arsenic (Lots 61 and 63), benzo(a)pyrene (Lots 57, 62, 63, 65, 67 and

69), naphthalene (Lot 62), PCBs (Lots 57) and 2,3,7,8-tetrachlorodibenzo-p-dioxin (Lot 70) (see RAGS D Table 7).

As shown below for the adult trespasser, the cumulative cancer risk estimates range from 2 x 10^{-6} to 2 x 10^{-5}, which are within NCP's risk range. Noncancer HIs range from 0.09 to 1, which are all at or below the protection goal of 1. The single-chemical cancer risks above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are arsenic (Lots 1, 58, 59, 60, 61, 62, 63, 65, 67, 68, 69 and 70), benzo(a)pyrene (Lots 57, 62, 63, 65, 67 and 69), naphthalene (Lot 62), PCBs (Lots 57 and 67), and 2,3,7,8-tetrachlorodibenzo-p-dioxin (Lots 60, 64 and 70) (see RAGS D Table 7).

Table 6-535. Cancer Risks and Noncancer HIs for Future Trespasser Exposure to Soil (0 to 2 ft.) and the Estimate for Vapor Inhalation Calculated Using Soil Data from All Sampled Depths (Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)~~Future Trespasser Cancer Risks and Noncancer HI From Contact with Contaminants in Soil Data (0 To 2 Ft.), And the Estimate for Vapor Inhalation Calculated Using Soil Data from All Sampled Depths. The Cancer Risk and HI Estimates from Exposures for The Adolescent and Adult Trespasser Are Within the NCP Risk Range And Noncancer Hazard Indices Are At Or Below The Protection Goal Of 1 At All Lots.~~

Lot	Adolescent Trespasser		Adult Trespasser	
	Risk	HI	Risk	HI
Lot 1	**3×10^{-6}**	0.1	**6×10^{-6}**	0.1
Lot 57	**5×10^{-6}**	0.4	**8×10^{-6}**	0.4
Lot 58	1×10^{-6}	0.5	**3×10^{-6}**	0.5
Lot 59	1×10^{-6}	0.09	**2×10^{-6}**	0.09
Lot 60	**4×10^{-6}**	0.2	**6×10^{-6}**	0.2
Lot 61	**8×10^{-6}**	0.3	**2×10^{-5}**	0.3
Lot 62	**6×10^{-6}**	0.2	**1×10^{-5}**	0.3
Lot 63	**5×10^{-6}**	1	**1×10^{-5}**	1
Lot 64	**2×10^{-6}**	0.2	**5×10^{-6}**	0.2
Lot 65	**4×10^{-6}**	0.4	**6×10^{-6}**	0.4
Lot 66	1×10^{-6}	0.1	**2×10^{-6}**	0.1
Lot 67	**1×10^{-5}**	0.8	**2×10^{-5}**	0.7
Lot 68	**2×10^{-6}**	0.5	**5×10^{-6}**	0.5
Lot 69	**6×10^{-6}**	0.4	**7×10^{-6}**	0.4
Lot 70	**8×10^{-6}**	0.8	**2×10^{-5}**	0.7
Note: The cumulative cancer risk and HI estimates for the adult trespasser are those presented for the outdoor worker, as discussed in Section 4.1. The outdoor worker is assumed to be on-site for a longer period (8 hours/day for 225 days/year for 25 years) compared to the adolescent trespasser (4 hours/day for 150 days/year for 8 years).				

To evaluate the scenario in which soil below the 0 to 2 ft. depth interval is brought to the surface in the course of site future ~~red~~development, the adolescent and adult trespassers' cumulative cancer risk and HI estimates are the sum of the estimates for ingestion, dermal contact, vapor and particulate inhalation calculated using soil data from all sampled depths. As shown below for the adolescent trespasser, the cumulative cancer risk estimates range from 9 x 10^{-7} to 1 x 10^{-5}, which are within NCP's risk range except for Lots 58 and 59 which are at or below the lower end of NCP's risk range. Noncancer HIs range from 0.07 to 1, which are all at or below the protection goal of 1. The single-chemical cancer risks above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are arsenic (Lots 61 and 63), benzo(a)pyrene (Lots 57, 61, 62, 63, 67 and 69), naphthalene (Lot 62), PCBs (Lot 70), and 2,3,7,8-tetrachlorodibenzo-p-dioxin (Lot 70) (see RAGS D Table 7).

As shown below for the adult trespasser, the cumulative cancer risk estimates range from 2 x 10^{-6} to 3 x 10^{-5}, which are all within NCP's risk range. The noncancer HIs range from 0.06 to 1, which are at or below the protection goal of 1. The single-chemical cancer risks above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are arsenic (Lots 1, 58, 60, 61, 62, 63, 65, 67, 68, 69 and 70), benzo(a)pyrene (Lots 57, 61, 62, 63, and 67), naphthalene (Lot 62), PCBs (Lots 57, 65, 67 and 70), 2,3,7,8-tetrachlorodibenzo-p-dioxin (Lots 60, 64, and 70) (see RAGS D Table 7).

Table 6-546. Cancer Risks and Noncancer HIs for Future Trespasser Exposure to Soil from All Sampled Depths During Future Development
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Future Trespasser Cancer Risks and Noncancer HI From Contact with Contaminants in Soil Data (all depths) During Future Development. The Cancer Risk and HI Estimates from Exposures for The Adolescent and Adult Trespasser Are Within the NCP Risk Range and Noncancer Hazard Indices Are At Or Below The Protection Goal Of 1 At All Lots. The Cancer Risks for Adolescent and Adult Trespasser Are Within or Below the NCP Risk Range and the Noncancer Hi is at or Below the Protection Goal of 1.

Lot	**Adolescent Trespasser**		**Adult Trespasser**	
	Risk	**HI**	**Risk**	**HI**
Lot 1	**2 x 10^{-6}**	0.08	**4 x 10^{-6}**	0.09
Lot 57	**8 x 10^{-6}**	0.5	**1 x 10^{-5}**	0.5
Lot 58	1 x 10^{-6}	0.3	**3 x 10^{-6}**	0.3
Lot 59	9 x 10^{-7}	0.07	**2 x 10^{-6}**	0.06
Lot 60	**3 x 10^{-6}**	0.2	**5 x 10^{-6}**	0.2
Lot 61	**8 x 10^{-6}**	0.3	**2 x 10^{-5}**	0.3
Lot 62	**6 x 10^{-6}**	0.2	**1 x 10^{-5}**	0.3
Lot 63	**8 x 10^{-6}**	0.8	**1 x 10^{-5}**	0.8
Lot 64	**3 x 10^{-6}**	0.2	**6 x 10^{-6}**	0.2
Lot 65	**4 x 10^{-6}**	0.4	**6 x 10^{-6}**	0.4
Lot 66	**2 x 10^{-6}**	0.2	**5 x 10^{-6}**	0.2
Lot 67	**9 x 10^{-6}**	0.6	**1 x 10^{-5}**	0.6
Lot 68	**2 x 10^{-6}**	0.5	**5 x 10^{-6}**	0.5
Lot 69	**3 x 10^{-6}**	0.2	**4 x 10^{-6}**	0.2
Lot 70	**1 x 10^{-5}**	1	**3 x 10^{-5}**	1
Note: the cumulative cancer risk and HI estimates for the adult trespasser are those presented for the outdoor worker, as discussed in Section 4.1.				

Lead. As discussed in Section 4.4.114.5.4, trespassers' exposure to lead in soil is evaluated using the outdoor workers' exposure to lead, as required by USEPA Region 2. As shown below, the average lead concentration in the 0 to 2 ft. depth interval is below 800 mg/kg at each property except for Lots 63 and 70. The estimated portion of the outdoor workers' fetal blood lead distribution (which is used to assess trespassers) that exceeds the 5 ug/dL level is less than 5% at each property except for Lots 63 and 60.

Table 6-557. Average Lead Concentrations in Surface Soil (PbS) and ALM Estimated Probabilities (P) that $PbB_{fetal} > PbB_t$ for Future Trespassers Exposed to the PbS Concentrations (PbS > 800 mg/kg and P > 5% are bolded and shaded)Average Lead Concentration Calculated for the Future Trespasser Using Soil Data from Depths of 0 to 2 Ft. Are Below the USEPA Region 2 Nonresidential Screening Level Of 800 mg/kg At Each Property Except For Lots 63 And Lot 70 Highlighted Below. The Future Trespassers' Fetal Blood Lead Distribution Exceeding the 5 ug/dl Level Is More Than 5% For Lots 63 and 70.

Lot	PbS (mg/kg)	$P(PbB_{fetal} > PbB_t)$ (%)
Lot 1	580	2.3%
Lot 57	305	0.44%
Lot 58	466	1.3%
Lot 59	240	0.24%
Lot 60	185	0.14%
Lot 61	505	1.6%
Lot 62	567	2.2%
Lot 63	**2,090**	**38%**
Lot 64	616	2.7%
Lot 65	619	2.7%
Lot 66	129	0.07%
Lot 67	429	1.0%
Lot 68	510	1.6%
Lot 69	343	0.58%
Lot 70	**934**	**7.7%**

As shown below, the average lead concentration calculated using soil data from all sampled depths (in case subsurface soil is moved to the surface during future site reddevelopment) is below the USEPA Region 2 nonresidential screening level of 800 mg/kg at each property except for Lot 63 and Lot 70. The estimated portion of the outdoor workers' fetal blood lead distribution (which is used to assess trespassers) that exceeds the 5 ug/dL level is less than 5% at each property except for Lots 63 and 60.

Table 6-568. Average Lead Concentrations in Soil from All Sample Depths (PbS) and ALM Estimated Probabilities (P) that PbB_{fetal} > PbB_t for Future Trespassers Exposed to the PbS Concentrations
(PbS > 800 mg/kg and P > 5% are bolded and shaded)Average Lead Concentration Calculated for the Future Trespasser Using Soil Data from Subsurface Soils if Soil of Moved to the Surface During Future Development Are Below the USEPA Region 2 Nonresidential Screening Level Of 800 mg/kg At Each Property Except For Lots 63 And Lot 70 Highlighted Below. The Future Trespassers' Fetal Blood Lead Distribution Exceeding the 5 ug/dl Level Is More Than 5% For Lots 63 and 70.

Lot	PbS (mg/kg)	P(PbB_{fetal} > PbB_t) (%)
Lot 1	426	1.0%
Lot 57	272	0.33%
Lot 58	318	0.48%
Lot 59	153	0.10%
Lot 60	171	0.12%
Lot 61	500	1.6%
Lot 62	493	1.5%
Lot 63	**2,530**	**49%**
Lot 64	688	3.6%
Lot 65	510	1.6%
Lot 66	206	0.17%
Lot 67	395	0.84%
Lot 68	586	2.4%
Lot 69	241	0.25%
Lot 70	**970**	**8.4%**

6.2.2.6 Visitors

Cancer Risk and Noncancer HI. The visitors' cumulative cancer risk and HI estimates are the sum of the estimates for ingestion, dermal contact, and particulate inhalation calculated using soil data from the 0 to 2 ft. depth interval, and the estimate for vapor inhalation calculated using soil data from all sampled depths.

- The cumulative cancer risk estimates range from 3 x 10^{-6} to 3 x 10^{-5}, which are all within NCP's risk range, as shown below. The single-chemical cancer risks above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are arsenic (Lots 1, 58, 60, 61, 62, 63, 65, 67, 68 and 70), PAHs[39] (Lots 1, 57, 60, 61, 62, 63, 65, 67 and 69), PCBs (Lots 57 and 67), and 2,3,7,8-tetrachlorodibenzo-p-dioxin (Lots 60 and 70) (see RAGS D Table 7).

- For adults, noncancer HIs range from 0.02 to 0.3, which are all below the protection goal of 1.

[39] Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and naphthalene

- For children, noncancer HIs range from 0.2 to 3, which are all below the protection goal of 1 except for Lots 63 and 70 which are above the protection goal. The single-chemical HQs are at or below the protection goal of 1, except for copper (Lot 63).

Table 6-589. Cancer Risks and Noncancer HIs for Future Visitor Exposure to Soil (0 to 2 ft) and Vapor Inhalation Calculated from Soil Data from All Sampled Depths (Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)
Future Visitor Cancer Risks and Noncancer Hazards for Site Visitor Exposed to Soil Data Depth Of 0 To 2 Ft. And Estimates for Vapor Inhalation Calculated Using Soil Data from All Sampled Depths. The Cancer Risks Are Within the Risk Range and the Noncancer HI is At or Below the Protection Goal of 1 Except for Lots 63 and 70. The Single-chemical HQs are at or below the Protection Goal of 1, Except for Copper (Lot 63).

Lot	**Adult/Child Risk**	**Adult HI**	**Child HI**
Lot 1	**8 x 10^{-6}**	0.02	0.2
Lot 57	**1 x 10^{-5}**	0.08	0.7
Lot 58	**3 x 10^{-6}**	0.1	1
Lot 59	**3 x 10^{-6}**	0.02	0.2
Lot 60	**9 x 10^{-6}**	0.03	0.3
Lot 61	**2 x 10^{-5}**	0.06	0.6
Lot 62	**1 x 10^{-5}**	0.04	0.3
Lot 63	**1 x 10^{-5}**	0.3	**3**
Lot 64	**5 x 10^{-6}**	0.04	0.4
Lot 65	**1 x 10^{-5}**	0.07	0.6
Lot 66	**3 x 10^{-6}**	0.03	0.2
Lot 67	**3 x 10^{-5}**	0.2	1
Lot 68	**6 x 10^{-6}**	0.1	0.9
Lot 69	**2 x 10^{-5}**	0.09	0.9
Lot 70	**2 x 10^{-5}**	0.2	**2**

Since the child visitor HIs for soil exposure at Lot 63 -and Lot 70- are above the protection goal of 1, the toxic organ endpoint specific HIs for child visitor exposure at Lots 63 and 70 are listed below. Toxic endpoint specific child visitor HI estimates for soil are at or below the protection goal of 1 for Lot 70 and are above the protection goal of 1 for Lot 63 (primarily from copper).

Table 6-5960. Noncancer Toxic Endpoint-Specific HIs for Future Child Visitor Exposure to Soil (0 to 2 ft.) and Vapor Inhalation Calculated from Soil Data from All Sampled Depths at Lot 63 and Lot 70
(HIs > 1 are bolded and shaded)
Future Visitor TOSHI from Exposures to Soil at Lot 63 and Lot 70. Exposure Are to Soils at Depths of 0 To 2 Ft. And Estimates for Vapor Inhalation Calculated Using Soil Data from All Sampled Depths Both Soil (all Depths).

Lot	Toxic Endpoint	HI
Lot 63	Cardiovascular	0.1
	Dermal	0.1
	Developmental/Reproductive	0.09
	Endocrine	0.2
	Gastrointestinal	**2**
	Hematologic	0.3
	Immune	0.06
	Nervous	0.03
	Ocular	0.02
	Other	0.3
	Respiratory	0.00004
	Urinary	0.05
Lot 70	Cardiovascular	0.04
	Dermal	0.2
	Developmental/Reproductive	1
	Endocrine	0.06
	Gastrointestinal	0.05
	Hematologic	0.02
	Immune	0.2
	Nervous	0.02
	Ocular	0.2
	Other	0.02
	Respiratory	0.001
	Urinary	0.01

To evaluate the scenario in which soil below the 0 to 2 ft. depth interval is brought to the surface in the course of future site redevelopment, the visitors' cumulative cancer risk and HI estimates are the sum of the estimates for ingestion, dermal contact, vapor and particulate inhalation calculated using soil data from all sampled depths.

- The cumulative cancer risk estimates range from 2 x 10^{-6} to 2 x 10^{-5}, which are all within NCP's risk range, as shown below. The single-chemical cancer risks above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are arsenic (Lots 1, 61, 62, 63, 64, 65, 66, 67, 68 and 70), PAHs[394032] (Lots 1, 57, 60, 61, 62, 63, 65, 66, 67 and 69), PCBs (Lots 57, 67, and 70), and 2,3,7,8-tetrachlorodibenzo-p-dioxin (Lots 60 and 70) (see RAGS D Table 7).

- For adults, noncancer HIs range from 0.01 to 0.2, which are all below the protection goal of 1.
- For children, noncancer HIs range from 0.2 to 2, which are all below the protection goal of 1 except for Lot 63 and 70 which are above the protection goal of 1. The single-chemical HQ are at or below the protect goal of 1.

Table 6-601. Cancer Risks and Noncancer HIs for Future Visitor Exposure to Soil from All Sampled Depths Brought to the Surface Under Future Site Development
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)

Future Site Visitor Cancer Risks and Noncancer Hazards from Exposures to Soils Below 0 to 2 Ft. Brought to the Surface Under Future Site Development and Vapor and Particulate Inhalation Calculated using Soil Data from All sampled Depths. The Child Visitor HI for Soil Exposure at Lot 63 and Lot 70 Exceed the Protection Goal of 1.

Lot	Adult/Child Risk	Adult HI	Child HI
Lot 1	**5 x 10^{-6}**	0.02	0.2
Lot 57	**2 x 10^{-5}**	0.09	0.8
Lot 58	**2 x 10^{-6}**	0.06	0.6
Lot 59	**2 x 10^{-6}**	0.01	0.1
Lot 60	**7 x 10^{-6}**	0.03	0.3
Lot 61	**2 x 10^{-5}**	0.07	0.7
Lot 62	**1 x 10^{-5}**	0.04	0.3
Lot 63	**2 x 10^{-5}**	0.2	**2**
Lot 64	**5 x 10^{-6}**	0.04	0.4
Lot 65	**9 x 10^{-6}**	0.07	0.6
Lot 66	**6 x 10^{-6}**	0.04	0.4
Lot 67	**2 x 10^{-5}**	0.1	1
Lot 68	**5 x 10^{-6}**	0.1	1
Lot 69	**8 x 10^{-6}**	0.05	0.6
Lot 70	**2 x 10^{-5}**	0.2	**2**

Since the child visitor HI for soil exposure at Lot 63 and Lot 70- are above the protection goal of 1, the toxic endpoint specific HIs for child visitor exposure at Lots 63 and 70 are listed below. Toxic organ endpoint specific child visitor HI estimates for soil are at or below the protection goal of 1 for Lot 63 and are above the protection goal of 1 for Lot 70 (primarily from copper).

Table 6-612. Noncancer Toxic Endpoint-Specific HIs for Future Child Visitor Exposure to Soil from All Sampled Depths Brought to the Surface During Future Development at Lot 63 and Lot 70
(HIs > 1 are bolded and shaded)
Future Child Visitor TOSHI from Exposures to Soil at Lot 63 and Lot 70. Exposure Are to Soils Below Depths of 0 To 2 Ft. Brought to the Surface During Future Development.

Lot	Toxic Endpoint	HI
Lot 63	Cardiovascular	0.1
	Dermal	0.1
	Developmental/Reproductive	0.1
	Endocrine	0.1
	Gastrointestinal	1
	Hematologic	0.3
	Immune	0.06
	Nervous	0.03
	Ocular	0.02
	Other	0.2
	Respiratory	0.00002
	Urinary	0.04
Lot 70	Cardiovascular	0.03
	Dermal	0.8
	Developmental/Reproductive	**2**
	Endocrine	0.07
	Gastrointestinal	0.04
	Hematologic	0.02
	Immune	0.7
	Nervous	0.02
	Ocular	0.7
	Other	0.02
	Respiratory	0.001
	Urinary	0.05

Lead. As shown below, all average soilsurface lead concentrations in soil from the 0 to 2 ft. depth interval at all properties are above the residential screening level of 200 mg/kg except for Lots 60 and 66. As discussed in Section 4.5.4, the child visitor's exposure to lead would be approximately 5% of the future child resident's exposure to lead based on the differences in exposure time, frequency and duration. Using thise percentage, tThe estimated portion of the future child visitor's blood lead distribution that exceeds USEPA Region 2's lead goal of 5 ug/dL for the 0 to 2 ft. depth interval is greaterat or less than 5% for Lot 1, Lot 62, Lot 63, Lot 64, Lot 65 and Lot 70. each property.

Table 6-623. Average Lead Concentrations in Surface Soil (PbS) and IEUBK Estimated Probabilities (P) that PbB_{fetal} > PbB_t for Future Child Visitors Exposed to the PbS Concentrations (PbS > 200 mg/kg and P > 5% are bolded and shaded)Average Lead Concentration Calculated for the Future Child Visitor Exposed to Soil Data from Subsurface Soils (0 to 2 Ft.). The Average Surface Lead Concentrations Exceed the Residential Screening Level of 200 mg/kg On All Lots Except Lot 60 and Lot 66 Highlighted Below. The Percent of Child BLLs Greater Than 5 ug/dl Based on the Visitor Exposure Assumptions are Below 5%.

Lot	PbS (mg/kg)	Time-Weighted PbS* (mg/kg)Child Res P(PbB> PbB_t) (%)	P(PbB > PbB_t) (%)
Lot 1	**580**	**76199202**	**3.84.785.19**
Lot 57	**305**	**37159163**	1.92.943.21
Lot 58	**466**	**64182186**	3.23.964.31
Lot 59	**240**	**24150153**	1.22.582.79
Lot 60	185	**14142145**	0.72.292.48
Lot 61	**505**	**69188**	4.42213.4
Lot 62	**567**	**75197200**	**4.685.083.8**
Lot 63	**2,0890**	**99.6414417.7**	**4.986.6823.73**
Lot 64	**616**	**20420779**	**4.05.065.48**
Lot 65	**619**	**79204208**	**5.125.544.0**
Lot 66	129	**5.8134138**	2.022.220.29
Lot 67	**429**	**18859180**	2.94.214.00
Lot 68	**510**	**18969192**	3.53.734.63
Lot 69	**343**	**16545168**	2.24.263.43
Lot 70	**934**	**24993252.6**	**4.78.278.54**

* -Time-Wweighted soil lead cConcentration of lead in soil was calculated assuming 1/7 of the soil lead EPC (PbS) in surface soil during exposure and at the lot and 6/7 of the average lead concentration (1395 mg/kg) at an offsite residential property concentration of 135 mg/kg as discussed in Section 4.4.111.

As shown below, the average soil lead concentration calculated using soil data from all sampled depths (in case subsurface soil is moved to the surface during futuresite re development) are above the USEPA Region 2 residential screening level of 200 mg/kg at each property except for Lot 59 and 60.

The estimated portion of the future child visitor's blood lead distribution that exceeds USEPA Region 2's lead goal of 5 ug/dL for soil from all sampled depths is greater than 5% for Lot 63, Lot 64, Lot 68 and Lot 70.

TAs discussed in Section 6.2.2.1, risk from potable and nonpotable4.5.4,and 4.4.10 the child visitor's exposure to lead was calculated consistent with Section 4.4.10 and USEPA's the Guidance on Assessing Intermittent or Variable Exposures at Lead Sites (USEPA, 2003c8) as discussed in Section 4.4.11. would be approximately 5% of the future child resident's exposure to lead based on the differences in exposure time, frequency and duration. Using the percentage, the estimated portion of the child visitor's blood lead distribution that exceeds USEPA Region 2's lead goal of 5 ug/dL for the all depths is at or less than 5% for each property.

Table 6-634. Average Lead Concentrations in Soil from All Sampled Depths (PbS) and IEUBK Model Estimated Probabilities (P) that PbB_{fetal} > PbB_t for Future Child Visitors Exposed to the PbS Concentrations
(PbS > 200 mg/kg and P > 5% are bolded and shaded)Child Visitor average lead concentration calculated using soil data from all sampled depths (in case subsurface soil is moved to the surface during future Site Development). The Average Surface Lead Concentrations Exceed the Residential Screening Level of 200 mg/kg On All Lots Except Lot 60 and Lot 66 Highlighted Below. The Percent of Child BLLs Greater Than 5 ug/dl Based on the Visitor Exposure Assumptions are Below 5%. Except at Lots 63, 64,65 and 70.

Lot	**PbS** (mg/kg)	**Time-Weighted PbS*** (mg/kg)**Child Res P(PbB> PbB_t)** (%)	**5% of Child Res P(PbB > PbB_t)** (%)
Lot 1	**426**	**18017758**	4.003.682.9
Lot 57	**272**	**15815531**	2.992.741.5
Lot 58	**318**	**16515340**	3.302.702.0
Lot 59	153	**1411389.0**	2.332.120.45
Lot 60	171	**14414012**	2.442.0220.59
Lot 61	**500**	**19118768**	4.584.213.4
Lot 62	**493**	**19018667**	4.524.163.4
Lot 63	**2,530**	**480.647799.8**	**30.2629.894.99**
Lot 64	**688**	**21784214**	**6.105.74.2**
Lot 65	**510**	**19220669**	4.635.233.5
Lot 66	**206**	**14914518**	2.632.400.90
Lot 67	**395**	**17617254**	3.813.502.7
Lot 68	**586**	**20319977**	**5.254.843.8**
Lot 69	**241**	**15415025**	2.832.581.2
Lot 70	**970**	**257.725494**	**8.928.664.7**

* -Time-Wweighted soil lead cConcentration of lead in soil was calculated assuming 1/7 of the soil lead EPC (PbS) in soil from all sampled depths during exposure and at the lot and 6/7 of the average lead concentration (1395 mg/kg) at an offsite residential property concentration of 135 mg/kg as discussed in Section 4.4.110.

The visitors' cumulative cancer risk and HI estimates for vapor intrusion exposure assuming a hypothetical future commercial/industrial building are summarized below for soil data from all sampled depths.

- The cumulative cancer risk estimates range from 2 x 10^{-9} to 6 x 10^{-6}, which are at or below NCP's risk range except for Lots 62 and 64 which are within NCP's risk range. The single-chemical cancer risks above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are benzene (Lots 64) and naphthalene (Lots 62) (see RAGS D Table 7).

- For adults, the noncancer HIs range from 0.00005 to 0.3, which are below the protection goal of 1.
- For children, the noncancer HIs range from 0.00003 to 1, which are at or below the protection goal of 1.

Table 6-645. Cancer Risks and Noncancer HIs for Future Adult and Child Visitor Exposure from Vapor Intrusion from Soil from All Sampled Depths Assuming a Future Commercial/Industrial Building
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)
The Visitors' Cumulative Cancer Risk and HI Estimates for Vapor Intrusion Exposure Assuming A L Future Commercial/Industrial Building. The Cancer Risks Are at Or Below the Risk Range and Non-Cancer His Are Below The Protection Goal Of 1 for the Adult and Child.

Lot	Adult/Child Risk	Adult HI	Child HI
Lot 1	5 x 10^{-7}	0.01	0.03
Lot 57	7 x 10^{-7}	0.04	0.04
Lot 58	4 x 10^{-7}	0.2	0.8
Lot 59	8 x 10^{-9}	0.0001	0.0003
Lot 60	1 x 10^{-7}	0.04	0.1
Lot 61	1 x 10^{-7}	0.05	0.1
Lot 62	**6 x 10^{-6}**	0.2	0.2
Lot 63	2 x 10^{-8}	0.01	0.01
Lot 64	**6 x 10^{-6}**	0.1	0.4
Lot 65	1 x 10^{-8}	0.03	0.03
Lot 66	3 x 10^{-9}	0.02	0.02
Lot 67	2 x 10^{-7}	0.02	0.02
Lot 68	1 x 10^{-6}	0.3	1
Lot 69	2 x 10^{-9}	0.00002	0.00003
Lot 70	4 x 10^{-7}	0.02	0.02

The visitors' cumulative cancer risk and HI estimates for vapor intrusion exposure assuming a hypothetical future commercial/industrial building are summarized below for shallow groundwater data. The cumulative cancer risk estimates range from 6 x 10^{-9} to 3 x 10^{-8}, which are below NCP's risk range. For adults and children[40], the noncancer HIs range from 0.00002 to 0.006, which are below the protection goal of 1.

[40] The child and adult groundwater vapor intrusion HI estimates are the same since the EPCs are the same (i.e., groundwater source is assumed to be infinite) and the exposure time and frequency are the same (i.e., 2 hours day for 52 days a years).

Table 6-656. Cancer Risks and Noncancer HIs for Future Visitor Exposure from Vapor Intrusion from Shallow Groundwater Assuming a Future Commercial/Industrial Building (Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)The Visitors' Cumulative Cancer Risk and HI Estimates for Vapor Intrusion Exposure Assuming A Future Commercial/Industrial Building for Shallow Groundwater Data. The Cancer Risks Are at Or Below the Risk Range and Noncancer HI Estimates Are Below the Protection Goal Of 1 for the Adult and Child.

Lot	**Adult/Child Risk**	**Adult HI**	**Child HI**
Lot 1	6 x 10^{-9}	0.00002	0.00002
Lot 57	1 x 10^{-8}	0.0005	0.0005
Lot 58	1 x 10^{-8}	0.006	0.006
Lot 59	1 x 10^{-8}	0.006	0.006
Lot 60	6 x 10^{-9}	0.00003	0.00003
Lot 61	1 x 10^{-8}	0.0008	0.0008
Lot 62	6 x 10^{-9}	0.00002	0.00002
Lot 63	8 x 10^{-9}	0.0001	0.0001
fLot 64	1 x 10^{-8}	0.0008	0.0008
Lot 65	6 x 10^{-9}	0.00004	0.00004
Lot 66	6 x 10^{-9}	0.00002	0.00002
Lot 67	6 x 10^{-9}	0.00002	0.00002
Lot 68	6 x 10^{-9}	0.00003	0.00003
Lot 69	3 x 10^{-8}	0.0005	0.0005
Lot 70	6 x 10^{-9}	0.00003	0.00003

Risks from potable groundwater use by visitors are evaluated for shallow and deep groundwater using hypothetical future residential risks to facilitate development of appropriate institutional controls for the Site. If shallow or deep groundwater is used in the future, visitors could be exposed through ingestion, dermal contact, and inhalation of vapors during potable use. The cumulative cancer risk and HIs for shallow groundwater potable use are shown below.

- For shallow groundwater potable use, the cumulative cancer risk estimates range from 7 x 10^{-4} to 4 x 10^{-3}, which are above NCP's risk range for every property, as shown below. The single-chemical cancer risks are above the lower end of NCP's risk range (10^{-6}) for a number ofseveral VOCs, SVOCs, PCBs, and metals at each of the 15 properties at the Site (see RAGS D Table 7). The highest risks (i.e., above the upper end of NCP's range) are for 1,3-dichloropropene (total), 1,2-dibromo-3-chloropropane, benzene, vinyl chloride, PAHs, pentachlorophenol, and arsenic.

- For adults, the noncancer HIs range from 5 to 200, which are above the protection goal of 1. The single-chemical HQs are above the protection goal of 1 for ~~a number of~~several VOCs, SVOCs, PCBs, and metals at each of the 15 properties at the Site (see RAGS D Table 7). The highest HQs (i.e., HQs above 10) are for trichloroethene, xylenes, 1,2,4-trichlorobenzene, 2-hexanone, cyanide, and naphthalene.

- For children, the noncancer HIs range from 7 to 200, which are above the protection goal of 1. The single-chemical HQs are above the protection goal of 1 for ~~a number of~~several VOCs, SVOCs, PCBs, and metals at each of the 15 properties at the Site (see RAGS D Table 7). The highest HQs (i.e., HQs above 10) are for trichloroethene, xylenes, 1,2,4-trichlorobenzene, 2-hexanone, cyanide, naphthalene, and iron.

Table 6-6~~67.~~ Cancer Risks and Noncancer HIs for Future Visitor Exposure to Shallow and Deep Groundwater through Ingestion, Dermal Contact, and Inhalation of Vapors During Hypothetical Potable Use
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)

~~The Visitors' Cumulative Cancer Risk and HI Estimates for Potable Groundwater Use by Visitors Are Evaluated for Shallow and Deep Groundwater Using Future Residential Risks. If Shallow or Deep Groundwater Is Used in the Future, Visitors Could Be Exposed Through Ingestion, Dermal Contact, And Inhalation of Vapors During Potable Use. Cancer Risks Exceed the Risk Range at All Lots and the Goal of Protection of 1 Is Exceeded for the Child and Adult at All Lots.~~

Lot	Adult/Child Risk	Adult HI	Child HI
Lot 1	**1 x 10^{-3}**	**8**	**10**
Lot 57	**3 x 10^{-3}**	**50**	**70**
Lot 58	**3 x 10^{-3}**	**200**	**200**
Lot 59	**3 x 10^{-3}**	**200**	**200**
Lot 60	**1 x 10^{-3}**	**9**	**10**
Lot 61	**3 x 10^{-3}**	**60**	**70**
Lot 62	**9 x 10^{-4}**	**6**	**8**
Lot 63	**2 x 10^{-3}**	**30**	**40**
Lot 64	**3 x 10^{-3}**	**60**	**70**
Lot 65	**2 x 10^{-3}**	**10**	**10**
Lot 66	**1 x 10^{-3}**	**9**	**10**
Lot 67	**9 x 10^{-4}**	**5**	**7**
Lot 68	**1 x 10^{-3}**	**9**	**10**
Lot 69	**4 x 10^{-3}**	**60**	**60**
Lot 70	**9 x 10^{-4}**	**7**	**9**

Lead. For shallow groundwater exposure to lead, the maximum lead concentration for shallow groundwater is below the federal action limit of 0.015 mg/L at each property except Lots 57, 60, 63, 64, 67, and 69, as shown in Section 6.2.2.1.

For deep groundwater potable use (site-wide) the cumulative cancer risk estimate is 7 x 10^{-4}, which is above NCP's risk range. The adult noncancer HI is 10 and the child noncancer HI is 20, which are above the protection goal of 1. The single-chemical cancer risks are above the lower end of NCP's risk range (10^{-6}) for benzene, chloroform, 1,4-dioxane, 1,1,2-trichloroethane, 1,1,2,2-tetrachloroethane, benzo(a)anthracene, benzo(a)pyrene, naphthalene, and arsenic. The single-chemical HQs are above the protection goal of 1 for arsenic, cyanide, iron, and manganese (see RAGS D Table 7). The toxic endpoint specific HI estimates are above the protection goal of 1 (see RAGS D Table 9).

Therefore, risk and hazards from potable use of the shallow and deep groundwater, if it were to occur in the future, would be unacceptable. However, such groundwater use at the Site is unlikely since site-specific conductivity readings of the shallow groundwater indicate possible brackish conditions, and the Site and surrounding area are served by the City of Newark's potable water system. In addition, Lots 67, 68 and 69 have restrictions in place against groundwater use.

~~6.2.2.6 Off-Site Workers~~

~~Potential~~ If visitors were to have exposure ~~of off-site workers~~ to soil while outdoors (0 to 2 ft interval) and both soil and shallow groundwater via vapor intrusion and potable shallow groundwater use in the future, the combined cumulative cancer risk estimates range from 9 x 10^{-4} to 4 x 10^{-3}, which are above NCP's risk range. For adults, the combined noncancer HIs range from 5 to 200, which are above the protection goal of 1. For children, the combined noncancer HIs range from 8 to 200, which are above the protection goal of 1.

Table 6-6~~78.~~ Cancer Risks and Noncancer HIs for Future Visitor Exposure to Soil (0 to 2 ft.) and Shallow Groundwater via Vapor Intrusion and Potable Use (Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)~~Visitor Cancer Risks and Noncancer HI from Exposure to Soil (0 to 2 Ft) and Shallow Groundwater via Vapor Intrusion and Potable Shallow Groundwater use. The Cancer Risks Exceed the Risk Range for All Lots and Exceed the Protection Goal of 1 at All Lots.~~

Lot	Adult/Child Risk	Adult HI	Child HI
Lot 1	**1×10^{-3}**	**8**	**10**
Lot 57	**3×10^{-3}**	**50**	**70**
Lot 58	**3×10^{-3}**	**200**	**200**
Lot 59	**3×10^{-3}**	**200**	**200**
Lot 60	**1×10^{-3}**	**9**	**10**
Lot 61	**3×10^{-3}**	**60**	**80**
Lot 62	**1×10^{-3}**	**6**	**9**
Lot 63	**2×10^{-3}**	**40**	**40**
Lot 64	**3×10^{-3}**	**60**	**80**
Lot 65	**2×10^{-3}**	**10**	**10**
Lot 66	**1×10^{-3}**	**9**	**10**
Lot 67	**9×10^{-4}**	**5**	**8**
Lot 68	**1×10^{-3}**	**10**	**10**
Lot 69	**4×10^{-3}**	**60**	**70**
Lot 70	**9×10^{-4}**	**8**	**10**

If visitors were to have exposure to soil while outdoors (in case subsurface soil is moved to the surface during site redevelopment) and both soil and shallow groundwater via vapor intrusion and potable shallow groundwater use in the future, the combined cumulative cancer risk estimates range from 9×10^{-4} to 4×10^{-3}, which are above NCP's risk range. For adults, the combined noncancer HIs range from 5 to 200, which are above the protection goal of 1. For children, the combined noncancer HIs range from 8 to 200, which are above the protection goal of 1.

Table 6-6~~8~~9~~.~~ Cancer Risks and Noncancer HIs for Future Visitor Exposure to Soil that Maybe Brought to the Surface During Future Site Development. Exposure to Soil (0 to 2 ft.) and Shallow Groundwater via Vapor Intrusion and Potable Use (Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)~~Visitor Cancer Risks and Noncancer HI from Exposure to Subsurface Soil that Maybe Brought to the Surface During Future Site Development. Exposure to Soil (0 to 2 Ft) and Shallow Groundwater via Vapor Intrusion and Potable Shallow Groundwater Use Are Assumed. The Cancer Risks Exceed the Risk Range for All Lots and Exceed the Protection Goal of 1 at All Lots.~~

Lot	Adult/Child Risk	Adult HI	Child HI
Lot 1	1×10^{-3}	8	10
Lot 57	3×10^{-3}	50	70
Lot 58	3×10^{-3}	200	200
Lot 59	3×10^{-3}	200	200
Lot 60	1×10^{-3}	9	10
Lot 61	3×10^{-3}	60	80
Lot 62	1×10^{-3}	6	8
Lot 63	2×10^{-3}	40	40
Lot 64	3×10^{-3}	60	80
Lot 65	2×10^{-3}	10	10
Lot 66	1×10^{-3}	9	10
Lot 67	9×10^{-4}	5	8
Lot 68	1×10^{-3}	10	10
Lot 69	4×10^{-3}	60	70
Lot 70	9×10^{-4}	8	10

Since the HI for every property is above the protection goal of 1, the toxic endpoint specific HIs for indoor worker exposure at these lots are shown on RAGS D Table 9. Generally, at least one toxic endpoint specific HI estimate is also above the protection goal of 1 at each property.

6.2.2.7 Off-Site Workers

Off-site workers may be exposed to COPCs in on-site soil that migrate off-site via windblown soil vapor and particulates or on-site groundwater ~~that might migrate~~ if it migrates off-site in the future in the small area in the northwestern corner of the Site ~~are evaluated indirectly in this risk assessment using risk estimates for on-site workers, as explained in Section 4.1. Specifically, the risk estimates for off-site workers are expected to be no higher than the~~ .

Cancer Risks and Noncancer HI. The off-site workers' cumulative cancer risk and HI estimates summarized below are the sum of the estimates for ~~on-site workers discussed in Section 6.2.2.1, which are within USEPA's limits for RME risks.~~particulate inhalation calculated using soil data from the 0 to 2 ft. depth interval, and the estimates for vapor inhalation calculated using soil data from all sampled depths. These risk estimates are calculated assuming there is no pavement or building covering the soil, and no air dispersion from the Site to the off-site property (i.e., as though the off-site workers are at the downwind edge of the Site). As shown below, the cumulative cancer risk estimates range from 2×10^{-8} to 5×10^{-6}, which are at or below NCP's risk range except for Lot 62 which is within NCP's risk range. The noncancer HIs range from 0.002 to 0.2, which are all below the protection goal of 1. The single-chemical cancer risk above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), is naphthalene (Lot 62) (see RAGS D Table 7).

Table 6-~~69~~70~~.~~ Cancer Risks and Noncancer HIs for Future Off-Site Worker Exposure from Inhalation of Particulates Released from Surface Soil (0 to 2 ft.) and Inhalation of Vapors

Released from Soil Using Soil Data from All Sampled Depths
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Off-Site Worker Cancer Risks and Noncancer HI For Particulate Inhalation Calculated Using Soil Data from the 0 To 2 Ft. Depth Interval and Estimates for Vapor Inhalation Calculated Using Soil Data from All Sampled Depths. The Estimates Calculated Assume No Pavement or Building Covering the Soil, And No Air Dispersion from The Site to the Off-Site Property. Cancer Risks Are Within or Below the Risk Range and Noncancer HIs are Below the Protection Goal of 1.

Lot	**Risk**	**HI**
Lot 1	3 x 10^{-7}	0.02
Lot 57	7 x 10^{-7}	0.09
Lot 58	6 x 10^{-8}	0.04
Lot 59	2 x 10^{-8}	0.002
Lot 60	6 x 10^{-8}	0.01
Lot 61	4 x 10^{-8}	0.05
Lot 62	**5 x 10^{-6}**	0.2
Lot 63	6 x 10^{-8}	0.07
Lot 64	1 x 10^{-6}	0.05
Lot 65	1 x 10^{-7}	0.1
Lot 66	3 x 10^{-8}	0.05
Lot 67	4 x 10^{-7}	0.06
Lot 68	2 x 10^{-7}	0.1
Lot 69	4 x 10^{-8}	0.01
Lot 70	9 x 10^{-7}	0.03

To evaluate the scenario in which soil below the 0 to 2 ft. depth interval is brought to the surface in the course of site redevelopment, the off-site workers' cumulative cancer risk and HI estimates are the sum of the estimates for vapor and particulate inhalation calculated using soil data from all sampled depths. These risk estimates are calculated assuming there is no pavement or building covering the soil, and no air dispersion from the Site to the off-site property (i.e., as though the off-site workers are at the downwind edge of the Site). As shown below, the cumulative cancer risk estimates range from 2 x 10^{-8} to 5 x 10^{-6}, which are at or below NCP's risk range except for Lot 62 which is within NCP's risk range. The noncancer HIs range from 0.002 to 0.2, which are all below the protection goal of 1. The single-chemical cancer risk above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), is naphthalene (Lot 62) (see RAGS D Table 7).

Table 6-701. Cancer Risks and Noncancer HIs for Future Off-Site Worker Exposure from Inhalation of Particulates and Vapors Released from Soil Using Soil Data from All Sampled Depths (Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Off-Site Worker Cancer Risks and Noncancer HI For Soil Below The 0 To 2 Ft. Depth Interval Brought to The Surface in The Course of Site Development. The Exposure Estimates Are the Sum of The Estimates for Vapor and Particulate Inhalation Calculated Using Soil Data from All Sampled Depths. The Estimates Calculated Assume No Pavement or Building Covering the Soil, And No Air Dispersion from The Site to the Off-Site Property. Cancer Risks Are Below or Within the Risk Range and Noncancer HIs Are Below the Protection Goal Of 1.

Lot	**Risk**	**HI**
Lot 1	3 x 10^{-7}	0.02
Lot 57	7 x 10^{-7}	0.1
Lot 58	6 x 10^{-8}	0.04
Lot 59	2 x 10^{-8}	0.002
Lot 60	6 x 10^{-8}	0.01
Lot 61	4 x 10^{-8}	0.05
Lot 62	**5 x 10^{-6}**	0.2
Lot 63	5 x 10^{-8}	0.07
Lot 64	1 x 10^{-6}	0.05
Lot 65	1 x 10^{-7}	0.1
Lot 66	3 x 10^{-8}	0.05
Lot 67	4 x 10^{-7}	0.06
Lot 68	2 x 10^{-7}	0.1
Lot 69	4 x 10^{-8}	0.01
Lot 70	9 x 10^{-7}	0.03

Off-site workers may contact contaminants in shallow groundwater during some utility repairs if shallow groundwater migrates off-site in the future. The off-site workers' cumulative cancer risk and HI estimates summarized below are the sum of the estimates for ingestion, dermal contact, and vapor inhalation calculated using the EPCs for shallow groundwater for each property. As shown below, the cumulative cancer risk estimates range from 5 x 10^{-7} to 5 x 10^{-6}, which are at the lower end or below NCP's risk range except for Lots 57, 58, 59, 60, 65, and 69 which are within NCP's risk range. The noncancer HIs range from 0.02 to 0.9, which are all below the protection goal of 1. The single-chemical cancer risks above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are pentachlorophenol (Lots 57, 58, and 59) and dibenz(a,h)anthracene (Lot 65) (see RAGS D Table 7).

Table 6-712. Cancer Risks and Noncancer HIs for Future Off-Site Worker Exposure to Shallow Groundwater through Ingestion, Dermal Contact, and Vapor Inhalation Assuming Shallow Groundwater Migrates Off the Site in the Future
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Off-Site Worker Cancer Risks and Noncancer HI From Contact with COPCs in shallow groundwater if shallow groundwater migrates off-site in the future. The off-site workers' cumulative cancer risk and HI estimates summarized below are the sum of the estimates for ingestion, dermal contact, and vapor inhalation calculated using the EPCs for shallow groundwater for each property. Cancer Risks Are Below or Within the Risk Range and Noncancer HIs Are Below the Protection Goal Of 1.

Lot	Risk	HI
Lot 1	7 x 10^{-7}	0.02
Lot 57	**4 x 10^{-6}**	0.1
Lot 58	**5 x 10^{-6}**	0.9
Lot 59	**5 x 10^{-6}**	0.9
Lot 60	**2 x 10^{-6}**	0.02
Lot 61	1 x 10^{-6}	0.2
Lot 62	5 x 10^{-7}	0.01
Lot 63	9 x 10^{-7}	0.05
Lot 64	1 x 10^{-6}	0.2
Lot 65	**2 x 10^{-6}**	0.02
Lot 66	7 x 10^{-7}	0.02
Lot 67	5 x 10^{-7}	0.01
Lot 68	5 x 10^{-7}	0.02
Lot 69	**2 x 10^{-6}**	0.1
Lot 70	5 x 10^{-7}	0.02

Potential inhalation exposures to shallow groundwater vapors may occur indoors if shallow groundwater migrates off-site in the future and vapors migrate through building foundations. The off-site workers' cumulative cancer risk and HI estimates for vapor intrusion exposure assuming a hypothetical future commercial/industrial building are summarized below for shallow groundwater data. The cumulative cancer risk estimates range from 4 x 10^{-8} to 2 x 10^{-7}, which are all below NCP's risk range. The noncancer HIs range from 0.0004 to 0.1, which are all below the protection goal of 1.

Table 6-723. Cancer Risks and Noncancer HIs for Future Off-Site Worker Exposure to Shallow Groundwater Assuming Shallow Groundwater Migrates Off the Site in the Future and Vapors Migrate through Building Foundations
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Off-Site Worker Cancer Risks and Noncancer HI From Contact with COPCs In Shallow Groundwater That Migrates Off-Site in The Future and Vapors Migrate Through Building Foundations. The Off-Site Workers' Cumulative Cancer Risk and HI Estimates for Vapor Intrusion Exposure Assuming A Hypothetical Future Commercial/Industrial Building Are Summarized Below for Shallow Groundwater Data. Cancer Risks Are Below or Within the Risk Range and Noncancer HI Are Below the Protection Goal Of 1.

Lot	Risk	HI
Lot 1	4 x 10^{-8}	0.0004
Lot 57	2 x 10^{-7}	0.01
Lot 58	1 x 10^{-7}	0.1
Lot 59	1 x 10^{-7}	0.1
Lot 60	5 x 10^{-8}	0.0006
Lot 61	2 x 10^{-7}	0.02
Lot 62	4 x 10^{-8}	0.0004
Lot 63	7 x 10^{-8}	0.002
Lot 64	2 x 10^{-7}	0.02
Lot 65	4 x 10^{-8}	0.0007
Lot 66	4 x 10^{-8}	0.0004
Lot 67	4 x 10^{-8}	0.0004
Lot 68	4 x 10^{-8}	0.0006
Lot 69	2 x 10^{-7}	0.01
Lot 70	4 x 10^{-8}	0.0005

6.2.2.7 Risks from potable Off-Site Residents

As shown on Table 6-9, the off-site residents' cumulative risk estimates for each property are within USEPA's limits for RME risks except at Lot 62. As discussed in Section 6.2.1.8, after segregating HQs by target organ/effect, the HI for respiratory/nervous system is no higher than 1.4 (naphthalene plus the remaining COPCs), which rounds to 1, and for the HI for developmental is no higher than 0.17 (benzo(a)pyrene plus the remaining COPCs), which rounds to 0.2. Neither HI estimates exceeds USEPA's limit.

Also, as discussed in Section 6.2.1.8groundwater use by off-site workers are evaluated for shallow and deep groundwater to facilitate development of appropriate institutional controls. If shallow or deep groundwater is used in the future, off-site workers could be exposed through ingestion, dermal contact, and inhalation of vapors during potable use.

For shallow groundwater potable use, the cumulative cancer risk estimates range from 1 x 10^{-4} to 7 x 10^{-4}, which are above NCP's risk range except for Lots 62, 67, 68 and 70 which are at the upper-end of NCP's risk range, as shown below. The single-chemical cancer risks are above the lower end of NCP's risk range (10^{-6}) for a number ofseveral VOCs, SVOCs, PCBs, and metals at each of the 15 properties at the Site (see RAGS D Table 7). The highest risks (i.e., above the upper end of NCP's range) are for 1,2-dibromo-3-chloropropane, pentachlorophenol, dibenz(a,h)anthracene, and arsenic.

The noncancer HIs range from 2 to 50, which are above the protection goal of 1. The single-chemical HQs are above the protection goal of 1 for a number ofseveral VOCs, SVOCs, and metals at each of the 15 properties at the Site (see RAGS D Table 7). The highest HQ (i.e., HQ above 10) is for xylene at Lots 58 and 59.

Table 6-734. Cancer Risks and Noncancer HIs for Future Off-Site Worker Exposure to Shallow and Deep Groundwater through Ingestion, Dermal Contact, and Inhalation of Vapors Assuming Potable Use
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Off-Site Worker Cancer Risks and Noncancer HI From Contact with COPCs In Shallow and Deep Groundwater Used as A Potable Source. Off-Site Workers May Be Exposed Through Ingestion, Dermal Contact, And Inhalation of Vapors During Potable Use. The Off-Site Workers' Cumulative Cancer Risk and HI Estimates Are Summarized Below for Shallow and Deep Groundwater Data. Cancer Risks Exceed the Risk Range and the Noncancer HI Protection Goal Of 1 Is Also Exceeded.

Lot	**Risk**	**HI**
Lot 1	**2 x 10^{-4}**	**3**
Lot 57	**7 x 10^{-4}**	**20**
Lot 58	**7 x 10^{-4}**	**50**
Lot 59	**7 x 10^{-4}**	**50**
Lot 60	**3 x 10^{-4}**	**3**
Lot 61	**6 x 10^{-4}**	**20**
Lot 62	**1 x 10^{-4}**	**2**
Lot 63	**3 x 10^{-4}**	**10**
Lot 64	**6 x 10^{-4}**	**20**
Lot 65	**4 x 10^{-4}**	**3**
Lot 66	**2 x 10^{-4}**	**3**
Lot 67	**1 x 10^{-4}**	**2**
Lot 68	**1 x 10^{-4}**	**3**
Lot 69	**4 x 10^{-4}**	**20**
Lot 70	**1 x 10^{-4}**	**2**

For shallow groundwater exposure to lead, the maximum lead concentration for shallow groundwater is below the federal action limit of 0.015 mg/L at each property except Lots 57, 60, 63, 64, 67, and 69, as shown in Section .

For deep groundwater potable use (site-wide), the cumulative cancer risk estimate is 2 x 10^{-4}, which is above NCP's risk range and the noncancer HI is 4, which is above the protection goal of 1. The single-chemical cancer risks are above the lower end of NCP's risk range (10^{-6}) for benzene, chloroform, 1,4-dioxane, 1,1,2-trichloroethane, benzo(a)pyrene, naphthalene, and arsenic. No single-chemical HQ exceeds the protection goal and the toxic endpoint specific HI estimates are at or below the protection goal of 1 as shown on RAGS D Table 9.

Therefore, risk and hazards from potable use of the shallow and the risk from potable use of deep groundwater, if it were to occur in the future, would be unacceptable. However, such future groundwater use near the Site is unlikely since site-specific conductivity readings of the shallow groundwater indicate possible brackish conditions, and the Site and surrounding area are served by the City of Newark's potable water system.

If off-site workers were to have exposure to both soil (0 to 2 ft. interval) and shallow groundwater (from contact during excavations, vapor intrusion, and potable use) in the future, the combined cumulative cancer risk estimates range from 1 x 10^{-4} to 7 x 10^{-4}, which are above NCP's risk range except for Lots 67, 68 and 70 which are at the upper end of NCP's risk range. The combined noncancer HIs range from 2 to 50, which are above the protection goal of 1. The toxic endpoint specific HI estimates are also above the protection goal of 1 except for Lots 1, 60, 62, 65, 66, 67, 68 and 70, which are at or below the protection goal, as shown on RAGS D Table 9.

Table 6-745~~.~~ Cancer Risks and Noncancer HIs for Future Off-Site Worker Exposure to Soil (0 to 2 ft.) and Shallow Groundwater from Contact during Excavations, Vapor Intrusion, and Potable Use
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)~~Off-Site Worker Cancer Risks and Noncancer HI From Potable Use (Site-Wide) exposure to both soil (0 to 2 ft. interval) and shallow groundwater (from contact during excavations, vapor intrusion, and potable use). The Off-Site Workers' Cumulative Cancer Risk and HI Estimates Are Summarized Below. Cancer Risks Exceed the Risk Range and the Noncancer HI Protection Goal of Protection of 1.~~

Lot	Risk	HI
Lot 1	2×10^{-4}	3
Lot 57	7×10^{-4}	20
Lot 58	7×10^{-4}	50
Lot 59	7×10^{-4}	50
Lot 60	3×10^{-4}	3
Lot 61	6×10^{-4}	20
Lot 62	2×10^{-4}	2
Lot 63	3×10^{-4}	10
Lot 64	6×10^{-4}	20
Lot 65	4×10^{-4}	3
Lot 66	2×10^{-4}	3
Lot 67	1×10^{-4}	2
Lot 68	1×10^{-4}	3
Lot 69	4×10^{-4}	20
Lot 70	1×10^{-4}	2

If off-site workers were to have exposure to both soil from all depths (in case subsurface soil is moved to the surface during site redevelopment) and shallow groundwater (from contact during excavations, vapor intrusion, and potable use) in the future, the combined cumulative cancer risk estimates range from 1×10^{-4} to 7×10^{-4}, which are above NCP's risk range except for Lots 67, 68, and 70 which are at the upper end of NCP's risk range. The combined noncancer HIs range from 2 to 50, which are above the protection goal of 1. The toxic endpoint specific HI estimates are also above the protection goal of 1 except for Lots 1, 60, 62, 65, 66, 67, 68 and 70, which are at or below the protection goal, as shown on RAGS D Table 9.

Table 6-7~~56.~~ Cancer Risks and Noncancer HIs for Future Off-Site Worker Exposure to Soil (All Sampled Depths) and Shallow Groundwater from Contact during Excavations, Vapor Intrusion, and Potable Use
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)~~Off-Site Worker Cancer Risks and Noncancer HI From Exposure to Potable Use (Site-Wide) exposure to both soil from all depths (in case subsurface soil is moved to the surface during site development) and shallow groundwater (from contact during excavations, vapor intrusion, and potable use) in the future. The Off-Site Workers' Cumulative Cancer Risk and HI Estimates Are Summarized Below. Cancer Risks Exceed the Risk Range and the Noncancer HI Protection Goal Of 1.~~

Lot	Risk	HI
Lot 1	**2 x 10^{-4}**	**3**
Lot 57	**7 x 10^{-4}**	**20**
Lot 58	**7 x 10^{-4}**	**50**
Lot 59	**7 x 10^{-4}**	**50**
Lot 60	**3 x 10^{-4}**	**3**
Lot 61	**6 x 10^{-4}**	**20**
Lot 62	**2 x 10^{-4}**	**2**
Lot 63	**3 x 10^{-4}**	**10**
Lot 64	**6 x 10^{-4}**	**20**
Lot 65	**4 x 10^{-4}**	**3**
Lot 66	**2 x 10^{-4}**	**3**
Lot 67	**1 x 10^{-4}**	**2**
Lot 68	**1 x 10^{-4}**	**3**
Lot 69	**4 x 10^{-4}**	**20**
Lot 70	**1 x 10^{-4}**	**2**

Lead. For shallow groundwater exposure to lead, the maximum lead concentration for shallow groundwater is below the federal action limit of 0.015 mg/L at each property except Lots 57, 60, 63, 64, 67, and 69, as shown in Section 6.2.2.1.

6.2.2.8 Off-Site Residents

Cancer Risk and Noncancer Hazards. The off-site resident cumulative cancer risk and HI estimates summarized below are the sum of the estimates for particulate inhalation calculated using soil data from the 0 to 2 ft. depth interval, and the estimate for vapor inhalation calculated using soil data from all sampled depths. As shown below, the cumulative cancer risk estimates range from 1 x 10^{-7} to 2 x 10^{-5}, which are at or below NCP's risk range except for Lots 57, 62, 64, 67, and 70 which are within NCP's risk range. The single-chemical cancer risks above the lower end of NCP's risk range

(10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are naphthalene (Lots 57 and 62) and benzene (Lot 64) (see RAGS D Table 7). For adults, noncancer HIs range from 0.01 to 0.8, which are all below the protection goal of 1. For children, noncancer HIs range from 0.02 to 2, which are at or below the protection goal of 1 except for Lots 62 and 68 which have HIs of 2. No single-chemical HQs are above the protection goal of 1.

Table 6-7557. Cancer Risks and Noncancer HIs for Future Off-Site Resident Exposure through Inhalation of Particulates Released from Soil (0 to 2 ft.) and Inhalation of Vapors Released from Soil (All Sampled Depths) (Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Off-Site Resident Cancer Risks and Noncancer HI From Exposure to Particulate Inhalation Calculated Using Soil Data from the 0 To 2 Ft. Depth Interval, and the Estimate for Vapor Inhalation Calculated Using Soil Data from All Sampled Depths. The Cumulative Cancer Risk and HI Estimates Are Summarized Below. Cancer Risks Are Below or Within the Risk Range and The Noncancer HI Are Below the Protection Goal Of 1 At All Lots for The Adult and Child Except For Lot 62 And 68 Where The Hi For The Child Is An HI = 2.

Lot	**Adult/Child Risk**	**Adult HI**	**Child HI**
Lot 1	1 x 10^{-6}	0.08	0.2
Lot 57	**4 x 10^{-6}**	0.5	0.9
Lot 58	4 x 10^{-7}	0.2	0.7
Lot 59	1 x 10^{-7}	0.01	0.02
Lot 60	4 x 10^{-7}	0.07	0.2
Lot 61	3 x 10^{-7}	0.3	0.5
Lot 62	**2 x 10^{-5}**	0.8	**2**
Lot 63	5 x 10^{-7}	0.4	0.6
Lot 64	**5 x 10^{-6}**	0.3	0.6
Lot 65	7 x 10^{-7}	0.6	1
Lot 66	2 x 10^{-7}	0.2	0.4
Lot 67	**2 x 10^{-6}**	0.3	0.6
Lot 68	1 x 10^{-6}	0.7	**2**
Lot 69	3 x 10^{-7}	0.07	0.1
Lot 70	**4 x 10^{-6}**	0.2	0.3

Since the off-site child resident HIs for soil exposure at or above the protection goal of 1 for Lot 62 and Lot 68, the toxic organ endpoint specific HIs for off-site child resident exposure at Lots 62 and 68 are listed below. All toxic endpoint specific off-site child resident HI estimates for soil are at or below the protection goal of 1.

Table 6-7~~6~~8~~.~~ Noncancer Toxic~~arget~~ Endpoint-Specific HIs for Future Off-Site Child Resident for Lot 62 and Lot 68
(HIs > 1 are bolded and shaded)~~Off-Site Resident Target Organ Specific HI for Lot 62 and Lot 68. The Specific HI are At or Below an HI = 1 Based on target Endpoints Listed.~~

Lot	Toxic Endpoint	HI
Lot 62	Cardiovascular	0.0002
	Dermal	0.0002
	Developmental/Reproductive	0.1
	Nervous	1
	Respiratory	1
Lot 68	Cardiovascular	0.7
	Dermal	0.0002
	Developmental/Reproductive	0.7
	Hepatic	0.002
	Immune	0.7
	Nervous	1
	Ocular	0.1
	Respiratory	0.0007

Additionally, the dispersion factor (Q/C) used to calculate the HI estimate for each property is based on an emission source area of 1.2 acres, which is the size of the largest property~~ at the Site~~, as discussed in Section ~~4.2.3.5.~~4.3.3.5. However, the area of ~~Lot~~Lots 62 ~~is~~and 68 are ~~actually 0.5~~0.5 acre each, as shown on Table 2-1. ~~The~~Use of a smaller area (i.e., more than half the area) to calculate the HI estimates would result in a lower HI estimate~~ calculated using this property-specific area is 1 (without segregating HQs), which meets USEPA's limits for RME risk, as shown in Appendix D.~~.

~~Table 6-17 shows the ~~The off-site resident cumulative cancer risk ~~estimates~~and HI estimates summarized below are the sum of the estimates for particulate and vapor inhalation calculated using soil data from all sampled depths for inhalation of vapor and particulates, to evaluate the scenario in which soil below the 0 to 2 ~~foot~~ft. depth interval is brought to the surface in the course of site redevelopment. ~~The ~~As shown below, the cumulative cancer risk estimates ~~for that scenario ~~range from 1 x 10^{-7} to 2 x 10^{-5}, which are at ~~each property are also~~or below NCP's risk range except for Lots 57, 62, 64, 67, and 70 which are within ~~USEPA's limits for RME~~NCP's risk range. The single-chemical cancer risks above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are naphthalene (Lots 57 and 62) and benzene (Lot 64) (see RAGS D Table 7). For adults, noncancer HIs range from 0.01 to 0.8, which are all below the protection goal of 1. For children, noncancer HIs range from 0.02 to 2, which are at or below the protection goal of 1 except for ~~Lot 62, as discussed above. ~~Lots 62 and 68 which have HIs of 2. No single-chemical HQs are above the protection goal of 1.

Table 6-779. Cancer Risks and Noncancer HIs for Future Off-Site Resident Exposure from Inhalation of Particulates and Vapors Released from Soil (All Sampled Depths)
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Off-Site Resident Cancer Risk and HI estimates for particulate and vapor inhalation calculated using soil data from all sampled depths for inhalation of vapor and particulates, to evaluate the scenario in which soil below the 0 to 2 ft. depth interval is brought to the surface in the course of site development. The Cancer Risks are Below or Within the NCP Risk Range and the Noncancer Hi for the Adult is below the Protection Goal of 1. The Noncancer Hi for the Child Exceeds the Protection Goal of 1 for Lots 62 and Lot 68 and the Hi for the Remaining Lots are At or Below the HI = 1.

As discussed in Section 6.2.2.1, risk

Lot	Adult/Child Risk	Adult HI	Child HI
Lot 1	1 x 10^{-6}	0.08	0.2
Lot 57	**4 x 10^{-6}**	0.5	0.9
Lot 58	4 x 10^{-7}	0.2	0.7
Lot 59	1 x 10^{-7}	0.01	0.02
Lot 60	4 x 10^{-7}	0.07	0.2
Lot 61	3 x 10^{-7}	0.3	0.5
Lot 62	**2 x 10^{-5}**	0.8	**2**
Lot 63	5 x 10^{-7}	0.4	0.6
Lot 64	**5 x 10^{-6}**	0.3	0.6
Lot 65	7 x 10^{-7}	0.6	1
Lot 66	2 x 10^{-7}	0.2	0.4
Lot 67	**2 x 10^{-6}**	0.3	0.6
Lot 68	1 x 10^{-6}	0.7	**2**
Lot 69	3 x 10^{-7}	0.06	0.1
Lot 70	**4 x 10^{-6}**	0.2	0.3

Since the off-site child resident HIs for soil exposure is at or above the protection goal of 1 for Lot 62 and Lot 68, the toxic organ endpoint specific HIs for off-site child resident exposure at Lots 62 and 68 are listed below. All toxic endpoint specific off-site child resident HI estimates for soil are at or below the protection goal of 1.

Table 6-780. Noncancer ToxicargetEndpoint Specific HIs for Future Off-Site Child Resident for Lot 62 and Lot 68. (HIs > 1 are bolded and shaded)Off-Site Resident Target Organ Specific HI for Lot 62 and Lot 68. The Specific HI are At or Below an HI = 1 Based on Target Endpoints Listed.

Lot	Toxic Endpoint	HI
Lot 62	Cardiovascular	0.0002
	Dermal	0.0002
	Developmental/Reproductive	0.1
	Nervous	1
	Respiratory	1
Lot 68	Cardiovascular	0.7
	Dermal	0.0002
	Developmental/Reproductive	0.7
	Hepatic	0.002
	Immune	0.7
	Nervous	1
	Ocular	0.1
	Respiratory	0.0007

For deep groundwater (site-wide) the cumulative cancer risk estimate is 7 x 10^{-4}, which is above NCP's risk range. The adult noncancer HI is 10 and the child noncancer HI is 20, which are above the protection goal of 1. The single-chemical cancer risks are above the lower end of NCP's risk range (10^{-6}) and single-chemical HQs are above the protection goal of 1 for a number ofseveral VOCs, SVOCs, and metals (see RAGS D Table 7). The toxic endpoint specific HI estimates are above the protection goal of 1 (see RAGS D Table 9). Therefore, risk and hazards from potable and nonpotable use of the deep groundwater, if to occur in the future, would be unacceptable. However, such groundwater use at the Site is unlikely since the Site and surrounding area are served by the City of Newark's potable water system.

If off-site residents were to have exposure to both soil (0 to 2 foot interval and in case subsurface soil is moved to the surface during site redevelopment) and groundwater in the future, the combined risk from these exposures would be unacceptable, and would be driven by risks from the use of groundwater (as indicated by Table 6-18).

6.2.2.86.2.2.9 Hypothetical Future Residents

Residential land use at the Site in the future is improbable since the Site is located within a dedicated industrial zone where residential use is not permitted, as discussed in Section 2.4.2.5. However, as required by USEPA Region 2, the BHHRA includes a hypothetical residential scenario which assumes the Site will have medium-density residential units like those west of McCarter Highwaythat west of

McCarter Highway, to facilitate development of appropriate institutional controls for the Site. For this purpose, the BHHRA evaluates, for each property, future residential soil exposure to contaminants in:in surface soil via incidental ingestion, dermal contact, and particulate inhalation; and surface and subsurface soil via vapor inhalation. These pathways are also evaluated for the scenario in which soil below the 0 to 2 footft. depth interval is brought to the surface in the course of site redevelopment. While indoors, potential inhalation exposures to surface and subsurface soil vapors or shallow groundwater vapors may occur if vapors migrate through building foundations.

Cancer Risks and Noncancer HI. As discussed in Section 4.3.6, noncancer risks for scenarios that include exposure during childhood years (under 6 years old) are calculated using an exposure duration of 6 years (i.e., child only) even if the scenario includes exposure during later years. As discussed in Section 6.3.3, chronic noncancer toxicity values are used to calculate risk estimates even though the 6-year period is considered subchronic, as required by USEPA Region 2 which can be overly conservative depending on the chemical according to USEPA 1996.

The future residents' cumulative cancer risk and HI estimates while outdoors summarized on Table 6-9below are the sum of the estimates for ingestion, dermal contact, and particulate inhalation calculated using soil data from the 0 to 2 footft. depth interval, and the estimate for vapor inhalation calculated using soil data from all sampled depths. As, as shown on Table 6-9, thesebelow.

- The cumulative cancer risk estimates for each property exceed USEPA's limits for RME risksrange from 2 x 10^{-5} to 2 x 10^{-4}, which are all within NCP's risk range except atfor Lot 59. The estimates of unacceptable67 which is above NCP's risk are due to a number of VOCs, SVOCs, PCBs, metals and dioxins (only at Lot 70range. The single-chemical cancer risks above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are arsenic (all lots), benzene (Lot 64), trichloroethene (Lot 68), PAHs[41] (all lots), PCBs (Lots 57, 59, 64, 67, 69 and 70), and 2,3,7,8-tetrachlorodibenzo-p-dioxin (Lots 60, 64, 66, 69 and 70) (see RAGS D Table 7).

- Table 6-17 shows the residents' cumulative risk estimates while outdoors calculated using soil data from all sampled depths for all routes of exposure, toFor adults, noncancer HIs range from 0.1 to 2, which are below the protection goal of 1 except for Lot 63 which is above the protection goal. Single-chemical HQs are at or below the protection goal.

- For children, noncancer HIs range from 1 to 20, which are above the protection goal of 1 except for Lot 59 which is at the protection goal. The single-chemical HQs above the protection goal of 1 are metals[42] (Lots 58, 61, 63, 65, 67, 68, and 69), benzo(a)pyrene (Lot 67), naphthalene (Lot 62), PCBs (Lot 57, 65, 67, and 70), 2,3,7,8-tetrachlorodibenzo-p-dioxin (Lots 60 and 70) (see RAGS D Table 7).

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[41] Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, naphthalene

[42] Antimony, arsenic, cobalt, copper (predominant), cyanide, mercury and vanadium.

Table 6-7981. Cancer risks and Noncancer HIs for Hypothetical Future Resident Exposure to Soil (0 to 2 ft.) through Ingestion, Dermal Contact, Inhalation of Particulates and Inhalation of Vapors Released from Soil (All Sampled Depths)
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Future resident cancer risk and noncancer HI estimates from exposure while outdoors. Exposure estimates are based on ingestion, dermal contact, and particulate inhalation calculated using soil data from the 0 to 2 ft. depth interval, and the estimate for vapor inhalation calculated using soil data from all sampled depths . The Cancer Risks are Within the Risk Range Except for Lot 67 Where the Risk is 2 x 10-4. The Noncancer HI are At or Below the HI for the Adult at All Lots Except Lot 63. The HI of 1 for the Child Exceeds the Goal of Protection of 1 at All Properties Except Lot 59.

Lot	Adult/Child Risk	Adult HI	Child HI
Lot 1	**5 x 10^{-5}**	0.2	**2**
Lot 57	**8 x 10^{-5}**	1	**5**
Lot 58	**2 x 10^{-5}**	0.9	**8**
Lot 59	**2 x 10^{-5}**	0.1	1
Lot 60	**6 x 10^{-5}**	0.3	**2**
Lot 61	**1 x 10^{-4}**	0.7	**5**
Lot 62	**1 x 10^{-4}**	1	**3**
Lot 63	**9 x 10^{-5}**	**2**	**20**
Lot 64	**4 x 10^{-5}**	0.5	**3**
Lot 65	**7 x 10^{-5}**	1	**5**
Lot 66	**2 x 10^{-5}**	0.4	**2**
Lot 67	**2 x 10^{-4}**	1	**10**
Lot 68	**4 x 10^{-5}**	1	**8**
Lot 69	**1 x 10^{-4}**	0.6	**6**
Lot 70	**1 x 10^{-4}**	1	**10**

To evaluate the scenario in which soil below the 0 to 2 footft. depth interval is brought to the surface in the course of site redevelopment. , residents' cumulative cancer risk and HI estimates are the sum of the estimates for ingestion, dermal contact, vapor and particulate inhalation calculated using soil data from all sampled depths, as shown below.

- The cumulative risk estimates for that scenario at each property also exceed USEPA's limits for RME risks except at Lot 1 and Lots 59. These estimates of unacceptable risks are also due to a number of VOCs, SVOCs, PCBs, metals and dioxins (only at Lot 70). cancer risk estimates range from 1 x 10^{-5} to 1 x 10^{-4}, which are all at or within NCP's risk range. The single-chemical cancer risks above the lower end of NCP's risk range (10^{-6}), but at or below the upper-end of NCP's risk range (10^{-4}), are arsenic (all lots), benzene (Lot 64), vinyl chloride

(Lot 68), bis(2-Ethylhexyl)phthalate (Lot 58), PAHs[414234] (all lots), PCBs (Lots 57, 65, 67 and 70), and 2,3,7,8-tetrachlorodibenzo-p-dioxin (Lots 60, 64, 66, 69 and 70) (see RAGS D Table 7).

- For adults, noncancer HIs range from 0.1 to 2, which are below the protection goal of 1 except for Lot 70 which is above the protection goal. Single-chemical HQs are below the protection goal.

- For children, noncancer HIs range from 1 to 20, which are above the protection goal of 1 except for Lot 59 which is at the protection goal. The single-chemical HQs above the protection goal of 1 are metals[43] (Lots 58, 61, 63, 65, 67, 68, and 69), naphthalene (Lot 62), PCBs (Lot 57, 65, 67, and 70), 2,3,7,8-tetrachlorodibenzo-p-dioxin (Lots 60 and 70) (see RAGS D Table 7).

Table 6-802. Cancer risks and Noncancer HIs for Hypothetical Future Resident Exposure to Soil (0 to 2 ft.) through Ingestion, Dermal Contact, and Inhalation of Particulates and Vapors Released from Soil (All Sampled Depths)
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Future resident cancer risk and noncancer HI estimates from exposure to soil below the 0 to 2 Ft. Depth Interval Brought to the Surface During Site Development. Exposure estimates are based on ingestion, dermal contact, vapor and particulate inhalation calculated using soil data from all sampled depths. The Cancer Risks are Within the Risk Range for the Adult/Child. The Noncancer HI for the Adult are At or Below the HI for All Lots Except Lot 70 where the HI = 2. The HI of 1 for the Child Exceeds the Goal of Protection of 1 at All Properties Except Lot 1 (HI = 1) and Lot 59 (HI = 1).

[43] Antimony, arsenic, copper (predominant), cyanide, mercury and vanadium.

Lot	Adult/Child Risk	Adult HI	Child HI
Lot 1	**4 x 10^{-5}**	0.2	1
Lot 57	**1 x 10^{-4}**	1	**6**
Lot 58	**2 x 10^{-5}**	0.6	**5**
Lot 59	**1 x 10^{-5}**	0.1	1
Lot 60	**5 x 10^{-5}**	0.3	**2**
Lot 61	**1 x 10^{-4}**	0.7	**5**
Lot 62	**1 x 10^{-4}**	1	**3**
Lot 63	**1 x 10^{-4}**	1	**10**
Lot 64	**4 x 10^{-5}**	0.5	**3**
Lot 65	**6 x 10^{-5}**	1	**5**
Lot 66	**4 x 10^{-5}**	0.5	**3**
Lot 67	**1 x 10^{-4}**	1	**8**
Lot 68	**3 x 10^{-5}**	1	**8**
Lot 69	**6 x 10^{-5}**	0.4	**4**
Lot 70	**1 x 10^{-4}**	**2**	**20**

Lead. The exposure to lead in soil may be assessed by comparing the average lead concentration at each property to the USEPA Region 2 residential lead screening level of 200 mg/kg. As shown ~~on Table 6-10~~below, the average concentration for each property for the 0 to 2 ~~foot~~ft. interval exceeds the residential screening level at each property, except for Lots 60 and 66. The estimated portion of the blood lead distribution for child resident for the 0 to 2 ft. depth interval exceeding the 5 ug/dL level is greater than 5% at each property except Lots 60 and 66.

Table 6-8~~13.~~ Average Lead Concentrations in Surface Soil (PbS) and IEUBK Model Estimated Probabilities (P) that PbB_{fetal} > PbB_t for Hypothetical Future Child Residents Exposed to the PbS Concentrations
(PbS > 200 mg/kg and P > 5% are bolded and shaded)~~Average Lead Concentration Calculated for the Future Resident Using Soil Data from Depths of 0 to 2 Ft. Compared to USEPA Region 2 Residential Screening Level Of 200 mg/kg. At Each Property Except For Lot 60 and Lot 66 The Screening Level Was Exceeded. The estimated portion of the blood lead distribution for the child resident for the 0 to 2 ft. depth interval exceeding the 5 ug/dL level is greater than 5% at each property.~~

Lot	PbS (mg/kg)	P(PbB > PbB_t) (%)
Lot 1	580	40.4376
Lot 57	305	12.7937
Lot 58	466	28.7464
Lot 59	240	7.6324
Lot 60	185	4.2614
Lot 61	505	32.8069
Lot 62	567	39.1475
Lot 63	2,080	95.8699.6
Lot 64	616	43.9579
Lot 65	619	44.2379
Lot 66	129	1.925.8
Lot 67	429	24.8859
Lot 68	510	33.3269
Lot 69	343	16.2745
Lot 70	934	68.6493

As shown ~~on Table 6-10~~below, the average concentrations for the scenario in which subsurface soil is moved to the surface during site ~~re~~development exceed the residential screening level at each property except at Lots 59 and 60.

~~As shown on Table 6-16, the estimated portion of the blood lead distribution for child resident for the 0 to 2 foot depth interval at each property exceeding the 5 ug/dl level is greater than 5% . As shown on Table 6-16, the~~The estimated portion of the blood lead distribution for child ~~visitors~~residents for the scenario that subsurface soil is moved to the surface during site ~~re~~development ~~at each property~~ exceeding the 5 ug/~~dl~~dL level is greater than 5~~%.~~% at each property except Lots 59 and 60.

Table 6-824. Average Lead Concentrations in Soil from All Sample Depths (PbS) and IEUBK Model Estimated Probabilities (P) that PbB_{fetal} > PbB_t for Hypothetical Future Child Residents Exposed to the PbS Concentrations (PbS > 200 mg/kg and P > 5% are bolded and shaded)Average Lead Concentration Calculated for the Future Resident Using Subsurface Soil Data Compared to USEPA Region 2 Residential Screening Level Of 200 mg/kg. At Each Property Except For Lot 59, Lot 60 and Lot 66 The Screening Level Was Exceeded. The estimated portion of the blood lead distribution for the child resident Exposed to Subsurface Soil exceeding the 5 ug/dL level is greater than 5% At all Lost Except Lot 59 and Lot 60.

Lot	**PbS** (mg/kg)	**P(PbB > PbB_t)** (%)
Lot 1	**426**	**24.5758**
Lot 57	**272**	**10.0331**
Lot 58	**318**	**13.9540**
Lot 59	153	2.799.0
Lot 60	171	3.5712
Lot 61	**500**	**32.2868**
Lot 62	**493**	**31.5567**
Lot 63	**2,530**	**97.8999.8**
Lot 64	**688**	**50.5884**
Lot 65	**510**	**33.3269**
Lot 66	**206**	**5.4218**
Lot 67	**395**	**21.3954**
Lot 68	**586**	**41.0377**
Lot 69	**241**	**7.7025**
Lot 70	**970**	**70.7094**

Cancer Risk and Noncancer HI. The residents' cumulative cancer risk and HI estimates for soil vapor intrusion are summarized on Table 6-9below for soil data from all sampled depths and Table 6-12 for shallow groundwater data. As shown on Table 6-9, the soil .

- The cumulative risk estimates for each property exceed USEPA's limits for RME risks except for Lot 59 and Lot 69. The cumulative risk estimates above USEPA's limit for RME risk are primarily from benzene, TCE, PCE, xylenes, naphthalene, and mercury. cancer risk estimates range from 3 x 10^{-6} to 1 x 10^{-2}, which are above NCP's risk range except for Lots 58, 59, 60, 61, 63, 65, 66 and 69 which are below NCP's risk range. The single-chemical cancer risks above the lower end of NCP's risk range (10^{-6}) are benzene (Lots 1, 57, 59, 63, 64, 68 and 70), trichloroethene (Lots 58, 60, 61, 63 and 68), tetrachloroethene (Lot 68), chloroform (Lot 64), naphthalene (Lots 1, 57, 62, 67 and 70), vinyl chloride (Lot 68), PCBs (Lots 57, 59, 64, 65, 66, 67, 69 and 70), and 2,3,7,8-tetrachlorodibenzo-p-dioxin (Lot 70) (see RAGS D Table 7).

As shown on Table 6-12, the cumulative risk estimates for shallow groundwater vapor intrusion are within USEPA's limits for RME risks except at Lots 57 and 58. For Lot 57, the cumulative cancer risk is

3 x 10^{-3} and the HI is 3, primarily from 1,2-dibromo-3-chloropropane, which was not detected in shallow groundwater at this property. 1,2-dibromo-3-chloropropane was identified as a COPC for site-wide groundwater based on one detection at Lot 69. Since 1,2-dibromo-3-chloropropane is a shallow groundwater site-wide COPC but not detected at Lot 57, one half of the maximum SQL was used as the EPC to calculate the risk estimates, as discussed in Section 4.2.2.4. The maximum SQL at Lot 57 is 0.44 mg/L, which is 1000 times higher than the SQLs for this chemical in the majority of the other groundwater samples. The SQL also far exceeds the one detected concentration at Lot 69 (0.001 mg/L), and therefore, could be considered unusually high for the matrix. The cumulative cancer risk and HI estimates for Lot 57 excluding 1,2-dibromo-3-chloropropane are 4 x 10^{-6} and 0.2, respectively, which are within USEPA's limits for RME risks.

- For Lot 58, For adults, the noncancer HIs range from 0.03 to 300, which are above the protection goal of 1 except for Lots 59 and 69. The single-chemical HQs above the protection goal are benzene (Lots 1 and 64), tetrachloroethene (Lot 68), trichloroethene (Lots 58, 60, 61 and 68), xylenes (Lots 58, 64, and 68), naphthalene (Lots 1, 57, 62, 67 and 70), cyanide (Lots 63, 65, 70), mercury (Lots 1, 57, 58, 61, 62, 63, 64 65, 66, 67, 68, and 70) (see RAGS D Table 7).

- For children, the noncancer HIs range from 0.04 to 300, which are above the protection goal of 1 except for Lots 59 and 69. The single-chemical HQs above the protection goal are the same as for adults with the addition of trichloroethene (Lots 63) (see RAGS D Table 7).

As discussed above, the single-chemical HQs for mercury and cyanide are above the protection goal of 1 for several properties. The use of an RfC for mercury and cyanide assumes that these metals are present in the volatile forms (i.e., elemental mercury and hydrogen cyanide). As discussed in Section 5.1, the type of mercury and cyanide present in the fill or used at the site is unknown and the analytical methods measures total concentrations, which could consist of various forms of inorganic mercury and cyanide. The use of an RfC to assess total mercury and total cyanide is conservative and may overestimate noncancer hazards from soil vapor intrusion depending on the form of mercury and cyanide actually presentpresent at the site. Mercury and cyanide contribute more than 50% to the total HI for soil vapor intrusion for Lots 63, 65 and 66. Excluding mercury and cyanide from the calculation of total HI, the adult HI is below the protection goal of 1 for Lots 63, 65 and 66 and the child HI is below the protection goal of 1 for Lots 65 and 66.

Table 6-835. Cancer risks and Noncancer HIs for Hypothetical Future Resident Exposure to Soil (All Sampled Depths) through Vapor Intrusion and Inhalation of Vapors Released from Soil (Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Future resident cancer risk and noncancer HI estimates from exposure to for soil vapor intrusion from all sampled depths. The cancer risk estimates are above the NCP's risk range at Lot 1, 57, 62, 64, 67, 68, and 70. The Cancer Risks at the remaining locate are at or within the risk range. The Noncancer HI for the Adult are At or Below the HI for All Lots Except Lot 70 where the HI = 2. The HI of 1 for the Adult Exceeds the Goal of Protection of 1 at All Properties Except Lot 59 (HI = 0.05) and Lot 69 (HI = 0.03), The HI of 1 for the Child is Exceeded at all Properties Except Lot 59 (HI = 0.1) and Lot 69 (HI = 0.04).

Lot	**Adult/Child Risk**	**Adult HI**	**Child HI**
Lot 1	**5 x 10^{-4}**	**10**	**20**
Lot 57	**1 x 10^{-3}**	**60**	**70**
Lot 58	**1 x 10^{-4}**	**100**	**300**
Lot 59	**5 x 10^{-6}**	0.05	0.1
Lot 60	**5 x 10^{-5}**	**20**	**50**
Lot 61	**5 x 10^{-5}**	**40**	**70**
Lot 62	**1 x 10^{-2}**	**300**	**300**
Lot 63	**9 x 10^{-6}**	**20**	**20**
Lot 64	**2 x 10^{-3}**	**70**	**200**
Lot 65	**2 x 10^{-5}**	**40**	**40**
Lot 66	**3 x 10^{-6}**	**30**	**30**
Lot 67	**4 x 10^{-4}**	**30**	**30**
Lot 68	**5 x 10^{-4}**	**200**	**500**
Lot 69	**4 x 10^{-6}**	0.03	0.04
Lot 70	**7 x 10^{-4}**	**20**	**30**

The residents' cumulative cancer risk and HI estimates for groundwater vapor intrusion are summarized below for shallow groundwater data. The cumulative cancer risk estimates range from 3 x 10^{-6} to 1 x 10^{-5}, which are within NCP's risk range. The single-chemical cancer risks above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are benzene (Lots 61 and 64), 1,2-dibromo-3-chloropropane (all lots) and naphthalene (Lots 58 and 59). For adult and children[44], the noncancer HIs range from 0.02 to 2, which are below the protection goal of 1 except for Lots 58 and 59 which are above the protection goal. The single-chemical HQ above the protection goal is xylenes at Lot 58 and 59 (see RAGS D Table 7).

Table 6-846. Cancer risks and Noncancer HIs for Hypothetical Future Resident Exposure to Groundwater through Inhalation of Vapors from Vapor Intrusion (Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)~~Future resident cancer risk and noncancer HI estimates from exposure to for groundwater vapor intrusion. The cancer risk estimates are with the NCP' risk range at all Lots. The Noncancer HI for the Adult are At or Below the HI for All Lots Except Lot 70 where the HI = 2. The HI of 1 for the Adult Exceeds the Goal of Protection of 1 at All Properties Except Lot 58 (HI = 2) and Lot 59 (HI = 2), The HI of 1 for the Child is Exceeded at Properties Lot 58 (HI = 2) and Lot 59 (HI = 2).~~

[44] The child and adult groundwater vapor intrusion HI estimates are the same since the EPCs are the same (i.e., groundwater source is assumed to be infinite) and the exposure time and frequency are the same (i.e., 2 hours day for 52 days a years).

Lot	Adult/Child Risk	Adult HI	Child HI
Lot 1	**3 x 10^{-6}**	0.01	0.01
Lot 57	**7 x 10^{-6}**	0.2	0.2
Lot 58	**5 x 10^{-6}**	**2**	**2**
Lot 59	**5 x 10^{-6}**	**2**	**2**
Lot 60	**3 x 10^{-6}**	0.02	0.02
Lot 61	**6 x 10^{-6}**	0.3	0.3
Lot 62	**3 x 10^{-6}**	0.01	0.01
Lot 63	**4 x 10^{-6}**	0.07	0.07
Lot 64	**6 x 10^{-6}**	0.3	0.3
Lot 65	**3 x 10^{-6}**	0.03	0.03
Lot 66	**3 x 10^{-6}**	0.01	0.01
Lot 67	**3 x 10^{-6}**	0.01	0.01
Lot 68	**3 x 10^{-6}**	0.02	0.02
Lot 69	**1 x 10^{-5}**	0.2	0.2
Lot 70	**3 x 10^{-6}**	0.02	0.02

For Lots 58 and 59, the HI of 2 is primarily from xylenes~~.~~ at Lot 58 (which are used to represent groundwater concentration at Lot 59 as discussed in Section 4.3.2.4). The EPC for xylenes is based on the maximum detected concentration since the UCL was greater than the maximum concentration. The maximum detected xylene concentration at Lot 58 (32.7 mg/L) is from the sample collected ~~in~~during Phase 2 at well MW-124. The next highest xylene concentration at Lot 58 is ~~2.51~~3.36 mg/L, which is ~~over~~almost 10 times lower.

~~If residents were to have exposure to soil while outdoors (0 to 2 foot interval and in case subsurface soil is moved to the surface during site redevelopment) and both soil and groundwater via vapor intrusion, the combined risk from these exposures would exceed USEPA's limits for RME risk for every property, as shown on Tables 6-13 and 6-19. Summing risk from both outdoor and indoor exposures greatly overestimates the risk since it would assume that~~ Risks from potable groundwater use by residents are ~~both (simultaneously) outdoors and indoors 24 hour a day.~~

~~Risk from potable and nonpotable groundwater use by residents (as well as other receptors) is~~ evaluated ~~by comparing the~~for shallow and deep groundwater ~~EPCs to the tap water RSLs (USEPA 2019)~~ to facilitate development of appropriate institutional controls for the Site. ~~As discussed in Section 6.2.2.1, risk from~~ If shallow or deep groundwater is used in the future, residents could be exposed through ingestion, dermal contact, and inhalation of vapors during potable ~~and nonpotable~~use. The cumulative cancer risk and HI for shallow groundwater potable use are shown below.

- The cumulative cancer risk estimates range from 7 x 10^{-4} to 4 x 10^{-3}, which are above NCP's risk range for every property, as shown below. The single-chemical cancer risks are above the lower end of NCP's risk range (10^{-6}) for ~~a number of~~several VOCs, SVOCs, PCBs, and metals at each of the 15 properties at the Site (see RAGS D Table 7). The highest risks (i.e., above the upper end of NCP's range) are for 1,3-dichloropropene (total), 1,2-dibromo-3-chloropropane, benzene, vinyl chloride, pentachlorophenol, benzo(a)pyrene, dibenz(a,h)anthracene, naphthalene, and arsenic.

- For adults, the noncancer HIs range from 5 to 200, which are above the protection goal of 1. The single-chemical HQs are above the protection goal of 1 for a number ofseveral VOCs, SVOCs, PCBs, and metals at each of the 15 properties at the Site (see RAGS D Table 7). The highest HQ (i.e., HQ above 10) are for trichloroethene, xylene, 1,2,4-trichlorobenzene, 2-hexanone, cyanide, and naphthalene.

- For children, the noncancer HIs range from 7 to 200, which are above the protection goal of 1. The single-chemical HQs are above the protection goal of 1 for a number ofseveral VOCs, SVOCs, PCBs, and metals at each of the 15 properties at the Site (see RAGS D Table 7). The highest HQ (i.e., HQ above 10) are for trichloroethene, 1,2,4-trichlorobenzene, 2-hexanone, xylene, naphthalene, cyanide, and iron.

Table 6-857. Cancer Risks and Noncancer HIs for Hypothetical Future Resident Exposure to Shallow and Deep Groundwater Assuming Potable Use
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Future Resident Cancer Risk and Noncancer Hazards From Consumption of Groundwater from Shallow and Deep Groundwater Assuming Future Site Development. The Cancer Risks Exceeded the Risk Range and Noncancer Hazards for the Adult and Child Exceeded the Protection Goal of 1.

Lot	Adult/Child Risk	Adult HI	Child HI
Lot 1	**1 x 10^{-3}**	**8**	**10**
Lot 57	**3 x 10^{-3}**	**50**	**70**
Lot 58	**3 x 10^{-3}**	**200**	**200**
Lot 59	**3 x 10^{-3}**	**200**	**200**
Lot 60	**1 x 10^{-3}**	**9**	**10**
Lot 61	**3 x 10^{-3}**	**60**	**70**
Lot 62	**9 x 10^{-4}**	**6**	**8**
Lot 63	**2 x 10^{-3}**	**30**	**40**
Lot 64	**3 x 10^{-3}**	**60**	**70**
Lot 65	**2 x 10^{-3}**	**10**	**10**
Lot 66	**1 x 10^{-3}**	**9**	**10**
Lot 67	**9 x 10^{-4}**	**5**	**7**
Lot 68	**1 x 10^{-3}**	**9**	**10**
Lot 69	**4 x 10^{-3}**	**60**	**60**
Lot 70	**9 x 10^{-4}**	**7**	**9**

For shallow groundwater exposure to lead, the maximum lead concentration for shallow groundwater is below the federal action limit of 0.015 mg/L at each property except Lots 57, 60, 63, 64, 67, and 69, as shown in Section 6.2.2.1.

For deep groundwater potable use (site-wide) the cumulative cancer risk estimate is 7 x 10^{-4}, which is above NCP's risk range. The adult noncancer HI is 10 and the child noncancer HI is 20, which are above the protection goal of 1. The single-chemical cancer risks are above the lower end of NCP's risk range (10^{-6}) benzene, chloroform, 1,4-dioxane, 1,1,2-trichloroethane, 1,1,2,2-tetrachloroethane, benzo(a)anthracene, benzo(a)pyrene, naphthalene, and arsenic. The single-chemical HQs are above the protection goal of 1 for arsenic, cyanide, iron, and manganese (see RAGS D Table 7). The toxic endpoint specific HI estimates are above the protection goal of 1 (see RAGS D Table 9).

Therefore, risk and hazards from potable use of the shallow and deep groundwater, if to occur in the future, would be unacceptable. However, such groundwater use at the Site is unlikely since site-specific conductivity readings of the shallow groundwater indicate possible brackish conditions, and the Site and surrounding area are served by the City of Newark's potable water system. In addition, Lots 67, 68 and 69 have restrictions in place against groundwater use.

If residents were to have exposure to soil while outdoors (0 to 2 foot interval and ft. interval) and both soil and shallow groundwater via vapor intrusion and potable shallow groundwater use in the future, the combined cumulative cancer risk estimates range from 1 x 10^{-3} to 1 x 10^{-2}, which are above NCP's risk range. For adults, the combined noncancer HIs range from 20 to 300, which are above the protection goal of 1. For children, the combined noncancer HIs range from 30 to 500, which are above the protection goal of 1.

Table 6-868. Cancer Risks and Noncancer HIs for Hypothetical Future Resident Exposure to Soil (0 to 2 ft.), Inhalation of Vapors Released from Soil (All Sampled Depths) and Shallow Groundwater via Vapor Intrusion, and Shallow Groundwater from Potable Use (Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)Future Resident Cancer Risks and Noncancer Hazards from Exposure to Soil while outdoors (0 to 2 ft. interval) and both soil and shallow groundwater via vapor intrusion and potable shallow groundwater use in the future By Lot. The combined cancer risk estimates range from 1 x 10^{-3} to 1 x 10^{-2} and exceed the NCP's risk range. For adults, the noncancer HIs range from 20 to 300, which are above the protection goal of 1. For children, the combined noncancer HIs range from 30 to 500, which are above the protection goal of 1.

Lot	Adult/Child Risk	Adult HI	Child HI
Lot 1	**2 x 10^{-3}**	**20**	**30**
Lot 57	**4 x 10^{-3}**	**100**	**100**
Lot 58	**3 x 10^{-3}**	**300**	**500**
Lot 59	**3 x 10^{-3}**	**200**	**200**
Lot 60	**1 x 10^{-3}**	**20**	**60**
Lot 61	**3 x 10^{-3}**	**100**	**200**
Lot 62	**1 x 10^{-2}**	**300**	**300**
Lot 63	**2 x 10^{-3}**	**50**	**80**
Lot 64	**5 x 10^{-3}**	**100**	**300**
Lot 65	**2 x 10^{-3}**	**60**	**60**
Lot 66	**1 x 10^{-3}**	**40**	**40**
Lot 67	**2 x 10^{-3}**	**40**	**50**
Lot 68	**1 x 10^{-3}**	**200**	**500**
Lot 69	**4 x 10^{-3}**	**60**	**70**
Lot 70	**2 x 10^{-3}**	**30**	**50**

If residents were to have exposure to soil while outdoors (in case subsurface soil is moved to the surface during site redevelopment) and both soil and shallow groundwater via vapor intrusion and potable and nonpotableshallow groundwater use in the future, the combined cumulative cancer risk estimates range from 1 x 10^{-3} to 1 x 10^{-2}, which are above NCP's risk range. For adults, the combined noncancer HIs range from 20 to 300, which are above the protection goal of 1. For children, the combined noncancer HIs range from 30 to 500, which are above the protection goal of 1.

Table 6-8~~79.~~ Cancer Risks and Noncancer HIs for Hypothetical Future Resident Exposure to Soil (All Sampled Depths), Shallow Groundwater via Vapor Intrusion, and Shallow Groundwater from Potable Use
(Risks > 1 x 10^{-6} are bolded. Risks > 1 x 10^{-4} and HIs > 1 are bolded and shaded)~~Future Resident Cancer Risks and Noncancer Hazards from Exposure to Subsurface Soil Moved During Future Development l and shallow groundwater via vapor intrusion and potable shallow groundwater use in the future By Lot. The combined cancer risk estimates for the Adult/Child Future Resident Range from 1 x 10^{-3} to 1 x 10^{-2}, and exceed the NCP's risk range. For adults, the noncancer HIs range from 20 to 300, which are above the protection goal of 1. For children, the combined noncancer HIs range from 30 to 500, which are above the protection goal of 1.~~

Lot	Adult/Child Risk	Adult HI	Child HI
Lot 1	**2 x 10^{-3}**	**20**	**30**
Lot 57	**4 x 10^{-3}**	**100**	**100**
Lot 58	**3 x 10^{-3}**	**300**	**500**
Lot 59	**3 x 10^{-3}**	**200**	**200**
Lot 60	**1 x 10^{-3}**	**20**	**70**
Lot 61	**3 x 10^{-3}**	**100**	**200**
Lot 62	**1 x 10^{-2}**	**300**	**300**
Lot 63	**2 x 10^{-3}**	**50**	**70**
Lot 64	**5 x 10^{-3}**	**100**	**300**
Lot 65	**2 x 10^{-3}**	**60**	**60**
Lot 66	**1 x 10^{-3}**	**40**	**40**
Lot 67	**1 x 10^{-3}**	**40**	**50**
Lot 68	**1 x 10^{-3}**	**200**	**500**
Lot 69	**4 x 10^{-3}**	**60**	**70**
Lot 70	**2 x 10^{-3}**	**30**	**50**

Since the HI for every property is above the protection goal of 1, the toxic endpoint specific HIs for future resident exposure at these ~~exposures would be unacceptable.~~ lots are shown on RAGS D Table 9. At least one toxic endpoint specific HI estimate is also above the protection goal of 1 at each property.

6.3 Uncertainty Analysis

The main areas of uncertainty associated with the risk estimates discussed in Section ~~6.2~~6.2 are discussed below. These areas of uncertainty relate to: data evaluation and screening (Section 6.3.1), exposure concentrations (Section ~~6.3.1);~~6.3.1.1); exposure factors (Section ~~6.3.2);~~6.3.3); toxicity values (Section ~~6.3.3);~~6.3.5); and risk characterization (Section ~~6.3.4).~~6.3.6).

~~6.3.11.1.1 Exposure Concentrations~~

6.3.1 ~~One factor that inflated some exposure concentrations~~Data Evaluation and ~~their associated estimates of site-related cancer risk and HIs is the assumption that all~~Screening

6.3.1.1 Chromium

As discussed in Section 3.2.1, total chromium concentrations are assessed as trivalent chromium because every soil and groundwater sample ~~was~~were analyzed for both hexavalent and total chromium, as required by USEPA Region 2. Any hexavalent chromium potentially present in the total chromium concentration is not accounted for based on consideration of analytical methods, and therefore, hazards for exposure to total chromium may be overestimated.

The impact of this assumption on the risk assessment is minimal since total chromium was not identified as a COPC. The maximum total chromium concentration in soil (479 mg/kg) is below the trivalent chromium residential RSL at THQ 0.1 (12,000 mg/kg) and the maximum total chromium concentration in groundwater (38.4 mg/L) is below the trivalent chromium tap water RSL at THQ 0.1 (2,200 mg/L).

6.3.1.2 Mercury

The most conservative screening level for mercury, which is mercury (elemental) (CAS 7439-97-6), is used to determine if mercury total is a COPC (Section 3.3). This screening level is conservatively used because the mercury analytical method measures total mercury concentration, which could consist of various forms of inorganic mercury including elemental mercury and mercuric chloride, and the type of mercury present in the fill or used at the site is unknown. If the RSL for mercuric chloride (7487-94-7) were used in screening instead, mercury would **not** be a COPC in shallow groundwater for the tap water pathway and in soil (Lots 1, 58, 62 and 70). If mercury was present as mercuric chloride (i.e., not elemental mercury), then the RME would be overestimated for these properties.

6.3.1.3 Nondetected Results Screening

As discussed in Section 3.3, only detected concentrations were used to determine COPCs, which potentially underestimates risks and hazards is chemicals are present at concentrations under the SQL. The SQLs for chemicals not detected in soil, SQLs for chemicals not detected in shallow groundwater, and SQLs for chemicals not detected in deep groundwater are compared to the screening levels outlined in Section 3.3 to determine if additional COPCs would be identified assuming chemicals would be present at concentrations below the SQLs. In soil, the SQLs for 5 VOCs and 6 SVOCs exceed the residential RSLs. In shallow groundwater, the SQLs for 1 metal, 8 VOCs, and 24 SVOCs exceed the tap water RSLs and/or the USEPA VISLs, and in deep groundwater the SQLs for 2 VOCs, 19 SVOCs, PCBs total, and 3 metals exceed the tap water RSLs. The counts of the SQLs that exceed the screening levels over the total number of analyses are summarized by matrix below. The SQLs compared to the screening levels are shown in Appendix F Attachment H.

Chem Group	Chemical	Soil	Shallow Groundwater	Deep Groundwater
VOC	1,1,2-Trichloroethane	3/188	--	NE
VOC	1,2,3-Trichlorobenzene	--	2/92	NE
VOC	1,2-Dibromo-3-chloropropane	--	--	5/5
VOC	1,2-Dibromoethane	33/188	92/92	5/5
VOC	1,2-Dichloroethane	1/191	3/92	NE
VOC	Bromochloromethane	NE	1/92	NE
VOC	Bromodichloromethane	3/188	--	NE
VOC	Bromoform	--	3/92	NE
VOC	Bromomethane	1/191	6/92	NE
VOC	Chloromethane	NE	2/92	NE
VOC	Dichlorodifluoromethane	NE	4/92	NE
SVOC	1,1-Biphenyl	--	--	5/5
SVOC	1,2,4,5-Tetrachlorobenzene	NE	89/89	5/5
SVOC	2,3,4,6-Tetrachlorophenol	NE	1/89	NE
SVOC	2,4,6-Trichlorophenol	NE	89/89	5/5
SVOC	2,4-Dichlorophenol	NE	8/89	NE
SVOC	2,4-Dinitrophenol	NE	12/91	NE
SVOC	2,4-Dinitrotoluene	NE	91/91	5/5
SVOC	2,6-Dinitrotoluene	NE	91/91	5/5
SVOC	2-Chlorophenol	NE	6/90	NE
SVOC	2-Nitroaniline	--	1/91	NE
SVOC	3,3'-Dichlorobenzidine	1/193	91/91	5/5
SVOC	3-Nitroaniline	NE	8/91	NE
SVOC	4,6-Dinitro-2-methylphenol	3/193	91/91	5/5
SVOC	4-Chloroaniline	NE	--	5/5
SVOC	4-Nitroaniline	--	8/91	NE
SVOC	Atrazine	--	90/90	5/5
SVOC	bis(2-Chloroethoxy)methane	NE	7/90	NE
SVOC	bis(2-Chloroethyl) ether	1/193	90/90	5/5
SVOC	Dibenz(a,h)anthracene	--	--	1/5
SVOC	Dibenzofuran	--	--	5/5
SVOC	Di-n-octylphthalate	--	1/91	NE
SVOC	Hexachlorobenzene	5/193	90/90	5/5
SVOC	Hexachlorobutadiene	NE	89/89	5/5
SVOC	Hexachlorocyclopentadiene	15/193	91/91	5/5
SVOC	Hexachloroethane	--	91/91	5/5
SVOC	Nitrobenzene	--	91/91	5/5
SVOC	N-Nitroso-di-n-propylamine	14/193	91/91	5/5
SVOC	N-Nitrosodiphenylamine	--	6/91	NE
SVOC	Pentachlorophenol	--	--	5/5
PCB	PCBs (total)	--	--	5/5

Chem Group	Chemical	Soil	Shallow Groundwater	Deep Groundwater
INORG	Chromium VI	--	--	5/5
INORG	Mercury	--	--	5/5
INORG	Thallium	--	91/91	5/5
Notes: -- - Not analyzed. NE - No exceedances.				

For chemicals not detected in the matrix, the majority of SQLs that exceed screening levels are SVOCs in shallow and deep groundwater. It is unknown if these compounds are related to releases at the Site. Since these chemicals may be present at concentrations below the SQLs but were not identified as COPCs, the RME might be underestimated. As shown by the screening comparison in Appendix F, however, the expected magnitude of this bias is anticipated to be low, particularly for soil.

6.3.2 Exposure Concentrations

~~site-related.~~ For the calculation of cancer risk and noncancer ~~risks~~HI in this risk assessment, the concentrations of all COPCs are assumed to be site-related, as required by USEPA Region 2. This assumption results in higher estimates of site-related risk for inorganic COPCs which have naturally occurring concentrations. As discussed in Section 4.3.2.4, there is no data to directly evaluate exposure to shallow groundwater at Lots 59 and 61. Cancer risk and HI for these two lots were estimated using shallow groundwater cancer risks and HI from the adjacent lots with the highest risk estimates (Lot 58 is used to assess Lot 59 and Lot 64 was used to assess Lot 61). While the shallow groundwater risks for these two lots are expected to be similar to those for the adjacent lots, shallow groundwater risks for Lots 59 and 61 might be overestimated since temporary well points were installed at these properties (B-18 and B-68) and it was decided to not install monitoring wells. Additional uncertainties regarding exposure concentrations are hot spots (Section ~~6.3.1.1),~~6.3.2.1), nondetected results (Section ~~6.3.1.2),~~6.3.2.2), rejected data (Section ~~6.3.1.3),~~6.3.2.3), and off-site air modeling (Section ~~6.3.4).~~6.3.2.4).

~~6.3.1.1~~6.3.2.1 Hot Spots

RAGS Part A (USEPA 1989) described "hot spots" as areas of very high contaminant concentrations relative to other areas of a site. If a hot spot is located near an area ~~where~~which, because of the site or population characteristics, is visited more frequently, exposure to the hot spot should be assessed separately (USEPA 1989). For this BHHRA, the potential for hot spots at each of the 15 properties ~~were identified~~was evaluated by using the outlier tests in ProUCL, as required by USEPA Region 2. ~~Specifically, upper outliers in each dataset that was used in EPC calculations were identified with the Dixon test if the sample size~~ A stepwise process of this analysis is ~~25 or less, or with the Rosner test if the sample size is larger than 25. The Rosner test was performed to identify up to 10 outliers in a dataset. The outliers identified by ProUCL are listed in Appendix G, and the number of outliers identified in each dataset is listed~~shown below~~:~~.

- ~~Soil: 0 to 2 ft. interval – 181 outliers at 56 boring locations.~~
- ~~Soil: 0 to 4 ft. interval – 191 outliers at 60 boring locations.~~

Soil: The hot spot analysis is only applicable to on-site receptors, since the migration of on-site contaminants off-site does not meet the definition of a hot spot as described above. The hot spot analysis was also not conducted for potable groundwater use since shallow and deep groundwater potable risks are calculated using maximum detected concentrations (See Section 4.3.2.4), not UCLs. Additionally, all the risk and HI estimates calculated for potable groundwater are either at or are above the upper-endupper end of NCP's risk range of (1×10^{-4}) and/or the hazard protection goal of 1. Therefore, the RME risks from potable use of shallow and deep groundwater at all Lots, if to occur in the future, are already identified as unacceptable. Additionally, calculating hot spots for groundwater potable use is not applicable since potable groundwater is a mobile medium and mixed, particularly for public water supply, which homogenizes the distribution of contaminants, thus not meeting the definition of a hot spot in RAGS Part A (USEPA 1989).

STEP 1: ProUCL Outlier Analysis

The datasets used in the EPC calculations (i.e., 0 to 2 ft. depth, 0 to 4 ft. depth and all depths for soil and shallow groundwater; see Appendix E, Attachment 3) were used to identify outliers with USEPA's ProUCL software using the Rosner or Dixon outlier tests at the 5% significance level.

- Rosner outlier tests were run on datasets with a sample size greater than 25, and25 and were performed to identify up to 10 outliers in a dataset. ProUCL output from these tests can be found in Appendix G, Attachment 4.
- Dixon outlier tests were run on datasets with a sample size less than or equal to 25. Only outliers identified in the right tail of the distribution by ProUCL were selected as outliers in this analysis. ProUCL output from these tests can be found in Appendix G, Attachment 4.
- Consistent with the ProUCL technical guidance (USEPA 2015c), non-detected results were included in the outlier datasets as half the SQL. These half SQLs for non-detected values were only identified as outliers within the Rosner outlier tests since these tests identify up to 10 outliers within a dataset which can include nondetected results.

The results of these ProUCL outlier tests identifying outliers within the full EPC dataset are found in Appendix G, Attachment G.3. The number of outliers identified in each matrix and depth interval is listed below:

- Soil for COPCs except lead:
    - 0 to 2 ft. interval – 167 outliers at 56 boring locations out of 2,336 total results at 95 borings used to calculate the UCLs (see Appendix G, Attachment G.3.2)
    - 0 to 4 ft. interval – 183 outliers at 59 boring locations out of 2,869 total results at 101 borings used to calculate the UCLs (see Appendix G, Attachment G.3.3)
    - All depths interval – 251 – 228 outliers at 69 66 boring- locations. out of 3,728 total results at 101 borings used to calculate the UCLs (see Appendix G, Attachment G.3.4)
- Soil Lead:
    - 0 to 2 ft. interval – 8 outliers out of 120 total results at 87 borings used to calculate the EPCs (see Appendix G, Attachment G.3.5)
    - 0 to 4 ft. interval – 10 outliers out of 146 total results at 93 borings used to calculate the EPCs (see Appendix G, Attachment G.3.5)
    - All depths interval – 11 outliers out of 193 total results at 93 borings used to calculate the EPCs (see Appendix G, Attachment G.3.5)

- Shallow Groundwater – 208 for COPCs except lead – 263[45] outliers at 30 37 monitoring well locations. out of 4,446 total results at 31 well locations used to calculate the UCL (see Appendix G, Attachment G.3.1)

Because**STEP 2: Identification of Hot Spot Locations**

Since no information suggests that receptors are likely to visit these areas of higher COPC concentrations more frequently than other areas, use of the EPCs discussed in Section 4.2 is 4.3 is believed to be appropriate, conservative, and is consistent with the general assumption that receptors are expected to have equal probability of exposure everywhere within an exposure unit (USEPA 1989).

However, an uncertainty analysis was performed to assess how the risk characterization results discussed in Section 6.2 6.2 might materially change if receptors were to visit the hot spots more frequently than other areas. Specifically,, as required by USEPA Region 2.

Locations with outliers identified using the results from the ProUCL outlier tests detailed in Step 1 were evaluated as "hot spot" locations for each receptorsthe specified depth interval and property combinationmatrix (i.e., 0 to 2 ft. soil, 0 to 4 ft. soil, all depth soil, and shallow groundwater). ProUCL is the software required by USEPA Region 2 for use in the identification of outliers, however as stated in the ProUCL technical guidance "robust outlier identification procedures are beyond the scope of the ProUCL software", (USEPA 2015c) so underlying assumptions and limitations of the outlier tests should be considered in the interpretation of the outlier results calculated by ProUCL.

- Within the ProUCL software both Rosner and Dixon tests require that has the underlying dataset without outliers is normally distributed. Environmental datasets are rarely normally distributed, and this assumption can lead to the misidentification of outliers in datasets with nonparametric distributions (USEPA 2015c).

- The Dixon test for outliers available in ProUCL looks for one outlier in each tail of the dataset. This assumption can lead masking effects, where multiple outliers mask the occurrence of an individual outlier present in the dataset.

- The Rosner test for outliers requires that the number of outliers be identified prior to running the test, up to 10 possible outliers. As indicated in the Pro UCL Technical guidance, Rosner Tests also suffer from masking effects, where some extreme outliers mask the occurrence of other intermediate outliers (USEPA 2015c).

STEP 3: Cancer Risk and HI Calculations and Lead Analysis

Cancer risk and HI estimates were calculated assuming the receptor spends the entire exposure period at the hot spot location. These cumulative cancer risk and HI estimates that are within USEPA's limitswere calculated for RME risk (as discussedeach "hot spot" location using all COPCs identified in Section 6.2), the potential significance of the hot spots at 3.3 for that property was assessed by assuming and/or matrix, regardless of whether each COPC was identified as an outlier. These cancer risk and HI estimates were calculated using the maximum detected COPC concentration within the

[45] As discussed in Section 4.3.2.4, there are no shallow groundwater wells on Lots 59 and 61. Groundwater data from Lot 58 is used to assess Lot 59 and groundwater data from Lot 64 was used to assess Lot 61. Therefore, outliers from these properties are double counted. Excluding the outliers for Lots 59 and 61, there are 207 outliers at 30 locations in the shallow groundwater.

specified matrix and depth interval at each "hot spot" location. Consistent with Section 4.3.2, if a COPC was not detected at the "hot spot" location and depth interval, ½ the maximum SQL at that the receptor spends the entire period of exposure at those hot spots.location and depth interval was used. The cumulative cancer and HI estimates calculated for each location based on thisthese extreme assumptionassumptions are considered maximal upper-bound rather than RME risk estimates. These upper (see Appendix G, Attachment G.1).

For lead, the maximum lead concentration at each "hot spot" soil location within the specified depth interval was used for the uncertainty analysis. These concentrations are screened against USEPA Region 2 residential and nonresidential soil screening levels of 200 and 800 mg/kg, respectively(see Appendix G, Attachment G.3.5).

Instances where identified hot spots would not materially change the risk characterization results discussed in Section 6.2 (i.e., property/receptor combinations already identified as having a cumulative cancer risk above the upper-end of NCP's risk range of 1 x 10^{-4} and/or noncancer hazard protection goal of 1 after accounting for toxic-specific HI) were not calculated and are marked "NA" in Appendix G, Attachment 1.

Similarly, properties where the arithmetic mean lead concentration was above the USEPA Region 2 residential screening level of 200 mg/kg were not included in the residential lead uncertainty analysis. For nonresidential receptors, properties where the arithmetic mean lead concentration was above the USEPA Region 2 nonresidential screening level of 800 mg/kg (Lots 63 and 70) were not included in the non-residential lead uncertainty analysis. These instances are marked "NA" in Appendix G, Attachment G.3.5.

STEP 4: Assessment of Toxic Organ Endpoint Specific HIs

Next, toxic endpoint-specific HIs were assessed for "hot spot" location and receptor combinations with upper bound risk estimates and are presented in Appendix G. The HI estimates above NCP's protection goal of 1. The HI estimates are at or below NCP's protection goal of 1 for all receptors assessed using the 0 to 2 ft soil data set (see Appendix G, Attachment G.1.2), 0 to 4 ft soil data set (see Appendix G, Attachment G.1.3) and the shallow groundwater data set (see Appendix G, Attachment G.1.1). HI estimates are above NCP's protection goal of 1 for the all depths soil data set (see Appendix G, Attachment G.1.4) for the receptor and location combinations listed below. The toxic endpoint specific HI for these receptor and location combinations are also shown.

- Indoor worker soil vapor intrusion HI estimates are above the NCP's protection goal for Locations B-34, B-35 and B-74 which are in Lot 64. As shown below, the toxic-organ specific endpoint specific HI are above the protection goal for Locations B-34 and B-74. All toxic-endpoint specific HI are below the protection goal for B-35.

Location	**Toxic Endpoint**	**HI**
B-34	Cardiovascular	0.2
	Developmental/Reproductive	0.2
	Immune	0.2
	Nasal Epithelium	0.01
	Nervous	**2**
B-35	Cardiovascular	0.03
	Developmental/Reproductive	0.04
	Immune	0.9
	Nasal Epithelium	0.002
	Nervous	0.9
B-74	Cardiovascular	0.03
	Developmental/Reproductive	0.04
	Immune	**4**
	Nasal Epithelium	0.001
	Nervous	0.3

- Construction worker HI estimates are above the protection goal for Location B-94 in Lot 64 and Location B-80 in Lot 68. As shown below, the toxic-endpoint specific HI are above the protection goal for ~~both of these~~both locations.

Location	**Toxic Endpoint**	**HI**
B-94	Cardiovascular	0.02
	Dermal	0.01
	Developmental/Reproductive	0.05
	Ear	0.00003
	Endocrine	0.01
	Gastrointestinal	0.04
	Hematologic	0.04
	Hepatic	0.00002
	Immune	0.01
	Nasal Epithelium	0.0004
	Nervous	**3**
	Other	0.03
	Respiratory	0.03
	Urinary	0.004
B-80	Cardiovascular	**2**
	Dermal	0.02
	Developmental/Reproductive	**2**
	Ear	0.00001
	Endocrine	0.005
	Gastrointestinal	0.1
	Hematologic	0.02
	Hepatic	0.0007
	Immune	**2**
	Nervous	1
	Ocular	0.3
	Other	0.01
	Respiratory	0.03
	Urinary	0.02

- Child visitor vapor intrusion HI estimate is above the protection goal for Location B-80 at Lot 68. As shown below, the toxic-endpoint specific HI are above the protection goal.

Location	Toxic Endpoint	HI
B-80	Cardiovascular	2
	Developmental/Reproductive	2
	Hepatic	0.001
	Immune	2
	Nervous	0.3
	Ocular	0.3

- Child visitor outdoor exposure HI estimate is above the protection goal for Location B-33 at Lot 63. As shown below, the toxic-endpoint specific HI are above the protection goal.

Location	Toxic Endpoint	HI
B-33	Cardiovascular	0.02
	Dermal	0.05
	Developmental/Reproductive	0.03
	Endocrine	0.4
	Gastrointestinal	2
	Hematologic	0.04
	Immune	0.06
	Nervous	0.03
	Ocular	0.03
	Other	0.06
	Respiratory	0.00005
	Urinary	0.01

- Child resident outdoor exposure HI estimate is above the protection goal for Location B-98 for Lot 1. As shown below, the toxic-endpoint specific HI are all below the protection goal.

Location	Toxic Endpoint	HI
B-98	Cardiovascular	0.2
	Dermal	0.2
	Developmental/Reproductive	0.3
	Endocrine	0.4
	Gastrointestinal	0.4
	Hematologic	0.3
	Hepatic	0.00000001
	Immune	0.02
	Nervous	0.3
	Other	0.3
	Respiratory	0.004
	Urinary	0.02

STEP 5: Hot Spot Analysis Results

Considering the above toxic endpoint-specific HIs, the following is a summary of the results for each dataset:

- For 0 to 2 ft. soil, the upper-bound cumulative cancer risk and HI estimates are within USEPA's limit for RME risk.

For the 0 to 4 ft. soil, the upper-bound cumulative cancer risk and HI estimates arefor each dataset:

For 0 to 2 ft. soil data sets (see Appendix G, Attachment G. 1.2) used to assess exposures for outdoor worker, indoor worker (dust), trespassers, visitors (outdoors) and future residents:

- All cumulative cancer risk estimates within USEPA's limit for RME risk.NCP's risk range (1 x 10^{-4} to 1 x 10^{-6}) for hot spot locations were already identified as such for the property and receptor combinations in Section 6.2.2.
- For all depths soil,Cumulative cancer risk estimates are below the upper-boundend of NCP's risk range (1 x 10^{-4}) for all hot spot locations.
- HI are below NCP's protection goal of 1 for all hot spot locations.
- Therefore, the hotspot analysis did not affect the risk assessment conclusions for the 0 to 2 ft data sets.

For the 0 to 4 ft. soil data sets (see Appendix G, Attachment G.1.3) used to assess utility worker exposures:

- All cumulative cancer risk and HI estimates are within USEPA's limit for RME risk except for: estimates within NCP's risk range (1 x 10^{-4} to 1 x 10^{-6}) for hot spot locations were already identified as such for the property and receptor combinations in Section 6.2.2.
- Cumulative cancer risk estimates are below the upper-endupper end of NCP's risk range (1 x 10^{-4}) for all hot spot locations.
- HI are below NCP's protection goal of 1 for all hot spot locations.
- Therefore, the hotspot analysis did not affect the risk assessment conclusions for the 0 to 4 ft data sets.

For all depths soil data sets (see Appendix G, Attachment G.1.4) used to assess construction worker exposures, soil vapor intrusion exposures, and assess exposure if subsurface soil is moved to the surface during site redevelopment for outdoor worker, indoor worker (dust), trespassers, visitors (outdoors) and future residents:

- Cumulative cancer risk estimates within NCP's risk range (1 x 10^{-4} to 1 x 10^{-6}) for hot spot locations which were not already identified as such for the property and receptor combinations in Section 6.2.2 are listed below.
    - Construction worker HI of 3: Location B-74 at Lot 64, location primarily from benzene

- Visitor vapor intrusion: Locations B-56 and B-80 at Lot 68 primarily from vinyl chloride

- Cumulative cancer risk estimates above the upper-end of NCP's risk range (1 x 10^{-4}) for hot spot locations which were not already identified as such for the property and receptor combinations in Section 6.2.2 are listed below.

  - Indoor worker vapor intrusion: Location B-74 at Lot 64 primarily from benzene

- HI estimates above NCP's protection goal of 1 for hot spot locations (after accounting for toxic-endpoint HI in Step 4) which were not already identified as such for the property and receptor combinations in Section 6.2.2 are listed below.

  - Indoor worker soil vapor intrusion: Locations B-34 (primarily from xylene) and B-74 (primarily from benzene) at Lot 64.

Construction worker: Location B-94 in Lot 64 (primarily from manganese) and Location B-80 in

Construction worker HI of 2 at Lot 68, location B-60 (primarily from manganese

- Construction worker HI of 3 at Lot 68, B-80 primarily from PCE, TCE and mercury in the surface sample).

- Resident – outdoors HI of 2 at Lot 1, location B-98 primarily from benzo(a)pyrene (HQ of 0.26) and metals (aluminum (HQ of 0.22), antimony (HQ of 0.27), arsenic (HQ of 0.15), cobalt (HQ of 0.37) and iron (HQ of 0.35)). The metal concentrations at B-98 are near or below 90th percentile background values for soil in this region of New Jersey (BEM Systems, Inc. 1997 as referenced in NJDEP 2003), as show in Appendix D.

- For shallow groundwater, the upper-bound cumulative cancer risk and HI estimates are within USEPA's limit for RME risk.

  - The above summary shows that only four hot spots have an upper-bound risk above USEPA's limits for RME risk, and these are upper-bound HI estimates of 2 or 3 (three for construction workers and one for future on-site residents). Since there are no specific plans for construction at Lot 64 or Lot 68 (even though they are expected to be redeveloped soon), noChild visitor vapor intrusion: Location B-80 at Lot 68 (primarily from TCE).

  - Child visitor outdoor exposure: Location B-33 at Lot 63 (primarily from copper).

- Therefore, the hot spot analysis identified several outlier locations with cumulative cancer risk above NCP's risk range[46] or HI above NCP's protection goal for properties and receptor combinations that were not already identified in Section 6.2.2, as summarized below.

  - Indoor worker soil vapor intrusion at Locations B-34 (HI = 2) and B-74 (HI = 4) at Lot 64. This analysis assumes a that in the future a conservatively small building (10 m by 10 m) is located precisely at the hot spot locations and the maximum detected

[46] Cumulative cancer risk estimates within NCP's risk range (1 x 10^{-4} to 1 x 10^{-6}) for hot spot locations which were not already identified as such are construction workers at Location B-74 at Lot 64 and visitor vapor intrusion at Locations B-56 and B-80 at Lot 68.

concentration at that location is uniformly present under the building footprint and over the depth of the unsaturated zone, which is a highly conservative[EPA14], worst-case scenario. The maximum concentration of xylene at B-34 and benzene at B-74 are in the deeper soil sample while the concentrations in the shallower (0 to 1 ft.) samples are much lower[47]. Additionally, other borings are located within the 10 m by 10 m building footprint. Therefore, the total VOC mass is at least 2 to 4 times lower than assumed in the outlier analysis after accounting for other samples within the building footprint, which results in HI that are at or below the protection goal.

- Construction worker at Location B-94 at Lot 64 and Location B-80 at Lot 68 (both with HI =3). No reasonable basis exists for expecting that construction workers will spend preferentially spend 6 months at each of the identified isolated hot spots on thosethese properties. For , particularly since both locations are on property boundaries.

- Visitor vapor intrusion at Location B-80 at Lot 1, the future on-site residents68 (HI = 2). This property was already haveidentified in Section 6.2.2.2 as having an HI estimateindoor worker vapor intrusion HI above the protection goal and thus is already being addressed in the BHHRA.

- Child visitor outdoor exposure at B-33 at Lot 63 (HI = 3) under the scenario in which soil below the 0 to 2 ft. depth interval is brought to the surface in the course of 2site redevelopment. The HI is primarily from copper in the 0.5 to 1.5 ft. sample at B-33. Children under the age of 6 years old are unlikely to visit industrial properties at the frequency assumed (i.e., 52 days per year), as discussed in Section 6.3.3, and are particularly unlikely to visit one location (i.e., a hotspot) at that frequency. Additionally, this property was already identified in Section 6.2.2.6 as having a child visitor outdoor exposure HI above the protection goal for the 0 to 2 ft. depth interval (which is the depth interval with the high copper concentration).

- Given the above discussions, the hotspot analysis did not affect the risk assessment conclusions for the cumulative cancer risk and HI estimates for the all depth data sets.

For shallow groundwater data sets (see Appendix G, Attachment G.1.1):

- Cumulative cancer risk estimates within NCP's risk range (1×10^{-4} to 1×10^{-6}) for hot spot locations which were not already identified as such for the property and receptor combinations in Section 6.2.2 are listed below.
  - Utility worker: MW-108 at Lot 63, MW-106[48] at Lot 64, MW-101 at Lot 65 (primarily from PAHs), and MW-110 at Lot 63 (primarily from pentachlorophenol).

- Cumulative cancer risk estimates are below the upper-endupper end of NCP's risk range (1×10^{-4}) for all hot spot locations.

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[47] Xylene concentrations in soil at B-34 are 8.96 mg/kg from 0 to 1 ft. bgs and 92.7 mg/kg from 5 to 5.5 ft. bgs and benzene concentrations at B-74 are non-detect at 0 to 1 ft. bgs and 68 mg/kg at 3 to 4 ft. bgs.

[48] MW-106[48] from Lot 64 was used to assess groundwater exposures at Lot 61, as discussed in Section 4.3.2.4.

- HI are below NCP's protection goal of 1 for all hot spot locations.
- Therefore, the hotspot analysis did not affect the risk assessment conclusions for the shallow groundwater data sets except for four groundwater locations with cumulative cancer risk estimates within NCP's risk range.

Lead (see Appendix G, Attachment G.3.5)

- While lead outliers are discussed below, comparing maximum concentrations to screening levels is inconsistent with lead guidance. As USEPA explained in promulgating the regulations at 40 CFR Part 745 (66 FR 1206, January 5, 2001), soil lead screening levels developed based on blood lead modeling should be compared with the arithmetic mean concentration of lead within the area where potential exposures are assumed to occur, in order to be consistent with the principles underlying the blood lead modeling approach.
- Soil - Nonresidential Screening Level
    - Outliers were not assessed for Lots 63 and 70, since the EPCs for ~~the 0 to 2 ft. depth interval, as shown~~these properties exceeded the nonresidential screening level of 800 mg/kg (Section 4.4.1) in all three data sets (0 to 2 ft, 0 to 4 ft and all depths).
    - For remaining properties, the maximum detected lead concentration for each location was compared to the nonresidential screening level of 800 mg/kg. 10 outliers were identified in Lots 1, 58, 61, 64, 68, and 69
    - For the 10 outliers, the same 7 outliers were identified in all three data sets (0 to 2 ft, 0 to 4 ft and all depths).
        - 0 to 2 ft: 7 outliers
        - 0 to 4 ft: 9 outliers
        - All depths: 10 outliers
    - The outliers in the above datasets ranged from 849 mg/kg at B-101 in Lot 69 to 8,690 mg/kg at B-75 in Lot 64, which exceed the screening level of 800 mg/kg. The highest outlier (8,690 mg/kg at B-75) is more than ten times the 800 mg/kg screening level. The next highest outlier is 3,080 mg/kg, which is less than four times the screening level.
    - The three highest outliers (B-75 at 1 to 3 ft. bgs of 8,690 mg/kg, B-74 at 3 to 4 ft. bgs of 3,080 mg/kg and B-70 at 5 to 7 ft. bgs of 3,020 mg/kg) are all on Lot 64 and are adjacent to the boundary of Lot 63, which was already identified as having a lead EPC greater than 800 mg/kg (Section 6.2.2.1). Given the proximity of these outlier locations to Lot 63, it is possible workers or trespassers from Lot 63 also could be exposed to these lead concentrations at the border as well, (i.e., trespasser or worker exposure from these three locations is not averaged with the other locations at Lot 64). Outdoor workers are only exposed to soil in the 0 to 2 ft. interval in the future since Lots 63 and 64 are not currently occupied. Trespassers are exposed to soil in the

0 to 2 ft. interval currently and in the future. Outdoor workers and trespassers could be exposed to soil at any depth if soil from the subsurface were to be moved during site redevelopment. While construction workers are exposed to soil at any depth, the estimated portion of the construction workers' fetal blood lead distribution was already identified exceeding the 5 ug/dL level is more than 5% for Lot 64, as discussed in Section 6.2.1.4, and thus is already being addressed in the BHHRA. Although prolonged exposure to these three points in isolation by the outdoor worker or trespasser is not anticipated, they will be retained for further evaluation in the FS.

- For the remaining outliers, two are located on ~~Table 6-9 (although the HI estimate is 1 for the scenario in which soil from below 2 feet is assumed to be moved to the surface during site redevelopment, as shown~~ Lot 64 (B-90 at 1 to 2 ft. bgs of 1,170 mg/kg and B-94 at 1 to 3 ft. bgs of 850 mg/kg) and are less than two times the screening level. The other five outliers are all located on ~~Table 6-17).~~ separate properties (Lots 1, 58, 61, 68, and 69) and therefore represent isolated areas. There is no reasonable basis for assuming workers would preferentially spend time at these isolated locations. Additionally, use of maximum concentrations is contrary to lead modeling, as discussed above and the highest outlier out of these outliers (2,150 mg/kg at B-59) is less than three times the screening level. Therefore, the remaining four lead outliers are not considered to affect the conclusions of the risk assessment.

~~Therefore, outliers identified by ProUCL do not change the risk assessment conclusions.~~

- Soil - Residential Screening Level
  - The lead EPCs for 0 to 2 ft soil exceed the residential screening level of 200 mg/kg for every property except Lots 60 and 66 (Section 6.2.2.9). As shown in Appendix G, Attachment 3.5, no outliers were identified for Lots 60 and 66 in the 0 to 2 ft soil datasets.
  - The lead EPCs for all depths soil exceed the residential screening level of 200 mg/kg for every property except Lots 59 and 60 (Section 6.2.2.9). As shown in Appendix G, Attachment 3.5, no outliers were identified for Lots 59 and 60 in all depths soil datasets.
  - Therefore, the hotspot analysis did not affect the residential soil lead assessment.

~~6.3.1.2~~6.3.2.2 Nondetected Results

Uncertainties associated with nondetected chemicals were minimized to the extent practical by the careful selection of detection limits and analytical methods for the RI. As documented in the project QAPP, they are the practically available limits and methods best able to achieve risk-based Project Action Levels (PAL). If no practical method was available to achieve a PAL, the QAPP limit was set to the limit achievable by the best available method (the QAPP calls it a Project Quantitation Limit) rather than the PAL.

As such, chemicals not detected at the QAPP limits do not warrant further characterization, because enough planning and efforts during the RI have been dedicated to reducing to the maximum practical extent the uncertainties with presence or absence of a chemical at the Site.

Some SQLs did not meet the QAPP limits due to sample-specific issue that were unavoidable (e.g., need for dilution due to a high concentration of another chemical in the sample). Nondetected results for COPCs were included in the ProUCL datasets unless the SQL was determined to be unusually high, as discussed in Section 4.2.2.4.3.2.

6.3.1.36.3.2.3 Rejected Data

The soil and groundwater data qualified as rejected by the validator are summarized in Appendix H. Attachments H.1.1 and H.2.1 summarize the rejected data counts in soil and groundwater, respectively. Attachments H.1.2 and H.2.2 list each rejected result in soil and groundwater, respectively. [EPA15]As shown in these tables, VOCs comprise the majority of the rejected data. As discussed in Section 2.4 of the RIR, results were rejected for the following reasons:

- Several organic results were rejected due to very low deuterated monitoring compound (DMC) recoveries, DMC calibration issues, very low matrix spike/matrix spike duplicates recoveries, very low standard recovery, very low surrogate recoveries, or very low internal standard area counts.
- Several VOC results were rejected due to holding time exceedances.
- Several inorganic results were qualified as unusable (rejected) due to very low interferent check sample recovery or very high laboratory control sample recovery.
- One inorganic result (thallium; CW-7-1_032318) was rejected due to very low matrix spike/matrix spike duplicates recoveries.
- A few inorganic results were rejected due to exceeded holding time exceedances.
- Several organic results were rejected due to very low DMC recoveries, very low surrogate and DMC compounds calibration issues, very low internal standard area counts, very low internal standard recoveries.

The rejected soil and groundwater results represent a small fraction of the analytical results for the RI, and they were not concentrated in samples from a small segment of the Site. As such, they are unlikely to impact the conclusions of the risk assessment.

6.3.1.46.3.2.4 Off-Site Air Modeling

Off-site workers' and residents' exposure to on-site soil that migrates off-site via windblown soil vapor and particulates are conservatively calculated as if thethese off-site resident is atreceptors are at the downwind edge of the on-site exposure unit, to avoid the need to account for air dispersion factors, which and predominant wind direction. This methodology overestimates RME. for off-site exposures to on-site soil.

6.3.26.3.3 Exposure Factors

As discussed in Section 4.3, most of the exposure factors used in the risk assessment are high-end (i.e., 90th to 95th percentile) estimates of the magnitude, frequency, and duration of potential exposures. When several such high-end factors are multiplied, the resulting estimates of dose will be higher than the 90th percentile of the distribution of exposures in the potentially exposed population and could be higher than the exposure to the maximally exposed individual.

Also, theThe use of generic default exposure factors for evaluation of potential exposure of workers to soil is more conservative than necessary for RME estimates, which allow the use of site-specific considerations (USEPA 1989). For example, the outdoor worker exposure frequency of 225 days per year is conservative and likely tomay potentially overestimate RME given that the climate at the Site is not conducive to year-round outdoor soil contact activities (i.e., winter weather precludes exposure to soil at the Site for extended periods during the year).

TheAdditionally, the ingestion rate used for the utility and construction workers of 330 mg/kg is the 95th percentile of the soil ingestion rates in the study (Stanek et al. 1997) cited by USEPA (2002b), which involved only 10 adults (so the 95th percentile is essentially the highest rate in the study, and is likely to overstatemay potentially overestimate the RME). For perspective, the 90th percentile in that study was approximately 200 mg/day. As discussed in Section 4.1.1, utility workers are assumed to excavate to a depth of 4 ft (i.e., the depth of the utilities at the Site per USEPA Region 2). As shown on Table 2-10 of the RIR, groundwater is shallower than 4 ft. bgs in some but not all portions of the Site. Therefore, assuming utility workers may contact groundwater during excavation at any property is conservative and may overestimate RME.

USEPA recommended Region 2 required values for exposure time and exposure frequency and duration for adolescent trespassers discussed in Section 4.3.54.4.5 likely overstateoverestimate the RME. Trespassers are assumed to be at the Site and inhaling vapors and particulates for 4 hours/day while trespassing. According to the 2011 EFH (Table 16-20, USEPA, 20112011a), people typically spend no more than 2 hours per day outdoors. Trespassers are assumed to be at the Site for 150 days/year which is highly conservative[EPA16] since this includes exposure during colder months and the activity in the occupied areas of the Site would likely dissuade trespassers from frequently being outdoors at the unoccupied lots for 4 hours/day. Additionally, a fraction contacted term of 1 is conservatively used, even though the ingestion rate and dermal contact rate are for an entire day and dowhich does not account for the fraction of the day spent on-site (4 hours out of 16 hours).waking hours). This is conservative since the ingestion rate and dermal contact rate are for an entire day. Trespassers present at the site after it has been redeveloped will likely spend less time at the site than current trespassers since the vacant buildings which are attractive to trespassers will no longer be present and therefore. Therefore, the use of these exposure factors to assess exposures for future trespassers likely overestimates RME.

USEPA Region 2 required the visitor include a child (< 6 years old) even though a child this age is unlikely to visit an occupied property frequently (i.e., 52 days per year). The site currently has several unoccupied properties with abandoned buildings adjacent to the occupied properties that are attractive to trespassers and would therefore dissuade parents from bringing young children (particularly unattended children) to the currently occupied properties. Even after site redevelopment, children under 6 years old are unlikely to frequently (i.e., 52 days per year) visit industrial properties. Additionally, a fraction contacted term of 1 is conservatively used, which does not account for the fraction of the day spent on-site (2 hours out of 16 waking hours). This is conservative since the ingestion rate and dermal contact rate are for an entire day. The inclusion of a child less than 6 years old for the visitor receptor and the use of a fraction contacted term of 1 likely overestimates RME.

As discussed in Section 4.4, workers are conservatively assumed to drinking 1.25 L/day of tap water from the Site and take a shower every working day. Risks from potable groundwater use by visitors are evaluated for shallow and deep groundwater using hypothetical future residential risks to facilitate development of appropriate institutional controls for the Site. These assumptions used in the potable groundwater use evaluation are highly conservatively [EPA17]and likely overestimates RME.

As requested by USEPA Region 2, cumulative cancer risk and HI estimates for soil and groundwater are summed to account for potential concurrent exposures to both media (e.g., utility or construction worker exposure to both soil and groundwater during excavations), as discussed in Section 4.4. The exposures to both soil and groundwater are calculated at the magnitudes, frequencies, and durations assumed for each medium and the risks and HI are then summed to determine the combined cumulative cancer risk and combined HI. This summation overestimates RME (e.g., a utility worker's skin cannot be completely covered with soil and groundwater at the same time or future residents cannot be inside and outside at the same time). The evaluation of combined cumulative cancer risk and combined HI did not affect the conclusions of the HHRA.

6.3.4 Lead

6.3.4.1 Screening Levels

The BHHRA followed USEPA Region 2's Lead Strategy, which uses a non-residential soil screening level of 800 mg/kg and a residential soil lead screening level of 200 mg/kg. These screening levels utilize a target BLL of 5 ug/dL (as opposed to 10 ug/dL). OLEM Directive 9285.6-56 estimates a screening level of 1,050 mg/kg using updated 2017 ALM parameters and a target BLL of 5 ug/dL. Using this screening level would only identify EPCs from one property (Lot 63) as exceeding the nonresidential screening level (i.e., Lot 70 EPC does not exceed the 1,050 mg/kg screening level).

The soil lead screening level for residential settings presented in the RSLs is 400 mg/kg (USEPA, 1994, 2019). The OLEM Soil Lead Directive (2016) identifies a risk range of 2-8 µg/dL for child BLLs associated with adverse health effects. Based on this Directive, various USEPA regions are currently using the new version of the IEUBK model with updated soil ingestion rates and other updated variables (TRW Lead Committee 2017 Annual Report, USEPA, 2017c) and evaluating risks for exceeding both 5 ug/dL (P5) and 8 ug/dL (P8). Associated screening levels are 200 mg/kg for the P5 and 400 mg/kg for the P8. ~~It is not yet clear when a common screening level will be issued for use by all USEPA Regions and what that level will be~~.

6.3.4.2 Exposure Factors

The evaluations to assess child exposures to lead were conducted using the IEUBK Model, with the model run two ways. One approach used the Batch Run Mode based on USEPA (2007) exposure parameters. The second approach used the Point Estimate Approach with updates to the exposure parameters based on recommendations from the Lead TRW. The IEUBK Model output from the Point Estimate Approach using the exposure factor updates was presented in the Risk Characterization. The output from these model runs is provided in Appendix F along with the output from Batch Run Mode model runs.

The differences in the two approaches reflect differences in the exposure factors. The Batch Run Mode Analysis used default exposure parameters from the User's Guide for the Integrated Exposure Uptake Biokinetic Model for Lead in Children (USEPA, 2007). The analysis developed using the recommendations from the Lead TRW are highlighted in Table 4-2 in Section 4.4.8.2.

The use of both exposure parameters introduces some uncertainty into the risk assessment. The uncertainties related to the exposure parameters may vary depending on the timeframe in which the exposure values were developed (i.e., 2007 for the Batch Run Mode and 2020 for the Point Estimate Approach). The updated include the following:

- The ingestion rate for lead in drinking water recommended in the 2007 User's Guide was 4 ug/L while the ingestion rate recommended by the Lead TRW is 0.9 ug/l.
- The maternal BLL was updated from 1 ug/dL to 0.6 ug/dL based on the National Health and Nutrition Examination Survey (NHANES) update (2009-2014) (EPA, 2017d).
- The exposure time frame for the young child was updated based on OLEM DIRECTIVE 9200.2-177 that recommended an age range of 12 to 72 months. The Batch Run Mode assumed 32 months. The FAQ on the Bath Run Mode indicates that the use of 32 months approximates the 12- to 72-month average calculated in the single run mode. Although some slight differences result between the geometric mean PbB and P10 value for the 32-month age group compared to the 12- to 72-month average, in general, the differences in the results are small and are not expected to affect decisions at the Site.

Multiple factors contribute to the decisions regarding potential remedial action at the individual lots. However, under the hypothetical future residential scenario, average soil lead concentrations are greater than the USEPA Region 2 residential soil screening level (200 mg/kg) at all lots except for soil from the 0 to 2 ft. interval at Lot 60 and Lot 66 and soil from all sampled depths at Lot 59 and Lot 60. And, the probability that estimated BBLs are above 5 ug/dL are greater than 5% at all lots except Lot 59 and Lot 60 based on the Point Estimate Approach and at all lots based on the Batch Run Mode, for both soil from the 0 to 2 ft. soil interval and soil from all sampled depths. Thus, the results of the various evaluations support the need to move forward with the consideration of lead on the individual properties, in the FS.

USEPA Region 2 required the exposure factors used in the adult lead modeling (Section 4.4.114.5.4) for outdoor workers, utility workers and construction workers, as outlined in the comments provided by USEPA on 10/10/2019 (Appendix B). The inconsistencies of these exposure factors with the ALM guidance (USEPA 2003) are discussed below by receptor and result in overestimates of lead exposures. The uncertainties associated with the lead assessment for child visitors are also discussed below.

Outdoor Workers

The soil ingestion rate of 67 mg/d, required by USEPA Region 2, is from the Hawley 1985 study and overestimates the central tendency soil ingestion rate by 30%. Soil ingestion rates from this study were replaced by USEPA as the default ingestion rate since the ingestion rate from this study is a theoretical calculation and not a measured value (see page 5-9 USEPA's Supplemental Guidance for Developing Soil Screening Levels for Superfund SitesSG [USEPA, 2002b]). USEPA's September 2017 Exposure Factors Handbook (EFH), page 5-3, states the methodology used in Hawley 1985 (and other studies) "is not discussed in this chapter because it yields rudimentary estimates of soil ingestion". Additionally, the 2014 OSWER directive (9200.1-120) states the outdoor worker soil ingestion rate is based on the adult resident and that the adult resident's central tendency soil ingestion rate is from the EFH. The 2017 EFH lists a central tendency adult ingestion rate on Table 5-1 of 30 mg/d (range 4 to 50 mg/d) (USEPA, 2017d), which is consistent with the worker ingestion rate of 50 mg/d from USEPA 2003c. If the central tendency soil ingestion rate of 50 mg/d were used instead of 67 mg/d, the estimated portion of the outdoor workers' fetal blood lead distribution exceeding the 5 ug/dL level is above 5% only for Lot 63 (i.e., not for Lot 70).

These uncertainties also apply to trespassers since the outdoor worker lead exposures are used to evaluate trespassers.

Utility Workers

USEPA guidance (2003c) recommends the ALM model be applied to "exposures that exceed a minimum frequency of one day per week and duration of 3 consecutive months". Since utility workers' expected intermittent exposures (1 week per quarter) are below this level, USEPA Region 2 required the use of the minimum exposure frequency and duration (13 days over a 91 day91-day averaging time). This assumption substantially overestimates the exposure to lead and the use another model (e.g., the All Ages Lead Model when it is finalized by USEPA) would be more appropriate.

Construction Worker

The assumed soil ingestion rate of 100 mg/d is higher than any central tendency ingestion rate measured in a soil ingestion rate study. In fact, the study (Stanek et al. 1997) from which USEPA selected the RME soil ingestion rate of 330 mg/day (the 95th percentile) presents a mean ingestion rate is 6 mg/day and the median is -11 mg/day, which is far lower than the 100 mg/day ingestion rate. Additionally, the most conservative averaging time was used (91 days/year), which assumes all ofall the construction workers exposure over a 6-month period occurs in the first 3 months. This high-end assumption for averaging time combined with a high-end ingestion rate results in a worst-case overestimate of lead exposures inconsistent with the use of central tendency exposure factors as outlined in the ALM (USEPA 2003c).

Use of central tendency values would alter the conclusions of the lead assessment (Section 6.2.2.4) which identified Lots 61, 62, 63, 64, 65, 68 and 70 as having an estimated portion of the construction workers' fetal blood lead distribution exceeding the 5 ug/dL level of more than 5%. If the central tendency soil ingestion rate of 50 mg/d were used with the conservative averaging time of 91 days/year, the estimated portion of the construction workers' fetal blood lead distribution exceeding the 5 ug/dL level is above 5% only for Lots 63 and 70. The results are the same if a soil ingestion rate of 100 mg/d were used with an averaging time of 180 days/year. If the central tendency soil ingestion rate of 50 mg/d were used with an averaging time of 180 days/year, the estimated portion of the construction workers' fetal blood lead distribution exceeding the 5 ug/dL level is above 5% only for Lot 63.

Child Visitor

Based on the uncertainties associated with establishing the concentration of lead in soil at the child's residence, the ability to predict where the child may live, the limited data on soil lead background concentrations for this area, and the limited exposures compared of the young child future resident and current/future outdoor worker, the child visitor is assessed qualitatively using the child residents' exposure, as required by USEPA Region 2. Per discussion with USEPA Region 2 on October 17, 2109, the child visitor's exposure to lead would be approximately 5% the future child resident's exposure to lead based on the differences in exposure time, frequency and duration. As discussed in Section 4.4.114.5.4, this assumption is conservative and therefore, likely overestimates lead exposures for the child visitors.

Young children are typically exposed to Pb in the top one inch of soils. The evaluation of Pb in soil on the individual properties evaluated depths of 0 to 2 ft., 0 to 4 ft.; all sampled data, and lead at depth brought to the surface under a future scenario. As indicated in the site history section of the RIR, the majority of the Pb is found at depth and therefore, the exposure point concentrations are expected to be protective of exposures to the young child in the top one inch. This is a potential uncertainty in the BHHRA.

6.3.36.3.5 Toxicity Values

6.3.3.16.3.5.1 Extrapolated Toxicity Values

As discussed in Section 5.4,5.4, the dermal toxicity values used in the risk assessment are oral toxicity values that are extrapolated to the dermal route without chemical-specific judgment regarding whether such extrapolation might be appropriate for a particular chemical. This is consistent with USEPA guidance (2004b) and is a conservative approach to ensure that potential risk or hazard via the dermal route is not overlooked. However, some chemicals might exhibit different degrees ofmetabolism and distribution causing variation in toxicity for the dermal route relative to the oral route. For such chemicals, the extrapolation approach used in the risk evaluation could introduce uncertainty. (i.e., overestimate or underestimate cancer risk or HI estimates).

6.3.3.26.3.5.2 Chemicals without Toxicity Values

COPCs lacking toxicity values were identified and sent to USEPA for guidance from the STSC. The STSC suggested several surrogates, as outlined in Section 5.1.5.1. Toxicity values were not identified for all COPCs (e.g., a RfD for 2-nitrophenol or an RfC for cis-1,2-dichloroethene). RisksCancer risk and HI estimates maybe underestimated for COPCs that lack toxicity values.

6.3.5.3 Cancer Toxicity Values

Uncertainties related to cancer toxicity values (i.e., the hexavalent chromium URF and cancer assessment for ethyl benzene) are discussed below.

Hexavalent Chromium URF

As discussed in Section 5.3, hexavalent chromium is classified by IRIS as Group A (Carcinogenic to Humans) by the inhalation route (USEPA 1998). The 1998 IRIS assessment derived an inhalation URF for hexavalent chromium of 12 per (mg/m^3). As discussed in the IRIS assessment, the exact ratio of trivalent chromium (which IRIS has classified as Group D (Not Classifiable as to Human Carcinogenicity)) to hexavalent chromium that chromate plant workers were exposed to in the study used to derive the URF is not known. This uncertainty may underestimate or overestimate inhalation cancer risk from hexavalent chromium. IRIS estimates the maximum ratio of trivalent chromium to hexavalent chromium in the study to be six and therefore the underestimation of risk for hexavalent chromium is unlikely to be greater than sevenfold. IRIS also notes that the risks in the study maybe overestimated as a result of the assumption that smoking habits of chromate workers were similar tolike those of the general white male population when it is generally accepted that the proportion of smokers is higher for industrial workers. If the background rate of lung cancer (due to smoking) for workers were accounted for in the URF, the URF would decrease by 25% (i.e., 8.7 per (mg/m^3)).

Inhalation exposure to hexavalent chromium only occurs from soil particulate inhalation since chromium is not volatile. The maximum hexavalent chromium EPC in soil is 111 mg/kg for the 0 to 2 ft. and the 0 to 4 ft. depth intervals at Lot 65 followed by the hexavalent chromium EPC of 74.5 mg/kg for all sampled depths interval also at Lot 65. The three highest cancer risks from hexavalent chromium using the 12 per (mg/m^3) URF are 5 x 10^{-7} for utility workers, 2 x 10^{-7} for construction workers and 1 x 10^{-7} for future residents all at Lot 65. If the hexavalent chromium cancer risks are multiplied by seven to conservatively account for the uncertainties in the ratio of trivalent to hexavalent chromium in the cancer toxicity study, the cancer risks would be 4 x 10^{-6} for utility workers, 2 x 10^{-6} for construction workers, and 9 x 10^{-7} for future residents at Lot 65. These higher hexavalent chromium cancer risk estimates marginally change the conclusions of the risk assessment presented in Section 6.2 for utility workers and construction workers at Lot 65, which would have cumulative cancer risks within NCP's risk range instead of below NCP's range. For future residents, the conclusions do not change as the higher hexavalent chromium cancer risk estimates result in a cumulative cancer risk at Lot 65 that is still at or below the lower end of NCP's risk range.

Ethyl Benzene Cancer Assessment

In the 1991 IRIS assessment, USEPA classified ethyl benzene as not classifiable to human carcinogenicity due to a lack of animal bioassays and human studies. In a subsequent 1999 study by the National Toxicology Program (NTP), exposure to ethyl benzene by inhalation resulted in increased incidence of kidney and testicular tumors in male rats, and a suggestive increase in kidney tumors in female rats, lung tumors in male mice, and liver tumors in female mice. Based on this data, on June 11, 2004, CalEPA identified ethyl benzene under Proposition 65 as a chemical known to the State of California to cause cancer and later adopted cancer toxicity values for ethyl benzene. Since IRIS has not updated its cancer assessment, the BHHRA did not include a quantitative evaluation of cancer risk for ethyl benzene, which may lead to a potential underestimation of cancer risks.

To address this uncertainty as required by USEPA Region 2, cancer risks were calculated using the CalEPA toxicity values for the exposure areas and media where ethyl benzene was identified as a COPC[49] (Lots 1, 58, 64 and 68 for soil, site-wide for shallow groundwater, site-wide for deep groundwater, and site-wide for indoor air) and compared to the cancer risk estimates presented in Section 6.2. The cumulative cancer risk estimates with and without ethyl benzene are presented in Appendix D Attachment D.9 for comparison.

For current and/or future soil exposures, the addition of ethyl benzene cancer risks does not change the conclusions of the cumulative risk estimates except for the following:

- Lot 58: Future resident vapor intrusion cumulative cancer risk with ethyl benzene (5 x 10^{-4}) exceeds NCP's risk range. The cumulative cancer risk without ethyl benzene (1 x 10^{-4}) is at the upper end of NCP's range.
- Lot 1: Off-site resident outdoor inhalation cumulative cancer risk with ethyl benzene (2 x 10^{-6}) is within NCP's risk range. The cumulative risk cancer without ethyl benzene (1 x 10^{-6}) is at the lower end of NCP's range.

For the scenario in which soil below the 0 to 2 ft. depth interval is brought to the surface in the course of site redevelopment, the conclusions are as described above.

For current and/or future shallow groundwater exposures, the addition of ethyl benzene cancer risks does not change the conclusions of the cumulative risk estimates except for the following:

[49] The ethyl benzene RSL includes cancer toxicity values.

- Lot 62: Outdoor, indoor and off-site worker potable groundwater cumulative risk estimate with ethyl benzene (2 x 10^{-4}) exceeds NCP's risk range. The cumulative cancer risk without ethyl benzene (1 x 10^{-4}) is at the upper end of NCP's range.
- Lot 64: Utility and off-site worker groundwater contact cumulative risk estimate with ethyl benzene (2 x 10^{-6}) is within NCP's risk range. The cumulative cancer risk without ethyl benzene (1 x 10^{-6}) is at the lower end of NCP's range.

The addition of ethyl benzene cancer risks does not change the conclusions of the cumulative risk estimates for deep groundwater and indoor air.

6.3.5.4 Noncancer Toxicity Values

Uncertainties related to noncancer toxicity values (i.e., the use of chronic toxicity values to assess subchronic exposures and the use of the inhalation toxicity values for mercury and cyanide) are discussed below.

As discussed in Section 5.3, chronic (i.e., exposures seven years or greater) noncancer toxicity values are used to calculate HI estimates for the child only (i.e., 0 to 6 years) resident and visitor. According to USEPA Region 2, the use of chronic values for a young child is designed to be protective for potential developmental effects. USEPA's 1996 Soil Screening Guidance Section 2.2 states that this can be overly conservative depending on the chemical. Per USEPA 1996, the approach of combining the higher 6-year exposure for children with chronic toxicity criteria is overly protective for most chemicals but there are instances when the chronic RfD may be based on endpoints of toxicity that are specific to children (e.g., fluoride and nitrates) or when the dose response curve is steep. Therefore, noncancer hazards may be overestimated depending on the chemical.

As discussed in Section 6.2.2.9, the single-chemical residential soil vapor intrusion HQ for mercury and cyanide are above the protection goal of 1 for several properties. The use of an RfC for mercury and cyanide assumes that these metals are present in the volatile forms (i.e., elemental mercury and hydrogen cyanide). As discussed in Section 5.1, the type of mercury and cyanide present in the fill or used at the site is unknown and the analytical methods measures total concentrations, which could consist of various forms of inorganic mercury and cyanide. The use of an RfC to assess total mercury and total cyanide is conservative and may overestimate noncancer hazards from vapor inhalation depending on the form of mercury and cyanide ~~actually present~~present at the site.

~~6.3.4~~6.3.6 Risk Characterization

The summation of cancer risks and HQs for multiple COPCs, as described in Section ~~6.1,~~6.1, is based on USEPA guidance (1989) to assume dose additivity, which means that COPCs in a mixture are assumed to have no synergistic or antagonistic interactions and each COPC has the same mode of action and elicits the same health effects. In general, this approach can introduce significant uncertainty. However, the majority of the cumulative cancer risk and HI estimates in this risk assessment are dominated by contributions from no more than a few COPCs, so that the cumulative cancer risk and HI estimates are nearly the same as those for the few key COPCs. Additionally, toxic endpoint specific HIs are calculated for all HIs above the protection goal of 1.

~~The resident~~Residential cumulative cancer risk and HI estimates for outdoor exposure are above ~~USEPA's limits for RME~~the upper-end of NCP's risk range and above the protection goal of 1, respectively, mostly for noncancer HI~~, and several~~. Several properties have HI estimates for outdoor exposure around 5 or less, as shown ~~on Table 6-9. The~~in Section 6.2.2.9. The visitor and residential scenario that includes exposure over 26 years from childhood years (0 to 6 years old) through adulthood. These HI estimates were calculated using an exposure duration of 6 years (i.e., child only), as required by USEPA Region 2, even though the scenario includes lower exposures during later years. These HI estimates were also calculated using chronic rather than subchronic noncancer toxicity values, as required by USEPA Region 2, even though the 6-year period is considered subchronic (USEPA 1989), which may be overly conservative depending on the chemical according to USEPA 1996.

7. SUMMARY AND CONCLUSIONS

The significance of potential exposures to concentrations of COPCs in soil and groundwater was evaluated based on conservative estimates of the RME under current and potential future land use at the Site. The significance of potential exposures was determined by comparing estimates of cumulative cancer risks ~~and noncancer HIs with USEPA's limits for RME risk (i.e., a~~ to NCP's cancer risk ~~limit~~range of 10^{-4} ~~and a HI limit~~to 10^{-6} and comparing noncancer HIs to a protection goal of 1~~, respectively)~~. The cancer risk, HI, and lead modeling are calculated using health protective ~~conservative~~ exposure parameters and assuming the absence of protective measures, such as existing pavement or capping.

Current Land Use

Under current land use, the potentially exposed populations at and around the Site are conservatively assumed to include~~:~~

- ~~Outdoor Workers~~ outdoor workers (only at occupied Lots 1, 57, 59, 60, 62, 69, and 70), indoor workers (only at occupied lots~~);~~
- ~~Indoor Workers~~), utility workers; construction workers (only at ~~occupied~~ lots~~);~~
- slated for redevelopment~~ in the near future~~, which are Lots 57, 58, 61, 63, 64, 68, and 70), trespassers, visitors~~Utility Workers;~~
- ~~Construction Workers;~~
- ~~Trespassers;~~
- ~~Visitors~~ (only at occupied lots~~);~~
- ~~Off-Site Workers~~), and ~~Residents~~off-site workers and residents (via wind transport).

~~Potential future exposures are evaluated for every receptor at each of the 15 properties at the Site (i.e., each property is assessed assuming future redevelopment under both industrial land use and residential land use). As required by USEPA, the BHHRA includes a hypothetical residential scenario which assumes the Site will have medium-density residential units like those west of McCarter Highway, as well as a hypothetical potable and nonpotable use scenario for shallow and deep groundwater to facilitate development of appropriate institutional controls for the Site.~~

~~Under current land use, the cumulative cancer risk and HI estimates for~~For exposures to COPCs in indoor air, soil and groundwater~~ do not exceed USEPA's limits for RME risk. No lead EPCs exceed~~, the cumulative cancer risk estimates are below or within NCP's risk range (10^{-4} to 10^{-6}) and the noncancer HI estimates are at or below the protection goal of 1, after accounting for the toxic organ specific ~~– endpoint~~ HI. As discussed further in Section 6.2.1, COPCs with single-chemical cancer risks above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), for benzene and chloroform in indoor air; arsenic, benzene, benzo(a)pyrene, dibenz(a,h)anthracene, naphthalene, PCBs, and 2,3,7,8-TCDD~~tetrachlorodibenzo-p-dioxin~~ in soil; and pentachlorophenol and dibenz(a,h)anthracene in groundwater.

No soil lead EPCs are greater than the USEPA Region 2 nonresidential screening level of 800 mg/kg at any lot, except for currently occupied ~~lots.~~

Under future commercial/industrial land use at the Site, the cumulative cancer risk and HI estimates for exposures to soil and groundwater do not exceed USEPA's limits for RME risk, except for indoor worker exposure to soil via vapor intrusion for Lots 58, 62, and 68. The vapor intrusion HI estimates above USEPA's limit of 1 are primarily from TCE (Lot 58 and 68), xylenes (Lot 58 and Lot 68), and naphthalene (Lot 62). Lead EPCs exceed the USEPA Region 2 nonresidential screening level of 800 mg/kg at Lot 63 and Lot 70. 70 and currently unoccupied Lot 63. The estimated portion of the fetal blood lead distribution exceeding the 5 ug/dl level is less than 5% at each property except Lot 63. As an additional comparison, the lead EPCs in Lot 63 are below the nonresidential screening level of 2,520 mg/kg calculated using a target blood lead level of 10 ug/dL instead of 5 ug/dL. The scenario in which soil below the 0 to 2 foot depth interval (0 to 4 foot depth interval for utility worker) is brought to the surface in the course of site redevelopment was also evaluated and also do not exceed USEPA's limits for RME risk. Risks from potable and nonpotable use of shallow and deep groundwater, if to occur in the future, are unacceptable. However, such groundwater use at the Site is unlikely since the shallow groundwater is brackish and the Site and surrounding area are served by the City of Newark's potable water systemdL level is greater than 5% for outdoor workers at Lot 70, trespassers at Lots 63 and 70, and construction workers at Lots 61, 63, 64, 68, and 70, trespassers at Lots 63 and 70, and visitors at Lots 1, Lot 62, and Lot 70. Outdoor workers and trespassers are not expected to contact soil at Lot 70 currently, because Lot 70 is paved and partly capped (Figure 6-1). A hot spot analysis identified one location from Lot 64 (B-75 from 1 to 3 ft. bgs, which is adjacent to Lot 63) that could affect the conclusions of the risk assessment for current trespasser exposure to lead. Although prolonged exposure to this location in isolation is not anticipated, it will be retained for further evaluation in the FS.

Since no cumulative cancer risk estimates are above the upper-end of NCP risk range (10^{-4}) and no HI estimates are above the protection goal of 1 after accounting for toxic organ endpoint specific HI, the only COPC that warrants evaluation in the Feasibility Study (FS) for current exposure is lead in soil.

Future Commercial/Industrial Land Use

Under hypothetical future residential commercial/industrial land use, the potentially exposed populations at and around the Site, the cumulative cancer risk and HI estimates for are conservatively assumed to be the same as for current land use except that each of the 15 properties are evaluated for all receptors (i.e. receptors may be present at refuture developed lots). The potentially exposed RME individuals populations at and around the Site are conservatively assumed to include outdoor workers, indoor workers, utility workers, construction workers, trespassers, visitors, off-site workers (via wind transport and future shallow groundwater migration), and off-site residents (via wind transport).

For exposures to soil for the 0 to 2 foot interval exceed USEPA's limits for RME risk, except at Lot 59. The COPCs in soil and groundwater, the cumulative cancer risk and HI estimates for outdoor estimates are below or within NCP's risk range (10^{-4} to 10^{-6}). As discussed further in Section 6.2.2, COPCs with single-chemical cancer risks above the above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), are arsenic, benzene, tetrachloroethene, trichloroethene, xylenes, PAHs, PCBs, and 2,3,7,8-tetrachlorodibenzo-p-dioxin in soil; and pentachlorophenol and dibenz(a,h)anthracene in groundwater. The noncancer HI estimates are at or below the protection goal of 1, after accounting for toxic-endpoint HI, except for indoor worker exposure to soil via vapor intrusion at Lots 58, 62, and 68, and child visitor outdoor exposure to soil at Lot 63. As discussed further in Section 6.2.2, COPCs with single-chemical soil vapor intrusion HQ estimates above the protection goal are trichloroethene (Lot 58 and 68), xylenes (Lot 58), and naphthalene (Lot 62) and the COPC with single-chemical child visitor outdoor HQ estimate above the protection goal of 1 is copper at Lot 63.

Soil lead EPCs are greater than the USEPA Region 2 nonresidential screening level of 800 mg/kg at Lots 63 and 70. The estimated portion of the fetal blood lead distribution exceeding the 5 ug/dL level is greater than 5% for outdoor workers and trespassers at Lots 63 and 70, indoor workers at Lot 63, and construction workers at Lots 61, 62, 63, 64, 65, 68 , and 70. For visitors, the estimated portion of the child visitor's blood lead distribution that exceeds USEPA Region 2's lead goal of no more than 5% of the exposed individuals with blood lead concentrations greater than -5 ug/dL for the 0 to 2 ft. depth interval is greaterless than 5% for soil from the 0 to 2 ft. depth interval at Lots 1, 62, 63, 64, 65 and 70each property and greater than 5% for soil from all sampled depths at Lots 63, 64, 68, and 70.. A hot spot analysis identified one location from Lot 64 (B-75 from 1 to 3 ft. bgs, which is adjacent to Lot 63) that could affect the conclusions of the risk assessment for future trespasser or outdoor worker exposure to lead. Although prolonged exposure to this location in isolation is not anticipated, it will be retained for further evaluation in the FS.

Since no cumulative cancer risk estimates are above the upper-endupper end of NCP risk range (10^{-4}), no COPCs warrant evaluation in the FS for future cancer risk. For future noncancer hazards, the COPCs [EPA18]in soil that warrant evaluation in the FS are trichloroethene at Lots 58 and 68, xylenes at Lot 58 and naphthalene at Lot 62 for future noncancer vapor intrusion exposure and copper at Lot 63 for future child outdoor visitor exposure. Although, children under the age of 6 years old are unlikely to visit industrial properties at the frequency assumed (i.e., 52 days per year), as discussed in Section 6.3.3. Lead in soil is also a COPC that warrants evaluation in the FS for future exposures to soil .

These conclusions remain the same for the scenario in which soil below the 0 to 2 footft. depth interval (or 0 to 4 ft. depth interval for utility worker) is brought to the surface in the course of site redevelopment exceed USEPA's limits for RME risk, except at Lot 1 and Lot , except for the lead hot spot analysis. A hot spot analysis identified three locations from Lot 64 (B-75 at 1 to 3 ft. bgs of 8,690 mg/kg, B-74 at 3 to 4 ft. bgs of 3,080 mg/kg and B-70 at 5 to 7 ft. bgs of 3,020 mg/kg, which are adjacent to Lot 63) that could affect the conclusions of the risk assessment for future trespasser or outdoor worker exposure to lead if soil from the subsurface is brought to the surface during site redevelopment. Although prolonged exposure to these locations in isolation is not anticipated, they will be retained for further evaluation in the FS.

Hypothetical Future Residential Land Use and Potable Groundwater Use

As required by USEPA, the BHHRA includes a hypothetical residential scenario which assumes the Site will have medium-density residential units like those west of McCarter Highwaythat west of McCarter Highway. Additionally, hypothetical potable shallow and deep groundwater use is evaluated for on- and off-site workers, visitors and residents to facilitate development of appropriate institutional controls for the Site.

For outdoor exposures to soil for the 0 to 2 ft. interval, the cumulative cancer risk estimates are within or at the upper end of NCP's range except for Lot 67, which is above the NCP's risk range (10^{-4} to 10^{-6}). For adult residents, the HI estimates are at or below the protection goal of 1 except for Lot 63. For child residents, the HI estimates are above the protection goal of 1 except for Lot 59. For the scenario in which soil below the 0 to 2 ft. depth interval is brought to the surface in the course of site redevelopment, the cumulative cancer risk estimates are within or at the upper end of NCP's range (10^{-4} to 10^{-6}). For adult residents, the HI estimates are at or below the protection goal of 1 except for Lot 70. For child residents, the HI estimates are above the protection goal of 1 except for Lots 1 and

59. These estimates of unacceptable risk are due to a number of VOCs, SVOCs, PCBs, metals and dioxins (only at Lot 70).As discussed further in Section 6.2.2.9, COPCs with single-chemical cancer risks above the above the lower end of NCP's risk range (10^{-6}), but below the upper-end of NCP's risk range (10^{-4}), or HQ above the protection goal of 1 are arsenic, benzene, trichloroethene, PAHs, PCBs, and 2,3,7,8-tetrachlorodibenzo-p-dioxin.

For the 0- to 2-foot ft. interval, the soil lead EPCs exceedare above the USEPA Region 2 residential screening level of 200 mg/kg at each property except Lot 60 and Lot 66. For the scenario in which subsurface soil is moved to the surface during site redevelopment, the lead soil EPCs exceed the USEPA Region 2 residential screening level of 200 mg/kg at each property except LotLots 59 and Lot 60. The estimated portion of the fetal blood lead distribution above USEPA Region 2 goal of exceeding the 5 ug/dL for child resident at each property exceedlevel is greater than 5% for the 0 to 2 foot depth interval and for the scenario that subsurface soil is moved to the surface during site redevelopment. all properties under both scenarios. For child resident, the estimated portion of the child's blood lead distribution that exceeds USEPA Region 2's lead goal of no more than 5% of the exposed individuals with blood lead concentrations greater than 5 ug/dL is greater than 5% for soil from the 0 to 2 ft. depth interval at all properties except Lots 60 and 66 and greater than 5% for soil from all sampled depths at all properties except Lots 59 and 60.

The residents' cumulative cancer risk and HI estimates for soil vapor intrusion exceed USEPA's limits for RME risks except for Lot 59 and Lot 69. The cumulative risk estimates above USEPA's limit for RME risk are primarily from benzene, TCE, PCE, xylenes, naphthalene, and mercury. The residents' cumulative risk estimates for shallow groundwater vapor intrusion are within USEPA's limits for RME risks except at Lot 58. For Lot 58, the HI of 2 is primarily from xylenes.

RisksFor soil vapor intrusion exposures, residents' cumulative cancer risk estimates are above NCP's risk range (10^{-4} to 10^{-6}) for Lots 1, 57, 62, 64, 67, 68, and 70. Both adult and child resident HI estimates are above the protection goal of 1 for every property except for Lots 59 and 69. For shallow groundwater vapor intrusion exposures, cumulative cancer risk estimates are within NCP's risk range (10^{-4} to 10^{-6}) and HI estimates are below the protection goal of 1 except for Lots 58 and 59. As discussed further in Section 6.2.2.9, COPCs with single-chemical risks are above the lower end of NCP's risk range (10^{-6}) and single-chemical HQs are above the protection goal of 1 for benzene, chloroform, cyanide, 1,2-dibromo-3-chloropropane, tetrachloroethene, trichloroethene, naphthalene, mercury, vinyl, chloride, xylenes, and 2,3,7,8-TCDDtetrachlorodibenzo-p-dioxin.

Cumulative cancer risk and HI estimates from potable and nonpotable use of shallow and deep groundwater, if to occur in the future, are unacceptable. However, such groundwater above NCP's risk range (10^{-4} to 10^{-6}) and protection goal of 1 for all properties. As discussed further in Section 6.2.2.9, COPCs with the highest single chemical cancer risks (i.e., above the upper end of NCP's range of 10^{-4}) are 1,3-dichloropropene (total), 1,2-dibromo-3-chloropropane, benzene, vinyl chloride, pentachlorophenol, benzo(a)pyrene, dibenz(a,h)anthracene, naphthalene, and arsenic. The COPCs with the highest single chemical HQs (i.e., above 10) are for trichloroethene, 1,2,4-trichlorobenzene, 2-hexanone, xylene, naphthalene, cyanide, and iron. For shallow groundwater exposure to lead, the maximum lead concentration is below the federal action limit of 0.015 mg/L at each property except Lots 57, 60, 63, 64, 67, and 69. Although it is noted that potable use of shallow groundwater at the Site is unlikely since site-specific conductivity readings of the shallow groundwater indicate possible brackish conditions and the Site and surrounding area are served by the City of Newark's potable water system, groundwater will need to be evaluated in the FS.

Since the hypothetical residential scenario and the hypothetical potable groundwater use scenarios are included in the BHHRA to facilitate development of appropriate ICs institutional controls for the Site, the identification of COPCs that warrant further evaluation in the FS for these hypothetical scenarios may be is not necessary. The results of the BHHRA are summarized by mediamedium, depth interval, exposure route for current industrial use (Table 7-1), future industrial use (Table 7-2) and future hypothetical residential land and hypothetical potable/nonpotable groundwater use (Table 7-3). The media and exposure routes that may trigger the need for remedial action are summarizedPer USEPA Region 2guidance in RAGS Part D, all instances with cumulative cancer risk above the NCP's risk range (10^{-4}) and/or HI above the protection goal of 1 as well as the single-chemical risk and HQ estimates used to calculate these estimates, are included in RAGS D Table 10 in (Appendix B. These are:A).

- Soil lead EPCs at Lot 63 for future outdoor worker (0 to 2 foot and soil brought to the surface during site redevelopment).
- Soil EPCs at Lot 58, Lot 62 and Lot 68 for future indoor worker exposure via vapor intrusion which are primarily from TCE (Lot 58 and 68), xylenes (Lot 58), and naphthalene (Lot 62).

The following is also listed on RAGS D Table 10 to facilitate development of appropriate institutional controls for the Site:

- Properties with shallow groundwater EPCs that exceed tap water RSLs.
- Site-wide deep groundwater which exceeds tap water RSLs.
- Properties with soil EPCs that with residential risk estimates (outdoors or indoors) that exceed USEPA's limit for RME risk or lead EPC that exceeds the target blood lead level.

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FIGURES

TABLES

APPENDIX A
USEPA REGION 2 COMMENTS ON THE OCTOBER 2018 PAR AND PPG'S RESPONSES

Attachment 1 – 10/11/18 STSC response to USEPA information request

Attachment 2 – 12/28/18 USEPA comments on 10/9/18 PAR

Attachment 3 – 2/7/19 PPG draft responses to 12/28/18 USEPA comments

Attachment 4 – 2/20/19 PPG email to USEPA on EPC calculation

Attachment 5 – 2/27/19 PPG memorandum to USEPA

Attachment 6 – 3/29/19 USEPA comments on 2/27/19 PPG memorandum

Attachment 7 – 4/2/19 PPG response to 3/29/19 USEPA comments

Attachment 8 – 4/16/19 USEPA response to 4/2/19 PPG responses

Attachment 9 – 5/22/19 USEPA comments on 4/25/2019 PAR and 6/28/19 PPG responses

~~ATTACHMENT 1~~
~~10/11/18 STSC RESPONSE TO USEPA INFORMATION REQUEST~~

~~ATTACHMENT 2~~
~~12/28/18 USEPA COMMENTS ON 10/9/18 PAR~~

~~ATTACHMENT 3~~
~~2/7/19 PPG DRAFT RESPONSES TO~~
~~12/28/18 USEPA COMMENTS~~

~~ATTACHMENT 4~~
~~2/20/19 PPG EMAIL TO USEPA ON EPC CALCULATION~~

~~ATTACHMENT 5~~
~~2/27/19 PPG MEMORANDUM TO USEPA~~

~~ATTACHMENT 6~~
~~3/29/19 USEPA COMMENTS ON 2/27/19 PPG MEMORANDUM~~

~~ATTACHMENT 7~~
~~4/2/19 PPG RESPONSE TO 3/29/19~~
~~USEPA COMMENTS~~

~~ATTACHMENT 8~~
~~4/16/19 USEPA RESPONSE TO 4/2/19 PPG RESPONSES~~

~~ATTACHMENT 9~~
~~5/22/19 USEPA COMMENTS ON 4/25/2019~~
~~PAR AND 6/28/19 PPG RESPONSES~~

~~APPENDIX B~~
~~RAGS PART D TABLES 1 TO 10~~

~~CONTENTS~~

~~APPENDIX C~~
~~USEPA REGION 2 LEAD STRATEGY~~

~~***Comment 57 of USEPA's 12/28/18 comments on 10/9/19 PAR:***~~

~~Region 2 Lead Strategy~~

- ~~Utilize a target blood lead level (BLL) of 5 µg/dL (as opposed to 10 µg/dL) based on the OLEM Directive 9200.2-167 to reduce BLLs from 10 ug/dl to a BLL within 2 to 8 ug/dL.~~
- ~~Collect bioavailability and background data when appropriate to assist in developing site-specific cleanup numbers.~~
- ~~Use a residential BHHRA screening of 200 ppm (as opposed to 400 ppm).~~
- ~~Use a commercial BHHRA screening and cleanup level 800 of ppm (unchanged with directive).~~
- ~~Continue to use the residential/commercial removal management levels of 400/800 ppm.~~
- ~~Residential Remediation Strategy: If lead poses unacceptable risk (> 5% with BLL over 5 µg/dL):~~
  - ~~No point in the exposure area (typically top two feet of soil) can exceed 400 ppm;~~
  - ~~The composite result or average (depending on the type of data collected) across exposure area should be at or below 200 ppm following cleanup;~~
  - ~~Cleanup of deeper soils would be based on other factors, such as the presence of source material, impact to groundwater, state cleanup requirements; and~~
  - ~~Lead concentration in clean backfill should not exceed 200 ppm.~~

~~APPENDIX D~~
~~BHHRA SUPPORTING CALCULATIONS~~

~~CONTENTS~~

~~ATTACHMENT D.1~~
~~PHYSICAL AND CHEMICAL PROPERTIES~~

~~ATTACHMENT D.2~~
~~BHHRA SUPPORTING CALCULATIONS FOR~~
~~Outdoor Workers~~

~~ATTACHMENT D.3~~
~~BHHRA SUPPORTING CALCULATIONS FOR INDOOR WORKERS~~

~~ATTACHMENT D.4~~
~~BHHRA SUPPORTING CALCULATIONS FOR UTILITY WORKERS~~

~~ATTACHMENT D.5~~
~~BHHRA SUPPORTING CALCULATIONS FOR CONSTRUCTION WORKERS~~

~~ATTACHMENT D.6~~
~~BHHRA SUPPORTING CALCULATIONS~~
~~FOR TRESPASSERS~~

~~ATTACHMENT D.7~~
~~BHHRA SUPPORTING CALCULATIONS~~
~~FOR RESIDENTS~~

~~ATTACHMENT D.8~~
~~BHHRA SUPPORTING CALCULATIONS FOR RESIDENTS WITH NONCANCER EXPOSURE DURATION~~

~~ATTACHMENT D.9~~
~~BACKGROUND METAL COMPARISON~~

~~APPENDIX E~~
~~UNUSUALLY HIGH SQLs AND ProUCL OUTPUT FOR COPCs~~ [1,2]

~~**Attachment 1** – Unusually High SQLs~~

~~**Attachment 2** – ProUCL Input for UCL Analysis~~

~~**Attachment 3** – ProUCL Output for COPCs~~

~~3.1 – Shallow Groundwater ProUCL Output~~

~~3.2 – All Depths Soil ProUCL Output~~

~~3.3 – Finite Soil (0 to 4 ft bgs) ProUCL Output~~

~~3.4 – Shallow Soil (0 to 2 ft bgs) ProUCL Output~~

~~3.5 – Additional Carcinogenic Soil COPCs ProUCL Output~~

~~**Attachment 4** – ProUCL Output Summary~~

~~Notes:~~

~~[1] The 0 to 2 foot dataset is the shallow dataset in this appendix.~~

~~[2] The 0 to 4 foot dataset is the finite dataset in this appendix.~~

~~ATTACHMENT 1~~
~~UNUSUALLY HIGH SQLs~~

~~ATTACHMENT 2~~
~~ProUCL INPUT FOR UCL ANALYSIS~~

~~ATTACHMENT 3~~
~~ProUCL OUTPUT FOR COPCs~~

~~ATTACHMENT 4~~
~~PROUCL OUTPUT SUMMARY~~

~~APPENDIX F~~
~~LEAD MODEL OUTPUTS~~

~~**Attachment 1** – IEUBK Model Input Values~~

~~**Attachment 2** – Resident All Depths Soil IEUBK Output~~

~~**Attachment 3** – Resident Surface Soil (0 to 2 ft bgs) IEUBK Output~~

~~**Attachment 4** – ALM Calculations of Blood Lead Concentrations (PbBs) and Risks in Nonresidential Areas~~

~~**Attachment 5** – A Blood Lead Empirical Model for Worker Exposure to Soil Lead~~

~~ATTACHMENT 1~~
~~IEUBK MODEL INPUT VALUES~~

~~ATTACHMENT 2~~
~~RESIDENT ALL DEPTHS SOIL IEUBK OUTPUT~~

~~ATTACHMENT 3~~
~~RESIDENT SURFACE SOIL (0 TO 2 FT BGS)~~
~~IEUBK OUTPUT~~

~~ATTACHMENT 4~~
~~ALM CALCULATIONS OF BLOOD LEAD CONCENTRATIONS (PbBS) AND RISKS IN NONRESIDENTIAL AREAS~~

~~ATTACHMENT 5~~
~~A BLOOD LEAD EMPIRICAL MODEL FOR WORKER EXPOSURE TO SOIL LEAD~~

~~APPENDIX G~~
~~ProUCL OUTLIER OUTPUT~~ [1,2]

~~See **Appendix E Attachment 2** for ProUCL Input for Outlier Analysis.~~

~~**Attachment 1** – Risk Estimate Tables for Locations with Outliers~~

~~1.1 – Cumulative Cancer Risk and HI Estimates for Shallow Groundwater in Wells with Outlier Concentrations~~

~~1.2 – Cumulative Cancer Risk and HI Estimates for Soil 0 to 2 ft bgs (Shallow) in Locations with Outlier Concentrations~~

~~1.3 – Cumulative Cancer Risk and HI Estimates for Soil 0 to 4 ft bgs (Finite) in Locations with Outlier Concentrations~~

~~1.4 – Cumulative Cancer Risk and HI Estimates for Soil at All Depths in Locations with Outlier Concentrations~~

~~**Attachment 2** – ProUCL Outlier Test Output~~

~~Dixon's Test ProUCL Output~~

~~Roser's Test ProUCL Output~~

~~**Attachment 3** – Outlier Test Results Summary~~

~~3.1 – Outlier Test Results for Shallow Groundwater~~

~~3.2 – Outlier Test Results for Shallow Soil~~

~~3.3 – Outlier Test Results for Finite Soil~~

~~3.4 – Outlier Test Results for Soil All Depths~~

~~Notes:~~

~~[1] The 0 to 2 foot dataset is the shallow dataset in this appendix.~~

~~[2] The 0 to 4 foot dataset is the finite dataset in this appendix.~~

~~ATTACHMENT 1~~
~~RISK ESTIMATE TABLES FOR LOCATIONS WITH OUTLIERS~~

~~ATTACHMENT 2~~
~~ProUCL OUTLIER TEST OUTPUT~~

~~ATTACHMENT 3~~
~~OUTLIER TEST RESULTS SUMMARY~~

~~APPENDIX H~~
~~REJECTED DATA SUMMARY~~

~~**Attachment 1** – Rejected Soil Data~~

~~1.1 – Summary of Soil Rejects~~

~~1.2 – Soil Screening Rejects Check~~

~~**Attachment 2** – Rejected Groundwater Data~~

~~2.1 – Summary of Groundwater Rejects~~

~~2.2 – Groundwater Screening Rejects Check~~

~~ATTACHMENT 1~~
~~REJECTED SOIL DATA~~

~~ATTACHMENT 2~~
~~REJECTED GROUNDWATER DATA~~

~~APPENDIX I~~
~~SAMPLED MEDIUM SUMMARY~~