Human Health Risk Assessment | *October 16, 2019*

Historical Storage Areas within Camp Kinser, MCB Camp Butler

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Executive Summary

As required by DoD Instruction 4715.08,[1] the Navy and Marine Corps Public Health Center (NMCPHC) performed a "health impact assessment" (human health risk assessment [HHRA]) to determine the likelihood of a substantial impact to human health and safety as a result of historical releases of chemicals stored at the Former Makiminato Service Area (MSA; Southern Area) and fill site (Northern Area) at Camp Kinser, Okinawa Prefecture, Japan. Two areas of interest, referred to as the Southern Area and Northern Area, were the focus of this investigation. For the purposes of the HHRA, the Southern Area and Northern Area are referred to as the Site.

Conclusion

As per the HHRA, and using USEPA Guidance, cancer risks and noncancer hazards were calculated for a six-year exposure duration (two tours) for a child and adult recreational user, and a 25-year adult landscaper. Based on this health impact assessment findings, NMCPHC concludes that there is not a likelihood of a substantial impact to human health and safety from historical releases of chemicals stored at the Former MSA (Southern Area) and fill site (Northern Area) at Camp Kinser, except for three locations in the Southern Area. These locations, or Decision Units (DUs), are DU-S1, DU-S2, and at one sample location (CKSA-SS40) in DU-S5. The USEPA noncancer hazard benchmark of 1 was exceeded for the six-year child recreational user primarily as a result of potential exposures to a single constituent at DU-S1 and DU-S2 (total 2,3,7,8-Tetrachlorodibenzodioxin [TCDD] Toxic Equivalents [TEQs]) and at one sample location (CKSA-SS40) in DU-S5 (Dichlorodiphenyldichloroethane [DDD]). For the 25-year adult landscaper, the noncancer benchmark was exceeded at DU-S1 (total 2,3,7,8-TCDD TEQs) and one sample location (CKSA-SS40) in DU-S5 (DDD).

Background

This HHRA is part of a Site investigation[2,3] for historical storage areas within Camp Kinser in the Okinawa Prefecture of Japan. In the late 1960s to early 1970s, the United States Army Garrison operated a chemical storage area at the Former MSA Lumber Yard, located at the southwestern part of the island approximately 4 miles north of the capital city of Naha (see Figure 1-5).

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[1] DoD Instruction 4715.08, Remediation of Environmental Contamination Outside the United States, 1 Nov 2013
[2] AECOM Site Investigation Report Former Makiminato Service Area (Southern Area) and Fill Site (Northern Area) Camp Kinser Okinawa Prefecture Japan, In progress
[3] Marine Corps Installations Pacific – MCB Camp Butler ltr 5090 G-F of 7 May 2018 – Camp Kinser Historic Contamination Plan of Action

Various supply materials retrograded from Vietnam were stored at an approximately 500,000-square-foot area along an open beach shoreline.

Storage conditions resulted in the chemical containers being subjected to oxidizing effects of weather that resulted in deterioration and ultimately a release in December 1974, contaminating the facility and surrounding tidal basin. All stored chemicals were removed and the following steps were taken:

- repack chemicals that were in leaking containers; investigation of extent and degree of contamination to the tideland and indigenous aquatic life; sampling and identification of unknown chemicals;
- dispose of certain chemicals by neutralization or burial on-Site, or burial in a sanitary landfill; and
- decontamination of the lumber yard; Approximately 950 cubic yards of contaminated soil was removed and disposed of in an unknown location. Documentation suggests that the most likely location of the fill site is near right-field of the current North Baseball Diamond of the Northern Area.

Sometime between 1979 and 1984, the beach shoreline of the Former MSA (Southern Area – Figure 1-5) was filled in with unknown material during a land reclamation project conducted by local government. The filled, ocean ward, reclaimed land is currently an industrial area. Currently, the Southern Area contains a Medical Clinic (Bldg. 1460), Dental Clinic (Bldg. 1463), baseball field, and other recreational fields; the Northern Area contains an elementary school (Bldg. 1040), soccer fields, berm, and baseball field.

HHRA Summary

The purpose of this report is to document the HHRA process used and present the risks for this Site based on current land use to support risk management decision-making (United States Environmental Protection Agency [USEPA] 1991).

The HHRA was focused on two portions of the Site known to have contamination: the Northern Area and the Southern Area (see Figure 1-2). The Southern Area is the Former MSA where historical releases have been documented. The Northern Area is the fill site (see Figure 1-3), where contaminated soil from the Southern Area (see Figure 1-4) was placed as part of a cleanup action for a chemical spill.

Constituents of potential concern (COPCs) were based on historical documentation of stored chemicals at the Former MSA:

Media	Analytical Group	Total Number of Samples Collected	Number of Samples Collected in Northern Area	Number of Samples Collected in Southern Area
Surface Soil	TPH-DRO	107	48	59
	SVOCs			
	PAHs			
	Organochlorine Pes icides			
	Organophosphorus Pes icides			
	Chlorinated Herbicides			
	Total Cyanide			
	Dioxins/Furans			
	Solvent-Extractable Non-VOCs			
	Hexavalent Chromium			
	Mercury			
	Other Metals			
	PCB Aroclors			
	PCB Congeners			
Groundwater	VOCs	6	3	3
	Carbonyls			
	TPH-GRO			
Sub-Slab Soil Gas	VOCs	37	23	14
	TPH-GRO			
	Aldehydes and Carbonyls			
Ambient Air	VOCs	2	1	1
	TPH-GRO			
	Aldehydes and Carbonyls			

The full suite of 209 PCB congeners were only analyzed in 11 surface soil samples (five in the Northern Area and six in the Southern Area). A sub-set of PCB congeners (dioxin-like) were analyzed in all 107 surface soil samples. VOCs were not analyzed in surface soil due to the age of the release. VOCs in surface soil would likely have volatilized in the time since the release. Sample count and analytical methods are based on those presented in the Final Site Investigation Work Plan (Naval Facilities Engineering Command [NAVFAC] 2018).

The goal of the HHRA was to determine whether or not concentrations of COPCs in Site surface soil (via dermal contact, ingestion, and inhalation), groundwater, and sub-slab soil gas (through vapor intrusion [VI]) may result in unacceptable risks to human health based on current land use (NAVFAC 2018).

Carcinogenic Risks

For carcinogenic risks, the USEPA recommended acceptable cancer risk range is 1E-04 (1×10^{-4} or 1 in 10,000) to 1E-06 (1×10^{-6} or 1 in 1,000,000; USEPA 1991). In general, the USEPA considers cancer risks below 1E-06 to be so small as to be negligible (i.e., below a level of regulatory concern; USEPA 1991). Conversely, cancer risks greater than 1E-04 are undesirable and typically require remedial action (e.g., soil removal).

Noncancer Health Effects

For noncancer health effects, the USEPA uses a Hazard Quotient (HQ) of 1 as the benchmark below which adverse, noncancer health effects are not expected and action generally is not warranted (USEPA 1991). An HQ greater than 1 shows that exposure levels exceed a reference dose (RfD) or reference concentration (RfC), indicating that adverse health effects via ingestion or inhalation are possible. Because many reference concentrations incorporate protective assumptions designed to provide a margin of safety, an HQ greater than one does not necessarily suggest a likelihood of adverse effects. An HQ greater than one can be best described as only indicating that a potential may exist for adverse health effects.

Vapor Intrusion

Before calculating cancer risks and noncancer hazards in the HHRA, two VI pathway evaluations were completed for receptors in the school buildings adjacent to the Northern Area and the dental and medical clinics located in the Southern Area. Appendix D presents the VI pathway evaluations of the Northern Area as a whole and the Southern Area, divided by building. Based on the results of the VI pathway evaluations, no significant VI concerns were identified for receptors in the Northern or Southern Areas and the VI COPCs were not evaluated further in the HHRA.

Child (0 to 6 years old) Recreators (recreational users)

Cancer risks and noncancer hazards were calculated for children using the Site for recreational purposes for six years (living with adults serving two tours of duty [6 years]). The total cancer risks and noncancer hazards calculated including arsenic are presented on Table 5-2 and the total risks and noncancer hazards calculated excluding arsenic are presented on Table 5-3. The total cancer risk calculated for child recreators were within the USEPA's acceptable risk range of 1E-04 to 1E-06 at each DU. Total noncancer HIs for child recreators were below 1, with the exception of a hazard index (HI) of 6.7 in DU-S1 and an HI of 2.5 in DU-S2. The HI for DU-S5 was 0.44 when the elevated results from sample CKSA-SS40 were removed from the calculation; the HI was 2.4 at sample location CKSA-SS40 (see Table 5-2).

Adult Recreators

Cancer risks and noncancer hazards were calculated for adults using the Site for recreational purposes while deployed to the Site for six years (i.e., two tours of duty). The total cancer risks and noncancer hazards calculated including arsenic are presented on Table 5-2 and the total risks and noncancer hazards calculated excluding arsenic are presented on Table 5-3. The total cancer risk calculated for adult recreators were within the USEPA's acceptable risk range of 1E-04 to 1E-06 in each DU. Total noncancer HIs for adult recreators were below 1 for all locations. The HI for DU-S5 was less than 1 with or without the inclusion of sample CKSA-SS40 in the calculation.

Adult Landscapers

Cancer risks and noncancer hazards were calculated for adult landscapers working at the Site for 25 years. The total cancer risks and noncancer hazards calculated including arsenic are presented on Table 5-2 and the total risks and noncancer hazards calculated excluding arsenic are presented on Table 5-3. The total cancer risk calculated for adult landscapers in each DU was within the USEPA's acceptable risk range of 1E-04 to 1E-06. The total noncancer HI for adult landscapers was below 1 in each DU except DU-S1, which had a noncancer HI of 2.1. Noncancer hazards were 2.1 for DU-S1 when including or excluding arsenic from the risk calculations (see Tables 5-2 and 5-3). The HI for DU-S5 was less than 1 with or without the inclusion of sample CKSA-SS40 in the calculation.

Summary of Risks

COPCs in surface soil responsible for the largest percentage of total cancer risks and noncancer hazards in both the Northern and Southern Areas include arsenic, dieldrin, DDD and total 2,3,7,8-TCDD TEQs (see Tables E-12 through E-22). Arsenic surface soil concentrations are presented on Figures 5-2 and 5-3; dieldrin surface soil concentrations are presented on Figures 5-6 and 5-7; and total 2,3,7,8-TCDD TEQ surface soil concentrations are presented on Figures 5-8 and 5-9.

Northern Area

In the Northern Area, cancer risks greater than 1E-06 were reported for arsenic, chlordane (technical), dieldrin, total carcinogenic polycyclic aromatic hydrocarbons (cPAHs), and total 2,3,7,8-TCDD TEQs for child recreator, adult recreator, and/or adult landscaper exposure scenarios; cancer risks were less than 1E-05 for all Northern Area COPCs for all exposure scenarios (see Tables E-1 through E-4). Each surface soil COPC was below the noncancer hazard benchmark of one in the Northern Area regardless of exposure scenario (see Tables E-1 through E-4). The highest total cancer risks and noncancer hazards were in DU-N4, located on the northernmost portion of the Northern Area (see Figure 5-4). DU-N4 is located in the approximate area of former Building 919, northeast of the soil berm (see Figure 1-3).

Southern Area

In the Southern Area, cancer risks greater than 1E-06 were reported for arsenic, dieldrin, total PCBs (Aroclor Method), DDD and total 2,3,7,8-TCDD TEQs for child recreator, adult recreator, and/or adult landscaper exposure scenarios; cancer risks greater than 1E-05 were reported for total 2,3,7,8-TCDD TEQs only in DU-S1 and dieldrin and total 2,3,7,8-TCDD TEQs in DU-S2 (see Tables E-5 through E-11). Only total 2,3,7,8-TCDD TEQs in DU-S1 and DU-S2 and DDD in sample CKSA-SS40 (located in DU-S5) exceeded the noncancer hazard benchmark of one in the

Southern Area (see Tables E-5 through E-11).[4] Cancer risks and noncancer hazards were assumed to be zero for COPCs that were not detected in any samples within a DU. The highest total cancer risks and noncancer hazards were in DU-S1 and DU-S2, located on the northernmost portion of the Southern Area (see Figure 5-5). DU-S1 includes the Skate Park and Maintenance Building (Bldg. 1304) and DU-S2 includes the Branch Medical Clinic and clinic field (see Figure 1-4 and Figure 1-7).

Evaluation of Lead Exposures - To assess whether or not lead levels at the Site pose a risk to human health, two USEPA lead models were used:

- The Integrated Exposure Uptake Biokinetic (IEUBK) model was used to evaluate lead risks in children (USEPA 2010); and
- The Adult Lead Methodology (ALM) model was used to evaluate lead risks (represented by blood lead levels [BLL]) in adult workers, while also estimating the probability of a pregnant worker's fetus having a BLL above a specified target value (USEPA 2017).

All predicted BLLs were less than 5 µg/dL. Based on available data, the results from the USEPA IEUBK and ALM models, and USEPA and ATSDR recommendations regarding BLL, the lead risks to children and the unborn fetus in pregnant women do not exceed the USEPA lead action levels for blood, or the current Centers for Disease Control and Prevention (CDC) and United States Department of the Navy (DoN) reference levels for children. The model parameters, lead evaluation, and results are presented in Appendix C.

Public Health Recommendations

Risk Communication

Recommendation: NMCPHC recommends that the results of this HHRA be communicated to the residents, recreators, and workers of Camp Kinser. This may include the final report(s), additional fact sheets, email, and/or other means of communication (e.g., media and social media).

Administrative Record

Recommendation: Create a Camp Kinser Administrative Record to gather in one location, all historical environmental records pertinent to Camp Kinser, and document actions taken and enduring processes recommended and implemented. It is likely these records will require retention to span the amount of time USMC will remain at Okinawa.

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[4] The HI for DU-S5 was 0.4 for a child-recreator when the elevated results from sample CKSA-SS40 were removed from the calculation and were 2.4 when the HI was calculated using only the sample results from CKSA-SS40. The His for an adult recreator and landscaper for DU-S5 were less than 1 when the elevated results from sample CKSA-SS40 were removed from the calculations and were also less than 1 when the HI was calculated using only the sample results from CKSA-SS40.

Medical Surveillance

Recommendation: For Camp Kinser residents and workers, no specific occupational or environmentally related medical screening is recommended at this time based on the sampling results and the HHRA results. Please note for general awareness of health care providers at U.S. Naval Hospital Okinawa, Navy medical surveillance for occupational exposures are based on Occupational Safety and Health Administration (OSHA) action level exceedances for workers and is contained in the NMCPHC Medical Surveillance Procedures Manual & Medical Matrix (NMCPHC – TM OM 6260 Apr 2016):
http://www.med.navy.mil/sites/nmcphc/occupational-and-environmentalmedicine/oemd/Pages/medical-matrix-online.aspx

Also note for responses to stakeholder concerns regarding general environmental exposures, health care providers should follow the guidance from the U.S. Preventive Services Task Force (USPSTF) recommendations:

http://www.uspreventiveservicestaskforce.org/BrowseRec/Index

For personnel concerned about their exposure and appropriate medical testing, continue to recommend health screening for eligible beneficiaries in accordance with the United States Preventive Services Task Force (USPSTF) Guide to Clinical Preventive Services which includes recommendations for cancer screening. Beneficiaries should discuss these recommendations with their health care providers. The USPSTF guidelines are already widely used and considered the standard of care within the medical community. The USPSTF, established in 1984 under the United States Department of Health and Human Services, has routinely published recommendations for primary care practitioners on the medical testing or procedures that should be provided to apparently healthy persons based on age, sex, and risk factors for disease. The USPSTF's recommendations are general medical screening recommendations that are appropriate for any and all members of the US population and provide early detection of diseases ranging from cancer to mental health conditions.

Land Use

Recommendation*:* This HHRA was conducted based on current land use; therefore, if intrusive activities (planned or yet unknown) occur which disturb soil in these affected DUs, a Soil Management Plan (SMP) should be developed to minimize contact with impacted soil and generation of airborne concentrations to adjacent building occupants, recreational users and workers performing the activities. The SMP should provide worker documentation of locations and levels of COPCs in soil for the Site, requirements for handling impacted soil and requirements for soil barrier management if required. Workers should be responsible for conducting Site work in accordance with the specifications outlined in the SMP and be under the oversight of the Camp Kinser representative. Construction specifications should be approved by the Camp Kinser representative in writing prior to construction activities including excavation for trenches (e.g., utility) and other activities. Earthwork and other necessary construction shall be planned to minimize disturbance of the soil. The SMP should include methods to achieve no visible emissions which may include, but are not limited to, equipment speed limits to reduce dust generation and/or low tipping of excavated loads. Use of a water spray unit to dampen surface materials should be considered if visible dusts are generated during excavation and soil movement. If water spraying is used, construction personnel shall avoid over-spraying the area to prevent run-off and mud-slick work surfaces.

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USEPA. 2017. Update of the Adult Lead Methodology's Default Baseline Blood Lead Concentration and Geometric Standard Deviation Parameter [OLEM Directive 9285.6-56]. https://www.epa.gov/superfund/lead-superfund-sites-software-and-users-manuals#recommend. Adult Lead Methodology model accessed May 10, 2019.

Table of Contents

Figures

Tables

Appendices

List of Acronyms

Acronym	Definition
2,3,7,8-TCDD	2,3,7,8-Tetrachlorodibenzo-p-dioxin
ABSd	Fractions of Constituent Absorbed Dermally from Soil
ADD	Average Daily Dose
ALM	Adult Lead Methodology
APPL	Agriculture & Priority Pollutants Laboratories, Inc.
Ah	Aryl Hydrocarbon
AT	Averaging Time
bgs	Below Ground Surface
BLL	Blood Lead Level
CDC	Centers for Disease Control and Prevention
cm	Centimeters
COPC	Constituent of Potential Concern
cPAH	Carcinogenic Polynuclear Aromatic Hydrocarbon
CSF	Cancer Slope Factor
CSM	Conceptual Site Model
CR	Cancer Risk
DA	Department of the Army
DAF	Department of the Air Force
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
DNA	Deoxyribonucleic Acid
DoD	Department of Defense
DOE	Department of Energy
DoN	Department of the Navy
DU	Decision Unit
ED	Exposure Duration
EF	Exposure Frequency
EMAX	EMAX Laboratories, Inc.
EPC	Exposure Point Concentration
ET	Exposure Time
GIABS	Gastrointestinal Absorption Factor
GRO	Gasoline Range Organic
HEAST	Health Effects Assessment Summary Table
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient

Acronym	Definition
HxBEN	Hexachlorobenzene
IRIS	USEPA's Integrated Risk Information System
IUR	Inhalation Unit Risk
IEUBK	Integrated Exposure Uptake Biokinetic
LADD	Lifetime Average Daily Dose
Landscaper	Host-Country Contract Landscaper
LOAELs	Lowest Observed Adverse Effect Levels
Log 95% UCL	Logarithmic 95% UCL on the Mean
LOQ	Limit of Quantification
MADEP	Massachusetts Department of Environmental Protection
MDL	Maximum Detection Limit
Mg/dL	Micrograms per Deciliter
mg/kg-day	Milligram per Kilogram-Day
mg/m^3	Milligram per Cubic Meter
MRL	Minimal Risk Level
MSA	Makiminato Service Area
MSL	Mean Sea Level
NAVFAC	Naval Facilities Engineering Command
NMCPHC	Navy and Marine Corps Public Health Center
NOAELs	No Observed Adverse Effect Level
Northern Area	Fill Site at Camp Kinser
OEHHA	Office of Environmental Health Hazard Assessment
OSHA	Occupational Safety and Health Administration
PAH	Polynuclear Aromatic Hydrocarbon
PCBs	Polychlorinated Biphenyls
PCDD	Polychlorinated Dibenzo-p-Dioxin
PCDF	Polychlorinated Dibenzo-p-Furan
PCP	Pentachlorophenol
ppm	Parts Per Million
PPRTVs	Provisional Peer Reviewed Toxicity Values
QSM	Quality Systems Manual
PIONEER	PIONEER Technologies Corporation
RAGS	Risk Assessment Guidance for Superfund
RBA	Relative Bioavailability Factor
RBSC	Risk-Based Screening Criteria
REL	Reference Exposure Level
RfCs	Reference Concentrations
RfD	Reference Dose
RME	Reasonable Maximum Exposure

Acronym	Definition
RSL	Regional Screening Level
Site	Southern Area and Northern Area
SiteSTAT	SiteSTAT™ Statistical Software
SMP	Soil Management Plan
Southern Area	Former Makiminoto Service Area at Camp Kinser
SSDS	Sub-slab Depressurization System
SSIC	Standard Subject Identification Code
STSC	USEPA's Superfund Technical Support Center
SVOC	Semi-volatile Organic Compound
TEF	Toxicity Equivalency Factor
TEQ	Toxic Equivalent
TPH	Total Petroleum Hydrocarbons
UCL	Upper Confidence Level
US	United States
USMC	United States Marine Corps
USEPA	United States Environmental Protection Agency
USPSTF	United States Preventive Services Task Force
VF	Volatilization Factor
VI	Vapor Intrusion
VISL	Vapor Intrusion Screening Level
VOC	Volatile Organic Compound
Work Plan	Final Site Investigation Work Plan

Section 1: Introduction

The Navy and Marine Corp Public Health Center (NMCPHC) conducted this human health risk assessment (HHRA) as part of an investigation of historical storage areas (Northern Area and Southern Area; Site) within Camp Kinser in the Okinawa Prefecture of Japan (see Figure 1-1). The investigation is being conducted in response to a Congressional Inquiry Letter from Congresswoman Julia Brownley (dated February 20, 2018) requesting information regarding the environmental status and potential contamination at Camp Kinser and any efforts to remediate the Site. The letter was written in response to a concern that a constituent from the Congresswoman's district (whose grandson was deployed to Japan), expressed about environmental conditions at the Site. A February 10, 2018 article in The Japan Times was attached to the inquiry, in which it was implied that there is extensive contamination at the Site (see Appendix A).

The goal of the HHRA was to determine whether or not constituent concentrations in surface soil (0 to 0.5 feet below ground surface [bgs]), shallow groundwater (less than 20 feet bgs), sub-slab soil gas, and/or ambient air in the two areas may result in unacceptable risks to human health based on current land use (Naval Facilities Engineering Command [NAVFAC] 2018).[5,6] In accordance with Department of Defense (DoD) Instruction 4715.08, the HHRA was focused on two portions of the Site known to have contamination: the Northern Area and the Southern Area (see Figure 1-2). The Southern Area is the former Makiminato Service Area (MSA) where historical releases have been documented. The Northern Area (see Figure 1-3), also referred to as the fill site, is the location where contaminated soil from the Southern Area (see Figure 1-4) was placed as part of a cleanup action for a constituent spill.

The purpose of this report is to document the HHRA process used and present the risks for the Site, based on current land use only, to support risk management decision-making.

Project Background

The former MSA was used in the late 1960s to early 1970s to store constituents (including pesticides) from the Vietnam War (see Figure 1-5). The constituents were stored in cardboard and metal containers (e.g., drums) along an approximately 500,000-square-foot open beach area. Some of the containers deteriorated over time and released contaminants to the former MSA and surrounding tidal basin area. The releases, coupled with heavy rainfall in December

[5] In accordance with Department of Defense (DoD) Instruction 4715.08, only impacts to human health were evaluated in the HHRA.

[6] Risks based on any future land use that differs from the current use were not evaluated in this HHRA.

1974, resulted in a fish-kill incident. It was later determined that the fish died due to concentrations of the pesticide Malathion (Department of the Air Force [DAF] 1994a).

Cleanup activities were conducted in response to the releases and fish kill incident. Stored constituents were removed and repackaged and some constituents were disposed (neutralized or buried in a sanitary landfill). The extent and degree of contamination was investigated, the former MSA was remediated, and long-term monitoring was implemented (NAVFAC 2018). The open beach area was filled during a land reclamation project initiated by the host nation (between 1979 and 1984); the reclaimed (filled) land is currently an industrial area (see Figure 1-4). As part of the cleanup activities, approximately 950 cubic yards of contaminated soil was removed from the former MSA and used in the Northern Area as fill in the berm and near former Building 919 (see Figure 1-3).

According to historical documentation, excess or waste constituents may have also been dumped in this area at the same time (DAF 1994b). The baseball field and soccer fields are potentially located on top of the contaminated fill area. It is unknown whether or not the contaminated soil was removed prior to the construction of these facilities or where the contaminated soil may have been transferred (NAVFAC 2018). Family housing, an elementary school, a child care facility, and recreational fields were built proximate to the contaminated soil in the Northern Area in the mid- to late-1980s (DAF 1994b). Summaries of previous investigations are presented in Table 1-1.

Site Summary

Site Setting

The Site is located in the southwestern portion of Okinawa Island, Japan, along the East China Sea, and approximately eight miles southwest of the city of Okinawa and four miles northeast of Naha (see Figure 1-1). The land surface of the Site slopes downward towards the East China Sea. The westernmost portions of the Site are approximately 15 feet above mean sea level (MSL) and the easternmost portions are approximately 100 feet MSL. The majority of the Northern and Southern Areas appear to have been filled, graded, or paved over during the construction of Camp Kinser support facilities (NAVFAC 2018). The Northern Area is relatively flat with the exception of a berm north of the softball field (see Figure 1-3). The elevation of the berm is approximately six to 10 feet above the surrounding area. The Southern Area is relatively flat with the exception of the baseball field, which is three to 12 feet higher than the surrounding areas (see Figure 1-4).

The Site was divided into nine decision units (DUs) for evaluation purposes only. Four DUs were drawn in the Northern Area and five DUs were drawn in the Southern Area. The DU boundaries were determined based on general land use and topography. The DUs are described in the following table and presented in Figures 1-6 and 1-7.

Area DUs			
Northern Area DU	**Boundary Description**	**Southern Area DU**	**Boundary Description**
DU-N1	The soil berm, where contaminated soil from the Southern Area was placed	DU-S1	Skate park, maintenance building, associated parking lot and surrounding area. Majority of this area is paved.
DU-N2	Baseball field	DU-S2	Area around the medical clinic, including the parking lot, ditch, and field. DU-S1 and DU-S2 are separated by a historical drainage ditch
DU-N3	Soccer fields	DU-S3	Dental clinic and surrounding area
DU-N4	Play area proximate to the elementary school	DU-S4	Softball field and surrounding area
		DU-S5	Swale/surface water collection area next to the softball field

Current Land Use

Military personnel and their families, DoD teachers and their families, civil servants and their families, and host-country contract landscapers (landscapers) are the most frequent users of the Northern and Southern Areas. Military personnel are deployed to the Site for one to two tours of duty (i.e., three to six years, respectively). DoD teachers, civil servants[7], and landscapers could be at the Site for 25 years.

Land use in the Northern and Southern Areas is currently used for commercial/industrial and recreational purposes. Land use around the Site is primarily residential to the northeast and east and commercial/industrial to the south. A summary of the areas is presented below:

Northern Area

The Northern Area currently contains one baseball and two soccer fields, a helipad, and a soil berm. Military personnel and their families, DoD teachers and their families, and civil servants and their families may use this area for recreational purposes; landscapers are responsible for maintaining this area. A preschool and an elementary school (and associated buildings) are located adjacent to this area towards the northeast (see Figure 1-3). Children of military personnel and DoD teachers occupy these buildings during school hours. The elementary school and associated buildings are located slightly outside of the Northern Area boundary but were

[7] Current policy states a civil servant is a single, two-year tour, which is extendable to five years and up to seven years, with Commanding General approval. This rule began to be enforced in 2014, so prior civilians could be there a decade or longer.

included in this HHRA because contaminated soil from the Southern Area was placed near former Building 919 and right field of the baseball field (see Figure 1-3). Although contaminated soil was not placed in the same location as the school and associated buildings, there is the potential for contaminants in Northern Area soil to leach to the groundwater and flow beneath the school, which could result in the potential for vapor intrusion (VI; i.e., volatile constituents in groundwater could volatilize and migrate into the indoor air of the buildings).

The media of potential concern in the Northern Area are surface soil, groundwater, and soil gas. The potential for people to come into contact with surface soil could occur during recreational or landscaping activities. The potential for people to come into contact with soil vapors in the indoor air of the school or associated buildings could occur if volatile constituents in groundwater volatilize and migrate into the indoor air of occupied buildings.

Southern Area

The Southern Area currently contains a medical clinic, dental clinic, baseball field, skate park, and maintenance building (see Figure 1-4). Military personnel and their families, DoD teachers and their families, and civil servants and their families may use this area for recreational and commercial purposes; landscapers are responsible for maintaining this area.

The media of potential concern in the Southern Area are surface soil, groundwater, and soil gas. The potential for people to come into contact with surface soil could occur during recreational or landscaping activities; people visiting the medical or dental clinic are unlikely to result in contact with surface soil due to asphalt and concrete pavement. The potential for people to come into contact with soil vapors in the indoor air of the medical or dental clinic could occur if volatile constituents in soil and/or groundwater volatilize and migrate into the indoor air of occupied buildings.

Climate

Okinawa's climate is subtropical with very mild winters, and long, rainy summers (Climates to Travel 2018). Although the winter is very mild, the sky is often cloudy, and wind and rain are common. The long summers are muggy, with fairly frequent (sometimes abundant) rain. On average, it rains 141 days per year, with over 80 inches (203 centimeters [cm]) of rain annually. Most rainfall occurs between May and September. With the exception of July, the average monthly rainfall for the summer months is nine inches (23 cm); the average monthly rainfall in July is 5.5 inches (14 cm). The average annual temperature on Okinawa is 72.1 °F (22.3 °C) with the hottest months being July and August (average high temperature of 90 °F [32 °C]) and the coldest months being January and February (average high temperature of 68 °F [20 °C]). Temperatures rarely fall below 55 °F (13 °C), even in the winter (Weathercloud 2018).

The predominant wind direction measured at Naha Airport (approximately four miles southwest of the Site) is from the southwest to northeast, with an average velocity of 4.0 meters per second (Weathercloud 2018).

Geology/Hydrogeology

Holocene alluvium (unconsolidated carbonate sands, silts, and gravels) and Ryukyu Limestone (unconsolidated to partially-lithified coralgal limestone biolithite with karst conditions) underlie the Site. The alluvium and limestone thicknesses are highly variable. The alluvium thickness is estimated to be, on average, 40-feet-thick and the limestone thickness is estimated to be less than 125-feet-thick (Takayasu 1978). The limestone is generally located nearer to the surface on the eastern upland portions of the Site, away from the East China Sea. The soil in the Northern Area consists of permeable, fat clays atop the limestone. The soil/bedrock contact is irregular, and pinnacle karst is common with relief to 10 feet bgs. The soil in the Southern Area consists of coral sand, which is generally indistinguishable from the underlying Holocene marine sands (Nicol et al. 1957).

Depth to groundwater in both the Northern and Southern Areas is shallow, measured at four to 13 feet bgs, and is typically shallower closer to the ocean. Groundwater flow occurs through both primary porosity (matrix flow through pore spaces within the sediment matrix) and secondary porosity (fracture flow). Matrix flow dominates within the vadose zone, while fracture flow dominates with depth. The Ryukyu Limestone contains significant secondary porosity in the form of macro-karst (i.e., caves and caverns) which results in rapid, conduit-type groundwater flow (Yoshimoto et al. 2011). Groundwater discharges into the East China Sea; however, localized flow directions vary due to the tidal influence and presence of karst.

On December 14, 2018, groundwater elevations varied between 1.6 and 3.7 feet MSL at the Site. Localized groundwater flow in the Northern Area was to the northeast, away from the East China Sea (potentially as a result of karst conditions) and localized groundwater flow in the Southern Area was to the northwest, towards the East China Sea. Additional information about the groundwater elevations will be presented in the Site Investigation Report, which is currently in production.

Overview of Risk Assessment Methodology

Risk assessment is an established, scientific approach used to evaluate the potential for impacts to human health and the environment associated with exposure to constituents in contaminated media (e.g., soil, water, and air). Risk assessment is a management decision tool; risk assessment does not provide absolute statements about health and environmental impacts, and typically focuses on constituents and exposure pathways (e.g., inhalation, ingestion, and dermal contact) directly related to a Site. Risk assessments generally do not address risks from other sources of exposure (e.g., dietary exposures, unless associated with food that might be contaminated from the Site), or risks from other constituents not associated with the Site. Risk managers use the results of risk assessments to determine if a Site, or a portion thereof, requires further investigation or action (e.g., mitigation and remediation).

This risk assessment was performed in accordance with:

- DoD Vapor Intrusion Handbook (DoD 2009);
- US Navy Human Health Risk Assessment Guidance (PIONEER Technologies Corporation [PIONEER] 2008);
- United States Environmental Protection Agency (USEPA) Risk Assessment Guidance for Superfund (RAGS; USEPA 1989); and
- OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air (USEPA 2015).

The HHRA process is comprised of the following steps:

- **Step 1 – Hazard Identification and Data Evaluation and Reduction.** In this step, data were identified and reduced for use in the risk assessment. Through this process, viable exposure pathways as well as constituents of potential concern (COPCs) were identified. Hazard identification and data evaluation and reduction tasks are presented in Section 2.
- **Step 2 – Exposure Assessment**. In this step, potentially exposed populations (i.e., receptors), exposure scenarios, complete exposure pathways, and exposure factors were identified. The algorithms used to calculate media concentration and exposure assessment tasks are presented in Section 3.
- **Step 3 – Toxicity Assessment**. In this step, toxicity values for the COPCs identified in Step 1 were identified. Toxicity values used in this HHRA included Inhalation Unit Risk (IUR) factors, noncarcinogenic reference concentrations (RfCs), noncarcinogenic reference doses (RfDs), cancer slope factors (CSFs), relative bioavailability (RBA) factors, volatilization factors (VFs), age dependent mutagen factors, and the fraction of constituents absorbed dermally through skin (ABSd). The toxicity assessment is presented in Section 4.
- **Step 4 – Risk Characterization**. In this step, health risks associated with exposure to the COPCs were calculated using the information developed in Steps 1 through 3. The health risks are summarized in Section 5.
- **Step 5 – Uncertainty and Sensitivity Analysis.** In this step, key uncertainties, either inherent in the evaluation or from Site-specific analyses, were identified. The results of the risk assessment were evaluated to determine sensitivity to modifications of specific input parameters. The uncertainty and sensitivity analysis is presented in Section 6.

The HHRA is organized into the following sections:

- Section 2 – Hazard Identification and Data Evaluation and Reduction
- Section 3 – Exposure Assessment
- Section 4 – Toxicity Evaluation
- Section 5 – Risk Characterization
- Section 6 – Uncertainty and Sensitivity Analysis
- Section 7 – Conclusions

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Section 2: Hazard Identification and Data Evaluation and Reduction

Hazard identification is the process of determining whether or not exposure to a constituent will cause an increase in adverse health effects in humans. The purpose of the data evaluation and reduction process is to identify the data that will be carried forward for consideration in the risk assessment. The rationale used to evaluate and reduce the data set for the HHRA are presented in this section.

Data Overview

A multimedia sampling event was conducted in November and December 2018 to determine constituent concentrations in soil, groundwater, sub-slab soil gas, and ambient air in the Northern and Southern Areas. Summaries of the samples collected for each area are presented below by medium. A sample methodology summary for all media is presented in Table 2-1.

	Number of Samples Collected			
Area	**Soil**	**Groundwater**	**Sub-Slab Soil Gas**	**Background Ambient Air**
Northern Area	48	3	23	1
Southern Area	59	3	14	1

Samples were collected in accordance with the Final Site Investigation Work Plan (Work Plan; NAVFAC 2018). The results of the sampling event, including the results of analytical data validation will be presented in the Site Investigation Report, which is currently in production.

Soil Data

Surface soil samples (0 to 0.5 feet below ground surface [bgs]) were collected from 107 locations on the Site: 48 samples were collected in the Northern Area and 59 were collected in the Southern Area (see Figures 2-1 and 2-2, respectively). Sub-surface soil samples were not collected since the focus of this HHRA was on current land use and it is not anticipated that receptors will contact deeper soil based on current land use.

The surface soil samples were analyzed for total petroleum hydrocarbons (TPH)-diesel range organics/lube oil range organics, metals, dioxins/furans, polychlorinated biphenyls (PCBs; aroclors and congeners), polynuclear aromatic hydrocarbons (PAHs), herbicides, semi-volatile organic compounds (SVOCs), organochlorine and organophosphorus pesticides, total cyanide, and a solvent-extractable nonvolatile compounds.[8] Surface soil analytical data will be presented in the Site Investigation Report, which is currently in production. A summary of the surface soil analytical methodology is presented in Table 2-1.

Groundwater Data

Shallow groundwater samples were collected from six monitoring wells, which were screened across the water table: three were located in the Northern Area and three were located in the Southern Area (see Figures 2-1 and 2-2, respectively). Groundwater samples were collected to evaluate the potential for VI only as groundwater is brackish and not used as drinking water and/or any other potable water use.

Groundwater samples were analyzed for VOCs, carbonyl compounds, and TPH-gasoline range organics (GRO). Groundwater analytical data will be presented in the Site Investigation Report, which is currently in production. A summary of the groundwater analytical methodology is presented in Table 2-1.

Sub-Slab Soil Gas Data

Sub-slab soil gas samples were collected from 37 locations on the Site: 23 samples were collected from the school and associated buildings (adjacent to the Northern Area to the northeast; see Figure 2-3 and Table 2-2) and 14 samples were collected from the medical and dental clinics in the Southern Area (see Figure 2-4 and Table 2-3). The Northern Area sub-slab soil gas samples were collected from the school and associated buildings even though the soil beneath these buildings was not impacted (i.e., from the former MSA cleanup actions). The sub-slabs of these buildings were sampled because the contaminated soil in the Northern Area could migrate to groundwater and be transported beneath the school and associated buildings (based on the direction of groundwater flow [see Figure 2-1]), resulting in the potential for VI. Southern Area sub-slab soil gas samples were collected from the medical and dental clinics to evaluate the potential for VI from impacted soil and/or groundwater beneath the buildings.[9]

The sub-slab soil gas sampling locations were selected based on how the indoor spaces in the buildings were used and the duration for which they were occupied. The sub-slab soil gas

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[8] Due to the age of the release at the Site, volatile organic compounds (VOCs) in surface soil would likely have volatilized and were therefore not sampled.

[9] Four of the seven sub-slab soil gas samples collected from the dental clinic (samples CK1463-01 through CK1463-03 and CK1463-05) were collected from a utility vault/corridor that runs beneath portions of the building. Although not true sub-slab soil gas samples, these samples were representative of air beneath the floor slab of the building.

sample locations in the Northern Area are presented on Figure 2-3; the sub-slab soil gas sample locations in the Southern Area are presented on Figure 2-4.

Sub-slab depressurization systems (SSDSs) were previously installed in five of the seven school-related buildings to mitigate radon concentrations (NAVFAC. 2018).[10] The systems were operating during sub-slab soil gas sampling to best represent actual building conditions (exposures) while occupied and may have impacted sub-slab soil gas results in these buildings (e.g., soil gas concentrations might have been higher if the systems were turned off during the sampling event).

Sub-slab soil gas samples were analyzed for VOCs, GRO, carbonyl compounds and aldehydes. Sub-slab soil gas analytical data will be presented in the Site Investigation Report, which is currently in production. A summary of the sub-slab soil gas analytical methodology is presented in Table 2-1.

Background Ambient Air Data

Background ambient air samples were collected from two locations on the Site: one in the Northern Area and one in the Southern Area (see Figures 2-3 and 2-4, respectively). The background air concentrations were used to support the VI evaluation (i.e., ambient air screening was not conducted).

Ambient air samples were analyzed for volatile organic compounds (VOCs), GRO, carbonyl compounds and aldehydes. Ambient air analytical data will be presented in the Site Investigation Report, which is currently in production. A summary of the ambient air analytical methodology is presented in Table 2-1.

Data Validation and Analysis

All analytical data packages were reviewed independently from the laboratory to assess data quality; analytical data will be included in the Site Investigation Report, which is currently in production. The data were reviewed for conformance to the analytical methods and requirements of the following documents:

- DoD and Department of Energy (DOE) Consolidated Quality Systems Manual for Environmental Laboratories, Version 5.1.1 (DoD and DOE 2018).

[10] SSDSs were installed in the following elementary school buildings; (1) Kinser 1039 (Preschool) - three SSDSs were installed in Jan 1999, (2) Kinser 1040R (Kindergarten) - one SSDS was installed in Jun 2012, (3) Kinser 1041A (Maintenance) - one SSDS was installed in Jan 1999, (4) Kinser 1042 (Art) - four SSDSs were installed in Jan 1999, and (5) Kinser 1043 (Gym) - four SSDSs were installed in Jan 1999. SSDSs were not installed in the main school building (Building 1040) and the cafeteria and music room (Building 1041).

- Project Procedures Manual, United States [U.S.] Naval Facilities Engineering Command Environmental Restoration Program, NAVFAC Pacific, (DoN 2015).
- Work Plan (NAVFAC 2018).

When the quality control parameters did not fall within the specific method or data review guidelines, the data reviewer qualified (flagged) the corresponding constituents in accordance with the relevant standards in the following USEPA guidelines:

- National Functional Guidelines for Inorganic Superfund Methods Data Review (USEPA 2017a).
- National Functional Guidelines for Organic Superfund Methods Data Review. (USEPA 2017b).

Data qualifiers and variances are presented in the Site Investigation Report which is currently in production. No significant data flags were reported and the data were considered usable. Multiple sample results were qualified as estimated or non-detected based on values exceeding quality control limits (e.g., laboratory blank detections or surrogate recoveries outside acceptable criteria).

Data Conversion

SiteSTAT™ Statistical Software (SiteSTAT™) was used to evaluate the soil, groundwater, sub-slab soil gas, and ambient air data. During the data upload process, the following conversions occurred to facilitate data evaluation:

- Field duplicate results were combined and a single analytical result was identified for each location using the following method:
  - If both results were detected, the average of the two values was used.
  - If one result was detected and one result was not detected, the detected value was used.
  - If both results were not detected, lowest detection limit was used.
- Analytical results qualified with an R (i.e., rejected) were eliminated from the dataset because the data did not meet quality control criteria.
- Essential nutrients (i.e., calcium, magnesium, potassium, and sodium) were eliminated from the dataset because they are not associated with toxicity in humans under normal circumstances (USEPA 1989).
- Southern Area soil samples were resampled as holding times from the initial sampling event were missed due to a shipment delay. Consequently, the results from the initial sampling event were eliminated from the dataset and the results from the second sampling event were used.

- Some sample numbers were reassigned to eliminate multiple sample numbers for one sample location. For example, sample number JK222 results were merged with JK096 results (and reassigned the JK096 sample number) since both were associated with sample location CKSA-SS01. In these instances, the lowest sample number was used.
- Two laboratories (EMAX Laboratories, Inc. [EMAX] and Agriculture & Priority Pollutants Laboratories, Inc. [APPL]) reported hexachlorobenzene (HxBEN) and pentachlorophenol. Below is an evaluation of those constituents that were the primary risk drivers for the calculated cancer risks and noncancer hazards via USEPA Method 8270D; APPL analyzed HxBEN via USEPA Method 8081B and PCP via USEPA Method 8151A. EMAX's detection limits were typically higher than APPL's; therefore, the HxBEN and PCP results from EMAX were eliminated from the dataset.
- A 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) toxic equivalent (TEQ) concentration was calculated for each sample based on dioxin and furan isomer and congener analytical results. The calculations were performed by multiplying the isomer/congener concentrations by the corresponding 2,3,7,8-TCDD toxicity equivalency factors (TEFs) and summing the results. The 2,3,7,8-TCDD TEFs for dioxins and dioxin-like PCB isomers/congeners are presented in Section 4.
- 2,3,7,8-TCDD TEQs were calculated for each sample based on dioxin-like PCB congeners using the process presented in the previous bullet. The 2,3,7,8-TCDD TEQ for the dioxin-like PCB and the 2,3,7,8-TCDD TEQs for dioxins were summed, resulting in total 2,3,7,8-TCDD TEQ for each sample. The individual dioxin and dioxin-like PCB congers and individual TEQs were eliminated from the dataset. A comparison of the 2,3,7,8-TCDD TEQs for dioxin-like PCBs and dioxins is presented in Section 6 to document the impact dioxin-like PCBs had on the total 2,3,7,8-TCDD TEQs.
- A total carcinogenic PAH (cPAH) concentration was calculated for each surface soil sample by multiplying the concentration of individual cPAHs by the corresponding benzo(a)pyrene TEF and summing the results. The benzo(a)pyrene TEFs are presented in Section 4.
- A total PCB aroclor concentration was calculated for each surface soil sample by summing the individual PCB aroclors for each sample. The total PCB aroclor concentrations were included in the dataset. Individual PCB aroclor concentrations were evaluated further to determine whether heavier or lighter spectrum aroclors were contributing to total PCB aroclor concentrations.
- Total PCB congener concentrations were calculated for the 11 surface soil samples that were analyzed for each of the 209 PCB congeners by summing the individual PCB congeners for each sample (see Section 6). The total PCB congener concentrations were then compared to the total PCB aroclor concentrations for those samples to determine

whether or not the total PCB aroclor concentrations underestimated total PCB concentrations. Individual PCB congeners were eliminated from the dataset.

- Compound totaling (i.e., calculating the total 2,3,7,8-TCDD TEQs, total cPAH, total PCB aroclor, and total PCB congener concentrations) was conducted using the following criteria:
  - If all constituent concentrations were not detected, the sum of the non-detected concentrations was used.
  - If only some constituent concentrations were not detected, the sum of the detected constituent concentrations plus half of the sum of the non-detected concentrations was used.
  - If all constituent concentrations were detected, the sum of the detected concentrations was used.

Data Reduction and Risk-Based Screening

Following data validation and conversion, a risk-based screening (i.e., a U.S. Navy Tier 1 evaluation) was conducted using the Site-wide dataset to focus the HHRA on those constituents that could pose a significant risk to human health. Constituents that were not eliminated during risk-based screening were identified as COPCs and retained for further evaluation in the HHRA.

Two risk-based screening evaluations were conducted to identify COPCs for further evaluation in the HHRA: one evaluation focused on surface soil and one evaluation focused on VI. For surface soil, concentrations were compared to May 2019 USEPA Regional Screening Levels (RSLs) for residential land use. For VI, groundwater and sub-slab soil gas sample results were compared to May 2019 VI Screening Levels (VISLs) for residential land use, which were derived from RSLs protective of residential ambient air.[11] Residential land use parameters were used for the Tier 1 screening evaluations; however, these parameters were overly conservative for the Site, which is not currently used for residential purposes. The RSLs/VISLs correspond to a cancer risk of 1E-06 and noncancer hazard quotient (HQ) of 1 using generic, health protective exposure assumptions (USEPA 2019).

The approach for identifying COPCs to retain in the HHRA is presented below and shown on Figure 2-5. The surface soil, groundwater, and sub-slab soil gas COPC data-reduction results are summarized in Appendix B.

[11] Groundwater results were evaluated for the VI pathway only; direct contact risks via groundwater were not evaluated.

Approach for Evaluating Constituents Not Detected in Any Sample

- A constituent was retained for further evaluation as a COPC in the HHRA if it was not detected in any sample and the method detection limit (MDL) was greater than 10 times the RSL/VISL (or 10 times the laboratory limit of quantification [LOQ] if a RSL/VISL was not available).[12]

Approach for Evaluating Constituents Detected in at Least One Sample

- A detected constituent was retained for further evaluation as a COPC in the HHRA if it was detected in:
  - greater than or equal to 5% of the samples and the maximum detected concentration was greater than the RSL/VISL or no RSL/VISL was available; or
  - less than 5% of the samples but the maximum detected concentration was greater than 10 times the RSL/VISL; or
  - less than 5% of the samples, there was geographical correlation, and an RSL or a VISL was not available.

Identification of Soil COPCs

Thirty-four constituents were identified as surface soil COPCs based on the Tier 1 screening and were retained for further evaluation in the HHRA (see Appendix B). Summary statistics for the COPCs identified in surface soil are presented in Table 2-4.

Surface Soil COPCs	
Constituent was detected in greater than or equal to 5% of samples and the maximum detected concentration was greater than the RSL	
Arsenic, Inorganic	DDE
Benzo[a]pyrene	DDT
Benzo[b]fluoranthene	Dibenz[a,h]anthracene
alpha-Chlordane	Dieldrin
gamma-Chlordane	Total Carcinogenic PAHs (BaP TEQs)
Chlordane, Technical	Total Dioxins/Furans (2,3,7,8-TCDD TEQs) as Dioxins
Chromium (VI)	Total Dioxins/Furans (2,3,7,8-TCDD TEQs) as PCBs[13]
DDD	Total PCBs (Aroclor Method)

[12] The laboratory LOQ was presented in the Work Plan (NAVFAC 2018).

[13] Total dioxins/furans (2,3,7,8-TCDD TEQs) as dioxins and total dioxins/furans (2,3,7,8-TCDD TEQs) as PCBs were combined in order to evaluate total dioxin/furans (2,3,7,8-TCDD TEQs) in the HHRA.

Surface Soil COPCs	
Constituent was detected in greater than or equal to 5% of samples and no RSL was available	
Acenaphthylene	Thorium-232
Benzo(g,h,i)perylene	Titanium
Carbazole	Phenanthrene
2,4-DDT	
Constituent was not detected in any sample and the MDL was greater than 10 times the RSL	
2-Acetylaminofluorene	N-Nitroso-di-N-butylamine
7,12-Dimethylbenz(a)anthracene	N-Nitroso-di-N-propylamine
p-Dimethylamino azobenzene	N-Nitrosomethylethylamine
3-Methylcholanthrene	N-Nitrosomorpholine
N-Nitrosodiethylamine	N-Nitrosopiperidine
N-Nitrosodimethylamine	

Identification of Groundwater-Related VI COPCs

Six constituents were identified as VI COPCs based on the Tier 1 groundwater screening and were retained for further evaluation in the HHRA. Statistical summaries for the VI COPCs identified in groundwater are presented in Table 2-5.

Groundwater-Related VI COPCs	
Constituent was detected in greater than or equal to 5% of samples and no VISL was available	
Dibromochloromethane	Tert-Butyl Alcohol
Constituent was not detected in any sample and the MDL was greater than 10 times the VISL	
2-Chloro-1,3-butadiene	cis-1,4-Dichloro-2-butene
1,2-Dibromo-3-chloropropane	trans-1,4-Dichloro-2-butene

Identification of Sub-Slab Soil Gas COPCs

Twenty-nine constituents were identified as VI COPCs based on the Tier 1 sub-slab soil gas screening and were retained for further evaluation in the HHRA. Statistical summaries for the VI COPCs identified in sub-slab soil gas are presented in Table 2-6.

Sub-Slab Soil Gas COPCs	
Constituent was detected in greater than or equal to 5% of samples and the maximum detected concentration was greater than the VISL	
Acetaldehyde	Isopropanol
Acrolein	Naphthalene

Sub-Slab Soil Gas COPCs	
Carbon Tetrachloride	Gasoline Range Organics (C3-C12)
Ethylbenzene	
Constituent was detected in greater than or equal to 5% of samples and no VISL was available	
n-Butylbenzene	Dodecane
sec-Butylbenzene	Ethanol
Butyraldehyde	4-Ethyltoluene
Crotonaldehyde, Total	Hexanal
Decane	p-Isopropyltoluene
Dibromochloromethane	Octane
1,3-Dichlorobenzene	Tert-Butyl Alcohol
1,2-cis-Dichloroethylene	Trichlorofluoromethane
1,2-trans-Dichloroethylene	2,2,4-Trimethylpentane
trans-1,3-Dichloropropene	Undecane
Constituent was not detected in any sample, a VISL was not available, and the MDL was greater than 10 times the laboratory LOQ presented in the Work Plan	
o-Chlorotoluene	1,3-Dichloropropane

References

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Section 3: Exposure Assessment

This HHRA was focused on current land use; therefore, the exposure scenarios evaluated in the HHRA reflected current land use only.

The purpose of this exposure assessment is to present the conceptual Site models (CSMs) for the Northern and Southern Areas based on current land use and identify the complete exposure pathways for the receptors evaluated in the HHRA. The results of the exposure assessment are combined with toxicity information (see Section 4) to characterize potential risks (see Section 5).

A COPC poses a risk to human health only if the exposure pathway is complete. A complete exposure pathway consists of the following elements:

- A source and mechanism of COPC release to the environment;
- An environmental transport medium for the released COPC;
- An exposure point (e.g., a point of potential human contact with the impacted medium) which includes a location where humans are present and where there is an activity that results in exposure, referred to as the exposure scenario; and
- An exposure route (i.e., inhalation, ingestion, dermal contact) at the exposure point.

Complete exposure pathways are the pathways that are expected to occur for a receptor. Complete and incomplete pathways are presented on Figures 3-1 and 3-2. A complete exposure pathway may result in possible health effects and is evaluated further in the HHRA. An incomplete exposure pathway results in no exposure, no health effects, and is not evaluated further in the HHRA. The following exposure pathways were considered complete for receptors living and working at or near the Site:

- Direct contact with soil via incidental ingestion, dermal contact, or inhalation of particulates and vapors in outdoor air; and
- Inhalation of indoor air impacted by VI from surface soil and groundwater (i.e., VI).

Conceptual Site Model

Two CSMs were developed for the Site: a Northern Area CSM and a Southern Area CSM (see Figures 3-1 and 3-2, respectively). The Site CSMs are visual representations of how exposure to COPCs at the Site could occur. The CSM is used to integrate all available information to identify how receptors may be exposed to COPCs, based on exposure scenarios for the receptors, assuming current land use.

Receptors can be exposed to COPCs via ingestion, inhalation, or dermal contact depending on the COPCs and the location found in the environment. Receptors can be exposed to COPCs directly from a source (e.g., incidental soil ingestion of constituents in soil) or indirectly (e.g. drinking groundwater impacted by a release from the soil to groundwater), as the COPCs distribute to the environment and ultimately result in human exposures.

Complete and incomplete exposure pathways were determined based on the current land uses for the Northern and Southern Areas. The current land uses for the Northern and Southern Areas are commercial and recreational. The Northern Area is comprised of a baseball field and two soccer fields and is used primarily for recreational purposes. An elementary school is located adjacent to the Northern Area, directly outside of the Northern Area boundary (see Figure 1-3). The Southern Area is used for commercial and recreational purposes. A dental clinic, medical clinic, and maintenance building are located in the northern portion of the Southern Area (see Figure 1-4). A baseball field and a skate park are located in the southernmost and northernmost portions of the Southern Area, respectively.

Quantifying Exposure

Quantifying the magnitude, frequency, and duration of exposure for the complete exposure pathways identified for each exposure scenario is the next step in the exposure assessment. Daily doses (i.e., the amount of COPCs that an individual would be exposed to each day [mg/kg-day]) for each exposed population (e.g., children and adults) are calculated using exposure factors that apply to each population evaluated. The basic equation used to calculate daily dose of a constituent is:

$$DD = C \ x \ HIF \ x \ MF$$

where,

Parameter	Definition
DD	Daily dose in mg/kg-day (mg of COPC per kg of body weight per day)
C	Concentration of the COPC in soil (mg/kg) or air (mg/m^3)
HIF	Human intake factor (product of all intake factors necessary to quantify exposure) in units per day^{-1}
MF	Exposure pathway and constituent-specific modifying factors (e.g., gastrointestinal absorption rate) with variable units

Each variable in this equation has a range of possible values. The intake variables for each pathway were selected so that the combination of all intake variables resulted in a realistic upper-bound estimate (referred to by USEPA as a reasonable maximum exposure [RME]) for that pathway.

The RME of a given receptor to constituents by a particular pathway can be defined as “the maximum exposure that is reasonably expected to occur within a potentially exposed population.” USEPA notes that each exposure factor used to estimate the RME should be selected so that the resulting estimate of exposure is consistent with the higher end of the range of plausible exposures (USEPA 1991). This approach does not require that the value of each exposure factor used in the calculation of constituent exposure be an upper percentile value (a value from the upper end of the possible range, such as the 90th or 95th percentile). More importantly, if high-end values are chosen for every exposure factor, then the resulting exposure estimate may no longer be consistent with the RME and may exceed the realm of possibility altogether.

Quantitative characterization of carcinogenic and noncarcinogenic effects requires estimating the potential human exposure level for each COPC. The daily dose for each carcinogen was averaged over the lifetime of the exposed individual (i.e., 70 years) and is referred to as lifetime average daily dose (LADD). The daily dose for noncarcinogens was averaged over the duration of exposure and is referred to as average daily dose (ADD).

The daily dose of a COPC was estimated from at least six basic exposure factors: exposure point concentration (EPC), exposure frequency (EF), exposure duration (ED), contact rate, body weight and averaging time (USEPA 1989). In this assessment, daily dose was normalized for time and body weight, and was expressed in milligrams of COPC per kilogram of body weight per day (mg/kg-day). The exposure parameters and algorithms used in this assessment to quantify exposure are presented in Tables 3-1 through 3-8.

Exposure Scenarios

The exposure scenarios for the Northern and Southern Areas are presented in this section.

> Cancer risks and noncancer hazards were only calculated for the longest exposure durations per receptor (i.e., 6-year child and adult recreator and 25-year landscaper). Total cancer risks for 3-year exposure durations were approximately one half the total cancer risks for 6-year exposure durations. Noncancer hazards do not change based on exposure duration and therefore, were the same for 3- and 6-year exposures.

Northern Area Exposure Scenarios

Exposure scenarios for the Northern Area include on-Site adult and child recreators, landscapers, teachers, and students.

Recreational Exposure Scenarios

Adult Recreator

This scenario represents the potential for an adult using the recreational fields (adult recreator) in the Northern Area to be exposed to constituents in soil via direct contact (incidental ingestion, dermal contact, and inhalation) while stationed at Camp Kinser for one or two tours (three or six years).[14,15] The exposure duration for a recreator was six years because this results in the highest risk and is protective of a 3-year exposure duration.

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[14] A three-year tour is the typical tour length for U.S. Navy and Marine Corps personnel.

[15] A six-year tour is the maximum tour length for U.S. Navy and Marine Corps personnel.

Child Recreator

This scenario represents the potential for a zero to six year old child using the recreational fields (child recreator) in the Northern Area to be exposed to constituents in soil via direct contact (incidental ingestion, dermal contact, and inhalation) while their family is stationed at Camp Kinser for one or two tours (three or six years). The exposure duration for a child recreator was six years because this results in the highest risk and is protective of a 3-year exposure duration.

Landscaper Exposure Scenario

This scenario represents the potential for a landscaper in the Northern Area to be exposed to constituents in soil via direct contact (incidental ingestion, dermal contact, and inhalation) while working at Camp Kinser for 25 years. The exposure duration for an adult landscaper was 25 years because this results in the highest risk and is protective of 3-year and 6-year exposure durations.

Teacher Exposure Scenario

This scenario represents the potential for a DoD teacher at the school outside of the Northern Area (off-Site) to be exposed to volatile constituents in indoor air from groundwater (VI) while working at the school for 25 years.

Although the soil beneath the school and associated buildings is not impacted from the former MSA, concentrations in Northern Area soil could migrate to groundwater and be transported beneath the school and associated buildings, resulting in a VI concern. Therefore, VI from the groundwater in the off-Site school and associated buildings was identified as a complete exposure pathway. The exposure duration for a teacher was 25 years because this results in the highest risk and is also protective of 3-year and 6-year exposure durations.

Student Exposure Scenario

This scenario represents the potential for a student attending the school outside of the Northern Area boundary (off-Site) to be exposed to volatile constituents in indoor air from groundwater (VI) while their family is stationed at Camp Kinser for one or two tours (three or six years). The exposure duration for a student was six years because this results in the highest risk and is protective of a 3-year exposure duration.

For the same rationale explained above (for the teacher exposure scenario), VI from the groundwater in the school buildings was considered a potentially complete exposure pathway.

Southern Area Exposure Scenarios

Exposure scenarios for the Southern Area include on-Site adult and child recreators, occupational workers, adult and child patients, and landscapers.

Recreational Exposure Scenarios

Adult Recreator

This scenario represents the potential for an adult recreator in the Southern Area to be exposed to soil via direct contact (incidental ingestion, dermal contact, and inhalation) while stationed at Camp Kinser for one or two tours (three or six years). The exposure duration for a recreator was six years because this results in the highest risk and is protective of a 3-year exposure duration.

Child Recreator

This scenario represents the potential for a zero to six year old child recreator in the Southern Area to be exposed to soil via direct contact (incidental ingestion, dermal contact, and inhalation) while their family is stationed at Camp Kinser for one or two tours (three or six years). The exposure duration for a child recreator was six years because this results in the highest risk and is protective of a 3-year exposure duration.

Landscaper Exposure Scenario

This scenario represents the potential for a landscaper in the Southern Area to be exposed to soil via direct contact (incidental ingestion, dermal contact, and inhalation) while working at Camp Kinser for 25 years. The exposure duration for a landscaper was 25 years because this results in the highest risk and is protective of 3-year and 6-year exposure durations.

Occupational Clinic Worker Exposure Scenario

This scenario represents the potential for a clinic worker in the Southern Area to be exposed to volatile constituents in indoor air from soil and/or groundwater (VI) beneath the medical or dental clinic while stationed at Camp Kinser for one or two tours (three or six years) or a civilian contract worker who works at Camp Kinser for 25 years. The exposure duration for a clinic worker 25 years because this results in the highest risk and is protective of 3-year and 6-year exposure durations.

Occupational Clinic Patient Exposure Scenarios

Clinic Adult Patient

This scenario represents the potential for an clinic adult patient in the Southern Area to be exposed to volatile constituents in indoor air from soil and/or groundwater (VI) beneath the medical or dental clinic while stationed at Camp Kinser for one or two tours (three or six years). The exposure duration for a patient was six years because this results in the highest risk and is protective of a 3-year exposure duration.

Clinic Child Patient

This scenario represents the potential for a zero to six year old on-Site clinic child patient in the Southern Area to be exposed to volatile constituents in indoor air from soil and/or groundwater (VI) beneath the medical or dental clinic while stationed at Camp Kinser for one or two tours (three or six years). The exposure duration for a patient was six years because this results in the highest risk and is protective of a 3-year exposure duration.

Exposure Point Concentrations

Once exposure scenarios and exposure pathways have been identified, EPCs are calculated and exposure algorithms are used to estimate daily COPC intakes based on these pathways. An EPC is the concentration of a COPC in soil at the location of potential contact with a receptor. The EPC represents the upper-bound estimate of the COPC concentration that a receptor could potentially be exposed to over an entire area (i.e., a DU for this Site). An EPC was calculated for each COPC in each DU (see Table 3-9).[16] The COPCs identified for each DU are shown on Table 3-10.

The EPCs were calculated using the following decision rule, listed in order of precedence:

1. Logarithmic 95% Upper Confidence Limit (UCL) on the mean (Log 95% UCL).
2. 95% UCL on the arithmetic mean if the underlying distribution was determined to be normal assuming a significance level of 5%.
3. The maximum detected concentration if the Log 95% UCL and/or the 95% UCL exceeded the maximum detected concentration.
4. The maximum detected concentration if less than three sample points are located within the DU (insufficient data points to calculate the Log 95% UCL and/or the 95% UCL).
5. Zero if the COPC was not detected in any sample within the DU.

[16] The EPC for DU-S5 excludes the elevated concentrations of surface soil sample CKSA-SS40 (see Section 5).

References

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USEPA. 1991. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03. Office of Emergency and Remedial Response, Toxics Integration Branch. U.S. Environmental Protection Agency. http://itrcweb.org/FileCabinet/GetFile?fileID=6890.

Section 4: Toxicity Evaluation

The purpose of the toxicity evaluation is to identify the constituent and route-specific health criteria that were used to evaluate potential health concerns and/or risks associated with COPCs. For this HHRA, toxicity values were used with calculated daily dose (exposure) estimates (from Section 3) to calculate cancer risks and noncancer hazards. Toxicity values were used to evaluate health impacts from different exposure pathways including ingestion, inhalation of particulates and volatiles, and dermal contact.

Toxicity Values

Toxicity values are developed and published by the USEPA and other agencies, and are used to evaluate potential health impacts from exposures to COPCs. Toxicity values are used to quantitatively estimate health effects based on level of exposure.

The toxicity values used to calculate human-health risks include RfDs, RfCs, CSFs, and IURs. The potential for both cancer risks and noncancer health effects must be evaluated when conducting a human health risk assessment. Depending on the COPC, toxicity values may be available for both cancer and noncancer, only cancer, or only noncancer health endpoints.

CSFs and IURs are used to evaluate potential cancer health impacts and estimate potential cancer risks from exposures to carcinogens. The RfDs for oral and RfCs for inhalation exposures are used to evaluate potential noncancer health effects.

The toxicity values used in this HHRA were obtained from the May 2019 USEPA RSL tables (USEPA 2019). The toxicity of any constituent depends on the magnitude and frequency of exposure and the route-specific relative absorption into the body. In some cases, a constituent may produce toxic effects only through a specific route of entry into the body and may not be toxic through other routes. Toxicity values used in this risk assessment are specific to the following complete pathways: incidental ingestion, dermal contact, and inhalation of particulates and/or vapors.

Toxicity values for some constituents may be available from several sources (e.g., USEPA and California Environmental Protection Agency). The following is the hierarchy of toxicity values used in this evaluation when multiple toxicity values exist for a given COPC. This hierarchy is based on the toxicity value order used in the USEPA RSL table (USEPA 2019).

- USEPA's Integrated Risk Information System (IRIS).
- Provisional Peer Reviewed Toxicity Values (PPRTVs) derived by USEPA's Superfund Technical Support Center (STSC) for the USEPA Superfund program.
- Agency for Toxic Substances and Disease Registry Minimal Risk Levels (MRLs).

- California Environmental Protection Agency, Office of Environmental Health Hazard Assessment's (OEHHA's) Chronic Reference Exposure Levels (RELs).
- Screening toxicity values in appendices for certain PPRTV assessments.
- The USEPA Superfund program's Health Effects Assessment Summary Table (HEAST).

Toxicity values used in this assessment are listed in Table 4-1. The following COPCs were not quantitatively evaluated in the HHRA due to a lack of toxicity values:

- Acenaphthylene
- Benzo(g,h,i)perylene
- Carbazole
- Phenanthrene
- Thorium-232
- Titanium

Cancer Toxicity Values

The USEPA describes the mechanism for how some constituents produce cancer as being a "non-threshold" process, meaning any level of exposure to a carcinogen carries some probability of causing cancer. Risks at low exposure levels cannot feasibly be measured directly either by animal experiments or by epidemiological studies; therefore, a number of mathematical models and procedures have been developed to extrapolate risks from high to low doses.

Extrapolation models or procedures may reasonably fit the observed data but may also lead to large differences in the projected risk at low doses. The USEPA assumes that the risk of cancer is linearly related to dose for calculating cancer toxicity values (CSFs and IURs). This means that relatively high doses, which are often used in animal studies, can be extrapolated downward to extremely small doses assuming that even a small number of molecules (possibly a single molecule) of a carcinogen may cause changes in a single cell which could ultimately lead to cancer.

There is some dispute as to whether or not extrapolation from high to low doses is a valid approach, biologically. It has been argued that cells have the ability to detoxify carcinogens or repair cellular damage from exposures to very low doses. Therefore, it is important to recognize the possibility that some carcinogens may have a threshold for toxicity, or nonlinear mode of action, where low doses would not lead to cancer.

The CSFs are numerical estimates of the potency of a constituent. When multiplied by an estimated lifetime average daily dose, CSFs yield a probability (e.g., 1 in a million) of an individual developing cancer due to exposure to the specific constituent over a lifetime. The CSFs are usually derived by the USEPA using a linearized multistage model and reflect the upper-bound limit of cancer potency for a carcinogenic constituent. As a result, the calculated risk is likely to represent a plausible upper limit of the risk. The actual risk for a specific constituent is unknown but is likely lower than the predicted risk, and may be as low as zero (USEPA 1989). The CSFs are in units of kg-day/mg and are applied to oral and dermal exposures after adjusting for appropriate constituent-specific parameters.

The IURs were used in this assessment to calculate cancer risks related to inhalation exposures (i.e., inhalation of particulates). The IURs provide a cancer risk estimate associated with an air concentration and are in units of micrograms per meter cubed $(\mu g/m^3)^{-1}$.

The CSFs and IURs used in the risk assessment are listed in Table 4-1.

Noncancer Toxicity Values

Constituents that produce noncancer health effects are thought to act through threshold mechanisms, (i.e., the constituents do not cause health effects below a certain level). The assumption of a threshold for toxicity is based on the concept that the body has protective mechanisms that eliminate or detoxify constituents at low levels. The threshold concept is important because it assumes that people can tolerate a certain amount of exposure without experiencing harmful health effects.

The RfDs and RfCs are toxicity values used to assess noncancer health effects from a given exposure. An RfD is defined as "an estimate (with uncertainty spanning perhaps an order of magnitude or greater) of a daily oral exposure level for a human population, including sensitive subgroups, that is likely to be without an appreciable risk of deleterious effects during a portion of the lifetime" (USEPA 1989). An RfD sets a daily oral intake level (in units of mg/kg-day) below which harmful noncancer health effects are not expected. The RfDs are also used to evaluate dermal exposures after accounting for any difference in oral and dermal absorption.

An RfC is defined as "an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime" (USEPA 2019). An RfC is a concentration of a constituent in air (in units of mg/m^3) which is compared to an estimated constituent air concentration to determine if noncancer health effects are expected. The USEPA develops RfCs to assess inhalation exposures to noncarcinogens.

The RfDs and RfCs are calculated based on no observed adverse effect levels (NOAELs) or lowest observed adverse effect levels (LOAELs) in animal toxicity studies, or occasionally, from human studies. A NOAEL is an experimentally-determined dose at which there was no statistically or biologically-significant indication of a toxic effect. A study chosen to establish a NOAEL represents the most sensitive target organ or tissue (i.e., critical organ) for that constituent. In an experiment with several NOAELs, generally the lowest one is chosen as the critical NOAEL upon which an RfD or RfC is based. Since many constituents can produce toxic effects in several organ systems, with each toxic effect possibly having a separate threshold dose, the distinction of the critical toxic effect provides added confidence that the NOAEL is protective of a range of harmful health effects. Uncertainty factors (ranging from 1 to not more than 3,000) are also incorporated in the calculation of RfDs and RfCs. The equation below shows how an RfD is calculated:

$$RfD\ (average\ daily\ human\, dose) = \frac{NOAEL_{Experimental\ Dose}}{Safety\ Factors + Modifying\, Factor}$$

Each safety factor represents a specific area of uncertainty inherent in the available data and is meant to account for these uncertainties (USEPA 2002, 2019). The types of uncertainties accounted for in developing the RfD include:

- Uncertainty in extrapolating animal toxicity data to humans (i.e., interspecies variability [factor of 10]).
- Variation in sensitivity or susceptibility among individuals in the human population (factor of 10).
- Uncertainty in extrapolating data from a study with less-than-lifetime exposure to lifetime exposure (i.e., using subchronic studies to predict chronic exposures [factor of 10]).
- Uncertainty when deriving an RfD from a LOAEL instead of a NOAEL [factor of 10]).[17]
- Uncertainty in extrapolating from valid results in experimental animals when data are "incomplete" (accounts for the inability of any single study to adequately address all possible adverse outcomes [factor of 10]).[18]

In addition to the safety factors, USEPA applies a modifying factor in some instances. Modifying factors range from 0 to 10 and are included to reflect a qualitative professional assessment of additional uncertainties in the critical study and in the entire database for the constituent not explicitly addressed by the uncertainty factors. The default value for the modifying factor is one (USEPA 2002).

The USEPA's IRIS profiles identify the target organ and critical effects from the study or studies used to develop an RfD or RfC. Noncancer toxicity values can be developed for different exposure lengths and time periods such as short-term, chronic (long-term), and developmental exposures (short-term exposures during pregnancy). Further, RfDs and RfCs are developed to

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[17] http://www.tera.org/Publications/UF%20in%20Noncancer.pdf

[18] http://www.tera.org/Publications/UF%20in%20Noncancer.pdf

be protective of the most sensitive members of the population, thereby providing added protection for everyone else (USEPA 2002).

The RfDs and RfCs used in this HHRA are listed in Table 4-1.

Adjustment of Toxicity Values and Estimation of Physical Properties for Certain COPCs

Dermal Toxicity

As described in the USEPA Dermal Risk Assessment Guidance (USEPA 2004), oral toxicity values can be used to evaluate toxicity from dermal exposures by adjusting for constituent-specific gastrointestinal absorption (GIABS). GIABS factors are used to account for differences in absorbed doses between gastrointestinal and dermal routes of exposure. The GIABS factors determine how much of a constituent is absorbed from soil compared to how much of that constituent is absorbed from a reference exposure medium (e.g., food, water) that relates back to the toxicity value of the constituent (USEPA 2019). GIABS factors are unitless and range from below 0.01 to 1.0 (1.0 is used as the default value). The following equations show how this adjustment is calculated:

$$Dermal\ CSF = Oral\ CSF \div GIABS$$

$$Dermal\ RfD = Oral\ RfD \times GIABS$$

The fraction of constituents absorbed dermally from soil (ABSd) can also vary. Certain constituent groups, such as PAHs, are more readily absorbed than others, like dioxins.

cPAHs were not evaluated for carcinogenic risks associated with dermal exposure. According to USEPA's RAGS, cancer slope factors should not be used to evaluate risks associated with dermal exposure to carcinogens such as benzo(a)pyrene, which cause skin cancer through direct action at the point of application (USEPA 1989).

Toxicity values (e.g., CSF) and physical properties of COPCs (e.g., GIABS values) used in this HHRA are presented in Tables 4-1 and 4-2, respectively. If a value was not available, a surrogate value with similar properties was applied. The following surrogates were used:

Toxicity Value/Physical Property Not Available	Surrogate	Reason
2,4-DDT and DDE	USEPA values for DDT	Similar constituents
Alpha- and gamma-chlordane	USEPA values for chlordane, technical	Similar constituents
Total cPAHs (BaP TEQs).	USEPA values for benzo(a)pyrene	Compound total value based on BaP TEQ
Total Dioxins/Furans (2,3,7,8-TCDD TEQs).	USEPA values for 2,3,7,8-TCDD	Compound total value based on 2,3,7,8-TCDD TEQ
Total PCBs (Aroclor Method)	USEPA values for PCB Aroclor 1260	Aroclor 1260 was the only Aroclor detected in surface soil samples

Arsenic Relative Bioavailability

Per USEPA guidance, arsenic exposures associated with incidental soil ingestion were calculated using a relative bioavailability (RBA) factor of 0.6 (USEPA 2019). The RBA factor accounts for the difference in absorption of arsenic from soil compared to drinking water, on which the arsenic toxicity values are based (see Table 4-2).

Toxic Equivalency Factors

Toxic equivalency factors (TEFs) are used to assess the toxicity of a mixture of similar constituents relative to the toxicity of an index, or reference constituent (USEPA 2010b). The TEF approach has been applied to mixtures of chlorinated dioxins, dioxin-like PCBs, and to PAHs, each of which are included in this risk assessment. For a mixture of chlorinated dioxins and dioxin-like PCBs, TEFs are used to estimate the toxicity of the mixture relative to the most toxic congener, 2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD). For a mixture of carcinogenic PAHs, TEFS are used to estimate the toxicity of the mixture relative to the most toxic carcinogenic PAH, benzo(a)pyrene.

The use of TEFs is based on the assumption that similar constituents produce toxicity via the same mechanism. For some chlorinated dioxins, the aryl hydrocarbon (Ah) receptor has been shown to mediate the dioxin-like toxic effects (USEPA 2010b).

The table below lists the TEFs for the different chlorinated dioxin and furan congeners as presented in the Work Plan.

Dioxin/Furan Congener	TEF
2,3,7,8-TCDD	1.0
1,2,3,7,8-PeCDD	1.0
1,2,3,4,7,8-HxCDD	0.1
1,2,3,6,7,8-HxCDD	0.1
1,2,3,7,8,9-HxCDD	0.1
1,2,3,4,6,7,8-HpCDD	0.01
2,3,7,8-TCDF	0.1
1,2,3,7,8-PeCDF	0.03
2,3,4,7,8-PeCDF	0.3
1,2,3,4,7,8-HxCDF	0.1
1,2,3,6,7,8-HxCDF	0.1
1,2,3,7,8,9-HxCDF	0.1
2,3,4,6,7,8-HxCDF	0.1
1,2,3,4,6,7,8-HpCDF	0.01
1,2,3,4,7,8,9-HpCDF	0.01

Dioxin/Furan Congener	TEF
OCDD	0.0003
OCDF	0.0003

The table below lists the TEFs for the different dioxin-like PCB congeners (Van den Berg et al. 2006), which were included with the dioxin/furan congener TEFs.

Dioxin-Like PCB Congener	TEF
PCB 77	0.0001
PCB 81	0.0003
PCB 105	0.00003
PCB 114	0.00003
PCB 118	0.00003
PCB 123	0.00003
PCB 126	0.1
PCB 156	0.00003
PCB 157	0.00003
PCB 167	0.00003
PCB 169	0.03
PCB 189	0.00003

The table below lists the TEFs for carcinogenic PAHs (USEPA 1993).

PAH	TEF
Benzo(a)pyrene	1.0
Benz(a)anthracene	0.1
Benzo(b)fluoranthene	0.1
Benzo(k)fluoranthene	0.01
Chrysene	0.001
Dibenz(a,h)anthracene	1.0
Indeno(1,2,3-c,d)pyrene	0.1

Individual chlorinated dioxin or furan, dioxin-like PCB, and carcinogenic PAH exposure concentrations are multiplied by the TEF to derive an adjusted concentration. The adjusted concentration for each constituent was summed to calculate risk using the following equation:

$$TEQ = \sum_{i=1}^{n} (C_i \, x \, TEF_i)$$

Where C_i = media concentration and TEF_i is the TEF for a given constituent *i*.

The TEQ concentration is then used to calculate the cancer risk and noncancer hazard using the toxicity value for the index constituent.

Mutagenic Mode of Action

Some carcinogens act via a mutagenic mode of action, meaning that the carcinogens or associated metabolites react directly with deoxyribonucleic acid (DNA) or have the ability to bind to DNA. Infants and children are more susceptible to cancer effects from mutagens because they are undergoing rapid growth and development. The USEPA recommends that age-dependent adjustment factors be applied when evaluating cancer risks for mutagens to account for greater susceptibility during early-life exposures (USEPA 2005). Below is a list of the eight COPCs evaluated in this assessment, which the USEPA identified as mutagenic (USEPA 2018).

The following carcinogenic COPCs are considered mutagens by the USEPA (2018):

- Benzo(a)pyrene
- Benzo(b)fluoranthene
- 7,12- Dimethylbenz(a)anthracene
- Dibenz(a,h)anthracene
- Hexavalent chromium
- 3-Methylcholanthrene
- N-Nitrosodiethylamine
- N-Nitrosodimethylamine

To account for mutagenic modes of action, CSFs or IURs are multiplied by age-dependent adjustment factors for the following age groups.

- A factor of 10 is used for exposures between birth and up to two years;
- A factor of 3 is used for exposures between the ages of two through 15 years; and
- No adjustment is used for exposures at 16 years and older.

Children are defined as from birth to age six for this HHRA. Therefore, a weighted age-dependent adjustment factor of 5.33 (i.e., [(2x10+4x3)/6]) was applied to the IUR to account for mutagenic modes of action for children at the Site.

Blood Lead Evaluation

Lead is not evaluated using toxicity values. Instead, two USEPA lead models are available to assess whether or not environmental lead levels at the Site pose a risk to human health:

- The Integrated Exposure Uptake Biokinetic (IEUBK) Model evaluates lead risk in children (USEPA 2010a); and
- The Adult Lead Methodology (ALM) Model evaluates lead risk in adult workers and also predicts fetal exposures for pregnant workers (USEPA 1996).

These models predict blood lead levels (BLLs) based on Site-specific exposure parameters and USEPA default values. Evaluation of lead hazards is based on identifying whether or not BLLs exceed action levels (5 and 10 µg lead/dL blood; ATSDR 2016). In addition, the DoN policy for children uses the recommended CDC reference level of 5 ug/dL (BUMEDINST 6200.14D - 30 Aug 2017). Please see Section 5 and Appendix C for details regarding the blood lead evaluation.

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Section 5: Risk Characterization

The purpose of the risk characterization is to combine the quantitative exposure estimates (daily doses) derived in the Exposure Assessment (Section 3) with the toxicity values described in the Toxicity Evaluation (Section 4) to develop numerical estimates of cancer risks and noncancer hazards for all exposure scenarios.

Cancer risks and noncancer hazards associated with COPCs and complete exposure pathways were summed to yield total risks and hazards for receptors (i.e., 6-year child and adult recreators, 6-year child and adult clinic patients, 6-year students, and 25-year teachers, clinic workers, and landscapers).

Total cancer risks and noncancer hazards associated with exposure to surface soil were calculated for the four Northern Area DUs (DU-N1, DU-N2, DU-N3, and DU-N4; see Figure 1-6) and five Southern Area DUs (DU-S1, DU-S2, DU-S3, DU-S4, and DU-S5; see Figure 1-7).[19]

The methods for calculating and evaluating cancer risks and noncancer hazards and evaluating exposures associated with surface soil are presented in this section.

> The use of a 6-year exposure duration for military and civilian adults and children (corresponding to two tours of duty) was used to calculate risk for these populations. Assuming an exposure duration of two tours of duty is plausible but overestimates the cancer for those spending only on tour of duty at Camp Kinser. The calculated noncancer hazard is the same for one tour of duty as it is for two tours. The exposure duration used to calculate risk for the landscaper contractor was 25 years.

Calculating Cancer Risks

Cancer risks associated with exposure to constituents are expressed as the probability of developing cancer during a lifetime (e.g., 1 in a million risk or 1.0E-06). Risk estimates for ingestion and dermal routes are calculated by multiplying the estimated lifetime average daily dose (LADD) for each carcinogenic COPC by the constituent-specific CSF (see Table 4-1).[20] Inhalation risk estimates for each carcinogenic COPC are derived by multiplying the estimated air concentration by the IUR. The sum of the risks for ingestion of soil, dermal contact with soil, and inhalation of air yields the total risk for a COPC, as described below:

$$CR_1\ (Ingestion\ of\ Soil) = Ingestion\ LADD\ \times CSF_{oral}$$

$$CR_2\ (Dermal\ Contact\ with\ Soil) = Dermal\ LADD\ \times CSF_{dermal}$$

$$CR_3\ (Inhalation\ of\ Air) = Inhalation\ Exposure\ Concentration\ \times IUR$$

[19] Risks and hazards were calculated for exposure scenarios using assumptions based on typical exposure durations and frequencies for conducting activities in each DU.

[20] Dermal CSFs are calculated by dividing the Oral CSF by the GIABS. Oral CSF and GIABS values are provided in the USEPA RSL tables (USEPA 2019) and are presented in Tables 4-1 and 4-2, respectively.

$$CR_{COPC} = CR_1 + CR_2 + CR_3$$

Where,

Parameter	Definition
CR	Cancer risk; Lifetime probability of cancer from exposure to COPC
LADD	Estimated lifetime average daily dose for ingestion and dermal absorption (mg/kg-day)
CSF	Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$
Inhalation Exposure Concentration	Concentration in air (mg/m^3)
IUR	Inhalation unit risk $(mg/m^3)^{-1}$

The total cancer risk was calculated for each receptor by summing the total cancer risk for each COPC associated with the receptor:

$$Total\ CR_{receptor} = \sum_{i=1}^{n}(CR(COPC_1 + COPC_2 + COPC_3 \ldots + COPC_n)$$

The calculated cancer risk-based screening criteria (RBSC) for each exposure pathway are presented in Table 5-1.

Calculating Noncancer Hazards

The potential for noncancer health impacts is quantitatively expressed as an HQ. The HQ for an ingestion and a dermal exposure route is the ratio of the calculated average daily dose (ADD) to the RfD (see Table 4-1).[21] The HQ for an inhalation exposure route is the ratio of the estimated air concentration to the inhalation RfC. The sum of the HQs for ingestion of soil, dermal contact with soil, and inhalation of air yields a HI for a COPC, as described below:

$$HQ_1\ (Ingestion\ of\ Soil) = Ingestion\ ADD \div RfD_{oral}$$

$$HQ_2\ (Dermal\ Contact\ with\ Soil) = Dermal\ ADD \div RfD_{dermal}$$

$$HQ_3\ (Inhalation\ of\ Air) = Air\ Concentration\ \div RfC$$

$$HI_{COPC} = HQ_1 + HQ_2 + HQ_3 + HQ_4$$

Where,

Parameter	Definition
HQ	Ratio of the calculated ADD to the RfD
HI	Sum of the HQs for all pathways
ADD	Average daily dose (mg/kg-day)
Air Concentration	Concentration in air (mg/m^3)
RfD	Estimate of a daily dose unlikely to produce harmful health impacts (mg/kg-day)

[21] Dermal RfDs are calculated by multiplying the Oral RfD with the GIABS. Oral RfD and GIABS values are provided in the USEPA RSL tables (USEPA 2019) and are presented in Tables 4-1 and 4-2, respectively.

RfC	Estimate of an air concentration unlikely to produce harmful health effects (mg/m^3)

The total noncancer hazard was calculated for each receptor by summing the HIs for the COPCs associated with the receptor:

$$Total\ HI_{receptor} = \sum_{i=1}^{n} (HI(COPC_1 + COPC_2 + COPC_3 \ldots + COPC_n)$$

The calculated noncancer RBSCs for each exposure pathway are presented in Table 5-1.

USEPA Acceptable Risk Range and USEPA Risk Benchmarks

Risk managers use risk ranges and risk benchmarks to evaluate the significance of risks for people exposed to COPCs. Risk ranges and risk benchmarks provide perspective on whether or not environmental levels are potentially harmful and help risk managers determine which areas and media may require further evaluation or actions.

USEPA Acceptable Cancer Risk Range

For carcinogenic risks, the USEPA recommends using an acceptable cancer risk range of 1.0E-04 (1×10^{-4} or 1 in 10,000) to 1.0E-06 (1×10^{-6} or 1 in 1,000,000), based on an RME scenario (USEPA 1991). In general, the USEPA considers cancer risks below 1E-06 to be so small as to be negligible (i.e., below a level of regulatory concern; USEPA 1991). Conversely, cancer risks greater than 1E-04 are undesirable and typically require remedial action (e.g., soil removal).

USEPA Noncancer Hazard Benchmark

The USEPA uses an HQ of 1 as the benchmark below which adverse, noncancer health effects are not expected and action generally is not warranted (USEPA 1991). An HQ greater than 1 shows that exposure levels exceed an RfD or RfC, indicating that adverse health effects are possible.

Vapor Intrusion Pathway Evaluation

If the results of the VI pathway evaluation had determined that the VI pathway was complete, then the VI pathway would have been included in the quantitative risk calculations presented in this section. However, since the results of the VI pathway evaluation indicated that the VI pathway was incomplete, the VI pathway was not included in the quantitative risk calculations presented in this section.

Before calculating cancer risks and noncancer hazards in the HHRA, a VI pathway evaluation was completed for the school buildings adjacent to the Northern Area and the clinics located in the Southern Area. The purpose of the detailed VI pathway evaluation was to determine if Site-specific data indicated that the VI Pathway was complete for buildings in the Northern Area and Southern Area of the Site. Appendix D presents the detailed VI pathway evaluation for the Northern and the Southern Areas. The VISLs used in the evaluation were overly conservative (i.e., based on residential land use) as the Site is currently used for commercial and recreational purposes only (see Appendix D). Based on the results of the VI pathway evaluation, the VI pathway was determined to be incomplete for buildings evaluated in the Northern and Southern Areas. Therefore, VI COPCs were not evaluated further in the HHRA. The results of the VI evaluation are summarized below:[22]

Northern Area

- No constituents were detected in groundwater (which is the only source of VI from the MSA in the elementary school buildings in the Northern Area) at concentrations exceeding GW-to-IA VISLs (see Appendix D).
- Acetaldehyde, acrolein, carbon tetrachloride, GRO, and isopropanol concentrations slightly exceeded the soil gas-to-indoor air screening levels (SG-to-IA VISLs) in two buildings at the elementary school (Building 1041 [cafeteria and music room] and Building 1041A [maintenance]); however, the constituents were either not detected in groundwater (acetaldehyde, acrolein, carbon tetrachloride, and GRO) or were detected at very low concentrations (isopropanol was detected orders of magnitude below the GW-to-IA VISL); therefore, the constituents were eliminated from further consideration for the VI pathway (see Appendix D).

Southern Area

- No constituents were detected in groundwater in the Southern Area at concentrations exceeding GW-to-IA VISLs (see Appendix D). Isopropanol was the only constituent

[22] This VI discussion/summary presented in this section is limited to those constituents with VISLs that were detected in groundwater and/or sub-slab soil gas. However, Appendix D also includes an evaluation of constituents that do not have VISLs and constituents that were not detected.

detected in groundwater but it was detected at concentrations orders of magnitude below the GW-to-IA VISL.

- Acetaldehyde, acrolein, and ethylbenzene exceeded the SG-to-IA VISL in one sample each in Building 1460 (medical clinic). No other detected COPC concentrations exceeded respective SG-to-IA VISLs in Building 1460 (see Appendix D).
  - **Acetaldehyde** was not detected in groundwater which rules out groundwater as a potential VI source. Ambient air does not contribute to the sub-slab soil gas concentrations for acetaldehyde. Acetaldehyde was detected in only one of seven sub-slab soil gas samples from this building. The concentrations of acetaldehyde were compared to the concentrations observed in the Northern Area buildings where it had been concluded that there was no VI source for any constituent (including acetaldehyde). The results of the comparison indicated that the range of concentrations of acetaldehyde in Building 1460 were similar to the range of concentrations in the Northern Area buildings. Therefore, the sub-slab soil gas results from these buildings can be considered indicative of local background concentrations. Consequently, acetaldehyde was eliminated from further consideration for the VI pathway in this building.
  - **Acrolein** was not detected in groundwater which rules out groundwater as a potential VI source. The ambient air concentration for acrolein was greater than the sub-slab soil gas concentration which indicates that ambient air may be responsible for the sub-slab soil gas result. Consequently, acrolein was eliminated from further consideration for the VI pathway in this building.
  - **Ethylbenzene** was not detected in groundwater which rules out groundwater as a potential VI source. Ambient air does not contribute to the sub-slab soil gas concentrations for ethylbenzene. Ethylbenzene was detected in all seven of the sub-slab soil gas samples from this building. However, only one sub-slab soil gas result exceeded the SG-to-IA VISL (i.e., 273 ug/m^3 versus the VISL of 37 ug/m^3). The next highest sub-slab soil gas concentration was 1.9 ug/m^3. Gasoline Range Organics (C3-C12), which are a likely source of ethylbenzene, were not detected in groundwater and were not detected in any of the sub-slab soil gas samples collected from this building. This indicates it is unlikely that a fuel spill/release is the source of the ethylbenzene that was detected. Given that (1) only one of the seven sub-slab soil gas concentrations exceed the SG-to-IA VISL and (2) Gasoline Range Organics (C3-C12) which is a likely source of ethylbenzene were not detected in groundwater and/or sub-slab soil gas samples—It is more likely that an indoor air source is responsible for the elevated soil gas concentration detected in the X-Ray Room 45

(CK1460-01) than VI from groundwater and/or soil. Consequently, ethylbenzene was eliminated from further consideration for the VI pathway in this building.

- Acetaldehyde, acrolein, ethylbenzene, GRO, isopropanol, and naphthalene exceeded SG-to-IA VISLs in Building 1463 (dental clinic), which was undergoing renovations and asbestos abatement at the time of sampling (see Appendix D).
  - **Acetaldehyde** exceeded the SG-to-IA VISL in four of the seven sub-slab soil gas samples. The sub-slab soil gas concentrations ranged from 4.8 ug/m^3 to 94 ug/m^3, with a mean of 48.7 ug/m^3 and standard deviation of 40.3 ug/m^3. The highest sub-slab soil gas concentrations were observed at CK1463-04 (66 ug/m^3), CK1463-06 (70 ug/m^3), and CK1463-07 (94 ug/m^3)—in the area of the building where asbestos abatement had been completed. It was also detected in ambient air at low concentrations (relative to the sub-slab soil gas concentrations) which indicates that ambient air is most likely not the source of the measured soil gas concentrations. Acetaldehyde was not detected in groundwater which rules out groundwater as a potential source of VI. The sub-slab soil gas concentrations in Building 1463 are similar to the sub-slab soil gas concentrations measured in the Northern Area where acetaldehyde was not identified as a VI COPC. For example, the range of sub-slab concentrations for ethanol in the Northern Area Buildings was 14 ug/m^3 to 150 ug/m^3 with a mean of 29.5 ug/m^3, and a standard deviation of 56 ug/m^3. This is very similar to the acetaldehyde in sub-slab soil gas observed in Building 1463. These data indicate that there is not a VI signature for acetaldehyde in this building. Consequently, acetaldehyde was eliminated from further consideration as a VI COPC in this building.
  - **Acrolein** sub-slab soil gas concentrations exceeded SG-to-IA VISLs but it was also detected in ambient air at high concentrations (relative to the sub-slab soil gas concentrations). The concentrations ranged from 0.4 ug/m^3 to 5.7 ug/m^3, with a mean of 2 ug/m^3, and standard deviation of 1.8 ug/m^3. Ambient air contributes significantly to the sub-slab soil gas concentration (approximately 42%). Acrolein was not detected in groundwater which rules out groundwater as a potential source of VI. The sub-slab soil gas concentrations in Building 1463 are similar to the sub-slab soil gas concentrations measured in the Northern Area where acrolein was not identified as a VI COPC. For example, the range of sub-slab concentrations for acrolein in the Northern Area buildings was 0.4 ug/m^3 to 3.2 ug/m^3 with a mean of 1 ug/m^3, and a standard deviation of 0.7 ug/m^3. This is very similar to the acrolein in sub-slab soil gas observed in Building 1463. These data indicate that there is not a VI signature for acrolein in this building. Consequently, acrolein was eliminated from further consideration as a VI COPC in this building.

- **Ethylbenzene** exceeded the SG-to-IA VISL in three of the seven sub-slab soil gas samples. The concentrations ranged from 3.2 ug/m^3 to 340 ug/m^3, with a mean of 115.4 ug/m^3, and standard deviation of 143.6 ug/m^3. Ethylbenzene was also detected in ambient air at low concentrations (relative to the sub-slab soil gas concentrations) which indicates that ambient air is most likely not the source of the measured soil gas concentrations. Ethylbenzene was not detected in groundwater which rules out groundwater as a potential source of VI. Sub-slab soil gas concentrations were variable with the highest concentrations observed at CK1463-04 (220 ug/m^3), CK1463-06 (340 ug/m^3), and CK1463-07 (230 ug/m^3) in the area of the building where asbestos abatement had been completed. A thorough examination of all sub-slab soil gas (including all constituents/locations sampled) revealed that nearly all of the highest sub-slab gas concentrations were detected at the same three stations: CK1463-04, CK1463-06, and CK1463-07. Other lines-of-evidence were evaluated and it was concluded that most likely indoor air sources (e.g., solvents/equipment used during asbestos abatement and renovations in Building 1463) and/or potential laboratory/analytical issues were responsible for the sub-slab soil gas concentrations in these samples and not VI.[23] Consequently, ethylbenzene was eliminated from further consideration as a VI COPC in this building.
- **GRO** exceeded the SG-to-IA VISL in four of the seven sub-slab soil gas samples. The sub-slab soil gas concentrations ranged from 2,900 ug/m^3 to 8,800 ug/m^3, with a mean of 4,359.5 ug/m^3 and standard deviation of 2,582.8 ug/m^3. The highest sub-slab soil gas concentrations were observed at CK1463-04 (5,200 ug/m^3), CK1463-06 (8,800 ug/m^3), and CK1463-07 (5,900 ug/m^3)—in the area of the building where asbestos abatement had been completed. It was also detected in ambient air at low concentrations (relative to the sub-slab soil gas concentrations) which indicates that ambient air is most likely not the source of the measured soil gas concentrations. GRO was not detected in groundwater which rules out groundwater as a potential source of VI. The sub-slab soil gas concentrations in Building 1463 are similar to the sub-slab soil gas concentrations measured in the Northern Area where GRO was not identified as a VI COPC. For example, the range of sub-slab concentrations for GRO in the Northern Area Buildings was 2,800 ug/m^3 to 5,900 ug/m^3 with a mean of

[23] The concentrations observed at these locations were typically one to two orders of magnitude greater than the sub-slab soil gas concentrations observed at CK1463-02, and CK1463-05, which were located in the area of the building where asbestos abatement had not been completed. This may be a coincidence but it is very unusual for the maximum detected concentrations of multiple, unrelated constituents to occur at the same locations.

1,322.5 ug/m^3, and a standard deviation of 1,345.7 ug/m^3. This is very similar to the GRO in sub-slab soil gas observed in Building 1463. These data indicate that there is not a VI signature for GRO in this building. Consequently, GRO was eliminated from further consideration as a VI COPC in this building.

- **Isopropanol** was detected in three of the seven sub-slab soil gas samples at concentrations that exceeded the SG-to-IA VISL. The sub-slab soil gas concentrations ranged from 850 ug/m^3 to 28,000 ug/m^3, with a mean of 10,601 ug/m^3 and standard deviation of 12,150 ug/m^3. It is unlikely that there is a source in groundwater because isopropanol was not detected in groundwater at concentrations exceeding the GW-to-IA VISL. Ambient air does not contribute significantly to the sub-slab soil gas concentration (i.e., <1%). Sub-slab soil gas concentrations were variable with the highest concentrations observed at CK1463-04 (20,000 ug/m^3), CK1463-06 (28,000 ug/m^3), and CK1463-07 (22,000 ug/m^3)—in the area of the building where asbestos abatement had been completed. Other lines-of-evidence were evaluated and it was concluded that most likely indoor air sources (e.g., solvents/equipment used during asbestos abatement and renovations in Building 1463) and/or potential laboratory/analytical issues were responsible for the sub-slab soil gas concentrations in these samples and not VI.[24] Consequently, isopropanol was eliminated from further consideration as a VI COPC in this building.
- **Naphthalene** was detected in one of the seven sub-slab soil gas samples at a concentration that exceeded the SG-to-IA VISL. The sub-slab soil gas concentrations ranged from 0.18 ug/m^3 to 4.2 ug/m^3, with a mean of 0.8 ug/m^3 and standard deviation of 1.5 ug/m^3. It is unlikely that there is a source in groundwater because naphthalene was not detected in groundwater at concentrations exceeding the GW-to-IA VISL. Ambient air does not contribute significantly to the sub-slab soil gas concentration (approximately 3%). Sub-slab soil gas concentrations were variable with the highest concentration observed at CK1463-04 (4.2 ug/m^3)—in the area of the building where asbestos abatement had been completed. Other lines-of-evidence were evaluated and it was concluded that most likely indoor air sources (e.g., solvents/equipment used during asbestos abatement and renovations in Building 1463) and/or potential laboratory/analytical issues were responsible for the

[24] The concentrations observed at these locations were typically one to two orders of magnitude greater than the sub-slab soil gas concentrations observed at CK1463-02, and CK1463-05, which were located in the area of the building where asbestos abatement had not been completed. This may be a coincidence but it is very unusual for the maximum detected concentrations of multiple, unrelated constituents to occur at the same locations.

sub-slab soil gas concentrations in these samples and not VI.[25] Consequently, naphthalene was eliminated from further consideration as a VI COPC in this building.

Surface Soil Elevated Concentration Evaluation for CKSA-SS40

A qualitative evaluation was performed to identify samples with constituent concentrations significantly higher than the surrounding samples (i.e., outliers) at the Site. The results of the evaluation indicated that DDD, DDE, DDT, and total PCB aroclors concentrations in surface soil sample CKSA-SS40 in DU-S5 were several orders of magnitude higher than in other, proximate samples (see Figure 5-1). The total cancer risk for child recreator, adult recreator and landscapers in DU-S5 with sample CKSA-SS40 data included is 1.71E-05, 1.76E-06, and 2.13E-05, respectively. The total noncancer hazard for the child recreators, adult recreators, and landscapers in DU-S5 with sample CKSA-SS40 data included is 2.5, 0.26 and 0.75, respectively (see Table 5-2).

Evaluations and Identification of Elevated Concentrations

For comparison purposes, the RMEs for DU-S5 were recalculated for three risk evaluations: 1) DU-S5 with sample CKSA-SS40 included, 2) DU-S5 with sample CKSA-SS40 data omitted from the DU, and 3) sample CKSA-SS40 only.[26]

The RMEs for DU-S5 significantly decreased when sample CKSA-SS40 data were excluded from the calculations (see Table 3-9). The total cancer risk for child recreators in DU-S5 is 6.3E-06 when CKSA-SS40 data were excluded from the calculation, compared to a total cancer risk of 1.8E-05 for CKSA-SS40 data only. The total noncancer hazard for child recreators in DU-S5 is 0.44 when CKSA-SS40 data were excluded from the calculation, compared to a total noncancer hazard of 2.4 for CKSA-SS40 data only. Similar decreases occurred for adult recreators and landscapers when sample CKSA-SS40 data were excluded from the calculations.

The risk drivers at DU-S5 were DDD, DDE, DDT, and total PCB aroclors for sample CKSA-SS40. Although the cancer risk at DU-S5 was within the USEPA acceptable cancer risk range when including the sample results for CKSA-SS40, the cancer risk decreased by over an order of magnitude (more than 10-fold) when CKSA-SS40 was excluded from the risk calculations for DU-S5. When CKSA-SS40 was excluded from the calculation of the noncancer HI, the HI was less than 1.

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[25] The concentrations observed at these locations were typically one to two orders of magnitude greater than the sub-slab soil gas concentrations observed at CK1463-02, and CK1463-05, which were located in the area of the building where asbestos abatement had not been completed. This may be a coincidence but it is very unusual for the maximum detected concentrations of multiple, unrelated constituents to occur at the same locations.

[26] See Appendix E (Tables E-9, E-10 and E-11) for a comparison of risks for DU-S5 when including sample CKSA-SS40 data, DU-S5 when excluding sample CKSA-SS40 data, and risks for sample CKSA-SS40 data only.

The table below shows the comparison between total cancer risks and noncancer hazards in DU-S5 when including and excluding sample CKSA-SS40 data to the total cancer risks and noncancer hazards calculated for CKSA-SS40 data only.

	Comparison of Total Risks in DU-S5 when Including and Excluding CKSA-SS40 Sample Data					
	6-Year Child Recreator		6-Year Adult Recreator		25-Year Landscaper	
Decision Unit	Cancer Risk Ratio	Hazard Index Ratio	Cancer Risk Ratio	Hazard Index Ratio	Cancer Risk Ratio	Hazard Index Ratio
DU-S5 (CKSA-SS40 Included)	0.95	1.0	0.93	1.0	0.95	1.0
DU-S5 (CKSA-SS40 Excluded)	0.35	0.18	0.32	0.17	0.35	0.19

A comparison done between the risk calculations including CKSA-SS40 data and the risk calculations of only sample CKSA-SS40 data, revealed that their cancer risks and hazard indices were nearly identical. This analysis indicates that higher concentrations of DDD, DDE, DDT and total PCB aroclors are in one central location (CKSA-SS40) and this sample of elevated concentrations is non-representative of the total cancer risk and noncancer hazards in DU-S5. For the purposes of the HHRA, sample CKSA-SS40 data was excluded from the risk assessment in DU-S5. Sample CKSA-SS40 data was evaluated separately from DU-S5 to investigate if the higher concentrations proposed a cancer risk outside the USEPA acceptable cancer risk range or a noncancer HI greater than one.

Arsenic in Surface Soil Evaluation

Arsenic was detected in surface soil throughout the Northern Area at concentrations ranging between 3.15 and 35.1 mg/kg and in the Southern Area at concentrations ranging between 3.6 and 29.5 mg/kg, which exceeded RBSCs (see Table 5-1 and Figures 5-2 and 5-3, respectively).

It is likely that the arsenic concentrations are representative of natural background concentrations and not related to the contamination, which has been documented in historical reports (DAF 1994a, 1994b; Shimada 2009). For example, naturally-occurring arsenic concentrations of over 20 mg/kg occurred in a random collection of soil samples taken on United States military installations in Japan (DAF 1994b). Naturally-occurring arsenic concentrations between 1 and 25 mg/kg are common for the Japanese Island Arc (Shimada 2009). Including arsenic in the risk calculations may overestimate risk from Site-related COPCs.

To evaluate the potential contribution of naturally-occurring arsenic at the Site, total cancer risks and noncancer hazards were calculated for complete exposure pathways. The cancer risks and noncancer hazards including arsenic concentrations are presented by DU, receptor, and exposure pathway in Table 5-2. The cancer risks and noncancer hazards excluding arsenic concentrations are presented by DU, receptor, and exposure pathway in Table 5-3. A sensitivity analysis for risks associated with arsenic is included in Section 6.

Total Cancer Risks and Noncancer Hazards

Total cancer risks and noncancer hazards were calculated for each DU and exposure scenario (see Table 5-2 and Appendix E Tables E-1 through E-11). Cancer risks and noncancer hazards were only calculated for the longest exposure durations per receptor (i.e., 6-year child and adult recreator and 25-year landscaper)[27] and for current land uses; future land uses were not considered. Figures 5-4 (Northern Area) and 5-5 (Southern Area) show total cancer risk and noncancer hazards calculated for each DU when including arsenic. Cancer risks and noncancer hazards were also evaluated by COPC and exposure pathway for each DU to determine risk drivers (see Appendix E, Tables E-12 through E-22).

Child Recreators

Cancer risks and noncancer hazards were calculated at all DUs for child recreators based on a 6-year exposure duration. These child recreators were assumed to spend four hours/day, two weekends each month at the Site (USEPA 2011).

The total cancer risk calculated for child recreators were within the USEPA risk range of 1E-04 to 1E-06 at each DU (see Table 5-2). The highest child recreator cancer risk (6.3E-05) was calculated for DU-S2. Appendix E presents cancer risks by COPC and exposure pathway for DU-S2. The ingestion pathway accounted for approximately 84% of the total cancer risk at DU-S2, with dieldrin contributing approximately 69% of the ingestion risk (see Table E-17). Dieldrin concentrations in surface soil in the Northern Area and Southern Area are presented on Figures 5-6 and 5-7, respectively.

Total noncancer HIs for child recreators were below 1 in all Southern DUs except DU-S1 and DU-S2, which had HIs of 6.7 and 2.5, respectively (see Table 5-2). The HI, which was above 1 (2.4) for DU-S5 was 0.44 when the elevated results from sample CKSA-SS40 were removed from the calculation (see Appendix E). The HI for CKSA-SS40 sample result was 2.4 (see Appendix E). Tables E-5 and E-6 present noncancer hazards by COPC and exposure pathway for DU-S1 and DU-S2, respectively. The ingestion pathway accounted for approximately 93% of the total noncancer risk at DU-S1, with total 2,3,7,8-TCDD TEQs contributing approximately 99% of the ingestion risk (see Table E-16). The ingestion pathway accounted for approximately 90% of the total noncancer risk at DU-S2, with total 2,3,7,8-TCDD TEQs contributing approximately 72% of the ingestion risk (see Table E-17). Total 2,3,7,8-TCDD TEQ concentrations in surface soil in the Northern Area and Southern Area are presented on Figures 5-8 and 5-9, respectively.

[27] Total cancer risks for 3-year exposure durations were approximately one half the total cancer risks for 6-year exposure durations. Noncancer hazards do not change based on exposure duration and therefore, were the same for 3- and 6-year exposures. Age-dependent mutagenic effects had a negligible effect on total cancer risk differences for 3- and 6-year exposure durations.

Total cancer risk decreased from 6.3E-05 to 6.0E-05 for DU-S2 when excluding arsenic from the risk calculations. Noncancer hazards were 6.7 for DU-S1 when including or excluding arsenic from the risk calculations (see Tables 5-2 and 5-3).

Adult Recreators

Cancer risks and noncancer hazards were calculated for adult recreators for all DUs based on a 6-year exposure duration. These adult recreators were assumed to spend four hours/day during two weekends each month at the Site.

The total cancer risk calculated for adult recreators were within the USEPA risk range of 1E-04 to 1E-06 in each DU (see Table 5-2). DU-S2 contained the highest adult recreator cancer risk of 6.5E-06. Appendix E presents cancer risks by COPC and exposure pathway for DU-S2. The ingestion pathway accounted for approximately 75% of the total cancer risk at DU-S2, with dieldrin contributing approximately 69% of the ingestion risk (see Table E-17). Dieldrin concentrations in surface soil in the Northern Area and Southern Area are presented on Figures 5-6 and 5-7, respectively.

Total noncancer HIs for adult recreators were below 1 for all locations (see Table 5-2). DU-S1 contained the highest adult recreator noncancer HI of 0.7. Appendix E presents noncancer hazards by COPC and exposure pathway for DU-S1. The ingestion pathway accounted for approximately 88% of the total noncancer risk at DU-S1, with Total 2,3,7,8-TCDD TEQs contributing approximately 99% of the ingestion risk (see Table E-16). Total 2,3,7,8-TCDD TEQ concentrations in surface soil for the Northern Area and Southern Area are presented on Figures 5-8 and 5-9, respectively.

Total cancer risk decreased from 6.5E-06 to 6.3E-06 for DU-S2 when excluding arsenic from the risk calculations. Noncancer hazards were 0.7 for DU-S1 when including or excluding arsenic from the risk calculations (see Tables 5-2 and 5-3).

Landscapers

Cancer risks and noncancer hazards were calculated for landscapers working in all DUs for 25 years. Landscapers were assumed to spend four hours/day at work one day per week at the Site with two weeks of vacation per year.

The total cancer risk calculated for landscapers in each DU was within the USEPA acceptable risk range of 1E-04 to 1E-06 (see Table 5-2). DU-S2 contained the highest landscaper cancer risk of 7.8E-05. Appendix E presents cancer risks by COPC and exposure pathway for DU-S2. The ingestion pathway accounted for approximately 90% of the total cancer risk in the DU, with dieldrin contributing approximately 69% of the ingestion risk (see Table E-17). Dieldrin concentrations in surface soil for the Northern Area and Southern Area are presented on Figures 5-6 and 5-7, respectively.

The total noncancer HI for landscapers was below 1 in each DU except DU-S1, which had a noncancer HI of 2.1 (see Table 5-2). Appendix E presents noncancer hazards by COPC and exposure pathway for DU-S1. The ingestion pathway accounted for approximately 96% of the total noncancer risk at DU-S1; total 2,3,7,8-TCDD TEQs contributed approximately 99% of the ingestion risk (see Table E-16). Total 2,3,7,8-TCDD TEQ concentrations in surface soil for the Northern Area and Southern Area are presented on Figures 5-8 and 5-9, respectively.

Total cancer risk decreased from 7.8E-05 to 7.5E-05 for DU-S2 when excluding arsenic from the risk calculations. Noncancer hazards were 2.1 for DU-S1 when including or excluding arsenic from the risk calculations (see Tables 5-2 and 5-3).

Summary of Risks

The surface soil COPCs responsible for the majority of total cancer risks and noncancer hazards at the Site were arsenic, dieldrin, and total 2,3,7,8-TCDD TEQs (see Tables E-12 through E-22). Arsenic surface soil concentrations are presented on Figures 5-2 and 5-3; dieldrin surface soil concentrations are presented on Figures 5-6 and 5-7; and total 2,3,7,8-TCDD TEQ surface soil concentrations are presented on Figures 5-8 and 5-9. Arsenic cancer risks exceeded 1E-06 for child recreators and landscapers in all DUs in the Northern and Southern Areas (see Table 5-2).

In the Northern Area, cancer risks greater than 1E-06 were reported for arsenic, chlordane (technical), dieldrin, total cPAHs, and total 2,3,7,8-TCDD TEQs for child recreator, adult recreator, and/or landscaper exposure scenarios; cancer risks were less than 1E-05 for all COPCs for all exposure scenarios (see Tables E-1 through E-4). Each surface soil COPC was below the noncancer hazard benchmark of one in the Northern Area regardless of exposure scenario (see Table 5-4). The highest total cancer risk and noncancer hazard were in DU-N4, which is located on the northernmost portion of the Northern Area (see Figure 5-4). DU-N4 is located in the approximate area of former Building 919, northeast of the soil berm (see Figure 1-3).

In the Southern Area, cancer risks greater than 1E-06 were reported for arsenic, dieldrin, and total 2,3,7,8-TCDD TEQs for child recreator, adult recreator, and/or landscaper exposure scenarios; cancer risks greater than 1E-05 were reported for only dieldrin in DU-S2 and total 2,3,7,8-TCDD TEQs in DU-S1 and DU-S2 (see Tables E-5 through E-11). In DU-S1 and DU-S2 only total 2,3,7,8-TCDD TEQs exceeded the noncancer hazard benchmark of one (see Table 5-4). A noncancer hazard greater than one was reported in DU-S5 when sample CKSA-SS40 data was included. Additionally, when evaluating the elevated COPC concentrations in surface soil at sample CKSA-SS40 [located in DU-S5], a noncancer hazard greater than one was reported for DDD. Noncancer hazards were below the noncancer hazard benchmark of one in DU-S5 when sample CKSA-SS40 data was omitted. Cancer risks and noncancer hazards were assumed to be zero for COPCs that were not detected in any samples within a DU. The highest total cancer risks and noncancer hazards were in DU-S1 and DU-S2, located on the northernmost portion of the Southern Area (see Figure 5-4). DU-S1 includes the skate park and maintenance building and DU-S2 includes the clinic field and the medical clinic (see Figure 1-4).

Evaluation of Lead Exposures

To assess whether or not lead levels at the Site pose a risk to human health, two USEPA lead models were used:

- The IEUBK model was used to evaluate lead risks in children (USEPA 2010); and
- The ALM model was used to evaluate lead risks (represented by BLL) in adult workers, while also estimating the probability of a pregnant worker's fetus having a BLL above a specified target value (USEPA 2017).

The modeled adult and fetal BLLs were compared to the USEPA level of action threshold value of 10 micrograms of lead per deciliter (µg/dL) of blood and the CDC threshold value 5 µg/dL of blood. A BLL of 10 µg/dL has been the USEPA threshold level of concern, requiring intervention if a child's BLL reached or exceeded this concentration. The USEPA set a post-remediation goal that the likelihood of a child having an elevated BLL (10 µg/dL or greater) should be no more than five percent (USEPA 2016). More recently, researchers have found that harmful health effects can occur at lower BLLs, leading the CDC and other organizations to recommend 5 µg/dL as the new BLL of concern in adults and children (ATSDR 2016).

All predicted BLLs were less than 5 µg/dL. Based on available data, the results from the USEPA IEUBK and ALM models, and USEPA and ATSDR recommendations regarding BLL, the lead risks to children, workers (landscapers), and pregnant workers' fetuses at the Site are below levels of concern. The model parameters, lead evaluation, and results are presented in Appendix C.

Toxicity Summaries for Selected COPCs

Arsenic risk is associated with the dermal and cardiovascular toxicity endpoints (ATSDR 2007); dieldrin risk is associated with the hepatic toxicity endpoint (ATSDR 2002); and total 2,3,7,8-TCDD TEQ risk is associated with the reproductive toxicity endpoint (ATSDR 1999). Toxicity summaries for arsenic, dieldrin, and dioxins, as well as chlordanes, DDD, DDE, DDT, PAHs, and PCBs, which pose a lesser risk to Site receptors, are presented in Appendix F.

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Section 6: Uncertainty and Sensitivity Analysis

The purpose of the uncertainty and sensitivity analysis is to evaluate sources of uncertainty and variability that can influence the results of the HHRA. The results reported in this HHRA depend on a number of factors including the confidence in how well the environmental monitoring and modeling data represent actual exposures, the availability of relevant scientific information, USEPA policy decisions and risk assessment methodology, and exposure and toxicity assumptions.

Uncertainty refers to a lack of data or an incomplete understanding of factors used in a risk assessment (e.g., lack of information about environmental concentrations). Uncertainty in estimating exposures can be reduced or eliminated with additional, more comprehensive data (USEPA 2019).

Variability refers to the inherent variation of data used in a risk assessment. Variability cannot be reduced with more sampling or data; however, it can be characterized or described qualitatively or quantitatively. Sources of variability include changes of environmental concentrations over time or under different conditions, human behaviors that influence exposures (e.g., how much time people spend at a location), and individual susceptibilities which could impact health outcomes.

Risk assessment is not meant to predict actual health risks for specific individuals; rather, it is a tool for understanding where potentially harmful exposures may potentially exist and deciding what, if any, actions are needed. The purpose of this section is to describe some of the uncertainty and variability associated with the data used in this HHRA in order to provide decision makers, and other users, information about how specific assumptions and parameters influence the risk results. This section provides information about the general uncertainties inherent in the risk assessment process as well as Site-specific uncertainties associated with estimating exposures at different locations on the Site. A sensitivity analysis is also provided to show how changing certain parameters and assumptions affect the risk results.

Key Sources of Uncertainty

According to the USEPA's Guidance for Risk Characterization, the discussion of uncertainties should include the type and complexity of the risk assessment, and an evaluation of how the key uncertainties may impact the overall risk assessment (USEPA 1992). Key sources of uncertainty identified in this HHRA and professional judgement regarding the direction and magnitude of the impacts on the risk assessment are presented in the table below. Key uncertainties are related to the development of EPCs, choice of toxicity values, lack of quantitative toxicity information, and the approach to estimating and aggregating risks (USEPA 2009).

Uncertainty	Direction[1]	Magnitude[2]	Action or Results
Data Evaluation			
Identification of COPCs	N/A	0	Site-specific information was used to develop the sampling work plan and to focus sampling efforts.
Sampling Conditions	+	1	Samples were collected during the winter (i.e., the heating season) when the potential for VI is greatest due to temperature differences between the indoor and subsurface air which maximizes the potential for VI. Soil and groundwater samples were collected during the dry season.
Sampling Locations	+/-	2	Soil sample locations were collected in a tightly-spaced grid and are likely representative of the range of concentrations at Camp Kinser. Groundwater sample locations were collected from perimeter locations and may not account for all constituents present in various portions of Camp Kinser groundwater. Sub-slab soil gas samples were collected from each building and are likely representative of the range of concentrations present within buildings at or adjacent to Camp Kinser.
Data Reduction	N/A	0	Data reduction focused on COPCs that could pose a significant risk to human health (see Section 2). RSLs and VISLs were used to screen out data that had minimal impact on the HHRA. Compound totaling of total PCBs, total cPAHs, and total 2,3,7,8-TCDD significantly reduced the number of data points, while preserving the risk associated with the individual data points. Data reduction is unlikely to under or overestimate risks.
Quality of Analytical Data	+	1	Samples were collected during one sampling event; however, conservative assumptions were used in the HHRA to ensure risks were not underestimated and samples were analyzed for a large set of data groups.
Exposure Assessment			
Exposure Parameters	+/-	1	Risks were calculated for exposed populations considered representative of the Site. The use of 6-year and 25-year exposure scenarios are the most conservative because they correspond to two tours (6-year) and host-nation, contractor work force career length (25-year). If the maximum tour length increased, the cancer risk would also increase. If the maximum tour length decreased, the cancer risk would decrease. 3-year exposure durations were not used to calculate risk because 6–year exposure durations were considered more conservative and would result in an overestimation of cancer risk compared to 3-year exposure durations.
Representativeness of EPCs	+	3	Upper-bound (i.e., Logarithmic 95% UCL, 95% UCL, maximum detected) measured media concentrations were used to calculate exposures at Camp Kinser. People are expected to encounter a range of concentrations during their daily activities at different locations at the Site and using upper-bound concentrations associated with a single elevated concentration is expected to overestimate risks. In situations where a COPC was not detected in any samples within a DU, the EPC was calculated as zero, which is expected to underestimate risk. The COPC may

Uncertainty	Direction[1]	Magnitude[2]	Action or Results
			be present at a concentration below the detection limit, but it is unlikely to have an impact on risk.
Arsenic Background	+	1	The natural background concentration of arsenic is uncertain. Including risk from background concentrations of arsenic may overestimate risks from Site COPCs if arsenic concentrations are within the range of natural background.
Land Use Assumptions	N/A	0	The HHRA was evaluated for current land-uses only. Future land uses were not accounted for in this HHRA.
Toxicity Assessment			
Toxicity Values	+/-	1	Risks were calculated using toxicity values from the USEPA's May 2019 RSL tables. While these values are the most-up-to-date scientific information, the values may be modified at a later time and the HHRA would thus be affected. If the values are modified, the risks could increase or decrease. In addition, RSLs were not available for 61 of the 253 constituents analyzed in surface soil. Excluding these constituents from the risk calculations could underestimate risks (see Table 6-1 for the list of constituents).
Physical Property Values	+/-	1	Risks were calculated using physical property values from the USEPA's May 2019 RSL tables. While these values are the most-up-to-date scientific information, the values may be modified at a later time and the HHRA would thus be affected. If the values are modified, the risks could increase or decrease.
Toxicity Studies	+	3	The USEPA's conservative approach of incorporating safety factors and upper-bound estimates were used. Uncertainty factors were included to account for the most sensitive human populations, conversions for NOAEL, and uncertainties in the database. Confidence stated by IRIS for toxicity values varies by constituent.
Extrapolation from Animal Studies to Human Toxicity	+	3	The USEPA's conservative approach of incorporating safety factors and upper-bound estimates was used. Uncertainty factors were included to account for laboratory animal-to-human interspecies.
Risk Characterization			
Assumed that Health Effects of Constituents are Additive	+	2	Risks from all COPCs are added together to calculate total cancer risks and noncancer hazards. Health effects from multiple constituents are assumed to be additive even if the constituents may not act similarly in the body or affect the same organ system. By summing all risks regardless of toxicity endpoint, risks are likely overestimated.

Notes:
[1]Direction ratings: +: May overestimate risk. -: May underestimate risk. N/A: Magnitude 0, direction not applicable.
[2]Magnitude ratings: 0: Negligible effect on risk calculations. 1: Small effect on risk calculations. 2. Medium effect on risk calculations. 3. Large effect on risk calculations.

Conservative assumptions were used in the HHRA to ensure risks were not underestimated. The uncertainties in the HHRA are more likely to overestimate than underestimate risks.

Site-Specific Sources of Variability

Sources of variability in this HHRA include possible changes in measured COPC concentrations over time. Environmental sampling was conducted at the Site in November and December 2018. Additional sampling could reveal variability in concentrations by season or other factors associated with Camp Kinser operations (e.g., building maintenance or heating, ventilating, air conditioning system replacement).

Additional sources of variability include differences in people's behaviors and activity patterns on the Site throughout the year. Within a population, a range of exposures is expected based on movement around a variety of DUs. For example, for the adult and child recreator exposure scenarios, it was assumed that adults and children remain at a single DU (and may be at the location with the highest concentration for DU) for the entirety of their time at the Site. In reality, exposures would vary by the time spent at different DUs during normal recreational activities.

Sensitivity Analysis

The purpose of the sensitivity analysis is to quantitatively evaluate the impact of certain parameters or assumptions on the risk estimates. Below is a discussion of three parameters selected for this evaluation:

1. Sensitivity Associated with Total PCB Aroclors versus Congeners in Risk Calculations
2. Sensitivity Associated with Including Dioxin-Like PCB Congeners in Total 2,3,7,8-TCDD TEQ
3. Sensitivity Associated with Including and Excluding Arsenic Risks

Sensitivity Associated with PCB Aroclor versus PCB Congener Totals in Risk Calculations

Total PCB aroclors were used to evaluate risk to Site receptors from surface soil rather than total PCB congeners. Each surface soil sample was analyzed for individual PCB aroclors, which were summed to equal total PCB aroclors. A total of 11 surface soil samples were also analyzed for the full suite of individual PCB congeners, which were summed to equal total PCB congeners.

The results of total PCB congeners and total PCB aroclors were consistently very low and had minimal impact on total risk. On average, the total PCB congener concentrations in surface soil were 41 times lower than the total PCB aroclor values. A total of 26 different congeners were detected (without data flags) in surface soil samples; these data will be presented in the Site Investigation Report, which is currently in production.[28] Calculating risk using total PCB aroclors rather than total PCB congeners did not result in a significant underestimation of risk to

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[28] Additional low-level PCB congener detections were qualified as estimates in the data set.

receptors, because PCBs were not a significant driver of risk. Analyzing all 209 PCB congeners for each surface soil sample would have had minimal impact on total risk calculations. The table below shows the total PCB concentrations for aroclors and congeners for the 11 samples analyzed for both types of PCBs, as well as the aroclor to congener ratio.

Sample ID	Total Aroclor Concentration (mg/kg)	Qualifier	Total Congener Concentration (mg/kg)	Qualifier	Aroclor to Congener Ratio
CKSA-SS08	0.048	U	0.069	J	0.69
CKSA-SS22	0.048	U	0.015	J	3.2
CKSA-SS25	0.048	U	0.024	J	2.0
CKSA-SS35	0.048	U	0.019	J	2.6
CKSA-SS48	0.048	U	0.074	J	0.65
CKSA-SS56	0.048	U	0.00026	J	182
CKNA-SS12	0.048	U	0.39	J	0.12
CKNA-SS14	0.048	U	0.0035	J	14
CKNA-SS25	0.048	U	0.00054	J	88
CKNA-SS32	0.048	U	0.00032	J	152
CKNA-SS44	0.048	U	0.024	J	2.0

Sensitivity Associated with Including Dioxin-Like PCB Congeners in Total 2,3,7,8-TCDD TEQs

Some PCB congeners can have dioxin-like toxic effects (referred to in this HHRA as dioxin-like PCBs). These PCBs generally include congeners with four or more chlorine atoms in the ortho positions (positions designated 2, 2', 6, or 6'). The results of the cancer risk calculations presented in Section 5 of this HHRA (where dioxin-like PCBs were assumed to have dioxin-like toxicity) were compared with cancer risks excluding dioxin-like PCBs. This evaluation was completed for the DU with the highest ratio of dioxin-like PCBs to dioxins in surface soil (DU-N2) and for the DU with the highest total 2,3,7,8-TCDD TEQ cancer risk (DU-S1). All other assumptions used to calculate risk were the same except for including the risks from dioxin-like PCBs.

On average, dioxin-like PCBs comprised 32% of the total 2,3,7,8-TCDD TEQ concentration for surface soil samples throughout the Site. However, dioxin-like PCBs accounted for 0.36% to 87% of the total 2,3,7,8-TCDD TEQ concentrations in various samples collected throughout the Site (see Table 6-2). For DU-N2, the dioxin-like PCBs accounted for 78% of the total 2,3,7,8-TCDD TEQ concentration (RME of 0.000042 mg/kg for total 2,3,7,8-TCDD and 0.000033 mg/kg for dioxin-like PCBs). For DU-S1, the dioxin-like PCBs accounted for only 0.36% of the total 2,3,7,8-TCDD TEQ concentration (RME of 0.0025 mg/kg for total 2,3,7,8-TCDD TEQ and 0.0000091 mg/kg for dioxin-like PCBs).

The cancer risks for total 2,3,7,8-TCDD TEQ (see Appendix E) and 2,3,7,8-TCDD TEQ without dioxin-like PCB congeners for DU-N2 and DU-S1 are presented on the following page. The total cancer risks from Appendix E are also compared to the total cancer risks including 2,3,7,8-TCDD TEQ without dioxin-like PCB congeners in both scenarios.

Sensitivity Analysis Results	Cancer Risks for DU-N2 Child Recreator 6-Year Exposure Duration	Adult Recreator 6-Year Exposure Duration	Landscaper 25-Year Exposure Duration
Total 2,3,7,8-TCDD TEQ risk (see Table E-2)	8.9E-07	8.7E-08	1.2E-06
2,3,7,8-TCDD TEQ without dioxin-like PCB risk (Sensitivity Analysis)	1.9E-07	1.9E-08	2.5E-07
Ratio of 2,3,7,8-TCDD TEQ Risks (All Exposure Pathways)	**4.6**	**4.6**	**4.5**
Total Risk (Total 2,3,7-8-TCDD TEQ + All Other Constituents; see Table E-2)	3.6E-06	3.4E-07	4.4E-06
Total Risk (2,3,7,8-TCDD TEQ without dioxin-like PCBs+ All Other Constituents;(Sensitivity Analysis)	2.9E-06	2.7E-07	3.5E-06
Ratio of Total Risks (All Constituents/All Exposure Pathways)	**1.2**	**1.3**	**1.3**

Sensitivity Analysis Results	Cancer Risks for DU-S1 Child Recreator 6-Year Exposure Duration	Adult Recreator 6-Year Exposure Duration	Landscaper 25-Year Exposure Duration
Total 2,3,7,8-TCDD TEQ risk (see Table E-5)	5.2E-05	5.1E-06	6.8E-05
2,3,7,8-TCDD TEQ without dioxin-like PCB risk (Sensitivity Analysis)	5.2E-05	5.1E-06	6.8E-05
Ratio of 2,3,7,8-TCDD TEQ Risks (All Exposure Pathways)	**1.0**	**1.0**	**1.0**
Total Risk (Total 2,3,7-8-TCDD TEQ + All Other Constituents; see Table E-5)	5.6E-05	5.5E-06	7.2E-05
Total Risk (2,3,7,8-TCDD TEQ without dioxin-like PCBs + All Other Constituents; Sensitivity Analysis)	5.5E-05	5.4E-06	7.2E-05
Ratio of Total Risks (All Constituents/All Exposure Pathways)	**1.0**	**1.0**	**1.0**

The results of this sensitivity analysis indicate that when high ratios of dioxins to dioxin-like PCBs are present (e.g., in DU-N1), the 2,3,7,8-TCDD TEQ cancer risks are approximately 4.6 times higher when dioxin-like PCBs are included in the risk calculation. When lower ratios of dioxins to dioxin-like PCBs are present (e.g., in DU-S2), the ratio of 2,3,7,8-TCDD TEQ cancer risks are approximately the same when dioxin-like PCBs are included in the risk calculation. In both scenarios, the impact of incorporating dioxin-like PCBs in the total cancer calculations is negligible as the ratio of total cancer risks (calculated with and without dioxin-like PCBs) is approximately one, which indicates minimal change in the overall risks. The total 2,3,7,8-TCDD TEQ concentrations used in the risk calculations in Section 5 include dioxin-like PCBs; therefore, risks were not underestimated.

Sensitivity Associated with Including and Excluding Risks from Arsenic

The comparison of total cancer risks and noncancer hazards when including and excluding arsenic are presented by DU below to determine the uncertainty associated with natural arsenic background at the Site.

	Comparison of Total Risks by DU when Including and Excluding Arsenic Risks					
	6-Year Child Recreator		6-Year Adult Recreator		25-Year Landscaper	
Decision Unit	Cancer Risk Ratio	Hazard Index Ratio	Cancer Risk Ratio	Hazard Index Ratio	Cancer Risk Ratio	Hazard Index Ratio
DU-N1	7.6	2.7	9.3	2.8	8.9	2.7
DU-N2	3.2	1.5	3.6	1.6	3.5	1.5
DU-N3	8.3	3.1	11	3.2	10	3.1
DU-N4	1.4	1.4	1.4	1.4	1.5	1.5
DU-S1	1.1	1.0	1.1	1.0	1.1	1.0
DU-S2	1.0	1.0	1.0	1.0	1.0	1.0
DU-S3	1.4	1.2	1.4	1.3	1.4	1.2
DU-S4	3.4	1.7	4.0	1.7	3.9	1.7
DU-S5	1.6	1.2	1.7	1.2	1.7	1.2

Ratios are shown as total cancer risk or noncancer hazard including arsenic (see Table 5-2) divided by total cancer risk or noncancer hazard excluding arsenic (see Table 5-3). For example, the total cancer risk when including arsenic was 7.6 times higher than the total cancer risk when excluding arsenic.

Arsenic had a minimal effect on risk decisions. Total cancer risks were greater and noncancer hazards were the same when arsenic concentrations were included in the risk/hazard calculations. The largest difference in total cancer risk and noncancer hazard when including and excluding arsenic concentrations was for DU-N3.

The total cancer risks at the Site were on average 3.7 times higher when including arsenic in the risk calculations (ranged from 1.0 to 11 times higher); however, total cancer risks were within the acceptable risk range of 1E-04 to 1E-06 for all DUs when including or excluding arsenic (see Tables 5-2 and 5-3).

The total noncancer hazard was on average 1.7 times higher when including arsenic in the risk calculations (ranged from 1.0 to 3.0). However, arsenic did not significantly contribute to the noncancer hazard for any exposure scenarios, as can be seen in Tables 5-2 and 5-3. HIs for DU-S1 and DU-S2 were above the USEPA benchmark of one regardless of whether arsenic was included or excluded from the hazard estimate. The noncancer hazard was below one for all other exposure scenarios regardless whether arsenic was included or excluded in the hazard estimate.

Therefore, the uncertainty associated with natural arsenic background did not significantly under or overestimate risks at the Site. Including and excluding arsenic from the risk calculations did not result in total cancer risks exceeding the acceptable risk range of 1E-04 to 1E-06 or total noncancer hazards exceeding 1.

References

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Section 7: Conclusions

Summary of Cancer Risks and Noncancer Hazards

This HHRA was completed to evaluate risk to Site receptors in the Northern and Southern Areas of Camp Kinser from surface soil (via dermal contact, ingestion, and inhalation) and groundwater and sub-slab soil gas (through VI). The VI pathway was evaluated and a comprehensive assessment of multiple lines-of-evidence indicate that the VI pathway was not a pathway of concern. Groundwater impacts were insignificant in the Northern and Southern Areas and were not responsible for concentrations in sub-slab soil gas that exceeded SG-to-IA VISLs. Sub-slab soil gas VISL exceedances in the Southern Area were likely associated with anthropogenic activities (i.e., asbestos abatement and building renovations) or COPC concentrations in ambient or indoor air.

The HHRA evaluated the potential for cancer and noncancer health affects for a 6-year adult and child recreator and a 25-year landscaper for various exposure in DUs within the Northern and Southern Areas.

Northern Area

Total cancer risks calculated for Site surface soils for all DUs in the Northern Area were within or below the USEPA's acceptable cancer risk range. DU-N4 had the highest cancer risks in the Northern Area which was 1.3E-05 for the 6-year child recreator and 1.5E-05 for the 25-year adult landscaper. All other cancer risks were below 1.0E-05. The primary risk drivers at DU-N4 were arsenic and dieldrin. Total noncancer hazards calculated for all DUs in the Northern Area were below the USEPA benchmark of one. Arsenic surface soil cancer risks greater than 1E-06 were widespread on the Site. Arsenic is likely naturally-occurring, given the Site-wide nature of the elevated risks compared to the more focused elevated risks of remaining surface soil COPCs. Naturally-occurring levels of arsenic similar to the concentrations found in surface soil at the Site have been noted in Okinawa.

Southern Area

Portions of the Southern Area (e.g., the baseball field) were historically filled with imported material and graded to allow for development. Total cancer risks calculated for Site surface soils for all DUs in the Southern Area were within or below the USEPA's acceptable cancer risk range for all exposure scenarios. The highest risks in the Southern Area are generally located in DUs where it appears that fill was not imported (DU-S1, DU-S2, and DU-S5). DU-S1 and DU-S2 had the highest cancer risks in the Southern Area. The cancer risks for the 6-year child recreator at DU-S1 and DU-S2 were 5.6E-05 and 6.3E-05, respectively. The cancer risks for the 25-year adult landscaper at DU-S1 and DU-S2 were 7.2E-05 and 8.0E-05, respectively. The cancer risk for all other exposure scenarios in the Southern Area were below 1E-05 except for DU-S5. The cancer risk for the Southern Area was primarily driven by the concentrations of dieldrin and to a lesser extent, total PCBs (Aroclor Method) in one sample (CKSA-SS40). The cancer risk for the 6-year child recreator was 1.8E-05 and 2.2E-05 for the 25-year adult landscaper. The noncancer HI for the southern area was above the USEPA benchmark of one for 2,3,7,8-TCDD TEQs in DU-S1 and DU-S2 and DDD in DU-S5. DDD, DDE, and DDT concentrations in sample CKSA-SS40 resulted in an HQ of 2.4 for the child recreator. Both the cancer risk and HI decreased by omitting CKSA-SS40 concentrations from the calculations resulting in cancer risks below 1E-05 for both the 6-year child recreator and the 25-year adult landscaper and reduced the 6-year child HI below the USEPA benchmark of 1.

Summary of Primary Risk Drivers for Cancer Risks and Noncancer Hazards

Below is an evaluation of those constituents that were the primary risk drivers for the calculated cancer risks and HIs.

Arsenic in Soil – For the 6-year child and the 25-year adult landscaper, the cancer risks associated with arsenic concentrations in soil are at the lower end of the acceptable cancer risk range of 1.0E-04 (1×10^{-4} or 1 in 10,000) to 1.0E-06 (1×10^{-6} or 1 in 1,000,000) for all DUs. Naturally-occurring concentrations of arsenic, similar to the concentrations found in surface soil at the Site, have been noted in Japan. The arsenic concentrations in soil across the Northern and Southern area of the Site range from 3.2 mg/kg to 35.1 mg/kg. As previously noted in this report, these concentrations are comparable to naturally-occurring arsenic concentrations of over 20 mg/kg that have been observed in a random collection of soil samples collected on United States military installations in Japan. Arsenic soil concentrations between 1 and 25 mg/kg are common for the Japanese Island Arc (Shimada 2009).

Risks Associated with Soil at Sample Location CKSA-SS40 (Located within DU-S5) – The HI associated with Total PCBs (Aroclor Method), DDD, DDE, and DDT in soil at sample location CKSA-SS40 (located in DU-S5) exceeded the USEPA noncancer benchmark of 1 for the 6-year child (i.e., the HI was 2.4 for a child recreator). For the purpose of this evaluation, it was assumed that a receptor spends all of their time (6-years for a recreator or 25-years for a landscaper) at the location of highest concentration at DU-S5 (CKSA-SS40), which is overly conservative and an unrealistic exposure scenario. It is important to note that the risks within DU-S5 are within USEPA risk management range when sample CKSA-SS40 is omitted from the analysis.

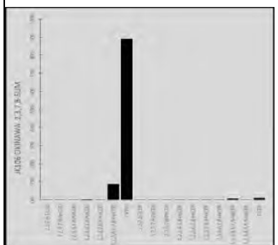
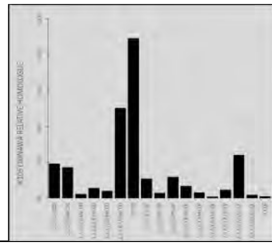
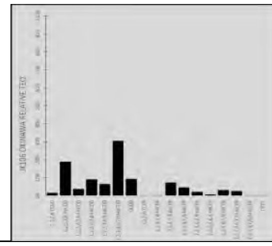
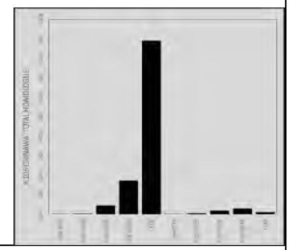
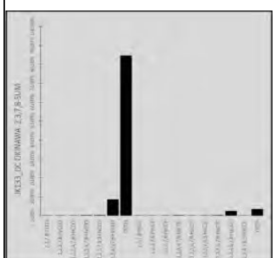
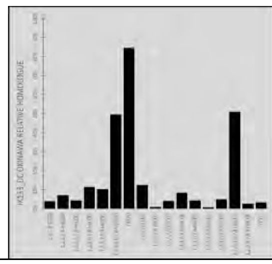
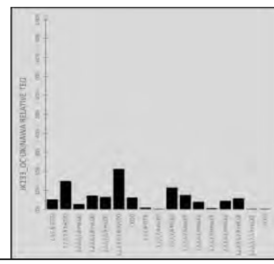
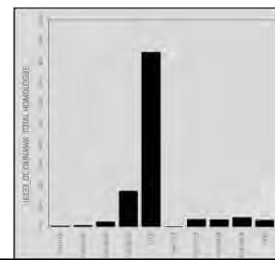
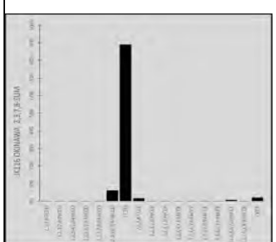
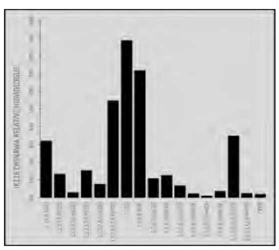
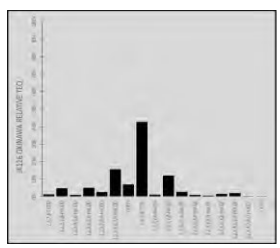
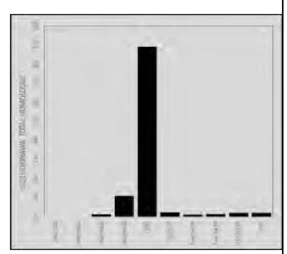
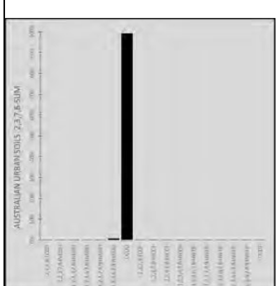
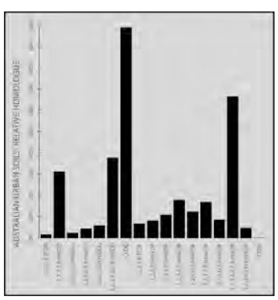
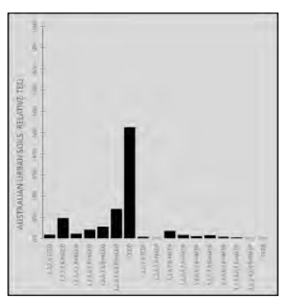
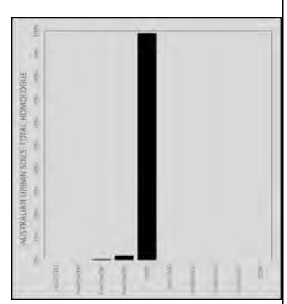
Concentration of Dieldrin in Soil at Sample Location CKNA-SS48 (Located within DU-N4) – The total risk for DU-N4 for the 6-year child is 1.3E-05 and the HI is 0.3. The total risk for the 25-year landscaper is 1.5E-05 and the HI is 0.09. The dieldrin soil concentration at sample location CKNA-SS48 was 2 mg/kg and was orders of magnitude higher than every other soil sample that was collected in the Northern Area. This soil concentration is driving the cancer risk at this location, which is located proximate to a sports court and to the Gymnasium (Building 1043).

The cancer risk associated with this dieldrin concentration for the child is 5.9E-06 and it is 7.8E-06 for the landscaper. The HIs associated with this dieldrin concentration, for both populations, are below the USEPA HQ benchmark 1.

2,3,7,8-TCDD (TEQs) in Soil – The risks associated with 2,3,7,8-TCDD (TEQs) exceeded the USEPA risk management range for the HI in DU-S1 and DU-S2. Based on the variability of the sampling results (two orders of magnitude (100-fold) difference between the highest and lowest concentrations), the maximum concentration was used to assess risk, per USEPA guidance. As such, the cancer risk and noncancer hazards for DUS1 and DUS2 may be overly conservative. However, total 2,3,7,8-TCDD (TEQs) may be associated with contributions from off-Site incinerators and not from releases from the MSA. A comparison (see below) of the 2,3,7,8-TCDD (TEQs) congener profiles that were developed based on Site-specific data with those obtained from literature studies indicate that the on-Site 2,3,7,8-TCDD (TEQs) concentrations are similar to profiles representing urban background concentrations. The profile analysis of dioxin congeners for several samples detected in soil from both the Southern and Northern Areas is consistent with that associated with background levels in urban soils as a result of airborne deposition from non-specific sources (see below). Review of the datasets for the Northern and Southern Areas indicates that dioxins in surface soils of the Northern Area appear to be consistent with the atmospheric deposition of dioxins but further evaluation would be needed on the Southern Area to clearly identify 2,3,7,8 concentrations that are greater than typical background soil concentrations in Okinawa and/or determine the source contribution for those concentrations on the Southern Area.

Note: Four standardization methods were used to graphically depict polychlorinated dibenzo-p-dioxin and furan (PCDD and PCDF) congener profiles in environmental media, including the 2,3,7,8-SUM, Relative Homologue, and Relative TEQ graphs:

1. The 2,3,7,8-SUM standardization method represents the percent of each PCDD and PCDF congener as part of the total concentration of dioxins in the profile.
2. The RELATIVE HOMOLOGUE standardization method presents each dioxin congener as a percentage of its homologue class. A homologue class is a grouping of dioxin compounds that all contain the same number of chlorine atoms.
3. The RELATIVE TEQ standardization method represents the percentage of each dioxin congener TEQ as part of the total TEQ for the dioxin profile.
4. The TOTAL HOMOLOGUE standardization method reflects the percentage of each homologue class as a percentage of the total dioxins in the profile.

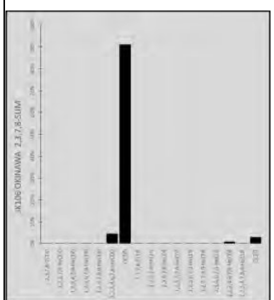
Comparison of Dioxin Profiles in Site Soil with Off-Site, Urban Background Dioxin Profiles			
2,3,7,8-SUM Profile	**RELATIVE HOMOLOGUE Profile**	**RELATIVE TEQ Profile**	**TOTAL HOMOLOGUE Profile**
Dioxin Profiles for Site Soil Sample JK106 (the highest concentration of dioxin TEQ and risk present in DU-S1)			
			
Dioxin Profiles for Site Soil Sample JK116 (the highest concentration of dioxin TEQ and risk present in DU-S2)			
			
Dioxin Profiles for Site Soil Sample JK133_DC from DU-S3			
			
All three of the dioxin profiles from Site soils are similar and so it can be assumed to come from the same or similar dioxin source or process.			
Dioxin Profiles for Australian Urban Background Soils from Wollongong (Muller et al. 2004)			
			
A visual comparison of the dioxin profiles for Site soils to those provided by Shields et al. (2006) indicates that the dioxins in the Site soils are consistent with the dioxins is urban background soils arising from non-specific airborne dioxin deposition (Muller et al 2004, Prinz 2017)			

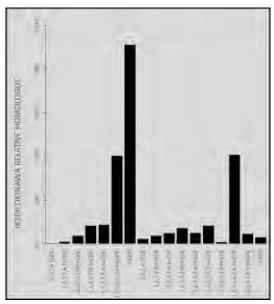
Comparison of Dioxin Profiles in Site Soil with Off-Site, Urban Background Dioxin Profiles

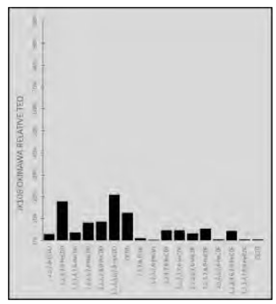
2,3,7,8-SUM Profile	RELATIVE HOMOLOGUE Profile	RELATIVE TEQ Profile	TOTAL HOMOLOGUE Profile

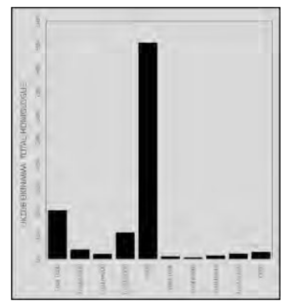
from various emission sources (e.g., waste incineration, production of chemicals). The primary task in the Muller et al. study was to determine background concentrations of dioxin-like chemicals in urban and industrial soils that are unrelated to specific sources. According to Sakurai (2003), the major sources of dioxins to aquatic surface sediments and soils in the Kanto region of Japan are multiple combustion processes, impurities in pentachlorophenol, and impurities in diphenyl ether herbicide chlornitrophen.

Dioxin Profiles for Sediment Cores (0 to 1 cm Depth) from Shinji Lake (1993-1994) (Masunaga et al. 2001)









These dioxin profiles in Site soils are also not visually different from that derived from dioxins detected in Lake Shinji sediment core samples (0 to 1 cm deep) which are suggested to be due to atmospheric deposition of combustion sources in 1993-1994.

References

Masunaga et al. 2001. Identifying Sources and Mass Balance of Dioxin Pollution in Lake Shinji Basin, Japan. July.

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Shields W.J., Tondeur Y., Benton L. and Edwards M.R. Chapter 14 Dioxins and Furans. In: Environmental Forensics, Contaminant Specific Guide. Eds R.D. Morrison and B.L. Murphy. Academic Press, Elsevier. Pp293-312.

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Figures

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PIONEER
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Site Location
Human Health Risk Assessment
Camp Kinser, Okinawa Prefecture, Japan

Figure 1-1

PIONEER TECHNOLOGIES CORPORATION

Northern and Southern Area Locations
Human Health Risk Assessment
Camp Kinser, Okinawa Prefecture, Japan

Figure 1-2

PIONEER TECHNOLOGIES CORPORATION

Northern Area Detail
Human Health Risk Assessment
Camp Kinser, Okinawa Prefecture, Japan

Figure 1-3

PIONEER TECHNOLOGIES CORPORATION

Southern Area Detail
Human Health Risk Assessment
Camp Kinser, Okinawa Prefecture, Japan

Figure 1-4

Legend

Approximate Boundary of MSA

Southern Area Boundary

Notes:
-MSA Boundary Source: DA 1976

0 200 400 600 Feet

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Makiminato Service Area Overlay
Human Health Risk Assessment
Camp Kinser, Okinawa Prefecture, Japan

Figure 1-5

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Northern Area Decision Units
Human Health Risk Assessment
Camp Kinser, Okinawa Prefecture, Japan

Figure 1-6

PIONEER
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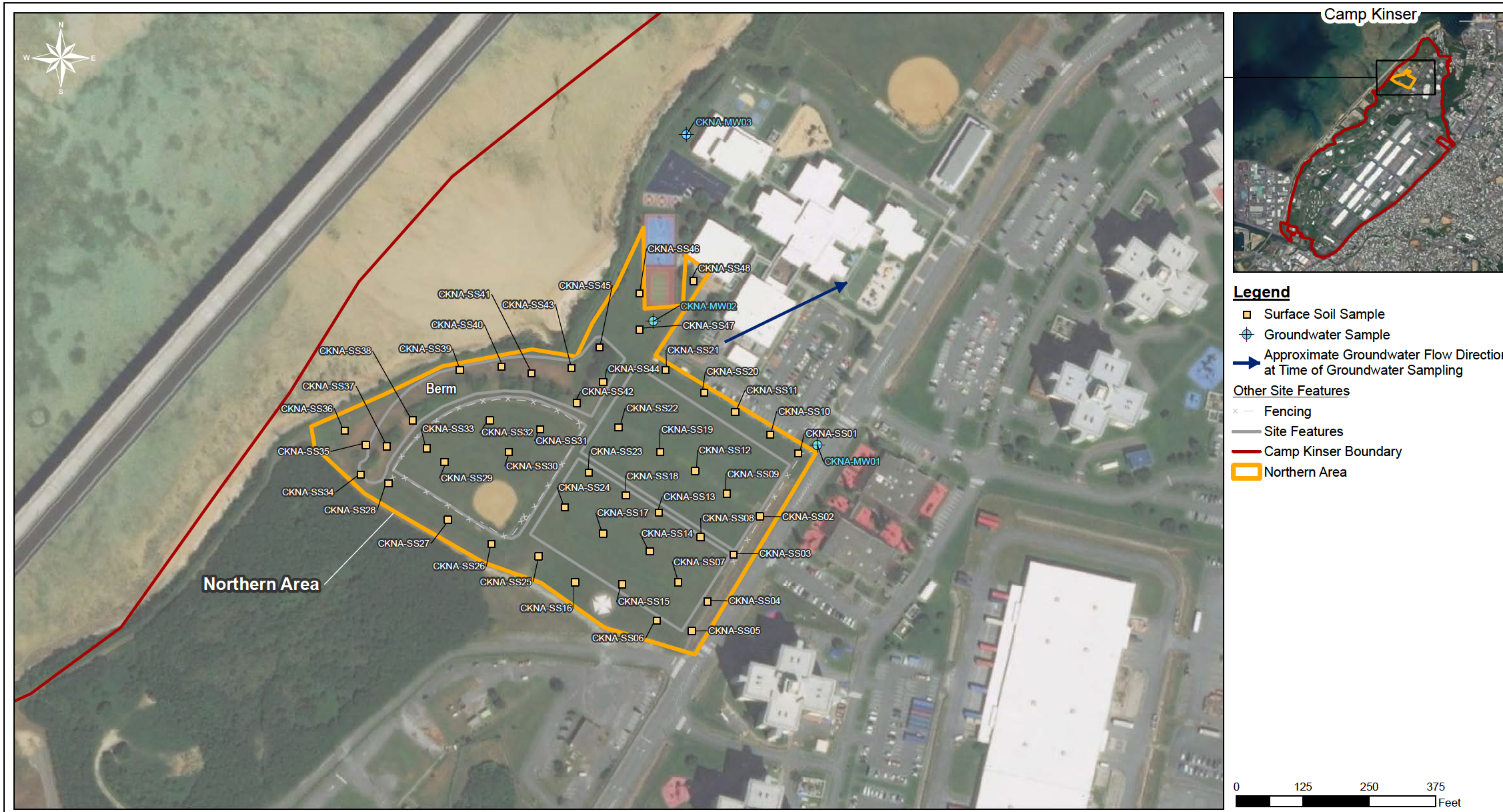
Southern Area Decision Units
Human Health Risk Assessment
Camp Kinser, Okinawa Prefecture, Japan

Figure 1-7



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Northern Area Soil and Groundwater Sample Locations
Human Health Risk Assessment
Camp Kinser, Okinawa Prefecture, Japan

Figure 2-1

PIONEER TECHNOLOGIES CORPORATION

Southern Area Soil and Groundwater Sample Locations
Human Health Risk Assessment
Camp Kinser, Okinawa Prefecture, Japan

Figure 2-2

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Northern Area Sub-Slab Soil Gas and Ambient Air Sample Locations
Human Health Risk Assessment
Camp Kinser, Okinawa Prefecture, Japan

Figure 2-3

Southern Area Sub-Slab Soil Gas and Ambient Air Sample Locations
Human Health Risk Assessment
Camp Kinser, Okinawa Prefecture, Japan

Figure 2-4

PIONEER TECHNOLOGIES CORPORATION

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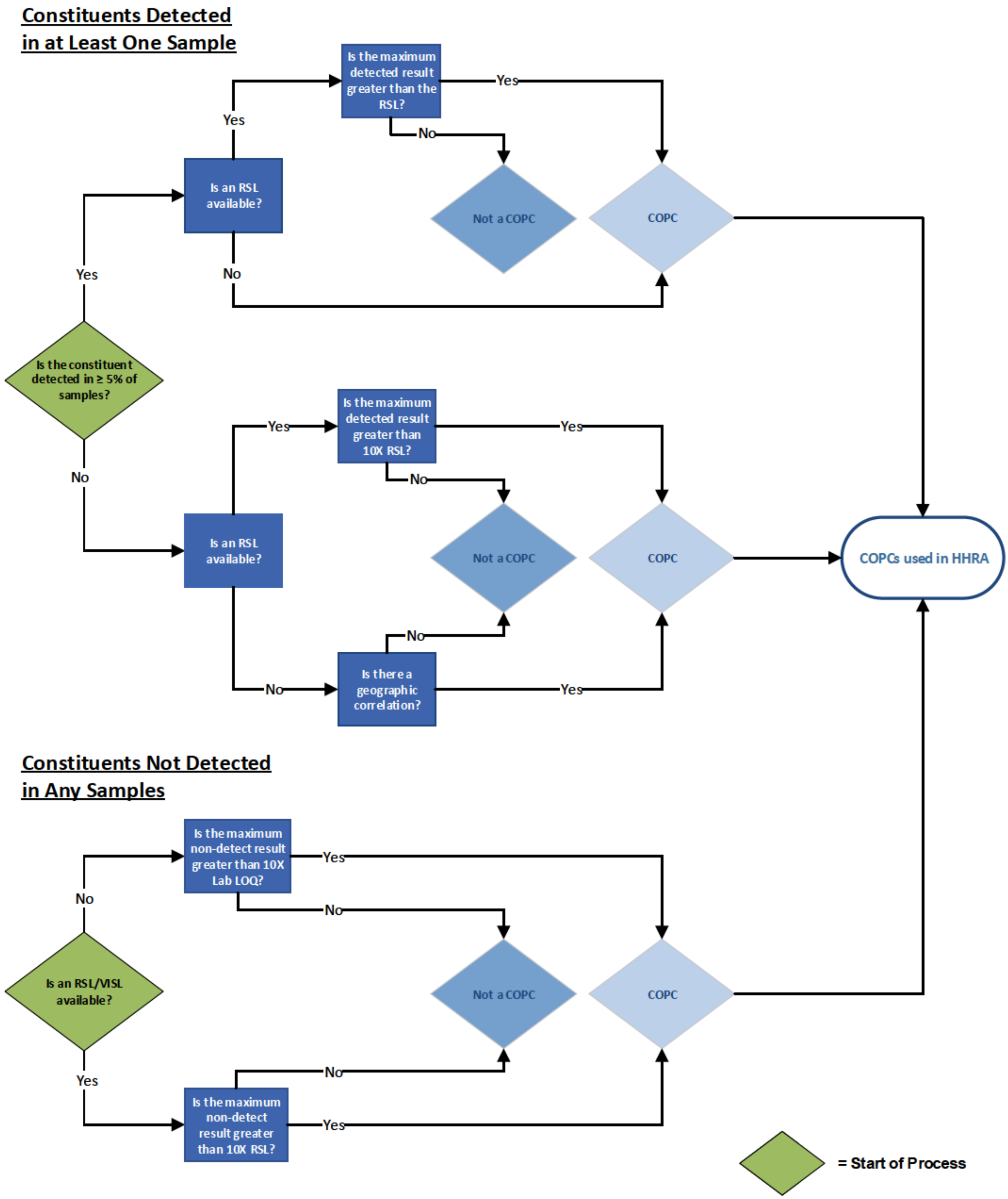

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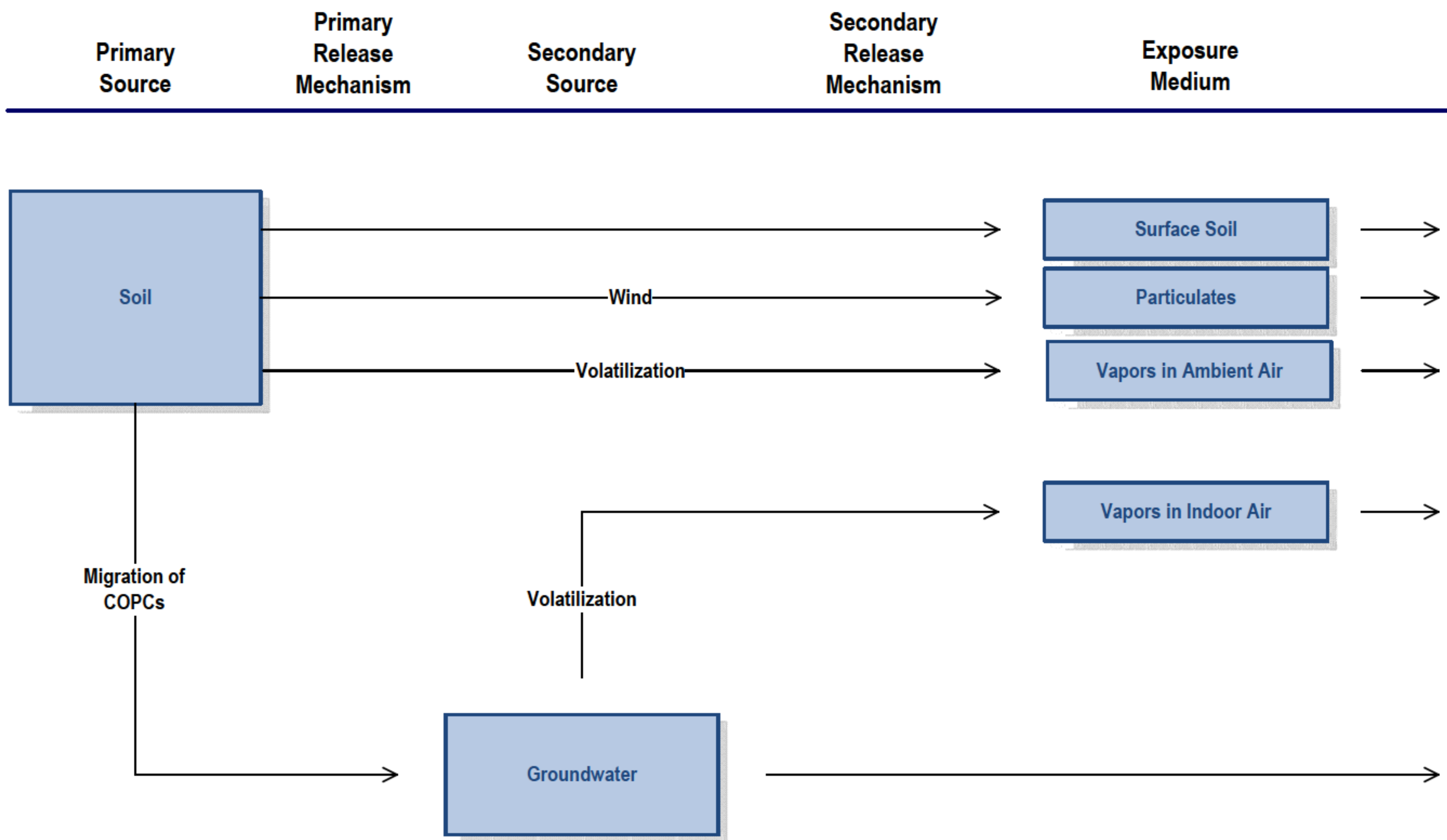
Risk-Based Screening COPC Criteria
Human Health Risk Assessment
Camp Kinser, Okinawa Prefecture, Japan

Figure 2-5

Northern Area



Potential Receptors

Exposure Medium	Exposure Route	On-Site: ADULT RECREATOR (3- and 6-year)	On-Site: CHILD RECREATOR (3-and 6-year)	On-Site: LANDSCAPER (25-year)	Off-Site: TEACHER (25-year)	Off-Site: STUDENT (3- and 6-year)
Surface Soil	Incidental Ingestion	X	X	X		
Surface Soil	Dermal Contact	X	X	X		
Particulates	Inhalation	X	X	X		
Vapors in Ambient Air	Inhalation	X	X	X		
Vapors in Indoor Air	Inhalation				X	X
Groundwater	Incidental Ingestion					
Groundwater	Dermal Contact					

Key

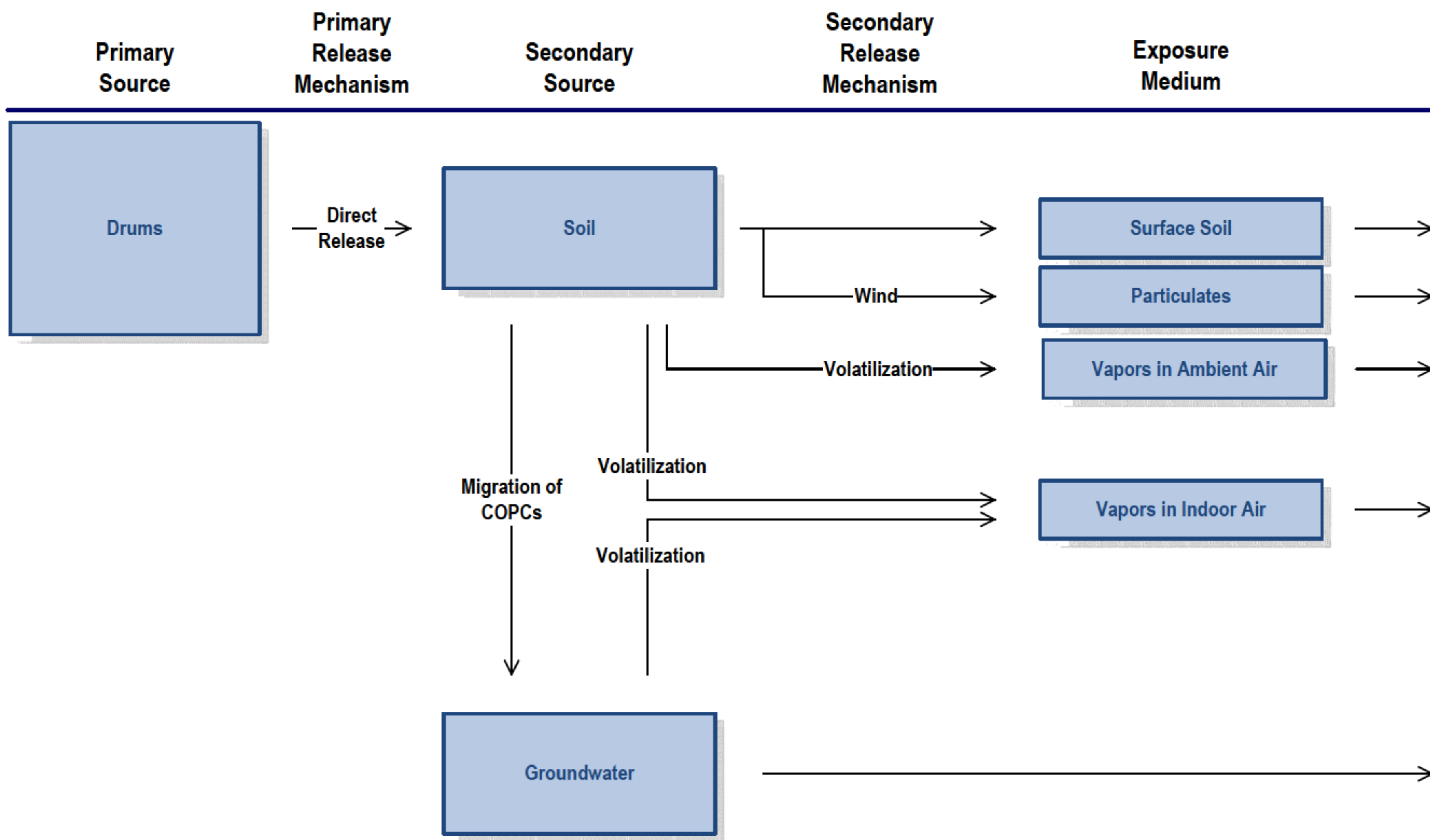
Key	
(blank)	Incomplete Pathway
X	Complete Pathway

PIONEER TECHNOLOGIES CORPORATION

Northern Area Conceptual Site Model
Human Health Risk Assessment
Camp Kinser, Okinawa, Japan

Figure 3-1

Southern Area



Potential Receptors

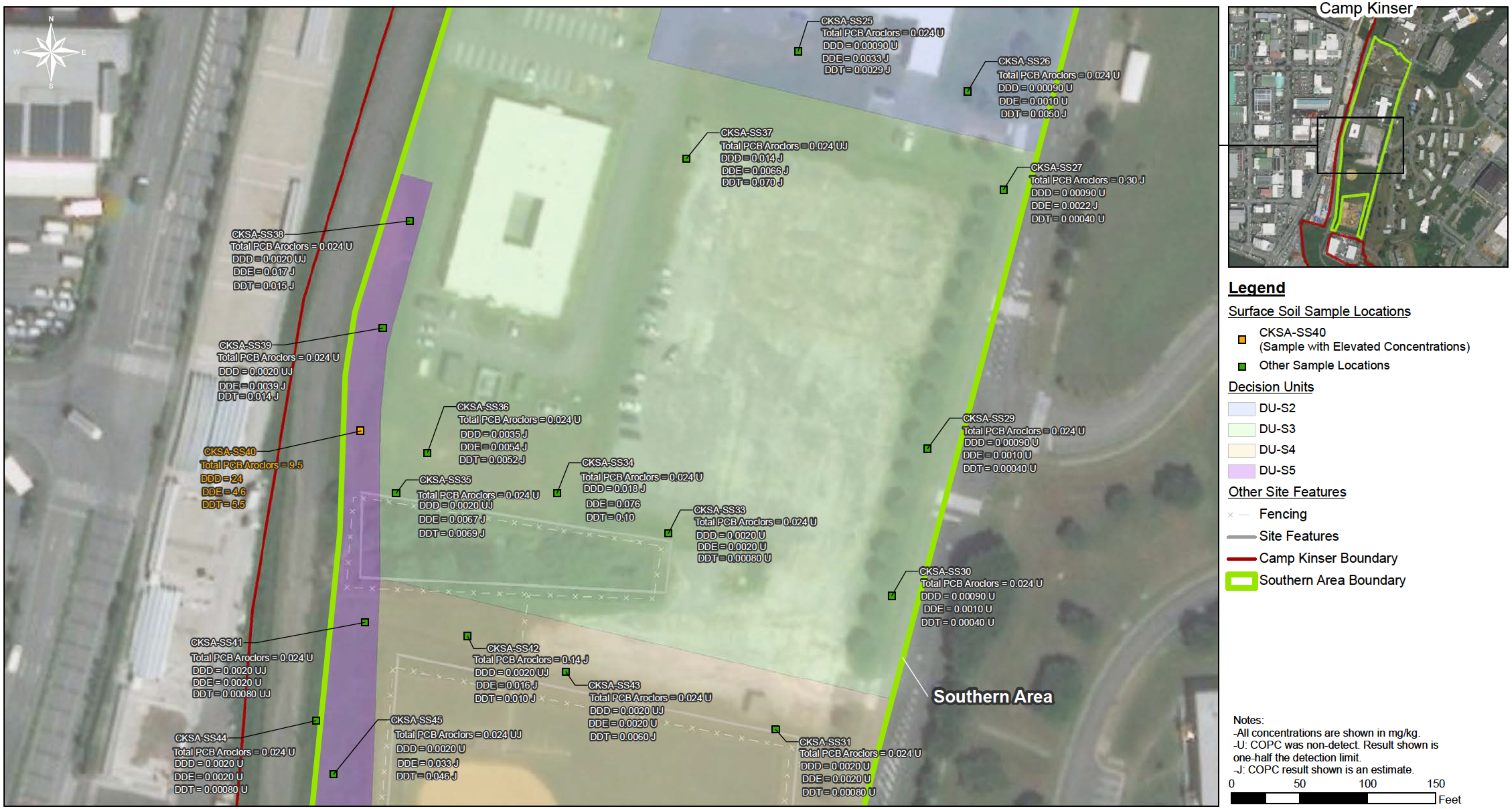
Exposure Medium	Exposure Route	On-Site: ADULT RECREATOR (3- and 6-year)	On-Site: CHILD RECREATOR (3- and 6-year)	On-Site: OCCUPATIONAL WORKER (3-, 6-, 25-year)	On-Site: ADULT PATIENT (3-, 6-, 25-year)	On-Site: CHILD PATIENT (3- and 6-year)	On-Site: LANDSCAPER (25-year)
Surface Soil	Incidental Ingestion	X	X				X
Surface Soil	Dermal Contact	X	X				X
Particulates	Inhalation	X	X				X
Vapors in Ambient Air	Inhalation	X	X				X
Vapors in Indoor Air	Inhalation			X	X	X	
Groundwater	Incidental Ingestion						
Groundwater	Dermal Contact						

Key	
(blank)	Incomplete Pathway
X	Complete Pathway

PIONEER TECHNOLOGIES CORPORATION

Southern Area Conceptual Site Model
Human Health Risk Assessment
Camp Kinser, Okinawa, Japan

Figure 3-2



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CKSA-SS40 Elevated Concentration Evaluation
Human Health Risk Assessment
Camp Kinser, Okinawa Prefecture, Japan

Figure 5-1

Legend

Concentration in Soil (mg/kg)

- Arsenic ≤ 20 (or Not Detected)
- 20 < Arsenic ≤ 25
- 25 < Arsenic ≤ 30
- Arsenic > 30

Other Site Features

- Fencing
- Site Features
- Camp Kinser Boundary
- Northern Area Boundary

Notes:
-All concentrations are shown in mg/kg.
-Arsenic concentrations in surface soil throughout the Site exceed the most conservative RBSC (5.1 mg/kg; Table 5-1). It is likely that the arsenic concentrations are representative of natural background concentrations and are not related to Site contamination (see Section 5 of the HHRA text).

0 125 250 375 Feet

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Arsenic Concentrations in Northern Area Surface Soil
Human Health Risk Assessment
Camp Kinser, Okinawa Prefecture, Japan

Figure 5-2

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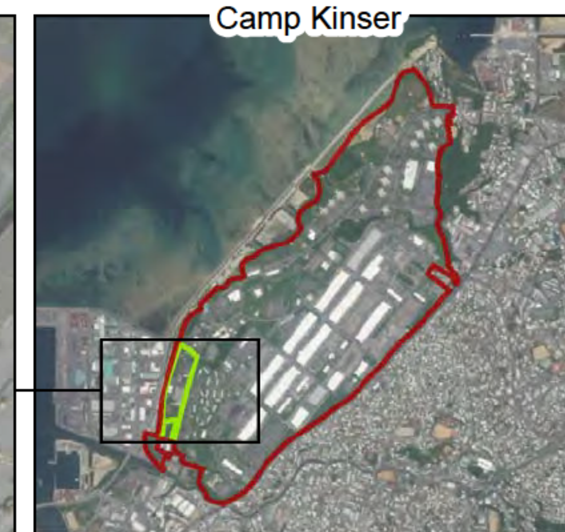


Legend

Concentration in Soil (mg/kg)

- Arsenic ≤ 20 (or Not Detected)
- 20 < Arsenic ≤ 25
- 25 < Arsenic ≤ 30
- Arsenic > 30

Other Site Features

- Fencing
- Site Features
- Camp Kinser Boundary
- Southern Area Boundary

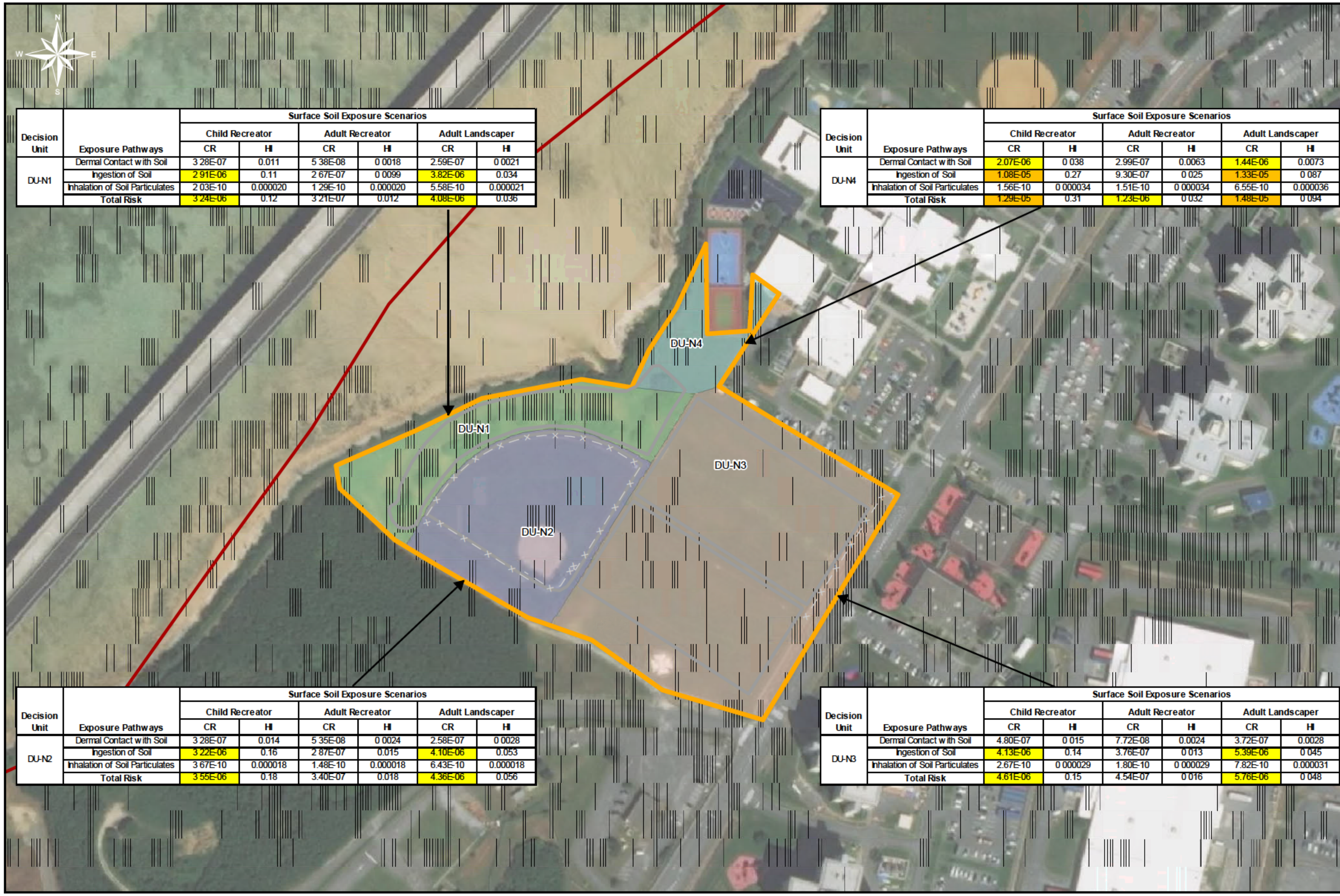
Notes:
-All concentrations are shown in mg/kg.
-Arsenic concentrations in surface soil throughout the Site exceed the most conservative RBSC (5.1 mg/kg; Table 5-1). It is likely that the arsenic concentrations are representative of natural background concentrations and are not related to Site contamination (see Section 5 of the HHRA text).

0 200 400 600 Feet

PIONEER TECHNOLOGIES CORPORATION

Arsenic Concentrations in Southern Area Surface Soil
Human Health Risk Assessment
Camp Kinser, Okinawa Prefecture, Japan

Figure 5-3



Decision Unit	Exposure Pathways	Surface Soil Exposure Scenarios					
		Child Recreator		Adult Recreator		Adult Landscaper	
		CR	HI	CR	HI	CR	HI
DU-N1	Dermal Contact with Soil	3.28E-07	0.011	5.38E-08	0.0018	2.59E-07	0.0021
	Ingestion of Soil	2.91E-06	0.11	2.67E-07	0.0099	3.82E-06	0.034
	Inhalation of Soil Particulates	2.03E-10	0.000020	1.29E-10	0.000020	5.58E-10	0.000021
	Total Risk	3.24E-06	0.12	3.21E-07	0.012	4.08E-06	0.036

Decision Unit	Exposure Pathways	Surface Soil Exposure Scenarios					
		Child Recreator		Adult Recreator		Adult Landscaper	
		CR	HI	CR	HI	CR	HI
DU-N4	Dermal Contact with Soil	2.07E-06	0.038	2.99E-07	0.0063	1.44E-06	0.0073
	Ingestion of Soil	1.08E-05	0.27	9.30E-07	0.025	1.33E-05	0.087
	Inhalation of Soil Particulates	1.56E-10	0.000034	1.51E-10	0.000034	6.55E-10	0.000036
	Total Risk	1.29E-05	0.31	1.23E-06	0.032	1.48E-05	0.094

Decision Unit	Exposure Pathways	Surface Soil Exposure Scenarios					
		Child Recreator		Adult Recreator		Adult Landscaper	
		CR	HI	CR	HI	CR	HI
DU-N2	Dermal Contact with Soil	3.28E-07	0.014	5.35E-08	0.0024	2.58E-07	0.0028
	Ingestion of Soil	3.22E-06	0.16	2.87E-07	0.015	4.10E-06	0.053
	Inhalation of Soil Particulates	3.67E-10	0.000018	1.48E-10	0.000018	6.43E-10	0.000018
	Total Risk	3.55E-06	0.18	3.40E-07	0.018	4.36E-06	0.056

Decision Unit	Exposure Pathways	Surface Soil Exposure Scenarios					
		Child Recreator		Adult Recreator		Adult Landscaper	
		CR	HI	CR	HI	CR	HI
DU-N3	Dermal Contact with Soil	4.80E-07	0.015	7.72E-08	0.0024	3.72E-07	0.0028
	Ingestion of Soil	4.13E-06	0.14	3.76E-07	0.013	5.39E-06	0.045
	Inhalation of Soil Particulates	2.67E-10	0.000029	1.80E-10	0.000029	7.82E-10	0.000031
	Total Risk	4.61E-06	0.15	4.54E-07	0.016	5.76E-06	0.048

Legend

Cancer Risk/Noncancer Hazard
- CR > 1E-05
- CR > 1E-06
- HI > 1

Decision Units
- DU-N1
- DU-N2
- DU-N3
- DU-N4

Other Site Features
- Fencing
- Site Features
- Camp Kinser Boundary
- Northern Area Boundary

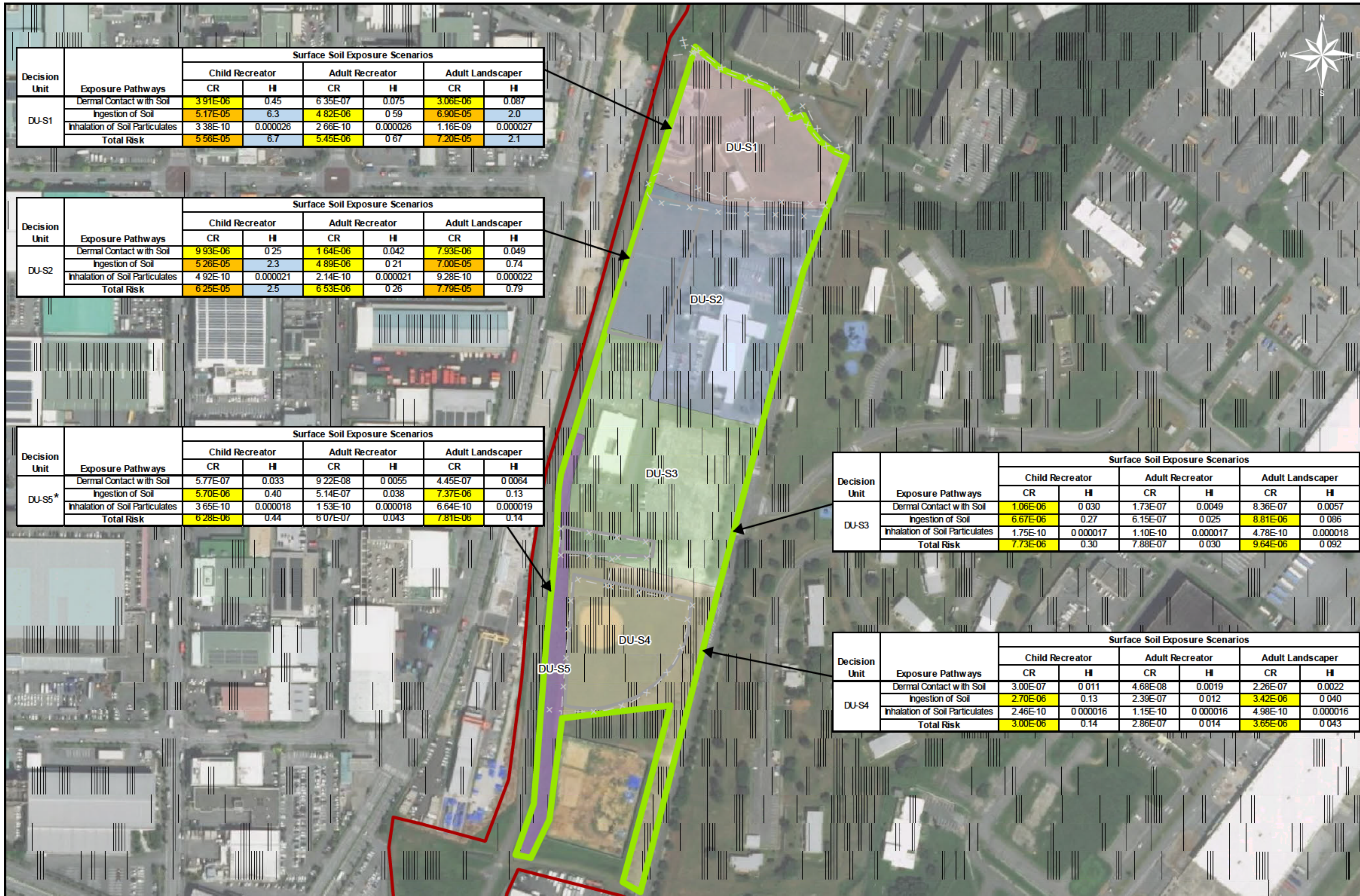
Notes:
-CR: Cancer Risk
-HI: Noncancer Hazard Index
-Total cancer risks and noncancer hazards shown include risk from arsenic.

0 125 250 375 Feet

PIONEER TECHNOLOGIES CORPORATION

Northern Area Total Cancer Risk and Noncancer Hazard by Decision Unit
Human Health Risk Assessment
Camp Kinser, Okinawa Prefecture, Japan

Figure 5-4



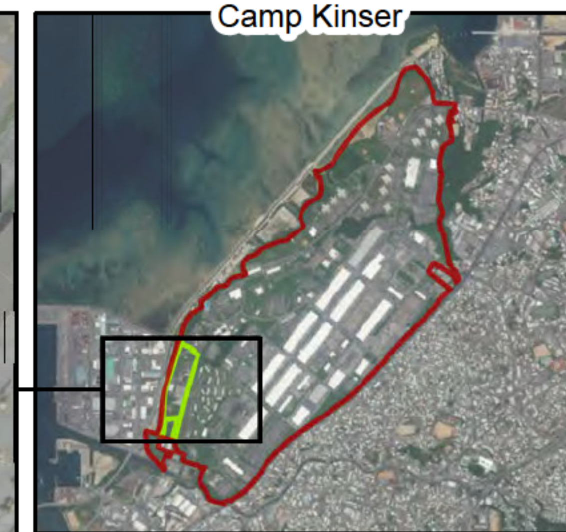
Decision Unit	Exposure Pathways	Surface Soil Exposure Scenarios					
		Child Recreator		Adult Recreator		Adult Landscaper	
		CR	HI	CR	HI	CR	HI
DU-S1	Dermal Contact with Soil	3.91E-06	0.45	6.35E-07	0.075	3.06E-06	0.087
	Ingestion of Soil	5.17E-05	6.3	4.82E-06	0.59	6.90E-05	2.0
	Inhalation of Soil Particulates	3.38E-10	0.000026	2.66E-10	0.000026	1.16E-09	0.000027
	Total Risk	5.56E-05	6.7	5.45E-06	0.67	7.20E-05	2.1

Decision Unit	Exposure Pathways	Surface Soil Exposure Scenarios					
		Child Recreator		Adult Recreator		Adult Landscaper	
		CR	HI	CR	HI	CR	HI
DU-S2	Dermal Contact with Soil	9.93E-06	0.25	1.64E-06	0.042	7.93E-06	0.049
	Ingestion of Soil	5.26E-05	2.3	4.89E-06	0.21	7.00E-05	0.74
	Inhalation of Soil Particulates	4.92E-10	0.000021	2.14E-10	0.000021	9.28E-10	0.000022
	Total Risk	6.25E-05	2.5	6.53E-06	0.26	7.79E-05	0.79

Decision Unit	Exposure Pathways	Surface Soil Exposure Scenarios					
		Child Recreator		Adult Recreator		Adult Landscaper	
		CR	HI	CR	HI	CR	HI
DU-S5*	Dermal Contact with Soil	5.77E-07	0.033	9.22E-08	0.0055	4.45E-07	0.0064
	Ingestion of Soil	5.70E-06	0.40	5.14E-07	0.038	7.37E-06	0.13
	Inhalation of Soil Particulates	3.65E-10	0.000018	1.53E-10	0.000018	6.64E-10	0.000019
	Total Risk	6.28E-06	0.44	6.07E-07	0.043	7.81E-06	0.14

Decision Unit	Exposure Pathways	Surface Soil Exposure Scenarios					
		Child Recreator		Adult Recreator		Adult Landscaper	
		CR	HI	CR	HI	CR	HI
DU-S3	Dermal Contact with Soil	1.06E-06	0.030	1.73E-07	0.0049	8.36E-07	0.0057
	Ingestion of Soil	6.67E-06	0.27	6.15E-07	0.025	8.81E-06	0.086
	Inhalation of Soil Particulates	1.75E-10	0.000017	1.10E-10	0.000017	4.78E-10	0.000018
	Total Risk	7.73E-06	0.30	7.88E-07	0.030	9.64E-06	0.092

Decision Unit	Exposure Pathways	Surface Soil Exposure Scenarios					
		Child Recreator		Adult Recreator		Adult Landscaper	
		CR	HI	CR	HI	CR	HI
DU-S4	Dermal Contact with Soil	3.00E-07	0.011	4.68E-08	0.0019	2.26E-07	0.0022
	Ingestion of Soil	2.70E-06	0.13	2.39E-07	0.012	3.42E-06	0.040
	Inhalation of Soil Particulates	2.46E-10	0.000016	1.15E-10	0.000016	4.98E-10	0.000016
	Total Risk	3.00E-06	0.14	2.86E-07	0.014	3.65E-06	0.043



Legend

Cancer Risk/Noncancer Hazard
- CR > 1E-05
- CR > 1E-06
- HI > 1

Decision Units
- DU-S1
- DU-S2
- DU-S3
- DU-S4
- DU-S5

Other Site Features
- Fencing
- Site Features
- Camp Kinser Boundary
- Southern Area Boundary

Notes:
-CR: Cancer Risk
-HI: Noncancer Hazard Index
-Total cancer risk and noncancer hazards shown include risk from arsenic.
*Sample CKSA-SS40 was identified as a hot spot and was removed from the risk calculations for DU-S5.

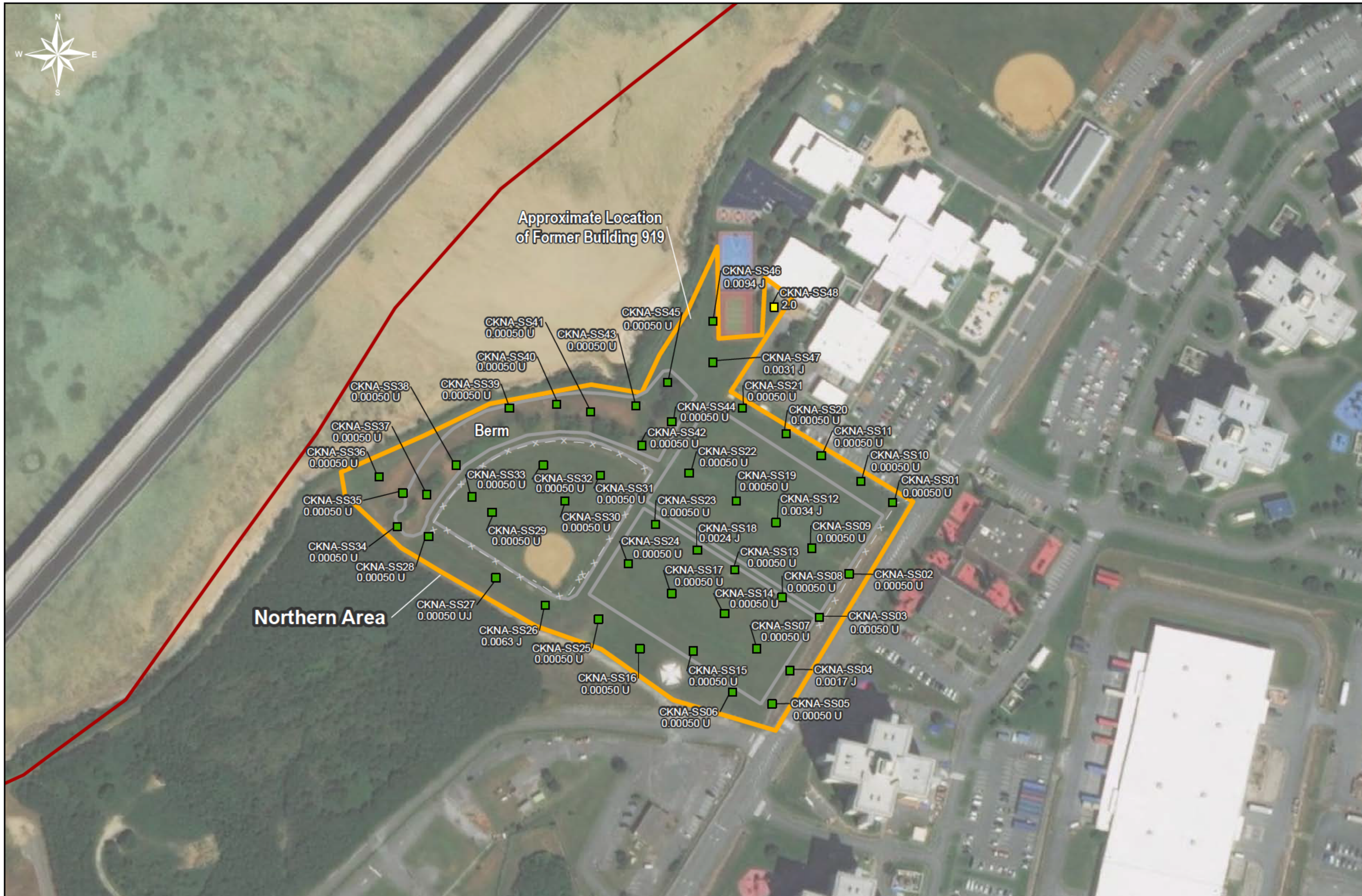
0 200 400 600 Feet

PIONEER TECHNOLOGIES CORPORATION

Southern Area Total Cancer Risk and Noncancer Hazard by Decision Unit
Human Health Risk Assessment
Camp Kinser, Okinawa Prefecture, Japan

Figure 5-5

Document Path: G:\Projects\Kinser Maps HHRA Fig 5-5_SA_RiskHazard_DU.mxd; Author: MK; Date Saved: 7/8/2019



Legend

Concentration in Soil (mg/kg)

- Dieldrin ≤ 0.27 (or Not Detected)
- 0.27 < Dieldrin ≤ 2.7
- 2.7 < Dieldrin ≤ 27
- Dieldrin > 27

Other Site Features

- Fencing
- Site Features
- Camp Kinser Boundary
- Northern Area Boundary

Notes:
-All concentrations are in mg/kg.
-U: COPC was non-detect. Result shown is one-half the detection limit.
-J: COPC result shown is an estimate.
-Most conservative RBSC: 0.27 mg/kg (see Table 5-1).

0 125 250 375 Feet

PIONEER TECHNOLOGIES CORPORATION

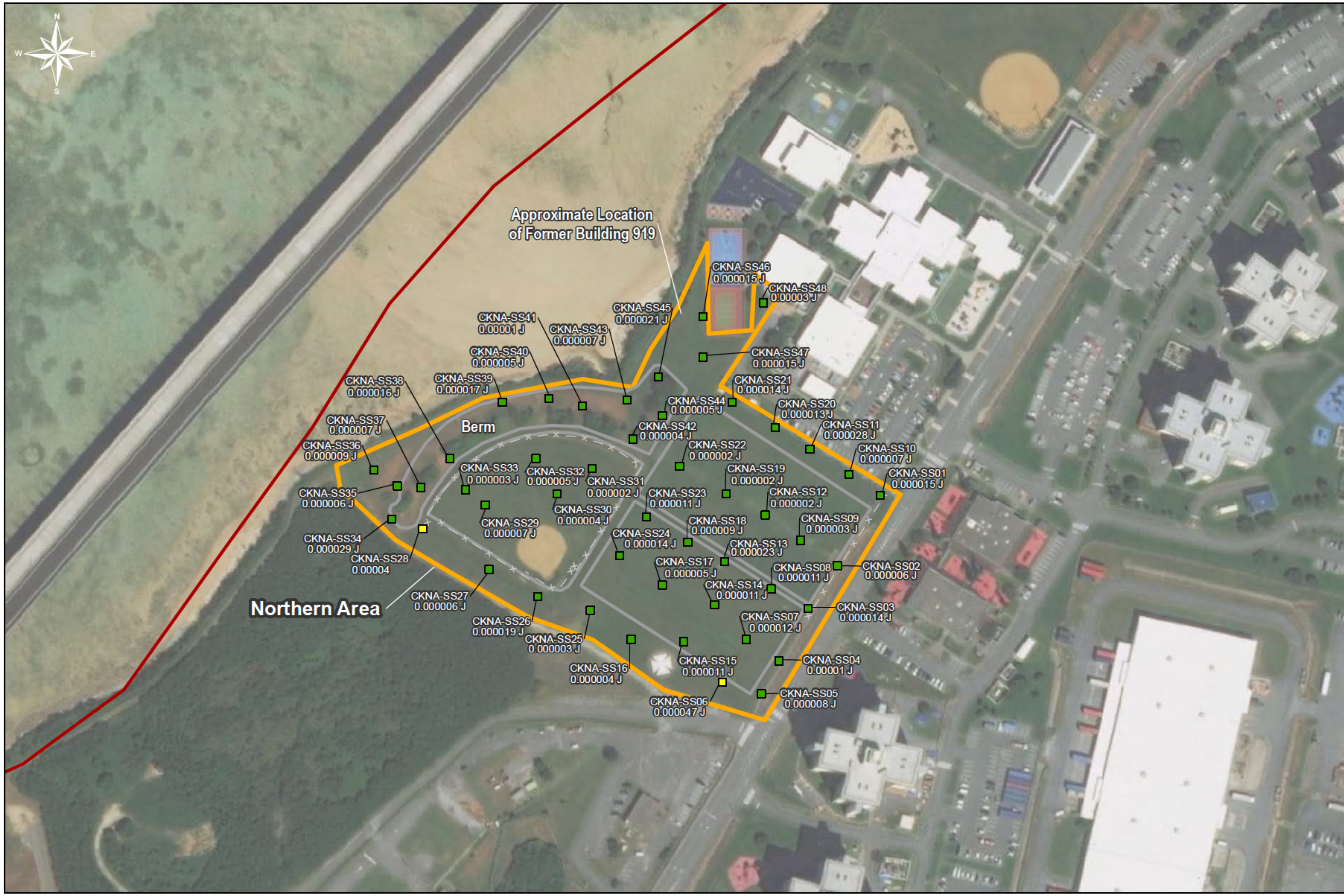
Dieldrin Concentrations in Northern Area Surface Soil
Human Health Risk Assessment
Camp Kinser, Okinawa Prefecture, Japan

Figure 5-6

PIONEER TECHNOLOGIES CORPORATION

Dieldrin Concentrations in Southern Area Surface Soil
Human Health Risk Assessment
Camp Kinser, Okinawa Prefecture, Japan

Figure 5-7



Legend

Concentration in Soil (mg/kg)

- Total 2,3,7,8-TCDD TEQ ≤ 0.000037 (or Not Detected)
- 0.000037 < Total 2,3,7,8-TCDD TEQ ≤ 0.00037
- 0.00037 < Total 2,3,7,8-TCDD TEQ ≤ 0.0037
- Total 2,3,7,8-TCDD TEQ > 0.0037

Other Site Features

- Fencing
- Site Features
- Camp Kinser Boundary
- Northern Area Boundary

Notes:
-All concentrations are in mg/kg.
-J: COPC result shown is an estimate.
-Most conservative RBSC: 0.000037 mg/kg (see Table 5-1).

0 125 250 375 Feet

PIONEER TECHNOLOGIES CORPORATION

Total 2,3,7,8-TCDD TEQ Concentrations in Northern Area Surface Soil
Human Health Risk Assessment
Camp Kinser, Okinawa Prefecture, Japan

Figure 5-8

Document Path: G:\Projects\Kinser\Maps\HHRA\Fig 5-9_SA_Total_Dioxins.mxd; Author: MK; Date Saved: 7/2/2019

PIONEER TECHNOLOGIES CORPORATION

Total 2,3,7,8-TCDD TEQ Concentrations in Southern Area Surface Soil
Human Health Risk Assessment
Camp Kinser, Okinawa Prefecture, Japan

Figure 5-9

Tables

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Table 1-1: Historical Reports

Document Title	Summary	Reference
Initial Interim Report	A summary of the following operations which were performed following the 1974 fish-kill incident were presented in this report. ▪ Identifying unknown chemicals; ▪ Neutralizing acids and a kalis; ▪ Burying ferric chloride; and ▪ Storing the remaining chemicals. Results of December 1974 soil, seawater, and dead fish sampling in and along the waterfront area of the MSA Lumber Yard (the Southern Area) indicated pesticide contamination of the following in decreasing volume of release: malathion, chlordane, diazinon, dichlorodiphenyltrichloroethane (DDT), and dieldrin. Malathion concentrations in fish were 300 to 500 ppb and diazinon concentrations were 2 to 8 ppb. Malathion concentrations were detected in soil; the highest concentration was 7,566 ppm. The delineation of the horizontal and vertical extent of pesticide contamination of the tideland area west of Camp Kinser was also presented in this report. Soil and seawater samples were collected from randomly selected points. Malathion values ranged from no detection to 1.1 ppb for seawater samples and from no detection to 118 ppb for soil samples, suggesting contamination should be contained within the natural drainage paths. Additional sampling conducted in February 1975 indicated that traces of pesticides were still being washed into the tidal basin.	DOA 1976
Report of Environmental Sample Analyses	Soil sample results for dioxins (specifically 2,3,7,8-tetrachlorodibenzo-p-dioxin) were presented in this report. All samples were reported as not detected. No additional information was provided in this report.	DoN 1985
Risk Assessment for MSA Chemical Storage Site Consultative Letter	The investigation and initial risk assessment completed as a result of the contamination near the medical and dental clinics in the Southern Area were presented in this report. Samples were collected from the top 1 to 3 inches of the soil surface near the drainage areas, fence line, and clinic fields in June 1994. Arsenic, lead, cadmium, selenium, chromium, chlordane, DDT, dieldrin, endrin, and heptachlor were detected in one or more soil samples. Results were used to calculate chronic noncancer and cancer risks from exposure. Cancer risks exceeded EPA action levels for all exposure scenarios.	DAF 1994a
Executive Summary of Risk Assessment for the MSA Chemical Storage Site Consultative Letter	The second risk assessment for the Southern Area was presented in this report. Chlorinated pesticides were found in soil samples collected from an open field adjacent to the clinic, the fence line, and a ditch located on the Site. Both cancer risks and long-term noncancer hazards exceeded EPA action levels. However, no evidence of contamination was found inside the medical and dental clinics. Further sampling was recommended to determine the extent of the contamination.	DAF 1994b

Table 1-1: Historical Reports

Document Title	Summary	Reference
Risk Assessment of North Baseball Field and Surrounding Areas Consultative Letter	The investigation and risk assessment based on soil contamination at the baseball and soccer fields in the Northern Area were presented in this report. The objective of the investigation and risk assessment was to determine if the area was contaminated with chlorinated pesticides and other chemicals associated with soil transported from the Southern Area, and to assess the risk to personnel from any contamination found. Samples were collected from the berm (to a depth of 5-feet) and the baseball and soccer fields (to a depth of 2.4 inches). Chlorinated pesticides and associated breakdown products were detected in some areas; however, none of the areas sampled contained high levels of chlorinated pesticides associated with soil removed from the Southern Area. Results were used to calculate chronic noncancer hazards and cancer risks from exposure. Cancer risk exceeded EPA action levels in all exposure scenarios for the soccer field and berm. The risk of chronic noncancer hazards from the Site did not exceed EPA action levels. The results of the risk assessment, which were based on highly conservative values and assumptions, indicated that some degree of long-term risk of cancer exists from exposure to the site. Further sampling was recommended to determine the extent of contamination on and around the soccer fields, as only a portion of the area was sampled.	DAF 1994c
Executive Summary of Soil Sampling and Risk Assessment Consultative Letter	Soil samples were collected from the Northern Area in July 1994 and the results were presented in this report. Pesticides were not detected in the soil samples collected from the baseball field. Pesticides were detected in the soil berm and soccer fields; however, the concentrations did not indicate that the soccer field or berm were composed solely of the heavily contaminated soil transferred from the Southern Area. The letter concluded that the contaminated soil (1) may have been removed from Camp Kinser, (2) may have been previously used as fill for construction projects on the Site, or (3) may still be present in the Northern Area, but was not discovered during sampling.	DAF 1994d
Report of Initial Findings at Former Army Storage Site	The results of additional soil sampling conducted in October 1994 were summarized in this report. The soil sampling was conducted to test for chlorinated pesticides, PCBs, and metals throughout the Southern Area. The Southern Area was divided into seven targeted areas, referred to as “Strata A” through “Strata G.” Pesticides (specifically chlordane, dieldrin, total DDT, heptachlor, endrin, and/or endosulfan) were detected in each of the seven areas, with the exception of the baseball field (Strata D). Metals were also detected in each area; however, at the time of the report (1994), background concentrations for metals were unknown. PCBs were detected in only Strata A, B, E, and G. A baseline risk assessment was conducted to determine the impact that the contaminated soil may have on human health and the environment. For Strata A through F, 95% UCLs were developed for the contaminants detected in soil. An insufficient number of samples were collected from Strata G (the northernmost portion of the Southern Area) to develop 95% UCLs; therefore, a comparison to EPA action levels was not completed. Contaminant concentrations in Strata C, D, and F were below EPA action levels for all exposure scenarios. Chlordane and dieldrin 95% UCLs in Strata A and B exceeded EPA action levels for children exposure scenarios. Chlordane, dieldrin, and total DDT 95% UCLs in Strata E exceeded EPA action levels for children exposure scenarios. Chlordane and dieldrin 95% UCLs in Strata E near the fence line exceeded EPA action levels for adult exposure scenarios. Recommendations were made for further sampling to refine the extent of contamination in the Southern Area.	DAF 1994e

Notes:

DoA. 1976. Interim Report, Special Study No. 90-011-75, Chemical Storage Area Clean-up, Makiminato Service Area, Okinawa, APO San Francisco 96248, 19 December 1974 - 31 July 1975. United States Army. Environmental Health Engineering Agency. Pacific. January 9.

DoN. 1985. Report of Environmental Sample Analyses. Memorandum from Commanding Officer, Naval Energy and Environmental Support Activity, to Commanding General, Marine Corps Base, Camp S. D. Butler, Okinawa, Japan. June 3.

DAF. 1994a. Consultative Letter, AL/OE-CL-1994-0103, Risk Assessment for Old Makiminato Service Area (MSA) Chemical Storage Site, Camp Kinser, Okinawa, Japan. Memorandum for Commanding General, Camp S. D. Butler, Facilities Engineer, Public Works Department. August 18.

DAF. 1994b. Consultative Letter, AL/OE-CL-1994-0104, Executive Summary of Risk Assessment for Old Makiminato Service Area (MSA) Chemical Storage Site, Camp Kinser, Okinawa, Japan. Memorandum for Commanding General, Camp S. D. Butler, Facilities Engineer, Public Works Department. August 24.

DAF. 1994c. Consultative Letter, AL/OE-CL-1994-0177, Risk Assessment of North Baseball Field and Surrounding Areas, Camp Kinser. Memorandum for Commanding General, Camp S. D. Butler, Facilities Engineer, Public Works Department. November 16.

DAF. 1994d. Consultative Letter, AL/OE-CL-1994-0178, Executive Summary of Soil Sampling and Risk Assessment, North Camp Kinser, Okinawa, Japan. Memorandum for Commanding General, Camp S. D. Butler, Facilities Engineer, Public Works Department. November 21.

DAF. 1994e. Report of Initial Findings at Former Army Storage Site, Camp Kinser. December 8.

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Table 2-1: Summary of Sampling Methodology

Media	Analytical Group	Analytical Method	Total Number of Samples Collected	Number of Samples Collected in Northern Area	Number of Samples Collected in Southern Area
Surface Soil	TPH-DRO	USEPA Me hod 8015	107	48	59
	SVOCs	USEPA Method 8270D			
	PAHs	USEPA Method 8270D SIM			
	Organochlorine Pesticides	USEPA Method 8081B			
	Organophosphorus Pesticides	USEPA Method 8141B			
	Chlorinated Herbicides	USEPA Method 8151A			
	Total Cyanide	USEPA Method 9010C			
	Dioxins/Furans	USEPA Method 8290A			
	Solvent-Extractable Non-VOCs	USEPA Method 8321B			
	Hexavalent Chromium	USEPA Method 7199			
	Mercury	USEPA Method 7471B			
	Other Metals	USEPA Method 6020C			
	PCB Aroclors	USEPA Method 8082A			
	PCB Congeners (1)	USEPA Method 1668B			
Groundwater	VOCs	USEPA Method 8260C	6	3	3
	Carbonyls	USEPA Method 8315A			
	TPH-GRO	USEPA Method 8015C			
Sub-Slab Soil Gas	VOCs	USEPA Method TO-15	37	23	14
	TPH-GRO	USEPA Method TO-03 (MOD)			
	Aldehydes and Carbonyls	USEPA Method TO-11A			
Ambient Air	VOCs	USEPA Method TO-15	2	1	1
	TPH-GRO	USEPA Method TO-03 (MOD)			
	Aldehydes and Carbonyls	USEPA Method TO-11A			

Notes

(1) The full suite of 209 PCB congeners were only analyzed in 11 surface soil samples (5 in the Northern Area and 6 in the Southern Area). A sub-set of PCB congeners (dioxin-like) were analyzed in all 107 surface soil samples.
VOCs were not analyzed in surface soil due to the age of the release. VOCs in surface soil would likely have volatilized in the time since the release.
Sample count and analytical methods are based on those presented in the Final Site Investigation Work Plan (NAVFAC 2018).

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Table 2-2: Northern Area Sub-Slab Soil Gas Sample Summary

Building	Sample No.	Room	Typical Occupancy: # of Adults in Room Full-time (Teachers)	Typical Occupancy: Percentage of Time in Room (Students)	Rationale	SSDS
Preschool (Building 1039)	CK1039-01	K-1: Preschool classroom	1	100%	Teacher and student occupy the room the majority of the time.	Yes
	CK1039-02	K-2: Preschool classroom	1	100%		
	CK1039-03	K-3: Preschool classroom (spare)	1	100%		
Main School (Building 1040)	CK1040-01	102: Main office	3	<5%	Teacher occupies the room the majority of the time.	No
	CK1040-01	139:Nurse's office	1	<5%		
	CK1040-02	118:School information center	1	<10%		
	CK1040-03	143: First grade classroom	1	100%	Teacher and student occupy the room the majority of the time.	
	CK1040-04	122: Classroom	1	100%		
	CK1040-05	132: Counselor's office	1	<5	Teacher occupies the room the majority of the time.	
Kindergarten (Building 1040R)	CK1040R-01	702: Classroom	1	100%	Teacher and student occupy the room the majority of the time.	Yes
	CK1040R-02	703: Classroom				
	CK1040R-03	704: Classroom				
Cafeteria and Music Room (Building 1041)	CK1041-01	Music Room	--	<5%	Spatial coverage within building.	No
	CK1041-02	Kitchen	--	<5%		
	CK1041-03	Kitchen office	--	<5%	Room is occupied the majority of the time by various personnel throughout the day.	
	CK1041-04	Cafeteria	--	<5%	Spatial coverage within building.	
Maintenance (Building 1041A)	CK1041A-01	302: Office	1-2	--	Teacher occupies the room the majority of the time.	Yes
Art (Building 1042)	CK1042-01	303: Storage	1	<5%	Spatial coverage within building.	Yes
	CK1042-02	304: Classroom (vacant)	--	--	No SSDS in vacant classroom.	
	CK1042-03	306: English as second language	1	<5	Spatial coverage within building.	
Gymnasium (Building 1043)	CK1043-01	Gym (beneath stage; elevated 7 feet above grade)	--	<5%	Representative of building (available sample location.	Yes
	CK1043-02	Office	1	<5%	Rooms are occupied the majority of the time.	
	CK1043-03	Girls' bathroom	--	<5%	Representative of building (available sample location.	

Notes:

--: Receptor not currently occupying this room

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Table 2-3: Southern Area Sub-Slab Soil Gas Sample Summary

Building	Sample No.	Room	Typical Occupancy: Number of Workers	Typical Occupancy: Frequency (Days/Week)	Typical Occupancy: Duration (Hours/Day)	Rationale	SSDS
Medical Clinic (Building1460)	CK1460-01	45: X-ray room	2	5	8	Frequency and duration	No
	CK1460-02	40: Laboratory	2-3	5	8	Frequency and duration	
	CK1460-03	2: Waiting hall	3	5	8	Frequency and duration; patient use	
	CK1460-04	23/26: Office	3	5	5.5	Frequency and duration	
	CK1460-05	63/64: Office	4	5	5	Frequency and duration	
	CK1460-06	69: Office	2	5	5.5	Frequency and duration	
	CK1460-07	37: Pharmacy	2	5	8	Frequency and duration	
Dental Clinic (Building 1463)	CK1463-01	Outside 8: Within corridor hatch	--	--	--	Representative of subsurface conditions	No
	CK1463-02	Outside 34: Within corridor hatch	--	--	--		
	CK1463-03	Outside 7: Within corridor hatch	--	--	--		
	CK1463-04	12: Lounge	Various	5	1	Frequency and location	
	CK1463-05	Outside 21: Within corridor hatch	--	--	--	Representative of subsurface conditions	
	CK1463-06	2: Waiting area	--	--	--	Frequency and duration; patient use	
	CK1463-07	3: Admin/records	2-6	5	8	Frequency and duration	

Notes:

--: Receptor not currently occupying this room

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Table 2-4: Statistical Summary for Surface Soil Sample COPCs

CAS Number	Data Group	COPC	Number of Samples	Number of Detected Samples	% of Detected Samples	Minimum Nondetected Concentration (mg/kg)	Maximum Nondetected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	USEPA Carcinogenic Residential RSL (mg/kg)	USEPA Non-Carcinogenic Residential RSL (mg/kg)
789-02-6	Pesticide	2,4-DDT	107	6	5.6	0.0030	0.010	0.0041	0.011	--	--
53-96-3	SVOC	2-Acetylaminofluorene	107	0	0.0	0.12	2.0	--	--	0.14	--
56-49-5	SVOC	3-Methylcholanthrene	107	0	0.0	0.12	2.0	--	--	0.0055	--
57-97-6	PAH	7,12-Dimethylbenz(a)anthracene	107	0	0.0	0.12	2.0	--	--	0.00046	--
208-96-8	PAH	Acenaphthylene	107	10	9.3	0.0017	0.030	0.0049	0.056	--	--
5103-71-9	Pesticide	alpha-Chlordane	107	25	23	0.0010	0.0020	0.0016	2.3	1.7	35
7440-38-2	Inorganic	Arsenic, Inorganic	107	107	100	--	--	3.2	35	0.68	35
191-24-2	PAH	Benzo(g,h,i)perylene	107	81	76	0.0018	0.026	0.0037	0.54	--	--
50-32-8	PAH	Benzo[a]pyrene	107	85	79	0.0018	0.026	0.0043	0.97	0.11	18
205-99-2	PAH	Benzo[b]fluoranthene	107	85	79	0.0018	0.026	0.0046	1.2	1.1	--
86-74-8	SVOC	Carbazole	107	12	11	0.0017	0.030	0.0044	0.13	--	--
12789-03-6	Pesticide	Chlordane, Technical	107	17	16	0.015	0.050	0.015	17	1.7	35
18540-29-9	Inorganic	Chromium(VI)	107	26	24	0.20	0.20	0.20	2.0	0.3	230
72-54-8	Pesticide	DDD	107	10	9.3	0.0018	0.0040	0.0034	24	2.3	1.9
72-55-9	Pesticide	DDE	107	54	50	0.0020	0.0040	0.0022	4.6	2	23
50-29-3	Pesticide	DDT	107	63	59	0.00080	0.0016	0.0015	5.5	1.9	37
53-70-3	PAH	Dibenz[a,h]anthracene	107	27	25	0.0017	0.030	0.0036	0.14	0.11	--
60-57-1	Pesticide	Dieldrin	107	32	30	0.0010	0.0020	0.0017	15	0.034	3.2
5566-34-7	Pesticide	gamma-Chlordane	107	20	19	0.0010	0.0020	0.0025	2.3	1.7	35
55-18-5	SVOC	N-Nitrosodiethylamine	107	0	0.0	0.12	2.0	--	--	0.00081	--
62-75-9	SVOC	N-Nitrosodimethylamine	107	0	0.0	0.12	2.0	--	--	0.002	0.53
924-16-3	SVOC	N-Nitroso-di-N-butylamine	107	0	0.0	0.12	2.0	--	--	0.099	--
621-64-7	SVOC	N-Nitroso-di-N-propylamine	107	0	0.0	0.12	2.0	--	--	0.078	--
10595-95-6	SVOC	N-Nitrosomethylethylamine	107	0	0.0	0.12	2.0	--	--	0.02	--
59-89-2	SVOC	N-Nitrosomorpholine	107	0	0.0	0.12	2.0	--	--	0.081	--
100-75-4	SVOC	N-Nitrosopiperidine	107	0	0.0	0.12	2.0	--	--	0.058	--
60-11-7	SVOC	p-Dimethylamino azobenzene	107	0	0.0	0.12	2.0	--	--	0.12	--
85-01-8	PAH	Phenanthrene	107	46	43	0.0017	0.030	0.0071	1.2	--	--
7440-29-1	Inorganic	Thorium-232	107	107	100	--	--	0.52	8.2	--	--
7440-32-6	Inorganic	Titanium	107	107	100	--	--	46	438	--	--
CPAH-TEQ	PAH	Total Carcinogenic PAHs (BaP TEQs)	107	87	81	0.0043	0.063	0.0039	1.4	0.11	18
DIOXIN-TEQ	Dioxin	Total Dioxins/Furans (2,3,7,8-TCDD TEQs) as Dioxins**	107	107	100	--	--	0.0000010	0.0025	0.0000048	0.000051
DIOXIN-TEQ	PCB	Total Dioxins/Furans (2,3,7,8-TCDD TEQs) as PCBs**	107	22	21	0.0000018	0.00018	0.00000018	0.000039	0.0000048	0.000051
PTC_000024	PCB	Total PCBs (Aroclor Method)	107	14	13	0.048	0.048	0.052	9.5	0.23	--

Notes:

--: No screening level available or constituent was not detected.

**: Total dioxin/furans (2,3,7,8-TCDD TEQs) as dioxins and total dioxin/furans (2,3,7,8-TCDD TEQs) as PCBs were combined in order to evaluate total dioxin/furans (2,3,7,8-TCDD TEQs) risks in the HHRA.

Maximum detected concentration exceeds RSL

Maximum non-detected concentration exceeds 10x RSL

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Table 2-5: Statistical Summary for Groundwater Sample COPCs

CAS Number	Data Group	Constituent	Number of Samples	Number of Detected Samples	% of Detected Samples	Minimum Nondetected Concentration (ug/L)	Maximum Nondetected Concentration (ug/L)	Minimum Detected Concentration (ug/L)	Maximum Detected Concentration (ug/L)	USEPA Carcinogenic Residential GW-to-IA VISL (ug/L)	USEPA Non-Carcinogenic Residential GW-to-IA VISL (ug/L)
96-12-8	SVOC	1,2-Dibromo-3-chloropropane	6	0	0.0	0.50	0.50	--	--	0.028	35
126-99-8	SVOC	2-Chloro-1,3-butadiene	6	0	0.0	1.0	1.0	--	--	0.0041	9.2
1476-11-5	SVOC	cis-1,4-Dichloro-2-butene	6	0	0.0	1.0	1.0	--	--	0.025	--
124-48-1	VOC	Dibromochloromethane	6	1	17	0.10	0.10	0.15	0.15	--	--
75-65-0	VOC	Tert-Butyl Alcohol	6	1	17	2.5	2.5	7.9	7.9	--	--
110-57-6	SVOC	trans-1,4-Dichloro-2-butene	6	0	0.0	1.0	1.0	--	--	0.025	--

Notes:

--: No screening level available or no detections were reported.

Maximum nondetected concentration exceeds 10x VISL.

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Table 2-6: Statistical Summary for Sub-Slab Soil Gas Sample COPCs

CAS Number	Data Group	Constituent	Number of Samples	Number of Detected Samples	% of Detected Samples	Minimum Nondetected Concentration (ug/m^3)	Maximum Nondetected Concentration (ug/m^3)	Minimum Detected Concentration (ug/m^3)	Maximum Detected Concentration (ug/m^3)	USEPA Carcinogenic Residential Sub-Slab SG-to-IA VISL (ug/m^3)	USEPA Non-Carcinogenic Residential Sub-Slab SG-to-IA VISL (ug/m^3)
156-59-2	VOC	1,2-cis-Dichloroethylene	37	6	16	0.011	0.31	0.016	1.8	--	--
156-60-5	VOC	1,2-trans-Dichloroethylene	37	2	5.4	0.0090	0.25	0.013	0.027	--	--
541-73-1	SVOC	1,3-Dichlorobenzene	38	38	100	--	--	0.20	550	--	--
142-28-9	SVOC	1,3-Dichloropropane	37	0	0.0	0.32	18	--	--	--	--
540-84-1	SVOC	2,2,4-Trimethylpentane	37	8	22	0.098	5.4	0.39	0.87	--	--
622-96-8	VOC	4-Ethyltoluene	37	16	43	0.10	1.3	0.23	45	--	--
75-07-0	SVOC	Acetaldehyde	37	15	41	0.096	0.096	4.8	150	43	313
107-02-8	SVOC	Acrolein	37	31	84	0.064	1.3	0.44	5.7	--	0.70
123-72-8	Aldehyde	Butraldehyde	37	4	11	0.22	0.22	0.41	0.82	--	--
56-23-5	VOC	Carbon Tetrachloride	37	24	65	0.020	0.41	0.34	18	16	3,333
4170-30-3	PCB	Crotonaldehyde, Total	37	3	8.1	0.12	0.12	0.36	1.1	--	--
124-18-5	Aldehyde	Decane	37	32	86	0.60	1.1	0.34	69	--	--
124-48-1	VOC	Dibromochloromethane	37	12	32	0.013	0.30	0.014	0.13	--	--
112-40-3	Aldehyde	Dodecane	37	33	89	1.4	10.0	0.72	12	--	--
64-17-5	VOC	Ethanol	37	34	92	0.61	0.62	12	360	--	--
100-41-4	VOC	Ethylbenzene	37	37	100	--	--	0.071	340	37	33,333
PTC_000204	Petroleum Compound	Gasoline Range Organics (C3-C12)**	37	10	27	1,100	1,900	2,800	8,800	--	1,033
66-25-1	Aldehyde	Hexanal	37	7	19	0.31	0.31	0.35	0.50	--	--
67-63-0	SVOC	Isopropanol	37	36	97	0.37	0.37	31	28,000	--	7,000
91-20-3	PAH	Naphthalene	37	31	84	0.031	0.54	0.039	4.2	2.8	103
104-51-8	SVOC	n-Butylbenzene	37	8	22	0.095	5.2	0.13	0.38	--	--
95-49-8	SVOC	o-Chlorotoluene	37	0	0.0	0.32	18	--	--	--	--
111-65-9	SVOC	Octane	37	20	54	0.20	8.1	0.20	0.62	--	--
99-87-6	VOC	p-Isopropyltoluene	37	19	51	0.10	5.5	0.13	12	--	--
135-98-8	SVOC	sec-Butylbenzene	37	2	5.4	0.090	4.9	0.18	0.32	--	--
75-65-0	VOC	Tert-Butyl Alcohol	37	20	54	0.26	2.5	0.30	36	--	--
10061-02-6	SVOC	trans-1,3-Dichloropropene	37	3	8.1	0.0068	0.19	0.027	0.34	--	--
75-69-4	SVOC	Trichlorofluoromethane	37	37	100	--	--	0.91	48	--	--
1120-21-4	Aldehyde	Undecane	37	20	54	0.21	9.5	0.18	31	--	--

Notes:

--: No screening level available or no detections/non-detections were reported.

**: Gasoline Range Organics (C3-C12) were compared to VISLs derived from USEPA RSLs for Total Petroleum Hydrocarbons (Aroma ic Low).

Maximum detected concentration exceeds VISL

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Table 3-1: Incidental Soil Ingestion Exposure Parameters – Northern Area

$$Incidental\ Soil\ Ingestion\ Dose\left(\frac{mg}{kg-day}\right):\frac{C_s \times EF \times ED \times IRS\ X\ RBA \times 10^{-6}\frac{kg}{mg}}{AT \times BW}$$

Parameter	Definition	Units	On-Site Exposure Scenarios				
			Adult Recreator		Child Recreator		Landscaper
			3 Years	6 Years	3 Years	6 Years	25 Years
C_s	Constituent concentration in soil	mg/kg	Constituent-specific				
BW	Body Weight	kg	80		15		80
ED	Exposure Duration	years	3	6	3	6	25
EF	Exposure Frequency	days/year	48				50
IRS	Soil Ingestion Rate	mg/day	100	100	200	200	330
AT_{nc}	Averaging time - noncarcinogenic	days	1,095	2,190	1,095	2,190	9,125
AT_c	Averaging time - carcinogenic	days	25,550				
RBA	Relative Bioavailability Factor	unitless	Constituent-specific or default value of 1				

Notes:

Exposure parameters were obtained from the USEPA RSL table (USEPA 2019) unless noted below. Values adjusted from default to site-specific exposures are documented below.

The ED was based on a typical tour length for military personnel or average 25-year career length for a civilian contract worker or landscaper (USEPA 1989).

The recreator EF was based on an estimated two weekends per month.

The landscaper EF was based on an estimated one day per week with two weeks vacation.

The AT_c value was based on a 70-year lifetime expectancy (USEPA 1989).

The AT_{nc} value was based on the ED (number of years at Camp Kinser; USEPA 1989).

The landscaper IRS value was based on USEPA's construction worker receptor scenario (USEPA 2002).

The adult and child recreator IRS value was based on USEPA's residential receptor scenario, which is considered overly conservative.

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Table 3-2: Dermal Contact with Soil Exposure Parameters – Northern Area

$$Dermal\ Contact\ with\ Soil\ Dose\left(\frac{mg}{kg-day}\right):\frac{C_s \times EF \times ED \times SA \times AF \times ABS_d \times 10^{-6}\frac{kg}{mg}}{AT \times BW}$$

Parameter	Definition	Units	On-Site Exposure Scenario				
			Adult Recreator		Child Recreator		Landscaper
			3 Years	6 Years	3 Years	6 Years	25 Years
C_s	Constituent concentration in soil	mg/kg	Constituent-specific				
BW	Body Weight	kg	80		15		80
AF	Soil to Skin Adherence factor	mg/cm^2	0.07		0.2		0.12
ED	Exposure Duration	years	3	6	3	6	25
EF	Exposure Frequency	days/year	48				50
ABS_d	Fraction absorbed dermally from soil	unitless	Constituent-specific				
AT_{nc}	Averaging time - noncarcinogenic	days	1,095	2,190	1,095	2,190	9,125
AT_c	Averaging time - carcinogenic	days	25,550				
SA	Skin Surface Area	cm^2	6,032		2,373		3,910

Notes:

Exposure parameters were obtained from the USEPA RSL table (USEPA 2019) unless noted below. Values adjusted from default to site-specific exposures are documented below.

The ED was based on a typical tour length for military personnel or average 25-year career length for a civilian contract worker or landscaper (USEPA 1989).

The recreator EF was based on an estimated two weekends per month.

The landscaper EF was based on an estimated one day per week with two weeks vacation.

The AT_c value was based on a 70-year lifetime expectancy (USEPA 1989).

The AT_{nc} value was based on the ED (number of years at Camp Kinser; USEPA 1989).

The landscaper SA was based on the skin surface area of the head, forearms, and hands (USEPA 2011, Table 7-12).

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Table 3-3: Inhalation of Particulates and Vapors in Ambient Air Exposure Parameters – Northern Area

$$Inhalation\ Exposure\ Concentration\ for\ Air\left(\frac{ug}{m^3}\right): \frac{C_s \times (\frac{1}{PEF} + \frac{1}{VF}) \times EF \times ED \times ET}{AT \times 24\ \frac{hours}{day}}$$

Exposure Parameter	Definition	Units	On-Site Exposure Scenario				
			Adult Recreator		Child Recreator		Landscaper
			3 Year	6 Year	3 Year	6 Year	25 Year
C_s	Constituent concentration in soil	mg/kg	Constituent-specific				
ED	Exposure duration	year	3	6	3	6	25
EF	Exposure frequency	days/year	48				50
ET	Exposure time	hours/day	4		4		4
AT_{nc}	Averaging time – Noncarcinogenic	days	1,095	2,190	1,095	2,190	9,125
AT_c	Averaging time – Carcinogenic (lifetime)	days	25,550				
VF	Volatilization factor	m^3/kg	Constituent-specific				
PEF	Particulate emission factor	m^3/kg	1.4E+09				

Notes:

Exposure parameters were obtained from the USEPA RSL table (USEPA 2019) unless noted below. Values adjusted from default to site-specific exposures are documented below.

The ED was based on a typical tour length for military personnel or average 25-year career length for a civilian contract worker or landscaper (USEPA 1989).

The adult recreator ET and EF were based on a 224-minute average outdoor recreation exposure time per day (USEPA 2011) and an estimated two weekends per mon h, respectively.

The child recreator ET and EF were were modeled as equal to the adult recreator ET and EF.

The landscaper EF was based on an estimated one day per week with two weeks vacation.

The AT_c value was based on a 70-year lifetime expectancy (USEPA 1989).

The AT_{nc} value was based on the ED (number of years at Camp Kinser; USEPA 1989).

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Table 3-4: Inhalation of Vapors in Indoor Air (from VI Only) Exposure Parameters – Northern Area

$$Inhalation\ Exposure\ Concentration\ for\ Air\left(\frac{ug}{m^3}\right): \frac{C_a \times EF \times ED \times ET}{AT \times 24\ \frac{hours}{day}}$$

Parameter	Definition	Units	Off-Site Exposure Scenario		
			Teacher	Student	
			25 Years	3 Years	6 Years
C_a	Constituent concentration in air	ug/m^3	Constituent-specific		
ED	Exposure Duration	years	25	3	6
EF	Exposure Frequency	days/year	235	180	180
ET	Exposure Time	hours/day	8	7	7
AT_{nc}	Averaging time - noncarcinogenic	days	9,125	1,095	2,190
AT_c	Averaging time - carcinogenic	days	25,550		

Notes:

Exposure parameters were obtained from the USEPA RSL table (USEPA 2019) unless noted below. Values adjusted from default to site-specific exposures are documented below.

The ED was based on a typical tour length for military personnel or average 25-year career length for a civilian contract worker or landscaper (USEPA 1989).

Teacher EF and ET were based on a 47-week per year administrator contract with an 8-hour work day.

Student EF and ET were based on United States average 180 day school year and 6.6 hour school day (National Center for Educational Statistics. 2007. Retrieved from https://nces.ed gov/surveys/sass/tables/sass0708_035_s1s.asp). The value provided in the USEPA Exposure Factors Handbook (Table 16-25) resulted in a less-conservative exposure time per day for schoolchildren under six years old (6.1 hours per day for doers only) and therefore was not used.

The AT_c value was based on a 70-year lifetime expectancy (USEPA 1989).

The AT_{nc} value was based on the ED (number of years at Camp Kinser; USEPA 1989).

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Table 3-5: Incidental Soil Ingestion Exposure Parameters – Southern Area

$$Incidental\ Soil\ Ingestion\ Dose\left(\frac{mg}{kg-day}\right): \frac{C_s \times EF \times ED \times IRS\ X\ RBA \times 10^{-6}\frac{kg}{mg}}{AT \times BW}$$

			On-Site Exposure Scenario				
			Adult Recreator		Child Recreator		Landscaper
Parameter	Definition	Units	3 Years	6 Years	3 Years	6 Years	25 Years
C_s	Constituent concentration in soil	mg/kg	Constituent-specific				
BW	Body Weight	kg	80		15		80
ED	Exposure Duration	years	3	6	3	6	25
EF	Exposure Frequency	days/year	48				50
IRS	Soil Ingestion Rate	mg/day	100		200		330
AT_{nc}	Averaging time - noncarcinogenic	days	1,095	2,190	1,095	2,190	9,125
AT_c	Averaging time - carcinogenic	days	25,550				
RBA	Relative Bioavailability Factor	unitlesss	Constituent-specific or default value of 1				

Notes:

Exposure parameters were obtained from the USEPA RSL table (USEPA 2019) unless noted below. Values adjusted from default to site-specific exposures are documented below.

The ED was based on a typical tour length for military personnel or average 25-year career length for a civilian contract worker or landscaper (USEPA 1989).

The recreator EF was based on an estimated two weekends per month.

The landscaper EF was based on an estimated one day per week with two weeks vacation.

The AT_c value was based on a 70-year lifetime expectancy (USEPA 1989).

The AT_{nc} value was based on the ED (number of years at Camp Kinser; USEPA 1989).

The landscaper IRS value was based on USEPA's construction worker receptor scenario (2002 EPA Supplemental Guidance For Developing Soil Screening Levels For Superfund Sites. Exhibit 1-2.)

The adult and child recreator IRS value was based on USEPA's residential receptor scenario, which is considered overly conservative.

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Table 3-6: Dermal Contact with Soil Exposure Parameters – Southern Area

$$Dermal\ Contact\ with\ Soil\ Dose\left(\frac{mg}{kg-day}\right):\frac{C_s \times EF \times ED \times SA \times AF \times ABS_d \times 10^{-6}\frac{kg}{mg}}{AT \times BW}$$

Parameter	Definition	Units	On-Site Exposure Scenario				
			Adult Recreator		Child Recreator		Landscaper
			3 Years	6 Years	3 Years	6 Years	25 Years
C_s	Constituent concentration in soil	mg/kg	Constituent-specific				
BW	Body Weight	kg	80		15		80
AF	Soil to Skin Adherence factor	mg/cm^2	0.07		0.2		0.12
ED	Exposure Duration	years	3	6	3	6	25
EF	Exposure Frequency	days/year	48				50
ABS_d	Fraction absorbed dermally from soil	unitless	Constituent-specific				
AT_{nc}	Averaging time - noncarcinogenic	days	1,095	2,190	1,095	2,190	9,125
AT_c	Averaging time - carcinogenic	days	25,550				
SA	Skin Surface Area	cm^2	6,032		2,373		3,910

Notes:

Exposure parameters were obtained from the USEPA RSL table (USEPA 2019) unless noted below. Values adjusted from default to site-specific exposures are documented below.

The ED was based on a typical tour length for military personnel or average 25-year career length for a civilian contract worker or landscaper (USEPA 1989).

The recreator EF was based on an estimated two weekends per month.

The landscaper EF was based on an estimated one day per week with two weeks vacation.

The AT_c value was based on a 70-year lifetime expectancy (USEPA 1989).

The AT_{nc} value was based on the ED (number of years at Camp Kinser; USEPA 1989).

The landscaper SA was based on the skin surface area of the head, forearms, and hands (USEPA 2011, Table 7-12).

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Table 3-7: Inhalation of Particulates and Vapors in Ambient Air Exposure Parameters – Southern Area

$$Inhalation\ Exposure\ Concentration\ for\ Air\left(\frac{ug}{m^3}\right): \frac{C_s \times (\frac{1}{PEF} + \frac{1}{VF}) \times EF \times ED \times ET}{AT\ \times\ 24\ \frac{hours}{day}}$$

Exposure Parameter[1]	Definition	Units	On-Site Exposure Scenario				
			Adult Recreator		Child Recreator		Landscaper
			3 Year	6 Year	3 Year	6 Year	25 Year
C_s	Constituent concentration in soil	mg/kg	Constituent-specific				
ED	Exposure duration	year	3	6	3	6	25
EF	Exposure frequency	days/year	48				50
ET	Exposure time	hours/day	4		4		4
AT_{nc}	Averaging time – Noncarcinogenic	days	1,095	2,190	1,095	2,190	9,125
AT_c	Averaging time – Carcinogenic (lifetime)	days	25,550				
VF	Volatilization factor	m^3/kg	Constituent-specific				
PEF	Particulate emission factor	m^3/kg	1.4E+09				

Notes:

Exposure parameters were obtained from the USEPA RSL table (USEPA 2019) unless noted below. Values adjusted from default to site-specific exposures are documented below.

The ED was based on a typical tour length for military personnel or average 25-year career length for a civilian contract worker or landscaper (USEPA 1989).

The adult recreator ET and EF were based on a 224-minute average outdoor recreation exposure time per day (USEPA 2011) and an estimated two weekends per mon h, respectively.

The child recreator ET and EF were were modeled as equal to the adult recreator ET and EF.

The landscaper EF was based on an estimated one day per week with two weeks vacation.

The AT_c value was based on a 70-year lifetime expectancy (USEPA 1989).

The AT_{nc} value was based on the ED (number of years at Camp Kinser; USEPA 1989).

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Table 3-8: Inhalation of Vapors in Indoor Air (from VI Only) Exposure Parameters – Southern Area

$$Inhalation\ Exposure\ Concentration\ for\ Air\left(\frac{ug}{m^3}\right): \frac{C_a \times EF \times ED \times ET}{AT \times 24\ \frac{hours}{day}}$$

Parameter	Definition	Units	On-Site Exposure Scenario						
			Occupational Clinic Worker			Adult Patient		Child Patient	
			3 Years	6 Years	25 Years	3 Years	6 Years	3 Years	6 Years
C_a	Constituent concentration in air	ug/m^3	Constituent-specific						
ED	Exposure Duration	years	3	6	25	3	6	3	6
EF	Exposure Frequency	days/year	250	250	250	3	3	3	3
ET	Exposure Time	hours/day	8	8	8	2	2	2	2
AT_{nc}	Averaging time - noncarcinogenic	days	1,095	2,190	9,125	1,095	2,190	1,095	2,190
AT_c	Averaging time - carcinogenic	days	25,550						

Notes

Exposure parameters were obtained from the USEPA RSL table (USEPA 2019) unless noted below. Values adjusted from default to site-specific exposures are documented below.

The ED was based on a typical tour length for military personnel or average 25-year career length for a civilian contract worker or landscaper (USEPA 1989).

The patient EF and ET were based on three clinic visits per year with a two hour exposure time per event.

The AT_c value was based on a 70-year lifetime expectancy (USEPA 1989).

The AT_{nc} value was based on the ED (number of years at Camp Kinser; USEPA 1989).

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Table 3-9: Surface Soil Exposure Point Concentrations by Decision Unit

COPC	DU-N1	DU-N2	DU-N3	DU-N4	DU-S1	DU-S2	DU-S3	DU-S4	DU-S5 [(1)]	DU-S5 [(2)]	CKSA-SS40
2,4- Dichlorodiphenyltrichloroethane (2,4-DDT)	--	--	0.0028	0.011	--	--	--	--		--	--
2-Acetylaminofluorene	--	--	--	--	--	--	--	--		--	--
3-Methylcholanthrene	--	--	--	--	--	--	--	--		--	--
7,12-Dimethylbenz(a)anthracene	--	--	--	--	--	--	--	--		--	--
Acenaphthylene	--	--	0.0031	0.0087	0.025	0.027	--	--	0.0037	0.0039	--
Arsenic, Inorganic	19	16	27	24	20	17	15	14	15	16	6.0
Benzo(g,h,i)perylene	0.024	0.015	0.040	0.54	0.18	0.20	0.051	0.042	0.053	0.057	0.029
Benzo[a]pyrene	0.022	0.027	0.076	0.97	0.39	0.26	0.080	0.064	0.079	0.087	0.038
Benzo[b]fluoranthene	0.031	0.036	0.14	1.2	0.81	0.35	0.11	0.11	0.10	0.11	0.056
Carbazole	--	--	0.0042	0.13	--	0.0073	--	0.0049	0.0069	0.0079	--
alpha-Chlordane	--	--	--	2.3	0.057	1.3	2.3	--	1.1	1.1	--
gamma-Chlordane	--	0.0012	--	2.3	0.15	1.2	1.8	--	1.9	1.9	--
Chlordane, Technical	--	--	--	17	--	9.1	13	--	10	10.0	--
Chromium (VI)	0.15	0.44	0.17	--	0.14	0.55	0.13	0.26	0.38	0.42	--
Dibenz[a,h]anthracene	0.0027	--	0.0051	0.14	0.048	0.026	0.0083	0.0057	0.012	0.015	--
Dichlorodiphenyldichloroethane (DDD)	--	--	0.0034	--	--	--	0.016	--	24	--	24
Dichlorodiphenyldichloroethylene (DDE)	0.0041	0.0035	0.013	0.13	0.017	1.2	0.19	0.0043	4.6	0.33	4.6
Dichlorodiphenyltrichloroethane (DDT)	0.036	0.24	0.17	0.42	0.028	0.20	0.36	0.0036	5.5	0.24	5.5
Dieldrin	--	0.0030	0.00086	2.0	0.0066	15	1.1	0.011	2.6	0.10	2.6
N-Nitrosodiethylamine	--	--	--	--	--	--	--	--		--	--
N-Nitrosodimethylamine	--	--	--	--	--	--	--	--		--	--
N-Nitroso-di-N-butylamine	--	--	--	--	--	--	--	--		--	--
N-Nitroso-di-N-propylamine	--	--	--	--	--	--	--	--		--	--
N-Nitrosomethylethylamine	--	--	--	--	--	--	--	--		--	--
N-Nitrosomorpholine	--	--	--	--	--	--	--	--		--	--
N-Nitrosopiperidine	--	--	--	--	--	--	--	--		--	--
p-Dimethylamino azobenzene	--	--	--	--	--	--	--	--		--	--
Phenanthrene	0.0095	0.0075	0.037	1.2	0.62	0.056	0.041	0.026	0.099	0.099	0.029
Thorium-232	5.8	4.5	5.1	5.9	4.2	4.9	4.6	3.7	3.1	3.1	0.95
Titanium	245	267	284	298	203	193	199	185	180	185	97
Total cPAHs (BaP TEQ)	0.030	0.036	0.084	1.4	0.48	0.37	0.11	0.095	0.11	0.12	0.052
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000016	0.000042	0.000018	0.000012	0.0025	0.00066	0.000045	0.000030	0.00018	0.00012	0.00018
Total PCB Aroclors	--	--	0.032	0.70	0.042	0.23	0.15	0.044	1.7	--	9.5

Notes:

[1] Including Sample CKSA-SS40 (see Sec ion 5 of the HHRA).

[2] Excluding Sample CKSA-SS40 (see Section 5 of the HHRA).

--: Constituent was not detected. The EPC was assumed to be zero in instances where the constituent was not detected.

EPCs are presented in mg/kg.

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Table 3-10: Identification of COPCs by Decision Unit

Soil COPC	DU-N1	DU-N2	DU-N3	DU-N4	DU-S1	DU-S2	DU-S3	DU-S4	DU-S5
2,4- Dichlorodiphenyltrichloroethane (2,4-DDT)	--	--	--	--	--	--	--	--	--
2-Acetylaminofluorene	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-Methylcholanthrene	ND	ND	ND	ND	ND	ND	ND	ND	ND
7,12-Dimethylbenz(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	--	--	--	--	--	--	--	--	--
Arsenic, Inorganic	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**
Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--
Benzo[a]pyrene	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**
Benzo[b]fluoranthene	--	--	--	--	--	--	--	--	--
Carbazole	--	--	--	--	--	--	--	--	--
alpha-Chlordane	ND	ND	ND	**COPC**	**COPC**	**COPC**	**COPC**	ND	**COPC**
gamma-Chlordane	ND	**COPC**	ND	**COPC**	**COPC**	**COPC**	**COPC**	ND	**COPC**
Chlordane, Technical	ND	ND	ND	**COPC**	ND	**COPC**	**COPC**	ND	**COPC**
Chromium (VI)	**COPC**	**COPC**	**COPC**	ND	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**
Dibenz[a,h]anthracene	--	--	--	--	--	--	--	--	--
Dichlorodiphenyldichloroethane (DDD)	ND	ND	**COPC**	ND	ND	ND	**COPC**	ND	ND
Dichlorodiphenyldichloroethylene (DDE)	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**
Dichlorodiphenyltrichloroethane (DDT)	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**
Dieldrin	ND	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**
N-Nitrosodiethylamine	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitrosodimethylamine	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitroso-di-N-butylamine	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitroso-di-N-propylamine	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitrosomethylethylamine	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitrosomorpholine	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitrosopiperidine	ND	ND	ND	ND	ND	ND	ND	ND	ND
p-Dimethylamino azobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	--	--	--	--	--	--	--	--	--
Thorium-232	--	--	--	--	--	--	--	--	--
Titanium	--	--	--	--	--	--	--	--	--
Total cPAHs (BaP TEQ)	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**
Total PCB (Aroclor Method)	ND	ND	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**	**COPC**

Notes:

--: No toxicity value is available for this COPC or he COPC is evaluated in the total cPAH compound total (e.g., benzo[b]fluoranthene, dibenz[a,h]anthracene)

ND: Not detected in the DU

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Table 4-1: Toxicity Values

CAS Number	Data Group	Constituent	Inhalation Reference Concentration (mg/m^3)	Inhalation Unit Risk $(ug/m^3)^{-1}$	Oral Reference Dose (mg/kg-day)	Oral Cancer Slope Factor (kg-day/mg)	Age-Dependent Cancer Mutagen Factor (unitless)
789-02-6	Pesticide	2,4-DDT	--	--	--	--	1.0
53-96-3	SVOC	2-Acetylaminofluorene	--	0.0013	--	3.8	1.0
56-49-5	SVOC	3-Methylcholanthrene [1]	--	0.0063	--	22	5.3
57-97-6	PAH	7,12-Dimethylbenz(a)anthracene [1]	--	0.071	--	250	5.3
208-96-8	PAH	Acenaphthylene	--	--	--	--	1.0
5103-71-9	Pesticide	alpha-Chlordane [2]	0.00070	0.00010	0.00050	0.35	1.0
7440-38-2	Inorganic	Arsenic, Inorganic	0.000015	0.0043	0.00030	1.5	1.0
191-24-2	PAH	Benzo(g,h,i)perylene	--	--	--	--	1.0
50-32-8	PAH	Benzo[a]pyrene [1]	0.0000020	-^-	0.00030	-^-	5.3
205-99-2	PAH	Benzo[b]fluoranthene [1]	--	-^-	--	-^-	1.0
86-74-8	SVOC	Carbazole	--	--	--	--	1.0
12789-03-6	Pesticide	Chlordane, Technical	0.00070	0.00010	0.00050	0.35	1.0
18540-29-9	Inorganic	Chromium(VI) [1]	0.00010	0.084	0.0030	0.50	5.3
72-54-8	Pesticide	DDD	--	0.000069	0.000030	0.24	1.0
72-55-9	Pesticide	DDE	--	0.000097	0.00030	0.34	1.0
50-29-3	Pesticide	DDT	--	0.000097	0.00050	0.34	1.0
53-70-3	PAH	D benz[a,h]anthracene [1]	--	-^-	--	-^-	5.3
60-57-1	Pesticide	Dieldrin	--	0.00046	0.000050	16	1.0
5566-34-7	Pesticide	gamma-Chlordane [2]	0.00070	0.00010	0.00050	0.35	1.0
55-18-5	SVOC	N-Nitrosodiethylamine [1]	--	0.043	--	150	5.3
62-75-9	SVOC	N-Nitrosodimethylamine [1]	0.000040	0.014	0.0000080	51	5.3
924-16-3	SVOC	N-Nitroso-di-N-butylamine	--	0.0016	--	5.4	1.0
621-64-7	SVOC	N-Nitroso-di-N-propylamine	--	0.0020	--	7.0	1.0
10595-95-6	SVOC	N-Nitrosomethylethylamine	--	0.00063	--	22	1.0
59-89-2	SVOC	N-Nitrosomorpholine	--	0.0019	--	6.7	1.0
100-75-4	SVOC	N-Nitrosopiperidine	--	0.0027	--	9.4	1.0
60-11-7	SVOC	p-Dimethylamino azobenzene	--	0.0013	--	4.6	1.0
85-01-8	PAH	Phenanthrene	--	--	--	--	1.0
7440-29-1	Inorganic	Thorium-232	--	--	--	--	1.0
7440-32-6	Inorganic	Titanium	--	--	--	--	1.0
CPAH-TEQ	PAH	Total Carcinogenic PAHs (BaP TEQs) [1,3]	--	0.00060	--	1.0	5.3
DIOXIN-TEQ	Dioxin	Total Dioxins/Furans (2,3,7,8-TCDD TEQs) [4]	0.000000040	38	7.0E-10	130,000	1.0
PTC_000024	PCB	Total PCBs (Aroclor Method) [5]	--	0.00057	--	2.0	1.0

Notes:

Listed RfC, IUR, RfD, CSF, and age-dependent cancer mutagen values were obtained from USEPA Resident Soil RSL Table - May 2019 wi h the noted exceptions.

[1] Constituent is a mutagen; therefore the IUR was multiplied by the age dependent cancer mutagen factor of 5.33 when determining toxicity in children (age 0-6).

[2] Chlordane, technical values were used as surrogate values for alpha- and gamma-chlordane due to the similarity of the constituents.

[3] IUR and CSF values for benzo(a)pyrene were applied to Total Carcinogenic PAHs (BaP TEQs).

[4] USEPA values for 2,3,7,8-TCDD were applied to Total Dioxins/Furans (2,3,7,8-TCDD TEQs).

[5] USEPA values for PCB Aroclor 1260 were applied to Total PCBs (Aroclor Method) because Aroclor 1260 was the only Aroclor detected in surface soil samples.

--: No toxicity value was available.

-^-: CSF and IUR values were removed from individual cPAHs to avoid an overestimation in the toxicity calculation (carcinogenic toxicity is evaluated using cPAH compound total).

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Table 4-2: Physical Properties

CAS Number	Data Group	Constituent	Dermal Absorption Factor (%)	Gastrointestinal Absorption Factor (unitless)	Volatilization Factor (m^3/kg)	Relative Bioavailability Factor (%)
789-02-6	Pesticide	2,4-DDT [1]	0.030	1.0	0.0	1.0
53-96-3	SVOC	2-Acetylaminofluorene	0.10	1.0	0.0	1.0
56-49-5	SVOC	3-Methylcholanthrene	0.10	1.0	0.0	1.0
57-97-6	PAH	7,12-Dimethylbenz(a)anthracene	0.13	1.0	0.0	1.0
208-96-8	PAH	Acenaphthylene	0.13	1.0	0.0	1.0
5103-71-9	Pesticide	alpha-Chlordane [2]	0.040	1.0	0.0	1.0
7440-38-2	Inorganic	Arsenic, Inorganic	0.030	1.0	0.0	0.60
191-24-2	PAH	Benzo(g,h,i)perylene	0.13	1.0	0.0	1.0
50-32-8	PAH	Benzo[a]pyrene	0.13	1.0	0.0	1.0
205-99-2	PAH	Benzo[b]fluoranthene	0.13	1.0	0.0	1.0
86-74-8	SVOC	Carbazole	0.10	1.0	0.0	1.0
12789-03-6	Pesticide	Chlordane, Technical	0.040	1.0	1,530,000	1.0
18540-29-9	Inorganic	Chromium (VI)	N/A	0.025	0.0	1.0
72-54-8	Pesticide	DDD	0.10	1.0	0.0	1.0
72-55-9	Pesticide	DDE [1]	0.030	1.0	2,100,000	1.0
50-29-3	Pesticide	DDT	0.030	1.0	0.0	1.0
53-70-3	PAH	Dibenz[a,h]anthracene	0.13	1.0	0.0	1.0
60-57-1	Pesticide	Dieldrin	0.10	1.0	0.0	1.0
5566-34-7	Pesticide	gamma-Chlordane [2]	0.040	1.0	0.0	1.0
55-18-5	SVOC	N-Nitrosodiethylamine	0.10	1.0	0.0	1.0
62-75-9	SVOC	N-Nitrosodimethylamine	0.10	1.0	82,300	1.0
924-16-3	SVOC	N-Nitroso-di-N-butylamine	0.10	1.0	243,000	1.0
621-64-7	SVOC	N-Nitroso-di-N-propylamine	0.10	1.0	0.0	1.0
10595-95-6	SVOC	N-Nitrosomethylethylamine	0.10	1.0	121,000	1.0
59-89-2	SVOC	N-Nitrosomorpholine	0.10	1.0	0.0	1.0
100-75-4	SVOC	N-Nitrosopiperidine	0.10	1.0	0.0	1.0
60-11-7	SVOC	p-Dimethylamino azobenzene	0.10	1.0	0.0	1.0
85-01-8	PAH	Phenanthrene	0.13	1.0	0.0	1.0
7440-29-1	Inorganic	Thorium-232	N/A	1.0	0.0	1.0
7440-32-6	Inorganic	Titanium	N/A	1.0	0.0	1.0
CPAH-TEQ	PAH	Total Carcinogenic PAHs (BaP TEQs) [3]	0.13	1.0	0.0	1.0
DIOXIN-TEQ	Dioxin	Total Dioxins/Furans (2,3,7,8-TCDD TEQs) [4]	0.030	1.0	1,960,000	1.0
PTC_000024	PCB	Total PCBs (Aroclor Method) [5]	0.14	1.0*	1,310,000	1.0

Notes:

Listed ABSd, GIABS, VF, and RBA values were obtained from USEPA Resident Soil RSL Table - May 2019, with the noted exceptions.

[1] ABSd values for DDT were used as surrogate values for 2,4-DDT and DDE due to the similarity of the constituents.

[2] ABSd values for chlordane, technical were used as surrogate values for alpha- and gamma-chlordane due to the similarity of the constituents.

[3] USEPA values for benzo(a)pyrene were applied to Total Carcinogenic PAHs (BaP TEQs).

[4] USEPA values for 2,3,7,8-TCDD were applied to Total Dioxins/Furans (2,3,7,8-TCDD TEQs).

[5] USEPA values for PCB Aroclor 1260 were applied to Total PCBs (Aroclor Method) because Aroclor 1260 was the only Aroclor detected in surface soil samples.

N/A: Assumed that the constituent will not absorb dermally.

A site-specific assessment of relative bioavailability (RBA) was not completed; therefore, default values were applied. EPA guidance suggests using a defalut RBA value of 0.6 for arsenic and 1 for other cons ituents.

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Table 5-1: Surface Soil Risk-Based Screening Criteria

COPC	6-Year Child Recreator		6-Year Adult Recreator		25-Year Adult Landscaper	
	Cancer RBSC	Noncancer RBSC	Cancer RBSC	Noncancer RBSC	Cancer RBSC	Noncancer RBSC
2,4- Dichlorodiphenyltrichloroethane (2,4-DDT)	NC	NC	NC	NC	NC	NC
2-Acetylaminofluorene	--	--	--	--	--	--
3-Methylcholanthrene	--	--	--	--	--	--
7,12-Dimethylbenz(a)anthracene	--	--	--	--	--	--
Acenaphthylene	NC	NC	NC	NC	NC	NC
Arsenic, Inorganic	6.6	255	65	2,505	5.1	825
Benzo(g,h,i)perylene	NC	NC	NC	NC	NC	NC
Benzo[a]pyrene	-^-	131	-^-	1,167	-^-	446
Benzo[b]fluoranthene	-^-	NC	-^-	NC	-^-	NC
Carbazole	NC	NC	NC	NC	NC	NC
alpha-Chlordane	17	260	173	2,602	13	837
gamma-Chlordane	17	260	173	2,602	13	837
Chlordane, Technical	17	260	173	2,602	13	837
Chromium (VI)	2.5	1,710	140	18,196	9.9	5,304
Dichlorodiphenyldichloroethane (DDD)	22	14	208	128	18	46
Dichlorodiphenyldichloroethylene (DDE)	18	160	185	1,620	14	509
Dichlorodiphenyltrichloroethane (DDT)	18	266	185	2,700	14	849
Dibenz[a,h]anthracene	-^-	NC	-^-	NC	-^-	NC
Dieldrin	0.34	23	3.1	214	0.27	77
N-Nitrosodiethylamine	--	--	--	--	--	--
N-Nitrosodimethylamine	--	--	--	--	--	--
N-Nitroso-di-N-butylamine	--	--	--	--	--	--
N-Nitroso-di-N-propylamine	--	--	--	--	--	--
N-Nitrosomethylethylamine	--	--	--	--	--	--
N-Nitrosomorpholine	--	--	--	--	--	--
N-Nitrosopiperidine	--	--	--	--	--	--
p-Dimethylamino azobenzene	--	--	--	--	--	--
Phenanthrene	NC	NC	NC	NC	NC	NC
Thorium-232	NC	NC	NC	NC	NC	NC
Titanium	NC	NC	NC	NC	NC	NC
Total cPAHs (BaP TEQ)	0.95	NC	46	NC	4.2	NC
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000048	0.00037	0.00048	0.0038	0.000037	0.0012
Total PCB Aroclors	2.5	NC	22	NC	2.1	NC

Notes:

--: COPC was not detected in surface soil and therefore RBSCs were not calculated.

NC: Toxicity values used to calculate risk were unavailable for he respective COPC.

-^-: Cancer risk is evaluated using cPAH compound total. RBSCs for individual cPAHs were not calculated.

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Table 5-2: Cancer Risk and Hazard Indices by Exposure Pathway (Including Arsenic)

Decision Unit	Exposure Pathways	Surface Soil Exposure Scenarios: 6-Year Child Recreator – Cancer Risk	6-Year Child Recreator – Hazard Index	6-Year Adult Recreator – Cancer Risk	6-Year Adult Recreator – Hazard Index	25-Year Adult Landscaper – Cancer Risk	25-Year Adult Landscaper – Hazard Index
DU-N1	Dermal Contact with Soil	3.28E-07	0.011	5.38E-08	0.0018	2.59E-07	0.0021
	Ingestion of Soil	2.91E-06	0.11	2.67E-07	0.0099	3.82E-06	0.034
	Inhalation of Soil Particulates	2.03E-10	0.000020	1.29E-10	0.000020	5.58E-10	0.000021
	Total Risk	3.24E-06	0.12	3.21E-07	0.012	4.08E-06	0.036
DU-N2	Dermal Contact with Soil	3.28E-07	0.014	5.35E-08	0.0024	2.58E-07	0.0028
	Ingestion of Soil	3.22E-06	0.16	2.87E-07	0.015	4.10E-06	0.053
	Inhalation of Soil Particulates	3.67E-10	0.000018	1.48E-10	0.000018	6.43E-10	0.000018
	Total Risk	3.55E-06	0.18	3.40E-07	0.018	4.36E-06	0.056
DU-N3	Dermal Contact with Soil	4.80E-07	0.015	7.72E-08	0.0024	3.72E-07	0.0028
	Ingestion of Soil	4.13E-06	0.14	3.76E-07	0.013	5.39E-06	0.045
	Inhalation of Soil Particulates	2.67E-10	0.000029	1.80E-10	0.000029	7.82E-10	0.000031
	Total Risk	4.61E-06	0.15	4.54E-07	0.016	5.76E-06	0.048
DU-N4	Dermal Contact with Soil	2.07E-06	0.038	2.99E-07	0.0063	1.44E-06	0.0073
	Ingestion of Soil	1.08E-05	0.27	9.30E-07	0.025	1.33E-05	0.087
	Inhalation of Soil Particulates	1.56E-10	0.000034	1.51E-10	0.000034	6.55E-10	0.000036
	Total Risk	1.29E-05	0.31	1.23E-06	0.032	1.48E-05	0.094
DU-S1	Dermal Contact with Soil	3.91E-06	0.45	6.35E-07	0.075	3.06E-06	0.087
	Ingestion of Soil	5.17E-05	6.3	4.82E-06	0.59	6.90E-05	2.0
	Inhalation of Soil Particulates	3.38E-10	0.000026	2.66E-10	0.000026	1.16E-09	0.000027
	Total Risk	5.56E-05	6.7	5.45E-06	0.67	7.24E-05	2.1
DU-S2	Dermal Contact with Soil	9.93E-06	0.25	1.64E-06	0.042	7.93E-06	0.049
	Ingestion of Soil	5.26E-05	2.3	4.89E-06	0.21	7.00E-05	0.74
	Inhalation of Soil Particulates	4.92E-10	0.000021	2.14E-10	0.000021	9.28E-10	0.000022
	Total Risk	6.25E-05	2.5	6.53E-06	0.26	7.79E-05	0.79
DU-S3	Dermal Contact with Soil	1.06E-06	0.030	1.73E-07	0.0049	8.36E-07	0.0057
	Ingestion of Soil	6.67E-06	0.27	6.15E-07	0.025	8.81E-06	0.086
	Inhalation of Soil Particulates	1.75E-10	0.000017	1.10E-10	0.000017	4.78E-10	0.000018
	Total Risk	7.73E-06	0.30	7.88E-07	0.030	9.64E-06	0.092
DU-S4	Dermal Contact with Soil	3.00E-07	0.011	4.68E-08	0.0019	2.26E-07	0.0022
	Ingestion of Soil	2.70E-06	0.13	2.39E-07	0.012	3.42E-06	0.040
	Inhalation of Soil Particulates	2.46E-10	0.000016	1.15E-10	0.000016	4.98E-10	0.000016
	Total Risk	3.00E-06	0.14	2.86E-07	0.014	3.65E-06	0.043
DU-S5 (1)	Dermal Contact with Soil	2.48E-06	0.40	4.10E-07	0.067	1.98E-06	0.077
	Ingestion of Soil	1.46E-05	2.1	1.35E-06	0.20	1.93E-05	0.67
	Inhalation of Soil Particulates	3.43E-10	0.000017	1.52E-10	0.000017	6.60E-10	0.000018
	Total Risk	1.71E-05	2.5	1.76E-06	0.26	2.13E-05	0.75
DU-S5 (2)	Dermal Contact with Soil	5.77E-07	0.033	9.22E-08	0.0055	4.45E-07	0.0064
	Ingestion of Soil	5.70E-06	0.40	5.14E-07	0.038	7.37E-06	0.13
	Inhalation of Soil Particulates	3.65E-10	0.000018	1.53E-10	0.000018	6.64E-10	0.000019
	Total Risk	6.28E-06	0.44	6.07E-07	0.043	7.81E-06	0.14
CKSA-SS40	Dermal Contact with Soil	3.04E-06	0.39	5.05E-07	0.066	2.44E-06	0.076
	Inges ion of Soil	1.49E-05	2.0	1.39E-06	0.19	2.00E-05	0.65
	Inhalation of Soil Particulates	5.82E-11	0.0000068	5.80E-11	0.0000068	2.52E-10	0.0000071
	Total Risk	1.80E-05	2.4	1.90E-06	0.25	2.24E-05	0.73

Notes

(1) Included surface soil sample CKSA-SS40 (see Section 5 of the HHRA).

(2) Excluded surface soil sample CKSA-SS40 (see Section 5 of the HHRA).

Color scale:

Cancer Risk >1E-05

Cancer Risk > 1E-06

Hazard Index >1

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Table 5-3: Cancer Risk and Hazard Indices by Exposure Pathway (Excluding Arsenic)

Decision Unit	Exposure Pathways	Surface Soil Exposure Scenarios					
		6-Year Child Recreator		6-Year Adult Recreator		25-Year Adult Landscaper	
		Cancer Risk	Hazard Index	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index
DU-N1	Dermal Contact with Soil	2.97E-08	0.0029	3.93E-09	0.00048	1.90E-08	0.00056
	Ingestion of Soil	3.95E-07	0.040	3.07E-08	0.0038	4.39E-07	0.013
	Inhalation of Soil Particulates	9.22E-11	0.00000020	1.80E-11	0.00000020	7.81E-11	0.00000021
	Total Risk	4.25E-07	0.043	3.46E-08	0.0042	4.58E-07	0.013
DU-N2	Dermal Contact with Soil	7.04E-08	0.0077	1.05E-08	0.0013	5.08E-08	0.0015
	Ingestion of Soil	1.05E-06	0.11	8.29E-08	0.010	1.19E-06	0.035
	Inhalation of Soil Particulates	2.72E-10	0.00000030	5.29E-11	0.00000030	2.29E-10	0.00000032
	Total Risk	1.12E-06	0.12	9.35E-08	0.011	1.24E-06	0.036
DU-N3	Dermal Contact with Soil	4.98E-08	0.0034	5.49E-09	0.00057	2.65E-08	0.00066
	Ingestion of Soil	5.04E-07	0.046	3.68E-08	0.0043	5.28E-07	0.015
	Inhalation of Soil Particulates	1.08E-10	0.00000065	2.11E-11	0.00000065	9.17E-11	0.00000068
	Total Risk	5.54E-07	0.049	4.24E-08	0.0049	5.54E-07	0.015
DU-N4	Dermal Contact with Soil	1.68E-06	0.028	2.34E-07	0.0047	1.13E-06	0.0054
	Ingestion of Soil	7.53E-06	0.18	6.22E-07	0.017	8.90E-06	0.060
	Inhalation of Soil Particulates	1.16E-11	0.0000083	6.67E-12	0.0000083	2.89E-11	0.0000087
	Total Risk	9.20E-06	0.21	8.56E-07	0.022	1.00E-05	0.065
DU-S1	Dermal Contact with Soil	3.58E-06	0.44	5.82E-07	0.074	2.80E-06	0.086
	Ingestion of Soil	4.90E-05	6.2	4.56E-06	0.58	6.53E-05	2.0
	Inhalation of Soil Particulates	2.19E-10	0.0000042	1.47E-10	0.0000042	6.38E-10	0.0000044
	Total Risk	5.26E-05	6.7	5.14E-06	0.66	6.81E-05	2.1
DU-S2	Dermal Contact with Soil	9.65E-06	0.25	1.60E-06	0.041	7.71E-06	0.048
	Ingestion of Soil	5.02E-05	2.2	4.67E-06	0.21	6.69E-05	0.72
	Inhalation of Soil Particulates	3.88E-10	0.0000027	1.10E-10	0.0000027	4.79E-10	0.0000028
	Total Risk	5.99E-05	2.5	6.27E-06	0.25	7.46E-05	0.77
DU-S3	Dermal Contact with Soil	8.20E-07	0.023	1.33E-07	0.0039	6.41E-07	0.0045
	Ingestion of Soil	4.63E-06	0.21	4.24E-07	0.020	6.07E-06	0.069
	Inhalation of Soil Particulates	8.56E-11	0.0000011	2.06E-11	0.0000011	8.95E-11	0.0000011
	Total Risk	5.45E-06	0.24	5.57E-07	0.024	6.71E-06	0.074
DU-S4	Dermal Contact with Soil	7.61E-08	0.0056	9.52E-09	0.00094	4.59E-08	0.0011
	Ingestion of Soil	8.11E-07	0.077	6.23E-08	0.0072	8.93E-07	0.025
	Inhalation of Soil Particulates	1.64E-10	0.00000057	3.20E-11	0.00000057	1.39E-10	0.00000059
	Total Risk	8.88E-07	0.082	7.19E-08	0.0081	9.39E-07	0.026
DU-S5 (1)	Dermal Contact with Soil	2.23E-06	0.39	3.69E-07	0.066	1.78E-06	0.076
	Ingestion of Soil	1.25E-05	2.0	1.15E-06	0.19	1.65E-05	0.65
	Inhalation of Soil Particulates	2.52E-10	0.0000011	6.18E-11	0.0000011	2.68E-10	0.0000011
	Total Risk	1.47E-05	2.4	1.52E-06	0.26	1.83E-05	0.73
DU-S5 (2)	Dermal Contact with Soil	3.18E-07	0.026	4.89E-08	0.0044	2.36E-07	0.0051
	Ingestion of Soil	3.52E-06	0.35	3.09E-07	0.033	4.43E-06	0.11
	Inhalation of Soil Particulates	2.69E-10	0.0000011	5.70E-11	0.0000011	2.47E-10	0.0000012
	Total Risk	3.83E-06	0.37	3.58E-07	0.037	4.67E-06	0.12
CKSA-SS40	Dermal Contact with Soil	2.94E-06	0.39	4.89E-07	0.065	2.36E-06	0.075
	Ingestion of Soil	1.41E-05	2.0	1.32E-06	0.19	1.89E-05	0.64
	Inhalation of Soil Particulates	2.26E-11	0.00000038	2.24E-11	0.00000038	9.72E-11	0.00000040
	Total Risk	1.70E-05	2.4	1.81E-06	0.25	2.12E-05	0.72

Notes

(1) Including sample CKSA-SS40 (see Section 5 of the HHRA).

(2) Excluding sample CKSA-SS40 (see Section 5 of the HHRA).

Color scale:

Cancer Risk >1E-05

Cancer Risk > 1E-06

Hazard Index >1

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Table 5-4: Summary of Risk by COPC and Decision Unit

COPC	DU-N1	DU-N2	DU-N3	DU-N4	DU-S1	DU-S2	DU-S3	DU-S4	DU-S5	DU-S5*
	DU with Cancer Risk > 1E-06									
COPC	**DU-N1**	**DU-N2**	**DU-N3**	**DU-N4**	**DU-S1**	**DU-S2**	**DU-S3**	**DU-S4**	**DU-S5**	**DU-S5***
Arsenic	X	X	X	X	X	X	X	X	X	X
Chlordane, Technical				X						
DDD									X	
Dieldrin				X		X	X		X	
Total Carcinogenic PAHs (BaP TEQs)				X						
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)		X		X	X	X	X		X	X
	DU with Cancer Risk > 1E-05									
COPC	**DU-N1**	**DU-N2**	**DU-N3**	**DU-N4**	**DU-S1**	**DU-S2**	**DU-S3**	**DU-S4**	**DU-S5**	**DU-S5***
Dieldrin						X				
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)					X	X				
	DU with Cancer Risk > 1E-04									
COPC	**DU-N1**	**DU-N2**	**DU-N3**	**DU-N4**	**DU-S1**	**DU-S2**	**DU-S3**	**DU-S4**	**DU-S5**	**DU-S5***
	No COPCs exceed cancer risk > 1E-04									
	DU with Noncancer Hazard > 1									
COPC	**DU-N1**	**DU-N2**	**DU-N3**	**DU-N4**	**DU-S1**	**DU-S2**	**DU-S3**	**DU-S4**	**DU-S5**	**DU-S5***
DDD									X	
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)					X	X				
	DU with Noncancer Hazard > 5									
COPC	**DU-N1**	**DU-N2**	**DU-N3**	**DU-N4**	**DU-S1**	**DU-S2**	**DU-S3**	**DU-S4**	**DU-S5**	**DU-S5***
DDD										
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)					X					
	DU with Noncancer Hazard > 10									
COPC	**DU-N1**	**DU-N2**	**DU-N3**	**DU-N4**	**DU-S1**	**DU-S2**	**DU-S3**	**DU-S4**	**DU-S5**	**DU-S5***
	No COPCs exceed noncancer hazard > 10									

Notes:

*: Surface soil sample CKSA-SS40 excluded from DU-S5.

X: COPC exceeds risk threshold for one or more exposure scenarios (6-year child recreator, 6-year adult recreator, or 25-year adult landscaper) in he selected DU.

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Table 6-1: Consituents with No Available RSLs or VISLs

Surface Soil	Groundwater	Sub-slab Soil Gas
1,3-Dichlorobenzene	1,1-Dichloropropene	1,2-cis-Dichloroethylene
1,4-Naphthoquinone	1,2,3-Trichlorobenzene	1,2-trans-Dichloroethylene
2,4-DDD	1,2-cis-Dichloroethylene	1,3-Dichlorobenzene
2,4-DDE	1,2-trans-Dichloroethylene	1,3-Dichloropropane
2,4-DDT	1,3-Dichlorobenzene	2,2,4-Trimethylpentane
2,6-Dichlorophenol	1,3-Dichloropropane	2,5-Dimethy benzaldehyde
2-Nitrophenol	1-Chlorohexane	4-Ethyltoluene
2-Picoline	2,2,4-Trimethylpentane	alpha-Methylstyrene
3-Nitroaniline	2,2-Dichloropropane	Benzaldehyde
4-Bromophenylphenylether	2-Chloroethyl vinyl ether	Butyraldehyde
4-Chlorophenylphenylether	Butraldehyde	cis-1,3-Dichloropropene
4-Nitrophenol	cis-1,3-Dichloropropene	Crotonaldehyde, Total
4-Nitroquinoline 1-oxide	Crotonaldehyde, Total	Decane
Acenaphthylene	Decanal	Dibromochloromethane
Acifluorfen	D bromochloromethane	Dodecane
Aldicarb sulfoxide	Ethanol	Ethanol
Aroclor 1262	Ethyl cyanide	Freon 114
Aroclor 1268	Ethyl Tert Butyl Ether	Hexanal
Bendiocarb	Freon 114	Isovaleraldehyde
Benzo(g,h,i)perylene	Hexanal	m&p-Methy benzaldehyde
Bolstar	Isobutyl Alcohol	n-Butylbenzene
Bromacil	Methyl Acetate	o-Chlorotoluene
Carbazole	Methyl Cyclohexane	Octane
Carbofuran-3-Hydroxy	Methyl Iodide	O-Tolualdehyde
Chloroxuron	n-Butylbenzene	Pentanal
Coumaphos	Nonanal	p-Isopropyltoluene
delta-Hexachlorocyclohexane	o-Chlorotoluene	sec-Butylbenzene
Dichlorprop	Octanal	Tert-Butyl Alcohol
Dimethyl Phthalate	p-Chlorotoluene	tert-Butylbenzene
Endosulfan I	Pentachloroethane	trans-1,3-Dichloropropene
Endosulfan II	p-Isopropyltoluene	Trichlorofluoromethane
Endosulfan sulfate	sec-Butylbenzene	Undecane
Endrin aldehyde	tert-Amylmethyl ether	
Endrin ketone	Tert-Butyl Alcohol	
Ethoprop	tert-Buty benzene	
Ethyl methanesulfonate	trans-1,3-Dichloropropene	
Famphur	Trichlorofluoromethane	
Fensulfothion		
Fenthion		
Fenuron		
Formetanate Hydrochloride		
Hexachloropropene		
Isodrin		
Isosafrole		
Methiocarb		
Metolcarb		
Mevinphos		
Monuron		
Neburon		
N-Methylcarbamate		
O,O,O-Triethylphosphorothioate		
Phenanthrene		

Table 6-1: Consituents with No Available RSLs or VISLs

Surface Soil	Groundwater	Sub-slab Soil Gas
Promecarb		
Prosulfocarb		
Prothiophos		
Siduron		
Tetrachlorvinphos		
Thionazin		
Thorium-232		
Titanium		
Trichloronate		

Table 6-2: Evaluation of Total 2,3,7,8-TCDD TEQ Concentrations

Sample ID	Total 2,3,7,8-TCDD TEQ (mg/kg)	Total 2,3,7,8-TCDD TEQ Dioxin-Like PCBs (mg/kg)	Qualifier	Total 2,3,7,8-TCDD TEQ Dioxins (mg/kg)	Qualifier	% of Total 2,3,7,8-TCDD TEQ Risk from Dioxin-like PCBs
CKSA-SS10	0.0025	0.0000090	U	0.0025000	J	0.36%
CKSA-SS01	0.00011	0.00000090	U	0.0001100	J	0.81%
CKSA-SS02	0.00071	0.0000090	UJ	0.0007000	J	1.3%
CKSA-SS14	0.00059	0.0000090	U	0.0005800	J	1.5%
CKNA-SS06	0.000047	0.00000090	U	0.0000460	J	1.9%
CKSA-SS11	0.000028	0.00000090	U	0.0000270	J	3.2%
CKSA-SS09	0.00025	0.0000090	U	0.0002400	J	3.6%
CKSA-SS50	0.00023	0.0000090	U	0.0002200	J	3.9%
CKNA-SS13	0.000023	0.00000091	J	0.0000220	J	4.0%
CKNA-SS39	0.000017	0.00000090	U	0.0000160	J	5.3%
CKSA-SS26	0.000017	0.00000090	U	0.0000160	J	5.3%
CKSA-SS03	0.00017	0.0000091	J	0.0001600	J	5.4%
CKNA-SS38	0.000016	0.00000090	U	0.0000150	J	5.7%
CKSA-SS18	0.000015	0.00000090	U	0.0000140	J	6.0%
CKNA-SS24	0.000014	0.00000091	J	0.0000130	J	6.5%
CKNA-SS07	0.000012	0.00000090	U	0.0000110	J	7.6%
CKSA-SS35	0.0000023	0.00000018	J	0.0000021	J	7.9%
CKNA-SS08	0.000011	0.00000090	U	0.0000100	J	8.3%
CKNA-SS15	0.000011	0.00000090	U	0.0000100	J	8.3%
CKSA-SS53	0.000011	0.00000090	U	0.0000098	J	8.4%
CKSA-SS16	0.000011	0.00000090	U	0.0000097	J	8.5%
CKNA-SS04	0.000010	0.00000091	J	0.0000095	J	8.7%
CKNA-SS41	0.000010	0.00000090	U	0.0000086	J	9.5%
CKNA-SS18	0.0000090	0.00000090	U	0.0000081	J	10%
CKNA-SS36	0.0000090	0.00000090	U	0.0000081	J	10%
CKSA-SS22	0.0000088	0.00000091	J	0.0000079	J	10%
CKNA-SS05	0.0000076	0.00000091	J	0.0000067	J	12%
CKNA-SS43	0.0000074	0.00000090	U	0.0000065	J	12%
CKSA-SS20	0.00074	0.000090	U	0.0006500	J	12%
CKNA-SS10	0.0000071	0.00000090	U	0.0000062	J	13%
CKNA-SS37	0.0000069	0.00000090	U	0.0000060	J	13%
CKNA-SS29	0.0000067	0.00000090	U	0.0000058	J	13%
CKSA-SS24	0.0000065	0.00000090	U	0.0000056	J	14%
CKSA-SS42	0.000065	0.0000090	U	0.0000560	J	14%

Table 6-2: Evaluation of Total 2,3,7,8-TCDD TEQ Concentrations

Sample ID	Total 2,3,7,8-TCDD TEQ (mg/kg)	Total 2,3,7,8-TCDD TEQ Dioxin-Like PCBs (mg/kg)	Qualifier	Total 2,3,7,8-TCDD TEQ Dioxins (mg/kg)	Qualifier	% of Total 2,3,7,8-TCDD TEQ Risk from Dioxin-like PCBs
CKNA-SS35	0.0000064	0.00000090	U	0.0000055	J	14%
CKSA-SS54	0.0000064	0.00000090	U	0.0000055	J	14%
CKNA-SS27	0.0000062	0.00000090	U	0.0000053	J	15%
CKSA-SS29	0.0000062	0.00000090	U	0.0000053	J	15%
CKNA-SS02	0.0000062	0.00000091	J	0.0000053	J	15%
CKSA-SS57	0.0000058	0.00000090	U	0.0000049	J	16%
CKSA-SS60	0.0000058	0.00000090	U	0.0000049	J	16%
CKSA-SS39	0.000050	0.0000090	U	0.0000410	J	18%
CKNA-SS17	0.0000049	0.00000090	U	0.0000040	J	18%
CKSA-SS59	0.0000049	0.00000090	U	0.0000040	J	18%
CKNA-SS44	0.0000049	0.00000091	J	0.0000040	J	19%
CKNA-SS40	0.0000048	0.00000090	J	0.0000039	J	19%
CKSA-SS12	0.000048	0.0000090	U	0.0000390	J	19%
CKSA-SS28	0.000048	0.0000090	U	0.0000390	J	19%
CKNA-SS32	0.0000047	0.00000090	U	0.0000038	J	19%
CKSA-SS17	0.000044	0.0000090	U	0.0000350	J	20%
CKNA-SS16	0.0000042	0.00000090	U	0.0000033	J	21%
CKSA-SS30	0.0000041	0.00000090	U	0.0000032	J	22%
CKSA-SS52	0.0000040	0.00000090	U	0.0000031	J	23%
CKNA-SS30	0.0000037	0.00000090	U	0.0000028	J	24%
CKNA-SS42	0.0000036	0.00000091	J	0.0000027	J	25%
CKNA-SS25	0.0000031	0.00000090	U	0.0000022	J	29%
CKSA-SS58	0.0000031	0.00000090	U	0.0000022	J	29%
CKSA-SS55	0.0000029	0.00000090	U	0.0000020	J	31%
CKSA-SS49	0.000028	0.0000090	U	0.0000190	J	32%
CKNA-SS09	0.0000028	0.00000090	U	0.0000019	J	32%
CKSA-SS33	0.0000028	0.00000090	U	0.0000019	J	32%
CKNA-SS33	0.0000027	0.00000090	U	0.0000018	J	33%
CKSA-SS04	0.000027	0.0000090	UJ	0.0000180	J	33%
CKSA-SS19	0.00027	0.000090	U	0.0001800	J	33%
CKSA-SS40	0.00027	0.000090	U	0.0001800	J	33%
CKNA-SS12	0.0000025	0.00000090	J	0.0000016	J	36%
CKNA-SS31	0.0000023	0.00000090	U	0.0000014	J	39%
CKSA-SS05	0.000023	0.0000090	UJ	0.0000140	J	39%

Table 6-2: Evaluation of Total 2,3,7,8-TCDD TEQ Concentrations

Sample ID	Total 2,3,7,8-TCDD TEQ (mg/kg)	Total 2,3,7,8-TCDD TEQ Dioxin-Like PCBs (mg/kg)	Qualifier	Total 2,3,7,8-TCDD TEQ Dioxins (mg/kg)	Qualifier	% of Total 2,3,7,8-TCDD TEQ Risk from Dioxin-like PCBs
CKSA-SS56	0.0000022	0.00000090	J	0.0000013	J	41%
CKSA-SS07	0.000022	0.0000090	UJ	0.0000130	J	41%
CKSA-SS08	0.000022	0.0000090	J	0.0000130	J	41%
CKSA-SS38	0.000022	0.0000090	U	0.0000130	J	41%
CKNA-SS45	0.000021	0.0000090	U	0.0000120	J	43%
CKSA-SS06	0.000021	0.0000090	UJ	0.0000120	J	43%
CKSA-SS27	0.000021	0.0000090	J	0.0000120	J	43%
CKSA-SS43	0.000021	0.0000090	U	0.0000120	J	43%
CKNA-SS22	0.0000021	0.00000090	U	0.0000012	J	43%
CKSA-SS21	0.00021	0.000090	U	0.0001200	J	43%
CKNA-SS19	0.0000019	0.00000090	U	0.0000010	J	47%
CKSA-SS13	0.00019	0.000090	U	0.0001000	J	47%
CKSA-SS15	0.00019	0.000090	U	0.0000990	J	48%
CKNA-SS26	0.000019	0.0000090	U	0.0000095	J	49%
CKSA-SS51	0.000019	0.0000090	U	0.0000095	J	49%
CKSA-SS46	0.000018	0.0000090	U	0.0000089	J	50%
CKSA-SS23	0.00017	0.000090	U	0.0000840	J	52%
CKNA-SS47	0.000015	0.0000090	U	0.0000064	J	58%
CKNA-SS01	0.000015	0.0000090	U	0.0000063	J	59%
CKNA-SS46	0.000015	0.0000090	U	0.0000061	J	60%
CKNA-SS48	0.000030	0.000018	U	0.0000120	J	60%
CKSA-SS41	0.000015	0.0000090	U	0.0000060	J	60%
CKSA-SS44	0.000015	0.0000090	U	0.0000058	J	61%
CKNA-SS14	0.000011	0.0000066	J	0.0000041	J	62%
CKNA-SS21	0.000014	0.0000090	U	0.0000052	J	63%
CKSA-SS48	0.000061	0.000039	J	0.0000220	J	64%
CKNA-SS03	0.000014	0.0000090	U	0.0000046	J	66%
CKSA-SS37	0.000014	0.0000090	U	0.0000046	J	66%
CKNA-SS20	0.000014	0.0000090	U	0.0000045	J	67%
CKSA-SS31	0.000024	0.000017		0.0000072	J	70%
CKSA-SS25	0.000013	0.0000090	J	0.0000038	J	70%
CKNA-SS34	0.000029	0.000022	J	0.0000074	J	75%
CKSA-SS36	0.000012	0.0000090	U	0.0000026	J	78%
CKNA-SS23	0.000011	0.0000090	U	0.0000023	J	80%

Table 6-2: Evaluation of Total 2,3,7,8-TCDD TEQ Concentrations

Sample ID	Total 2,3,7,8-TCDD TEQ (mg/kg)	Total 2,3,7,8-TCDD TEQ Dioxin-Like PCBs (mg/kg)	Qualifier	Total 2,3,7,8-TCDD TEQ Dioxins (mg/kg)	Qualifier	% of Total 2,3,7,8-TCDD TEQ Risk from Dioxin-like PCBs
CKSA-SS34	0.000011	0.0000090	U	0.0000021	J	81%
CKSA-SS47	0.00011	0.000090	U	0.0000190	J	83%
CKNA-SS28	0.000040	0.000033		0.0000067	J	83%
CKNA-SS11	0.000028	0.000023	J	0.0000046	J	83%
CKSA-SS45	0.00010	0.000090	U	0.0000140	J	87%

Notes:

Non-detect (U) values listed were one-half of the detection limit.

Appendix A

Congressional Inquiry Letter

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OFFICE OF LEGISLATIVE AFFAIRS (OLAC), HQMC
TELEPHONE (DSN prefix 22): (b) (6)
PHONE report or due date extension: 45680, 45772, 48454
TELECOPIER (24 hours daily): 44172, 44768
TELECOPIER VERIFICATION #'s: 41738, 45663
E-MAIL ADDRESS: (b) (6)

5730
OLAC-5P
14 Mar 18

TELECOPIER MEMORANDUM

From: CMC (OLAC), HQMC, Washington, DC
To: CG, MCIPAC, MCB CAMP BUTLER, OKINAWA, JAPAN

Subj: CONGRESSIONAL/SPECIAL INTEREST CORRESPONDENCE, RE: (b) (6)

Encl: (1) Copy of Congresswoman Julia Brownley's ltr of 20 Feb 18, w/encls

1. Information to respond to enclosure (1) is requested. **Please acknowledge the receipt of this fax via the e-mail address.**

2. **The final Marine Corps reply to enclosure (1) will be signed by the Legislative Assistant to the Commandant.**

3. Time your report to arrive to OLAC by **27 Mar 18**. **Extensions will not normally be granted. To expedite this case, a signed copy of your response may be sent as an email attachment.**

4. Comment on enclosure (1) as deemed appropriate. In particular, please address the following items:

a. (b) (6) would like information regarding the environmental status and potential contamination of the base in Japan and any efforts to remediate the site. Her grandson was recently stationed there and she is concerned about the environment him and his family will be exposed to.

b. Please provide complete information to assist OLAC in preparing a comprehensive reply for signature by the Legislative Assistant to the Commandant.

(b) (6)

DEPARTMENT OF THE NAVY
COMMANDER NAVY INSTALLATIONS COMMAND
716 SICARD STREET SE SUITE 1000
WASHINGTON NAVY YARD DC 20374-5140

12000
Ser N00/ 18U079
March 1, 2018

The Honorable Julia Brownley
Attn: Constituent Services
223 E. Thousand Oaks Blvd, Suite 220
Thousand Oaks, CA 91360

MAR 5 2018

Dear Congresswoman Brownley:

(b) (6) … for your letter of February 20, 2018 on behalf of your constituent, (b) (6) concerning potential environmental contamination at Camp Kinser, near Okinawa's capital.

Your letter has been forwarded to Marine Corps Installations Command (MCICOM) who has cognizance over this issue.

If you should need any further assistance, my point of contact is (b) (6) who may be reached at (b) (6)

Sincerely,

(b) (6)

JULIA BROWNLEY
28TH DISTRICT, CALIFORNIA
MEMBER OF CONGRESS
http://juliabrownley.house.gov

COMMITTEE ON VETERANS' AFFAIRS
RANKING MEMBER, SUBCOMMITTEE ON HEALTH
SUBCOMMITTEE ON DISABILITY ASSISTANCE AND MEMORIAL AFFAIRS

COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE
SUBCOMMITTEE ON AVIATION
SUBCOMMITTEE ON COAST GUARD AND MARITIME TRANSPORTATION
SUBCOMMITTEE ON HIGHWAYS AND TRANSIT

Congress of the United States
House of Representatives
Washington, DC 20515–0526

WASHINGTON, DC OFFICE:
1019 LONGWORTH HOUSE OFFICE BUILDING
WASHINGTON, DC 20515
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THOUSAND OAKS, CA OFFICE:
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OXNARD, CA OFFICE:
300 EAST ESPLANADE DRIVE, SUITE 470
OXNARD, CA 93036
PHONE: 805-379-1779
FAX: 805-379-1799

February 20, 2018

(b) (6)
U.S. Department of the Navy

Dear (b) (6)

Enclosed please find correspondence from my constituent, (b) (6) I believe you will find this to be self-explanatory.

I would appreciate your careful review of this situation and any information which might be helpful to my constituent. Please direct your response to (b) (6) in my district office at (b) (6)

Thank you for your assistance.

Sincerely,

Julia Brownley
Member of Congress

JB/LS

JULIA BROWNLEY
26TH DISTRICT, CALIFORNIA
MEMBER OF CONGRESS
http://juliabrownley.house.gov

COMMITTEE ON VETERANS' AFFAIRS
RANKING MEMBER, SUBCOMMITTEE ON HEALTH
SUBCOMMITTEE ON DISABILITY ASSISTANCE AND MEMORIAL AFFAIRS

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Congresswoman Julia Brownley
Casework Authorization Form

(Please print, sign, and mail or fax the completed form to Congresswoman Brownley's District Office.)

Date: 2/10/18

Agency Involved: ____________________

Numbers Identifying Case (VA claim, A number, tax ID, etc.): ____________________

Name: (b) (6)

Branch of Service (if applicable): ____________________

Years of Service (if applicable): ____________________

Place and Date of Birth: ____________________

Social Security #: ____________________

Full Home Address:
(b) (6)

Telephone #: ____________________

Email Address: (b) (6)

I, ____________________, authorize the ____________________ (agency involved) to release personal information to Congresswoman Julia Brownley United States Representative. I authorize Congresswoman Julia Brownley to request and have access to all records and reports pertinent to my request for her assistance in the following matter:

Nature of Problem:
See ~~[illegible]~~ attached

NOTE:
The Privacy Act of 1974 requires that Members of Congress or their staff have written authorization before they can obtain information about an individual's case. We must have your signature

Signatur (b) (6)

Date: 2/10/18

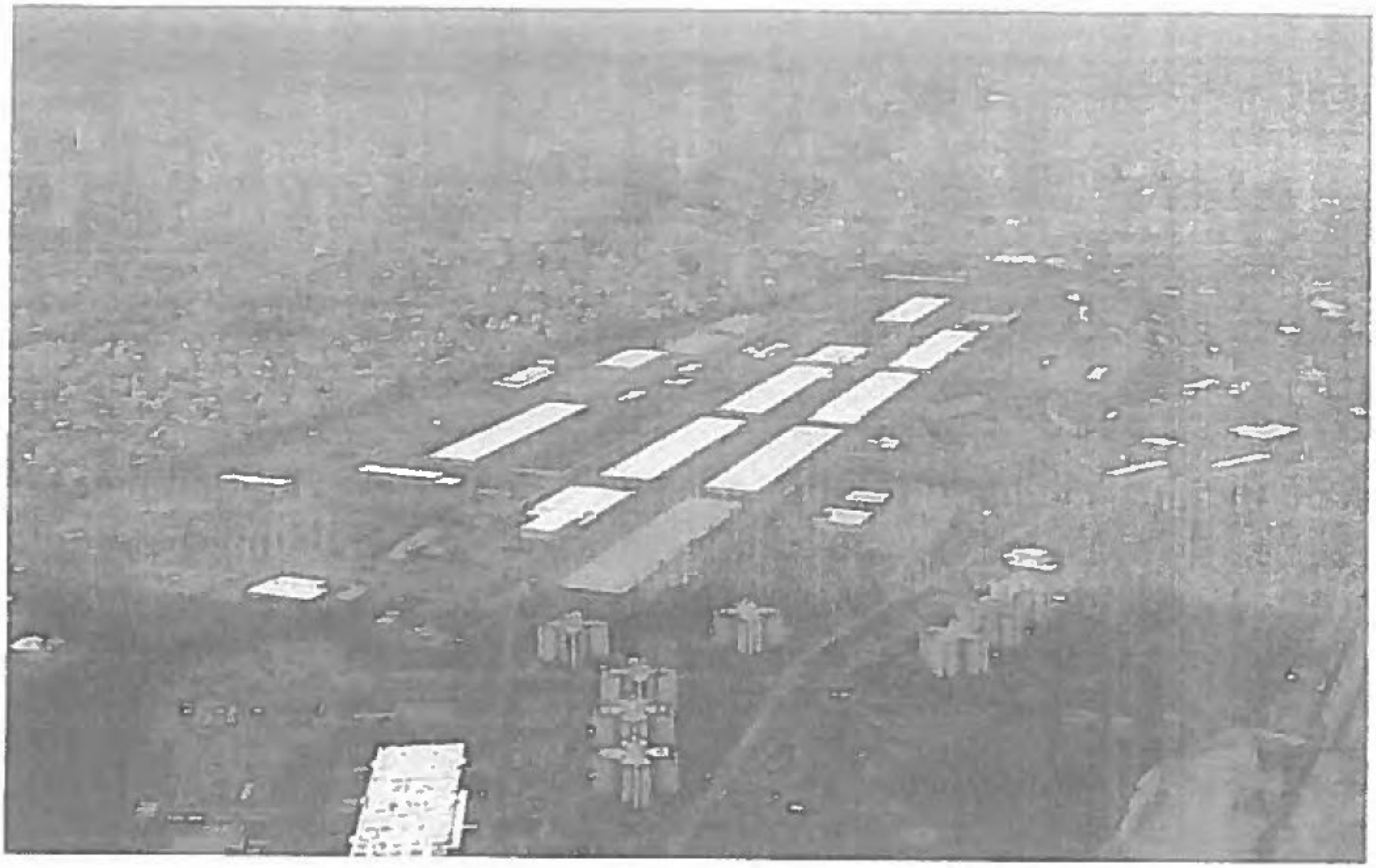
Print, sign and then mail or fax your completed authorization form to Congresswoman Julia Brownley at the following address:

Office of Congresswoman Julia Brownley
Attention: Constituent Services
223 E. Thousand Oaks Blvd., Suite 220
Thousand Oaks, CA 91360
Phone: (805) 379-1779
Fax: (805) 379-1799

[✓] I authorize that a statement, interview, photograph, video, and/or audio recording may be taken of me by Congresswoman Julia Brownley (and/or her staff) or by members of the news media regarding my case with Congresswoman Brownley's office for the purposes of responding to a media inquiry, or for promoting Congresswoman Brownley's constituent services.
Initial Here (b) (6)

[ ] I would like to sign up for Congresswoman Brownley's e-Newsletter.

the japan times



Pentagon blocks report on 'toxic contamination' at base outside Okinawa capital

The U.S. military is refusing to release a report detailing environmental contamination at Camp Kinser, a 2.7-sq.-km U.S. Marine Corps supply base near Okinawa's capital, Naha, that is scheduled for return to civilian use.

Since April 2014, U.S. Pacific Command has repeatedly stonewalled a Freedom of Information Act request for the 1993 report, titled "USFJ Talking Paper on Possible Toxic Contamination at Camp Kinser, Okinawa." Initially, in October 2014, the U.S. authorities acknowledged they possessed the report but refused to release it, citing, among other reasons, a need "to protect against public confusion." Following an FOIA appeal and further demands for the document, officials appeared to backtrack in August by suggesting that they did not have the report and they required more time to locate it.

Although the full text of the discussion paper remains under wraps, excerpts have been previously quoted in documents prepared for the U.S. military that are publicly available. These excerpts suggest extensive pollution on Camp Kinser.

One section cites "evidence of environmental contamination by heavy metals and pesticides caused by past hazardous material storage practices." Another part reveals the burial of more than 12.5 tons of toxic ferric chloride on the base and the dumping of pesticides in a landfill at Camp Hansen, central Okinawa.

The report describes Camp Kinser — which was formerly called the Machinato or Makiminato Service Area — as a key storage site for retrograde chemicals from the Vietnam War including "insecticides, rodenticides, herbicides, inorganic and organic acids, alkalis, inorganic salts, organic solvents, and vapor degreasers."

At the time of publication, U.S. Forces Japan had not responded to requests for comment on its reluctance to release the full discussion paper.

However, Manabu Sato, a professor of political science at Okinawa International University, suggested the motivation might relate to future plans for the base.

"The return of Camp Kinser is one of the most celebrated features of the so-called 'reduction of the U.S. military footprint on Okinawa.' Thus the Pentagon wants to conceal the reality of contamination that would damage the political value of its return," he told The Japan Times.

Under a 2013 Japan-U.S. agreement to consolidate the Pentagon presence on Okinawa, Camp Kinser is supposed to be returned to civilian control in a three-phase plan expected to be completed in "2025 or later." A 1-hectare section of the base consisting of an access road was returned in 2013; another 2-hectare parcel was scheduled to be returned in 2014, but that handover has not yet taken place.

Due to Camp Kinser's proximity to Naha, the land is considered prime real estate for future development — particularly for the island's tourist industry. Okinawa's economy used to be dependent on the U.S. military; however, today, according to prefecture statistics, the Pentagon presence contributes only about 5 percent to the local economy. Moreover, in recent years, contamination on former military land has hampered plans for its smooth transition to civilian control.

Camp Kinser is one of the USMC's largest supply bases on Okinawa, stockpiling ammunition, fuel and vehicles. It also hosts an elementary school and accommodation for service members and their families; approximately 1,000 base employees work on the installation. Some 114,000 people live in the neighboring city of Urasoe.

A series of incidents have sparked fears among local residents about environmental pollution at Camp Kinser. In 2009, six Japanese workers fell ill following exposure to an unknown substance at a warehouse on the base. In 2013, mongooses caught near the installation showed high levels of poisonous polychlorinated biphenyls (PCBs), while earlier this month, scientists from Meio University and Ehime University reported that *habu* snakes in the vicinity of Camp Kinser were also found to contain elevated concentrations of PCBs and the banned insecticide DDT.

In response to the habu report, the mayor of Urasoe, Tetsuji Matsumoto, ordered tests on local water and announced he would ask Tokyo to conduct an investigation.

Under the Japan-U.S. Status of Forces Agreement, Washington is not obliged to allow Japanese officials to inspect its military bases for contamination — nor is it responsible for the cleanup of polluted former base land.

Currently the U.S. and Japan are finalizing an environmental stewardship agreement to supplement SOFA that is expected to allow local officials access to bases in the event of chemical spills or to conduct surveys on land scheduled for imminent return.

Jon Mitchell received the inaugural Foreign Correspondents' Club of Japan Freedom of the Press Award for Lifetime Achievement earlier this year for his investigations into U.S. military contamination on Okinawa and other base-related problems. Your comments: community@japantimes.co.jp (mailto:community@japantimes.co.jp)

Appendix B

Risk-Based Screening Evaluations

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Risk-Based Screening Evaluation

A risk-based screening evaluation (i.e., a U.S. Navy Tier 1 evaluation) was performed as part of an investigation of historical storage areas (Northern Area and Southern Area) within Camp Kinser (Site). The risk-based screening evaluation was conducted using the site-wide dataset to focus the Human Health Risk Assessment (HHRA) on those constituents that could pose a significant risk to human health, identified as constituents of potential concern (COPCs).

Two risk-based screening evaluations were conducted to identify COPCs for further evaluation in the HHRA: one evaluation focused on surface soil and one evaluation focused on VI. For surface soil, concentrations were compared to May 2019 USEPA Regional Screening Levels (RSLs) for residential land use. For VI, groundwater and sub-slab soil gas sample results were compared to May 2019 VI Screening Levels (VISLs) for residential land use, which were derived from RSLs protective of residential ambient air.[1] Residential land use parameters were used for the Tier 1 screening evaluations; however, these parameters were overly conservative for the Site, which is not currently used for residential purposes. The RSLs/VISLs correspond to a cancer risk of 1E-06 and noncancer hazard quotient (HQ) of 1 using generic, health protective exposure assumptions (USEPA 2019).

The approach for identifying COPCs to retain in the HHRA is presented below. The surface soil, groundwater, and sub-slab soil gas COPC data-reduction results are summarized in Tables B-1 through B-3, respectively.

Approach for Evaluating Constituents Not Detected in Any Sample

- A constituent was retained for further evaluation as a COPC in the HHRA if it was not detected in any sample and:
    - the method detection limit (MDL) was greater than 10 times the RSL/VISL (or 10 times the laboratory limit of quantification [LOQ] if a RSL/VISL was not available).[2]

Approach for Evaluating Constituents Detected in at Least One Sample

- A detected constituent was retained for further evaluation as a COPC in the HHRA if it was detected in:
    - greater than or equal to 5% of the samples and the maximum detected concentration was greater than the RSL/VISL or no RSL/VISL was available; or
    - less than 5% of the samples but the maximum detected concentration was greater than 10 times the RSL/VISL; or
    - less than 5% of the samples, there was geographical correlation, and an RSL or a VISL was not available.

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[1] Groundwater results were evaluated for the VI pathway only; direct contact risks via groundwater were not evaluated.

[2] The laboratory LOQ was presented in the Work Plan (NAVFAC 2018).

Results

A total of 34 surface soil COPCs[3], 6 groundwater COPCs, and 29 sub-slab soil gas COPCs were identified based on the Tier 1 screening. The COPCs were retained for further evaluation in the HHRA.

References

NAVFAC. 2018. Final Site Investigation Work Plan Former Makiminato Service Area (Southern Area) and Fill Site (Northern Area). Camp Kinser Okinawa Prefecture Japan. October.

USEPA 2019. Regional Screening Levels for Chemical Contaminants at Superfund Sites. Retrieved from https://www.epa.gov/risk/regional-screening-levels-rsls. May.

[3] Total dioxins/furans (2,3,7,8-TCDD TEQs) as dioxins and total dioxins/furans (2,3,7,8-TCDD TEQs) as PCBs were combined in order to evaluate total dioxin/furans (2,3,7,8-TCDD TEQs) in the HHRA.

Tables

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Table B-1: Surface Soil Risk-Based Screening Evaluation

Constituent	Number of Samples	Number of Detected Samples	% of Detected Samples	Maximum Nondetected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	May 2019 USEPA Carcinogenic Residential RSL (mg/kg)	May 2019 USEPA Non-Carcinogenic Residential RSL (mg/kg)	COPC?	COPC Reason[1]
Total Dioxins/Furans (2,3,7,8-TCDD TEQs) as Dioxins	107	107	100	--	0.0025	0.0000048	0.000051	COPC[2]	Detected in ≥5% of samples and >RSL
Total Dioxins/Furans (2,3,7,8-TCDD TEQs) as PCBs	107	22	21	0.00018	0.000039	0.0000048	0.000051	COPC[2]	Detected in ≥5% of samples and >RSL
Arsenic, Inorganic	107	107	100	--	35	0.68	35	COPC	Detected in ≥5% of samples and >RSL
Total Carcinogenic PAHs (BaP TEQs)	107	87	81	0.063	1.4	0.11	18	COPC	Detected in ≥5% of samples and >RSL
Benzo[a]pyrene	107	85	79	0.026	0.97	0.11	18	COPC	Detected in ≥5% of samples and >RSL
Benzo[b]fluoranthene	107	85	79	0.026	1.2	1.1	--	COPC	Detected in ≥5% of samples and >RSL
DDT	107	63	59	0.0016	5.5	1.9	37	COPC	Detected in ≥5% of samples and >RSL
DDE	107	54	50	0.0040	4.6	2.0	23	COPC	Detected in ≥5% of samples and >RSL
Dieldrin	107	32	30	0.0020	15	0.034	3.2	COPC	Detected in ≥5% of samples and >RSL
Dibenz[a,h]anthracene	107	27	25	0.030	0.14	0.11	--	COPC	Detected in ≥5% of samples and >RSL
Chromium(VI)	107	26	24	0.20	2.0	0.30	230	COPC	Detected in ≥5% of samples and >RSL
alpha-Chlordane	107	25	23	0.0020	2.3	1.7	35	COPC	Detected in ≥5% of samples and >RSL
gamma-Chlordane	107	20	19	0.0020	2.3	1.7	35	COPC	Detected in ≥5% of samples and >RSL
Chlordane, Technical	107	17	16	0.050	17	1.7	35	COPC	Detected in ≥5% of samples and >RSL
Total PCBs (Aroclor Method)	107	14	13	0.048	9.5	0.23	--	COPC	Detected in ≥5% of samples and >RSL
DDD	107	10	9.3	0.0040	24	2.3	1.9	COPC	Detected in ≥5% of samples and >RSL
Thorium-232	107	107	100	--	8.2	--	--	COPC	Detected in ≥5% of samples and no RSL
Titanium	107	107	100	--	438	--	--	COPC	Detected in ≥5% of samples and no RSL
Benzo(g,h,i)perylene	107	81	76	0.026	0.54	--	--	COPC	Detected in ≥5% of samples and no RSL
Phenanthrene	107	46	43	0.030	1.2	--	--	COPC	Detected in ≥5% of samples and no RSL
Carbazole	107	12	11	0.030	0.13	--	--	COPC	Detected in ≥5% of samples and no RSL
Acenaphthylene	107	10	9.3	0.030	0.056	--	--	COPC	Detected in ≥5% of samples and no RSL
2,4-DDT	107	6	5.6	0.010	0.011	--	--	COPC	Detected in ≥5% of samples and no RSL
7,12-Dimethylbenz(a)anthracene	107	0	0.0	2.0	--	0.00046	--	COPC	ND in each sample and maximum ND >10x RSL
2-Acetylaminofluorene	107	0	0.0	2.0	--	0.14	--	COPC	ND in each sample and maximum ND >10x RSL
3-Methylcholanthrene	107	0	0.0	2.0	--	0.0055	--	COPC	ND in each sample and maximum ND >10x RSL
N-Nitrosodiethylamine	107	0	0.0	2.0	--	0.00081	--	COPC	ND in each sample and maximum ND >10x RSL
N-Nitrosodimethylamine	107	0	0.0	2.0	--	0.0020	0.53	COPC	ND in each sample and maximum ND >10x RSL
N-Nitroso-di-N-butylamine	107	0	0.0	2.0	--	0.099	--	COPC	ND in each sample and maximum ND >10x RSL
N-Nitroso-di-N-propylamine	107	0	0.0	2.0	--	0.078	--	COPC	ND in each sample and maximum ND >10x RSL
N-Nitrosomethylethylamine	107	0	0.0	2.0	--	0.020	--	COPC	ND in each sample and maximum ND >10x RSL
N-Nitrosomorpholine	107	0	0.0	2.0	--	0.081	--	COPC	ND in each sample and maximum ND >10x RSL
N-Nitrosopiperidine	107	0	0.0	2.0	--	0.058	--	COPC	ND in each sample and maximum ND >10x RSL
p-Dimethylamino azobenzene	107	0	0.0	2.0	--	0.12	--	COPC	ND in each sample and maximum ND >10x RSL
Total PCBs (Congener Method)	107	101	94	0.00033	2.3	0.23	--	^^	Detected in ≥5% of samples and >RSL
Aroclor 1260	107	14	13	0.0040	9.5	0.24	--	^^	Detected in ≥5% of samples and >RSL
Fluorene	107	5	4.7	0.030	0.086	--	2,400	--	Detected in ≤5% of samples and max detect <10x RSL
Bis(2-ethylhexyl)phthalate	107	5	4.7	2.8	3.2	39	1,300	--	Detected in ≤5% of samples and max detect <10x RSL
Pentachlorophenol	107	4	3.7	0.038	0.037	1.0	250	--	Detected in ≤5% of samples and max detect <10x RSL
Naphthalene	107	2	1.9	0.030	0.0030	3.8	130	--	Detected in ≤5% of samples and max detect <10x RSL
Diethyl Phthalate	107	2	1.9	2.0	3.8	--	51,000	--	Detected in ≤5% of samples and max detect <10x RSL
1-Methylnaphthalene	107	1	0.93	0.030	0.020	18	4,200	--	Detected in ≤5% of samples and max detect <10x RSL
2-Methylnaphthalene	107	1	0.93	0.030	0.016	--	240	--	Detected in ≤5% of samples and max detect <10x RSL
Butylate	107	1	0.93	0.080	0.063	--	3,900	--	Detected in ≤5% of samples and max detect <10x RSL
Heptachlor	107	1	0.93	0.0020	0.15	0.13	39	--	Detected in ≤5% of samples and max detect <10x RSL
Heptachlor Epoxide	107	1	0.93	0.0020	0.095	0.070	1.0	--	Detected in ≤5% of samples and max detect <10x RSL
Motor Oil Range Organics (~C24~C40)	107	107	100	--	230	--	230,000**	--	Detected in ≥5% of samples and max detect <RSL
Aluminum	107	107	100	--	19,400	--	77,000	--	Detected in ≥5% of samples and max detect <RSL
Barium	107	107	100	--	77	--	15,000	--	Detected in ≥5% of samples and max detect <RSL
Beryllium and compounds	107	107	100	--	1.4	1,600	160	--	Detected in ≥5% of samples and max detect <RSL
Cadmium	107	107	100	--	3.4	2,100	71	--	Detected in ≥5% of samples and max detect <RSL
Chromium, Total	107	107	100	--	68	--	120,000	--	Detected in ≥5% of samples and max detect <RSL
Cobalt	107	107	100	--	9.0	420	23	--	Detected in ≥5% of samples and max detect <RSL
Copper	107	107	100	--	69	--	3,100	--	Detected in ≥5% of samples and max detect <RSL
Iron	107	107	100	--	39,600	--	55,000	--	Detected in ≥5% of samples and max detect <RSL
Lead and Compounds	107	107	100	--	197	--	400	--	Detected in ≥5% of samples and max detect <RSL
Lithium	107	107	100	--	14	--	160	--	Detected in ≥5% of samples and max detect <RSL
Manganese	107	107	100	--	819	--	1,800	--	Detected in ≥5% of samples and max detect <RSL

Table B-1: Surface Soil Risk-Based Screening Evaluation

Constituent	Number of Samples	Number of Detected Samples	% of Detected Samples	Maximum Nondetected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	May 2019 USEPA Carcinogenic Residential RSL (mg/kg)	May 2019 USEPA Non-Carcinogenic Residential RSL (mg/kg)	COPC?	COPC Reason[1]
Mercury (elemental)	107	107	100	--	0.37	--	11	--	Detected in ≥5% of samples and max detect <RSL
Nickel Soluble Salts	107	107	100	--	21	15,000	1,500	--	Detected in ≥5% of samples and max detect <RSL
Selenium	107	107	100	--	0.40	--	390	--	Detected in ≥5% of samples and max detect <RSL
Strontium, Stable	107	107	100	--	5,985	--	47,000	--	Detected in ≥5% of samples and max detect <RSL
Vanadium	107	107	100	--	38	--	390	--	Detected in ≥5% of samples and max detect <RSL
Molybdenum	107	106	99	0.010	0.84	--	390	--	Detected in ≥5% of samples and max detect <RSL
Antimony (metallic)	107	104	97	0.070	7.0	--	31	--	Detected in ≥5% of samples and max detect <RSL
Thallium (Soluble Salts)	107	104	97	0.020	0.23	--	0.78	--	Detected in ≥5% of samples and max detect <RSL
Zinc and Compounds	107	101	94	0.75	1,260	--	23,000	--	Detected in ≥5% of samples and max detect <RSL
Cyanide (CN-)	107	97	91	0.16	0.92	--	23	--	Detected in ≥5% of samples and max detect <RSL
Silver	107	97	91	0.020	0.46	--	390	--	Detected in ≥5% of samples and max detect <RSL
Pyrene	107	89	83	0.026	1.7	--	1,800	--	Detected in ≥5% of samples and max detect <RSL
Fluoranthene	107	84	79	0.026	2.1	--	2,400	--	Detected in ≥5% of samples and max detect <RSL
Boron And Borates Only	107	82	77	1.6	38	--	16,000	--	Detected in ≥5% of samples and max detect <RSL
Benz[a]anthracene	107	77	72	0.051	0.88	1.1	--	--	Detected in ≥5% of samples and max detect <RSL
Indeno[1,2,3-cd]pyrene	107	76	71	0.026	0.51	1.1	--	--	Detected in ≥5% of samples and max detect <RSL
Diesel Range Organics [C10-C24]	107	71	66	33	48	--	96**	--	Detected in ≥5% of samples and max detect <RSL
Chrysene	107	64	60	0.046	0.82	110	--	--	Detected in ≥5% of samples and max detect <RSL
Benzo[k]fluoranthene	107	62	58	0.026	0.38	11	--	--	Detected in ≥5% of samples and max detect <RSL
Anthracene	107	26	24	0.030	0.26	--	18,000	--	Detected in ≥5% of samples and max detect <RSL
Tin	107	21	20	0.20	14	--	47,000	--	Detected in ≥5% of samples and max detect <RSL
Endrin	107	14	13	0.0020	0.38	--	19	--	Detected in ≥5% of samples and max detect <RSL
Acenaphthene	107	9	8.4	0.030	0.17	--	3,600	--	Detected in ≥5% of samples and max detect <RSL
Dibenzofuran	107	0	0.0	2.0	--	--	73	--	ND in each sample and max ND <10x RSL
beta-Chloronaphthalene	107	0	0.0	2.0	--	--	4,800	--	ND in each sample and max ND <10x RSL
Aroclor 1016	107	0	0.0	0.010	--	6.7	4.1	--	ND in each sample and max ND <10x RSL
Aroclor 1221	107	0	0.0	0.0060	--	0.20	--	--	ND in each sample and max ND <10x RSL
Aroclor 1232	107	0	0.0	0.0040	--	0.17	--	--	ND in each sample and max ND <10x RSL
Aroclor 1242	107	0	0.0	0.0040	--	0.23	--	--	ND in each sample and max ND <10x RSL
Aroclor 1248	107	0	0.0	0.0040	--	0.23	--	--	ND in each sample and max ND <10x RSL
Aroclor 1254	107	0	0.0	0.0040	--	0.24	1.2	--	ND in each sample and max ND <10x RSL
2,4,5-Trichlorophenoxyacetic Acid	107	0	0.0	0.038	--	--	630	--	ND in each sample and max ND <10x RSL
2,4,5-Trichlorophenoxypropionic Acid	107	0	0.0	0.038	--	--	510	--	ND in each sample and max ND <10x RSL
2,4-Dichlorophenoxy Acetic Acid	107	0	0.0	0.19	--	--	700	--	ND in each sample and max ND <10x RSL
Aldrin	107	0	0.0	0.0020	--	0.039	2.3	--	ND in each sample and max ND <10x RSL
alpha-Hexachlorocyclohexane	107	0	0.0	0.0020	--	0.086	510	--	ND in each sample and max ND <10x RSL
beta-Hexachlorocyclohexane	107	0	0.0	0.0020	--	0.30	--	--	ND in each sample and max ND <10x RSL
Diazinon	107	0	0.0	0.040	--	--	44	--	ND in each sample and max ND <10x RSL
Dimethoate	107	0	0.0	0.050	--	--	140	--	ND in each sample and max ND <10x RSL
Disulfoton	107	0	0.0	0.030	--	--	2.5	--	ND in each sample and max ND <10x RSL
Hexachlorocyclohexane, Gamma- (Lindane)	107	0	0.0	0.0020	--	0.57	21	--	ND in each sample and max ND <10x RSL
Malathion	107	0	0.0	0.050	--	--	1,300	--	ND in each sample and max ND <10x RSL
Methoxychlor	107	0	0.0	0.0020	--	--	320	--	ND in each sample and max ND <10x RSL
Methyl Parathion	107	0	0.0	0.040	--	--	16	--	ND in each sample and max ND <10x RSL
Parathion	107	0	0.0	0.040	--	--	380	--	ND in each sample and max ND <10x RSL
Phorate	107	0	0.0	0.040	--	--	13	--	ND in each sample and max ND <10x RSL
Tetraethyl Dithiopyrophosphate	107	0	0.0	0.040	--	--	32	--	ND in each sample and max ND <10x RSL
Toxaphene	107	0	0.0	0.050	--	0.49	5.7	--	ND in each sample and max ND <10x RSL
1,1'-Biphenyl	107	0	0.0	2.0	--	87	47	--	ND in each sample and max ND <10x RSL
1,2,4,5-Tetrachlorobenzene	107	0	0.0	2.0	--	--	23	--	ND in each sample and max ND <10x RSL
1,2,4-Trichlorobenzene	107	0	0.0	2.0	--	24	58	--	ND in each sample and max ND <10x RSL
1,2-Dichlorobenzene	107	0	0.0	2.0	--	--	1,800	--	ND in each sample and max ND <10x RSL
1,2-Diphenylhydrazine	107	0	0.0	2.3	--	0.68	--	--	ND in each sample and max ND <10x RSL
1,3,5-Trinitrobenzene	107	0	0.0	2.0	--	--	2,200	--	ND in each sample and max ND <10x RSL
1,3-Dinitrobenzene	107	0	0.0	2.0	--	--	6.3	--	ND in each sample and max ND <10x RSL
1,4-Dichlorobenzene	107	0	0.0	2.0	--	2.6	3,400	--	ND in each sample and max ND <10x RSL
1,4-Dioxane	107	0	0.0	4.0	--	5.3	810	--	ND in each sample and max ND <10x RSL
2,3,4,6-Tetrachlorophenol	107	0	0.0	2.0	--	--	1,900	--	ND in each sample and max ND <10x RSL

Table B-1: Surface Soil Risk-Based Screening Evaluation

Constituent	Number of Samples	Number of Detected Samples	% of Detected Samples	Maximum Nondetected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	May 2019 USEPA Carcinogenic Residential RSL (mg/kg)	May 2019 USEPA Non-Carcinogenic Residential RSL (mg/kg)	COPC?	COPC Reason[1]
2,4,5-Trichlorophenol	107	0	0.0	2.2	--	--	6,300	--	ND in each sample and max ND <10x RSL
2,4,6-Trichlorophenol	107	0	0.0	2.0	--	49	63	--	ND in each sample and max ND <10x RSL
2,4-Dichlorophenol	107	0	0.0	2.0	--	--	190	--	ND in each sample and max ND <10x RSL
2,4-Dimethylphenol	107	0	0.0	2.0	--	--	1,300	--	ND in each sample and max ND <10x RSL
2,4-Dinitrophenol	106	0	0.0	4.0	--	--	130	--	ND in each sample and max ND <10x RSL
2,4-Dinitrotoluene	107	0	0.0	2.0	--	1.7	130	--	ND in each sample and max ND <10x RSL
2,6-Dinitrotoluene	107	0	0.0	2.0	--	0.36	19	--	ND in each sample and max ND <10x RSL
2-Chlorophenol	107	0	0.0	2.0	--	--	390	--	ND in each sample and max ND <10x RSL
2-Methyl-5-Nitroaniline	107	0	0.0	2.0	--	60	1,300	--	ND in each sample and max ND <10x RSL
2-Nitroaniline	107	0	0.0	2.0	--	--	630	--	ND in each sample and max ND <10x RSL
3,3'-Dichlorobenzidine	107	0	0.0	2.0	--	1.2	--	--	ND in each sample and max ND <10x RSL
4-(2,4-Dichlorophenoxy)butyric Acid	107	0	0.0	0.38	--	--	1,900	--	ND in each sample and max ND <10x RSL
4,6-Dinitro-o-cresol	107	0	0.0	2.0	--	--	5.1	--	ND in each sample and max ND <10x RSL
4-Nitroaniline	107	0	0.0	4.0	--	27	250	--	ND in each sample and max ND <10x RSL
Acetophenone	107	0	0.0	2.0	--	--	7,800	--	ND in each sample and max ND <10x RSL
Aldicarb	107	0	0.0	0.040	--	--	63	--	ND in each sample and max ND <10x RSL
Aldicarb Sulfone	107	0	0.0	0.030	--	--	63	--	ND in each sample and max ND <10x RSL
Atrazine	107	0	0.0	2.0	--	2.4	2,200	--	ND in each sample and max ND <10x RSL
Baygon	107	0	0.0	0.020	--	--	250	--	ND in each sample and max ND <10x RSL
Benomyl	107	0	0.0	0.040	--	--	3,200	--	ND in each sample and max ND <10x RSL
Benzyl Alcohol	107	0	0.0	2.0	--	--	6,300	--	ND in each sample and max ND <10x RSL
Bis(2-chloro-1-methylethyl) ether	107	0	0.0	2.0	--	--	3,100	--	ND in each sample and max ND <10x RSL
Bis(2-chloroethoxy)methane	107	0	0.0	2.0	--	--	190	--	ND in each sample and max ND <10x RSL
Bis(2-chloroethyl)ether	107	0	0.0	2.0	--	0.23	--	--	ND in each sample and max ND <10x RSL
Butyl Benzyl Phthlate	107	0	0.0	2.0	--	290	13,000	--	ND in each sample and max ND <10x RSL
Caprolactam	107	0	0.0	8.0	--	--	31,000	--	ND in each sample and max ND <10x RSL
Carbaryl	107	0	0.0	0.020	--	--	6,300	--	ND in each sample and max ND <10x RSL
Carbofuran	107	0	0.0	0.030	--	--	320	--	ND in each sample and max ND <10x RSL
Chloramben	107	0	0.0	0.19	--	--	950	--	ND in each sample and max ND <10x RSL
Chlorobenzilate	107	0	0.0	2.0	--	4.9	1,300	--	ND in each sample and max ND <10x RSL
Chlorpyrifos	107	0	0.0	0.090	--	--	63	--	ND in each sample and max ND <10x RSL
Dacthal	107	0	0.0	0.040	--	--	630	--	ND in each sample and max ND <10x RSL
Dalapon	107	0	0.0	0.38	--	--	1,900	--	ND in each sample and max ND <10x RSL
Demeton	107	0	0.0	0.040	--	--	2.5	--	ND in each sample and max ND <10x RSL
Di(2-ethylhexyl)adipate	107	0	0.0	2.0	--	450	38,000	--	ND in each sample and max ND <10x RSL
Diallate	107	0	0.0	2.4	--	8.9	--	--	ND in each sample and max ND <10x RSL
Dibutyl-n-butyl Phthalate	107	0	0.0	2.3	--	--	6,300	--	ND in each sample and max ND <10x RSL
Dicamba	107	0	0.0	0.038	--	--	1,900	--	ND in each sample and max ND <10x RSL
Dichlorvos	107	0	0.0	0.090	--	1.9	32	--	ND in each sample and max ND <10x RSL
Di-n-octyl Phthalate	107	0	0.0	2.3	--	--	630	--	ND in each sample and max ND <10x RSL
Dinoseb	107	0	0.0	0.096	--	--	63	--	ND in each sample and max ND <10x RSL
Diphenyl Ether	107	0	0.0	2.0	--	--	34	--	ND in each sample and max ND <10x RSL
Diuron	107	0	0.0	0.050	--	--	130	--	ND in each sample and max ND <10x RSL
EPTC	107	0	0.0	0.20	--	--	3,900	--	ND in each sample and max ND <10x RSL
Ethion	107	0	0.0	0.040	--	--	32	--	ND in each sample and max ND <10x RSL
Ethyl-p-nitrophenyl Phosphonate	107	0	0.0	0.040	--	--	0.63	--	ND in each sample and max ND <10x RSL
Fluometuron	107	0	0.0	0.020	--	--	820	--	ND in each sample and max ND <10x RSL
Guthion	107	0	0.0	0.050	--	--	190	--	ND in each sample and max ND <10x RSL
Hexachlorobenzene	107	0	0.0	0.010	--	0.21	63	--	ND in each sample and max ND <10x RSL
Hexachlorobutadiene	107	0	0.0	2.0	--	1.2	78	--	ND in each sample and max ND <10x RSL
Hexachlorocyclopentadiene	107	0	0.0	4.0	--	--	1.8	--	ND in each sample and max ND <10x RSL
Hexachloroethane	107	0	0.0	2.0	--	1.8	45	--	ND in each sample and max ND <10x RSL
Isophorone	107	0	0.0	2.0	--	570	13,000	--	ND in each sample and max ND <10x RSL
Kerb	107	0	0.0	2.0	--	--	4,700	--	ND in each sample and max ND <10x RSL
Linuron	107	0	0.0	0.050	--	--	490	--	ND in each sample and max ND <10x RSL
MCPA	107	0	0.0	38	--	--	32	--	ND in each sample and max ND <10x RSL
MCPP	107	0	0.0	38	--	--	63	--	ND in each sample and max ND <10x RSL
Merphos	107	0	0.0	0.080	--	--	2.3	--	ND in each sample and max ND <10x RSL

Table B-1: Surface Soil Risk-Based Screening Evaluation

Constituent	Number of Samples	Number of Detected Samples	% of Detected Samples	Maximum Nondetected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	May 2019 USEPA Carcinogenic Residential RSL (mg/kg)	May 2019 USEPA Non-Carcinogenic Residential RSL (mg/kg)	COPC?	COPC Reason[1]
Methomyl	107	0	0.0	0.040	--	--	1,600	--	ND in each sample and max ND <10x RSL
Methyl methanesulfonate	107	0	0.0	2.0	--	5.5	--	--	ND in each sample and max ND <10x RSL
Mirex	107	0	0.0	0.040	--	0.036	16	--	ND in each sample and max ND <10x RSL
Molinate	107	0	0.0	0.15	--	--	130	--	ND in each sample and max ND <10x RSL
Naled	107	0	0.0	0.10	--	--	160	--	ND in each sample and max ND <10x RSL
Nitrobenzene	107	0	0.0	2.0	--	5.1	130	--	ND in each sample and max ND <10x RSL
N-Nitrosodiphenylamine	107	0	0.0	3.7	--	110	--	--	ND in each sample and max ND <10x RSL
N-Nitrosopyrrolidine	107	0	0.0	2.0	--	0.26	--	--	ND in each sample and max ND <10x RSL
o-Cresol	107	0	0.0	2.0	--	--	3,200	--	ND in each sample and max ND <10x RSL
Oxamyl	107	0	0.0	0.070	--	--	1,600	--	ND in each sample and max ND <10x RSL
p-Chloroaniline	107	0	0.0	2.0	--	2.7	250	--	ND in each sample and max ND <10x RSL
p-chloro-m-Cresol	107	0	0.0	2.0	--	--	6,300	--	ND in each sample and max ND <10x RSL
p-Cresol	107	0	0.0	2.0	--	--	6,300	--	ND in each sample and max ND <10x RSL
Pebulate	107	0	0.0	0.20	--	--	3,900	--	ND in each sample and max ND <10x RSL
Pentachlorobenzene	107	0	0.0	2.0	--	--	63	--	ND in each sample and max ND <10x RSL
Pentachloroethane	107	0	0.0	2.0	--	7.7	--	--	ND in each sample and max ND <10x RSL
Pentachloronitrobenzene	107	0	0.0	2.0	--	2.7	230	--	ND in each sample and max ND <10x RSL
Phenacetin	107	0	0.0	2.0	--	250	--	--	ND in each sample and max ND <10x RSL
Phenol	107	0	0.0	2.0	--	--	19,000	--	ND in each sample and max ND <10x RSL
Phosmet	107	0	0.0	0.080	--	--	1,300	--	ND in each sample and max ND <10x RSL
Propham	107	0	0.0	0.030	--	--	1,300	--	ND in each sample and max ND <10x RSL
Ronnel	107	0	0.0	0.040	--	--	3,900	--	ND in each sample and max ND <10x RSL
Safrole	107	0	0.0	2.0	--	0.55	--	--	ND in each sample and max ND <10x RSL
Simazine	107	0	0.0	0.040	--	4.5	320	--	ND in each sample and max ND <10x RSL
Tebuthiuron	107	0	0.0	0.020	--	--	4,400	--	ND in each sample and max ND <10x RSL
Aroclor 1262	107	0	0.0	0.0060	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Aroclor 1268	107	0	0.0	0.0060	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
2,4-DDD	107	0	0.0	0.010	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
2,4-DDE	107	0	0.0	0.010	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Acifluorfen	107	0	0.0	0.096	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Bendiocarb	107	0	0.0	0.040	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Bolstar	107	0	0.0	0.040	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Bromacil	107	0	0.0	0.050	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Carbofuran-3-Hydroxy	107	0	0.0	0.010	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Chloroxuron	107	0	0.0	0.050	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Coumaphos	107	0	0.0	0.050	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
delta-Hexachlorocyclohexane	107	0	0.0	0.0020	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Dichlorprop	107	0	0.0	0.19	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Endosulfan I	107	0	0.0	0.0016	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Endosulfan II	107	0	0.0	0.0016	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Endosulfan sulfate	107	0	0.0	0.0020	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Endrin aldehyde	107	0	0.0	0.0040	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Endrin ketone	107	0	0.0	0.0040	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Ethoprop	107	0	0.0	0.040	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Fensulfothion	107	0	0.0	0.050	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Fenthion	107	0	0.0	0.040	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Fenuron	107	0	0.0	0.020	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Formetanate Hydrochloride	107	0	0.0	0.10	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Methiocarb	107	0	0.0	0.030	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Metolcarb	107	0	0.0	0.040	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Mevinphos	107	0	0.0	0.050	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Monuron	107	0	0.0	0.030	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Neburon	107	0	0.0	0.040	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
N-Methylcarbamate	107	0	0.0	0.020	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Promecarb	107	0	0.0	0.10	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Prosulfocarb	107	0	0.0	0.040	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Prothiophos	107	0	0.0	0.040	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Siduron	107	0	0.0	0.070	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ

Table B-1: Surface Soil Risk-Based Screening Evaluation

Constituent	Number of Samples	Number of Detected Samples	% of Detected Samples	Maximum Nondetected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	May 2019 USEPA Carcinogenic Residential RSL (mg/kg)	May 2019 USEPA Non-Carcinogenic Residential RSL (mg/kg)	COPC?	COPC Reason[1]
Tetrachlorvinphos	107	0	0.0	0.080	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Trichloronate	107	0	0.0	0.050	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
1,3-Dichlorobenzene	107	0	0.0	2.0	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
1,4-Naphthoquinone	107	0	0.0	2.0	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
2,6-Dichlorophenol	107	0	0.0	2.0	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
2-Nitrophenol	107	0	0.0	2.0	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
2-Picoline	107	0	0.0	2.0	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
3-Nitroaniline	107	0	0.0	2.0	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
4-Bromophenylphenylether	107	0	0.0	2.2	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
4-Chlorophenylphenylether	107	0	0.0	2.0	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
4-Nitrophenol	107	0	0.0	6.0	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
4-Nitroquinoline 1-oxide	107	0	0.0	2.0	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Aldicarb sulfoxide	107	0	0.0	0.030	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Dimethyl Phthalate	107	0	0.0	2.0	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Ethyl methanesulfonate	107	0	0.0	2.0	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Famphur	107	0	0.0	0.20	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Hexachloropropene	107	0	0.0	2.0	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Isodrin	107	0	0.0	4.1	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Isosafrole	107	0	0.0	2.0	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
O,O,O-Triethylphosphorothioate	107	0	0.0	2.0	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ
Thionazin	107	0	0.0	2.0	--	--	--	--	ND in each sample, no RSL, and max ND <10x Lab LOQ

Notes

[1] COPC Reason

'Detected in ≥5% of samples and >RSL - Constituent was identified as a COPC because it was detected in ≥5% of samples and exceeded the RSL

'ND in each sample and maximum ND >10x RSL - Constituent was identified as a COPC because it was non-detect in each sample and the maximum non-detect value exceeded 10 times the RSL

'Detected in ≥5% of samples and no RSL - Constituent was identified as a COPC because it was detected in ≥5% of samples and did not have an RSL

'Detected in ≥5% of samples and max detect <RSL - Constituent was not identified as a COPC because ≥5% of sample results were detected and all detections were less than the RSL

'Detected in <5% of samples and max detect <10x RSL - Constituent was not identified as a COPC because <5% of sample results were detected and all detections were less than 10 times the RSL

'ND in each sample and max ND <10x RSL - Constituent was not identified as a COPC because each sample was non-detect and the maximum non-detect value was less than 10 times the RSL

'ND in each sample, no RSL, and max ND <10x Lab LOQ - Constituent was not identified as a COPC because each sample was non-detect, there was no RSL, and the maximum non-detect value was less than 10 times the laboratory LOQ identified in the Work Plan

[2] Total Dioxin/Furans (2,3,7,8-TCDD TEQs) as Dioxins and Total Dioxin/Furans (2,3,7,8-TCDD TEQs) as PCBs were combined in order to evaluate Total Dioxin/Furans (2,3,7,8-TCDD TEQs) risk in the HHRA.

^^: Total PCB Congeners and Aroclor 1260 met the criteria to be considered COPCs; however, the risk associated with these constituents is accounted for in Total PCBs (Aroclors). Aroclor 1260 contained higher overall values than PCB Congeners.

**: Diesel Range Organics (C10-C24) were compared to USEPA RSLs for TPH (Aliphatic Medium). Motor Oil Range Organics (C24-C40) were compared to USEPA RSLs for TPH (Aliphatic High).

--: No RSL available, no detections/non-detections were reported, or data group not applicable.

Essential metals (i e., calcium, magnesium, potassium, and sodium) and individual PCB and dioxin congeners accounted for in compound totaling are not listed.

Full analytical data set is presented in Site Investigation Report (AECOM 2019).

Table B-2: Groundwater Risk-Based Screening Evaluation

Constituent	Number of Samples	Number of Detected Samples	% of Detected Samples	Maximum Nondetected Concentration (ug/L)	Maximum Detected Concentration (ug/L)	Residential Carcinogenic GW-to-IA VISL (ug/L) [1]	Residential Non-Carcinogenic GW-to-IA VISL (ug/L) [1]	COPC?	COPC Reason[2]
Dibromochloromethane	6	1	17	0.10	0.15	--	--	**COPC**	Detected in ≥5% of samples and no VISL
Tert-Butyl Alcohol	6	1	17	2.5	7.9	--	--	**COPC**	Detected in ≥5% of samples and no VISL
1,2-Dibromo-3-chloropropane	6	0	0.0	0.50	--	0.028	35	**COPC**	ND in each sample and maximum ND >10x VISL
2-Chloro-1,3-butadiene	6	0	0.0	1.0	--	0.0041	9.2	**COPC**	ND in each sample and maximum ND >10x VISL
cis-1,4-Dichloro-2-butene	6	0	0.0	1.0	--	0.025	--	**COPC**	ND in each sample and maximum ND >10x VISL
trans-1,4-Dichloro-2-butene	6	0	0.0	1.0	--	0.025	--	**COPC**	ND in each sample and maximum ND >10x VISL
Acetone	6	1	17	5.0	6.6	--	22,377,622	--	Detected in ≥5% of samples and max detect <VISL
Chloroform	6	1	17	0.10	0.17	0.80	667	--	Detected in ≥5% of samples and max detect <VISL
Isopropanol	6	4	67	10.0	57	--	634,441	--	Detected in ≥5% of samples and max detect <VISL
Trichloroethylene	6	3	50	0.10	0.40	1.2	5.2	--	Detected in ≥5% of samples and max detect <VISL
m&p-Xylene	6	0	0.0	0.21	--	--	340	--	ND in each sample and max ND <10x VISL
1,1,1,2-Tetrachloroethane	6	0	0.0	0.10	--	3.7	--	--	ND in each sample and max ND <10x VISL
1,1,1-Trichloroethane	6	0	0.0	0.10	--	--	7,397	--	ND in each sample and max ND <10x VISL
1,1,2,2-Tetrachloroethane	6	0	0.0	0.11	--	3.2	--	--	ND in each sample and max ND <10x VISL
1,1,2-Trichloro-1,2,2-trifluoroethane	6	0	0.0	0.17	--	--	242	--	ND in each sample and max ND <10x VISL
1,1,2-Trichloroethane	6	0	0.0	0.10	--	5.3	6.2	--	ND in each sample and max ND <10x VISL
1,1-Dichloroethane	6	0	0.0	0.10	--	7.8	--	--	ND in each sample and max ND <10x VISL
1,1-Dichloroethylene	6	0	0.0	0.10	--	--	196	--	ND in each sample and max ND <10x VISL
1,2,3-Trichloropropane	6	0	0.0	0.25	--	--	22	--	ND in each sample and max ND <10x VISL
1,2,4-Trichlorobenzene	6	0	0.0	0.15	--	--	36	--	ND in each sample and max ND <10x VISL
1,2,4-Trimethylbenzene	6	0	0.0	0.11	--	--	250	--	ND in each sample and max ND <10x VISL
1,2-Dibromoethane	6	0	0.0	0.10	--	0.18	353	--	ND in each sample and max ND <10x VISL
1,2-Dichlorobenzene	6	0	0.0	0.10	--	--	2,675	--	ND in each sample and max ND <10x VISL
1,2-Dichloroethane	6	0	0.0	0.10	--	2.3	151	--	ND in each sample and max ND <10x VISL
1,2-Dichloropropane	6	0	0.0	0.10	--	6.6	37	--	ND in each sample and max ND <10x VISL
1,3,5-Trimethylbenzene	6	0	0.0	0.12	--	--	175	--	ND in each sample and max ND <10x VISL
1,3-Dichloropropene	6	0	0.0	0.10	--	4.8	145	--	ND in each sample and max ND <10x VISL
1,4-Dichlorobenzene	6	0	0.0	0.10	--	2.6	8,426	--	ND in each sample and max ND <10x VISL
1,4-Dioxane	6	0	0.0	20	--	2,857	158,163	--	ND in each sample and max ND <10x VISL
2-Hexanone	6	0	0.0	2.3	--	--	8,136	--	ND in each sample and max ND <10x VISL
Acetaldehyde	6	0	0.0	1.0	--	476	3,443	--	ND in each sample and max ND <10x VISL
Acetonitrile	6	0	0.0	5.6	--	--	44,681	--	ND in each sample and max ND <10x VISL
Acrolein	6	0	0.0	2.5	--	--	4.2	--	ND in each sample and max ND <10x VISL
Acrylonitrile	6	0	0.0	2.5	--	7.3	372	--	ND in each sample and max ND <10x VISL
Allyl Chloride	6	0	0.0	0.37	--	1.0	2.2	--	ND in each sample and max ND <10x VISL
Benzene	6	0	0.0	0.10	--	1.6	137	--	ND in each sample and max ND <10x VISL
Benzyl Chloride	6	0	0.0	0.80	--	3.4	60	--	ND in each sample and max ND <10x VISL
Bromobenzene	6	0	0.0	0.20	--	--	624	--	ND in each sample and max ND <10x VISL
Bromochloromethane	6	0	0.0	0.11	--	--	704	--	ND in each sample and max ND <10x VISL
Bromodichloromethane	6	0	0.0	0.10	--	0.88	--	--	ND in each sample and max ND <10x VISL
Bromoform	6	0	0.0	0.15	--	119	--	--	ND in each sample and max ND <10x VISL
Bromomethane	6	0	0.0	0.25	--	--	17	--	ND in each sample and max ND <10x VISL
Carbon Disulfide	6	0	0.0	0.25	--	--	1,239	--	ND in each sample and max ND <10x VISL
Carbon Tetrachloride	6	0	0.0	0.10	--	0.42	88	--	ND in each sample and max ND <10x VISL
Chlorobenzene	6	0	0.0	0.10	--	--	409	--	ND in each sample and max ND <10x VISL
Chloromethane	6	0	0.0	0.15	--	--	260	--	ND in each sample and max ND <10x VISL
Cumene	6	0	0.0	0.10	--	--	894	--	ND in each sample and max ND <10x VISL
Cyclohexane	6	0	0.0	0.50	--	--	1,028	--	ND in each sample and max ND <10x VISL
Dibromomethane (Methylene Bromide)	6	0	0.0	0.10	--	--	125	--	ND in each sample and max ND <10x VISL

Table B-2: Groundwater Risk-Based Screening Evaluation

Constituent	Number of Samples	Number of Detected Samples	% of Detected Samples	Maximum Nondetected Concentration (ug/L)	Maximum Detected Concentration (ug/L)	Residential Carcinogenic GW-to-IA VISL (ug/L) [1]	Residential Non-Carcinogenic GW-to-IA VISL (ug/L) [1]	COPC?	COPC Reason[2]
Dichlorodifluoromethane	6	0	0.0	0.15	--	--	7.1	--	ND in each sample and max ND <10x VISL
Diisopropyl Ether	6	0	0.0	0.11	--	--	6,952	--	ND in each sample and max ND <10x VISL
Ethyl Chloride	6	0	0.0	0.50	--	--	22,026	--	ND in each sample and max ND <10x VISL
Ethyl Methacrylate	6	0	0.0	0.50	--	--	13,248	--	ND in each sample and max ND <10x VISL
Ethylbenzene	6	0	0.0	0.10	--	3.4	3,106	--	ND in each sample and max ND <10x VISL
Formaldehyde	6	0	0.0	0.86	--	15,942	724,638	--	ND in each sample and max ND <10x VISL
Gasoline Range Organics [C6-C10]	6	0	0.0	10.0	--	--	135**	--	ND in each sample and max ND <10x VISL
Heptanal, n-	6	0	0.0	1.1	--	--	282	--	ND in each sample and max ND <10x VISL
Hexachlorobutadiene	6	0	0.0	0.22	--	0.31	--	--	ND in each sample and max ND <10x VISL
Methacrylonitrile	6	0	0.0	25	--	--	3,069	--	ND in each sample and max ND <10x VISL
Methyl Ethyl Ketone (2-Butanone)	6	0	0.0	2.0	--	--	2,231,760	--	ND in each sample and max ND <10x VISL
Methyl Isobutyl Ketone (4-methyl-2-pentanone)	6	0	0.0	5.0	--	--	549,645	--	ND in each sample and max ND <10x VISL
Methyl Methacrylate	6	0	0.0	0.39	--	--	56,154	--	ND in each sample and max ND <10x VISL
Methyl tert-Butyl Ether (MTBE)	6	0	0.0	0.13	--	458	129,167	--	ND in each sample and max ND <10x VISL
Methylene Chloride	6	0	0.0	0.50	--	752	4,737	--	ND in each sample and max ND <10x VISL
Naphthalene	6	0	0.0	0.50	--	4.6	172	--	ND in each sample and max ND <10x VISL
o-Xylene	6	0	0.0	0.10	--	--	472	--	ND in each sample and max ND <10x VISL
Propionaldehyde	6	0	0.0	0.68	--	--	2,767	--	ND in each sample and max ND <10x VISL
Propyl benzene	6	0	0.0	0.13	--	--	2,331	--	ND in each sample and max ND <10x VISL
Styrene	6	0	0.0	0.25	--	--	8,929	--	ND in each sample and max ND <10x VISL
Tetrachloroethylene	6	0	0.0	0.15	--	15	58	--	ND in each sample and max ND <10x VISL
Tetrahydrofuran	6	0	0.0	0.25	--	--	729,167	--	ND in each sample and max ND <10x VISL
Toluene	6	0	0.0	0.10	--	--	19,188	--	ND in each sample and max ND <10x VISL
Vinyl Acetate	6	0	0.0	0.25	--	--	10,048	--	ND in each sample and max ND <10x VISL
Vinyl Chloride	6	0	0.0	0.12	--	0.15	88	--	ND in each sample and max ND <10x VISL
Xylenes	6	0	0.0	0.10	--	--	369	--	ND in each sample and max ND <10x VISL
1,1-Dichloropropene	6	0	0.0	0.10	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
1,2,3-Trichlorobenzene	6	0	0.0	0.25	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
1,2-cis-Dichloroethylene	6	0	0.0	0.10	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
1,2-trans-Dichloroethylene	6	0	0.0	0.11	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
1,3-Dichlorobenzene	6	0	0.0	0.11	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
1,3-Dichloropropane	6	0	0.0	0.10	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
1-Chlorohexane	6	0	0.0	0.50	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
2,2,4-Trimethylpentane	6	0	0.0	0.25	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
2,2-Dichloropropane	6	0	0.0	0.20	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
2-Chloroethyl vinyl ether	5	0	0.0	0.50	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
Butraldehyde	6	0	0.0	1.0	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
cis-1,3-Dichloropropene	6	0	0.0	0.10	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
Crotonaldehyde, Total	6	0	0.0	0.38	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
Decanal	6	0	0.0	1.3	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
Ethanol	6	0	0.0	46	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
Ethyl cyanide	6	0	0.0	10.0	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
Ethyl Tert Butyl Ether	6	0	0.0	0.20	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
Freon 114	6	0	0.0	0.50	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
Hexanal	6	0	0.0	1.0	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
Isobutyl Alcohol	6	0	0.0	25	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
Methyl Acetate	6	0	0.0	0.50	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
Methyl Cyclohexane	6	0	0.0	0.50	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
Methyl Iodide	6	0	0.0	0.25	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
n-Butylbenzene	6	0	0.0	0.17	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
Nonanal	6	0	0.0	1.4	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
o-Chlorotoluene	6	0	0.0	0.12	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ

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Table B-2: Groundwater Risk-Based Screening Evaluation

Constituent	Number of Samples	Number of Detected Samples	% of Detected Samples	Maximum Nondetected Concentration (ug/L)	Maximum Detected Concentration (ug/L)	Residential Carcinogenic GW-to-IA VISL (ug/L) [1]	Residential Non-Carcinogenic GW-to-IA VISL (ug/L) [1]	COPC?	COPC Reason[2]
Octanal	6	0	0.0	1.4	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
p-Chlorotoluene	6	0	0.0	0.20	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
Pentachloroethane	6	0	0.0	0.50	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
p-Isopropyltoluene	6	0	0.0	0.25	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
sec-Butylbenzene	6	0	0.0	0.13	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
tert-Amylmethyl ether	6	0	0.0	0.50	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
tert-Butylbenzene	6	0	0.0	0.25	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
trans-1,3-Dichloropropene	6	0	0.0	0.11	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
Trichlorofluoromethane	6	0	0.0	0.15	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ

Notes

[1] GW-to-IA VISLs are derived from May 2019 USEPA RSLs for ambient air

[2] COPC Reason Codes

'ND in each sample and maximum ND >10x VISL - Constituent was identified as a COPC because it was non-detect in each sample and the maximum non-detect value exceeded 10 times the VISL

'Detected in ≥5% of samples and no VISL - Constituent was identified as a COPC because it was detected in ≥5% of samples and did not have an VISL

'Detected in ≥5% of samples and max detect <VISL - Constituent was not identified as a COPC because ≥5% of sample results were detected and all detections were less than the VISL

'ND in each sample and max ND <10x VISL - Constituent was not identified as a COPC because each sample was non-detect and the maximum non-detect value was less than 10 times the VISL

'ND in each sample, no VISL, and max ND <10x Lab LOQ - Constituent was not identified as a COPC because each sample was non-detect, there was no VISL, and the maximum non-detect value was less than 10 times the laboratory LOQ identified in the Work Plan

--: No VISL available, no detections/non-detections were reported, or data group not applicable.

**: Gasoline Range Organics (C6-C10) were compared to VISLs derived from USEPA RSLs for TPH (Aromatic Low).

Full analytical data set is presented in Site Investigation Report (AECOM 2019).

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Table B-3: Sub-Slab Soil Gas Risk-Based Screening Evaluation

Constituent	Number of Samples	Number of Detected Samples	% of Detected Samples	Maximum Nondetected Concentration (ug/m^3)	Maximum Detected Concentration (ug/m^3)	Residential Carcinogenic SG-to-IA VISL (ug/m^3) [1]	Residential Non-Carcinogenic SG-to-IA VISL (ug/m^3) [1]	COPC?	COPC Reason[2]
Acetaldehyde	37	15	41	0.096	150	43	313	COPC	Detected in ≥5% of samples and >VISL
Acrolein	37	31	84	1.3	5.7	--	0.70	COPC	Detected in ≥5% of samples and >VISL
Carbon Tetrachloride	37	24	65	0.41	18	16	3,333	COPC	Detected in ≥5% of samples and >VISL
Ethylbenzene	37	37	100	--	340	37	33,333	COPC	Detected in ≥5% of samples and >VISL
Isopropanol	37	36	97	0.37	28,000	--	7,000	COPC	Detected in ≥5% of samples and >VISL
Naphthalene	37	31	84	0.54	4.2	2.8	103	COPC	Detected in ≥5% of samples and >VISL
Gasoline Range Organics (C3-C12)	37	10	27	1,900	8,800	--	1,033**	COPC	Detected in ≥5% of samples and >VISL
1,2-cis-Dichloroethylene	37	6	16	0.31	1.8	--	--	COPC	Detected in ≥5% of samples and no VISL
1,2-trans-Dichloroethylene	37	2	5.4	0.25	0.027	--	--	COPC	Detected in ≥5% of samples and no VISL
1,3-Dichlorobenzene	37	37	100	--	550	--	--	COPC	Detected in ≥5% of samples and no VISL
2,2,4-Trimethylpentane	37	8	22	5.4	0.87	--	--	COPC	Detected in ≥5% of samples and no VISL
4-Ethyltoluene	37	16	43	1.3	45	--	--	COPC	Detected in ≥5% of samples and no VISL
Butyraldehyde	37	4	11	0.22	0.82	--	--	COPC	Detected in ≥5% of samples and no VISL
Crotonaldehyde, Total	37	3	8.1	0.12	1.1	--	--	COPC	Detected in ≥5% of samples and no VISL
Decane	37	32	86	1.1	69	--	--	COPC	Detected in ≥5% of samples and no VISL
Dibromochloromethane	37	12	32	0.30	0.13	--	--	COPC	Detected in ≥5% of samples and no VISL
Dodecane	37	33	89	10.0	12	--	--	COPC	Detected in ≥5% of samples and no VISL
Ethanol	37	34	92	0.62	360	--	--	COPC	Detected in ≥5% of samples and no VISL
Hexanal	37	7	19	0.31	0.50	--	--	COPC	Detected in ≥5% of samples and no VISL
n-Butylbenzene	37	8	22	5.2	0.38	--	--	COPC	Detected in ≥5% of samples and no VISL
Octane	37	20	54	8.1	0.62	--	--	COPC	Detected in ≥5% of samples and no VISL
p-Isopropyltoluene	37	19	51	5.5	12	--	--	COPC	Detected in ≥5% of samples and no VISL
sec-Butylbenzene	37	2	5.4	4.9	0.32	--	--	COPC	Detected in ≥5% of samples and no VISL
Tert-Butyl Alcohol	37	20	54	2.5	36	--	--	COPC	Detected in ≥5% of samples and no VISL
trans-1,3-Dichloropropene	37	3	8.1	0.19	0.34	--	--	COPC	Detected in ≥5% of samples and no VISL
Trichlorofluoromethane	37	37	100	--	48	--	--	COPC	Detected in ≥5% of samples and no VISL
Undecane	37	20	54	9.5	31	--	--	COPC	Detected in ≥5% of samples and no VISL
1,3-Dichloropropane	37	0	0.0	18	--	--	--	COPC	ND in all samples, no VISL, max ND >10x Lab LOQ
o-Chlorotoluene	37	0	0.0	18	--	--	--	COPC	ND in all samples, no VISL, max ND >10x Lab LOQ
1,1,1,2-Tetrachloroethane	37	1	2.7	0.31	0.029	13	--	--	Detected in <5% of samples and max detect <10x VISL
1,1,2-Trichloroethane	37	1	2.7	0.27	0.028	6.0	7.0	--	Detected in <5% of samples and max detect <10x VISL
1,2-Dibromoethane	37	1	2.7	0.27	0.041	0.16	313	--	Detected in <5% of samples and max detect <10x VISL
Allyl Chloride	37	1	2.7	4.9	0.32	16	33	--	Detected in <5% of samples and max detect <10x VISL
Benzyl Chloride	37	1	2.7	8.1	0.60	1.9	33	--	Detected in <5% of samples and max detect <10x VISL
Bromoform	37	1	2.7	7.4	0.60	87	--	--	Detected in <5% of samples and max detect <10x VISL
Benzaldehyde	37	1	2.7	0.40	0.44	--	--	--	Detected in <5% of samples, no geo correlation, and no VISL
Freon 114	37	1	2.7	5.7	0.59	--	--	--	Detected in <5% of samples, no geo correlation, and no VISL
Pentanal	37	1	2.7	0.33	0.78	--	--	--	Detected in <5% of samples, no geo correlation, and no VISL
tert-Butylbenzene	37	1	2.7	5.4	0.60	--	--	--	Detected in <5% of samples, no geo correlation, and no VISL
alpha-Methylstyrene	37	1	2.7	5.7	0.59	--	--	--	Detected in <5% of samples, no geo correlation, and no VISL
1,1,1-Trichloroethane	37	11	30	0.20	0.15	--	173,333	--	Detected in ≥5% of samples and max detect <VISL
1,1,2,2-Tetrachloroethane	37	2	5.4	0.24	0.066	1.6	--	--	Detected in ≥5% of samples and max detect <VISL
1,1,2-Trichloro-1,2,2-trifluoroethane	37	37	100	--	1.7	--	173,333	--	Detected in ≥5% of samples and max detect <VISL
1,1-Dichloroethane	37	36	97	0.010	3.9	60	--	--	Detected in ≥5% of samples and max detect <VISL
1,1-Dichloroethylene	37	2	5.4	0.29	0.12	--	7,000	--	Detected in ≥5% of samples and max detect <VISL
1,2,3-Trichloropropane	37	14	38	0.29	0.18	--	10	--	Detected in ≥5% of samples and max detect <VISL
1,2,4-Trichlorobenzene	37	17	46	0.44	0.63	--	70	--	Detected in ≥5% of samples and max detect <VISL
1,2,4-Trimethylbenzene	37	36	97	0.045	260	--	2,100	--	Detected in ≥5% of samples and max detect <VISL
1,2-Dichlorobenzene	37	12	32	0.045	0.53	--	7,000	--	Detected in ≥5% of samples and max detect <VISL
1,2-Dichloroethane	37	34	92	0.28	0.44	3.7	243	--	Detected in ≥5% of samples and max detect <VISL
1,2-Dichloropropane	37	30	81	0.25	0.33	25	140	--	Detected in ≥5% of samples and max detect <VISL
1,3,5-Trimethylbenzene	37	36	97	0.039	53	--	2,100	--	Detected in ≥5% of samples and max detect <VISL
1,3-Butadiene	37	4	11	0.47	0.11	3.1	70	--	Detected in ≥5% of samples and max detect <VISL
1,4-Dichlorobenzene	37	31	84	0.27	2.4	8.7	27,667	--	Detected in ≥5% of samples and max detect <VISL
1,4-Dioxane	37	8	22	0.29	1.3	19	1,033	--	Detected in ≥5% of samples and max detect <VISL
2-Hexanone	37	20	54	4.5	2.3	--	1,033	--	Detected in ≥5% of samples and max detect <VISL
Acetone	37	37	100	--	520	--	1,066,667	--	Detected in ≥5% of samples and max detect <VISL
Acetonitrile	37	30	81	8.8	2.8	--	2,100	--	Detected in ≥5% of samples and max detect <VISL

Table B-3: Sub-Slab Soil Gas Risk-Based Screening Evaluation

Constituent	Number of Samples	Number of Detected Samples	% of Detected Samples	Maximum Nondetected Concentration (ug/m^3)	Maximum Detected Concentration (ug/m^3)	Residential Carcinogenic SG-to-IA VISL (ug/m^3) [1]	Residential Non-Carcinogenic SG-to-IA VISL (ug/m^3) [1]	COPC?	COPC Reason[2]
Acrylonitrile	37	3	8.1	7.4	0.60	1.4	70	--	Detected in ≥5% of samples and max detect <VISL
Benzene	37	37	100	--	1.4	12	1,033	--	Detected in ≥5% of samples and max detect <VISL
Bromodichloromethane	37	4	11	0.23	0.059	2.5	--	--	Detected in ≥5% of samples and max detect <VISL
Bromomethane	37	24	65	0.31	0.099	--	173	--	Detected in ≥5% of samples and max detect <VISL
Carbon Disulfide	37	21	57	11	63	--	24,333	--	Detected in ≥5% of samples and max detect <VISL
Chlorobenzene	37	17	46	0.31	0.066	--	1,733	--	Detected in ≥5% of samples and max detect <VISL
Chloroform	37	36	97	0.61	2.1	4.0	3,333	--	Detected in ≥5% of samples and max detect <VISL
Chloromethane	37	33	89	0.64	0.65	--	3,133	--	Detected in ≥5% of samples and max detect <VISL
Cumene	37	9	24	5.2	7.9	--	14,000	--	Detected in ≥5% of samples and max detect <VISL
Cyclohexane	37	13	35	10.0	72	--	210,000	--	Detected in ≥5% of samples and max detect <VISL
Dichlorodifluoromethane	37	37	100	--	51	--	3,333	--	Detected in ≥5% of samples and max detect <VISL
Diisopropyl Ether	37	2	5.4	4.7	0.60	--	24,333	--	Detected in ≥5% of samples and max detect <VISL
Ethyl Acetate	37	37	100	--	70	--	2,433	--	Detected in ≥5% of samples and max detect <VISL
Ethyl Chloride	37	28	76	0.29	0.13	--	333,333	--	Detected in ≥5% of samples and max detect <VISL
Formaldehyde	37	2	5.4	0.039	1.0	7.3	333	--	Detected in ≥5% of samples and max detect <VISL
Heptane, N-	37	28	76	5.7	8.9	--	14,000	--	Detected in ≥5% of samples and max detect <VISL
Hexachlorobutadiene	37	3	8.1	0.31	0.069	4.3	--	--	Detected in ≥5% of samples and max detect <VISL
m&p-Xylene	37	36	97	0.10	223	--	3,333	--	Detected in ≥5% of samples and max detect <VISL
Methyl Ethyl Ketone (2-Butanone)	37	37	100	--	43	--	173,333	--	Detected in ≥5% of samples and max detect <VISL
Methyl Isobutyl Ketone (4-methyl-2-pentanone)	37	30	81	4.9	8.8	--	103,333	--	Detected in ≥5% of samples and max detect <VISL
Methyl Methacrylate	37	2	5.4	13	1.2	--	24,333	--	Detected in ≥5% of samples and max detect <VISL
Methyl tert-Butyl Ether (MTBE)	37	2	5.4	0.31	3.9	367	103,333	--	Detected in ≥5% of samples and max detect <VISL
Methylene Chloride	37	37	100	--	17	3,333	21,000	--	Detected in ≥5% of samples and max detect <VISL
N-Hexane	37	33	89	1.7	96	--	24,333	--	Detected in ≥5% of samples and max detect <VISL
n-Nonane	37	34	92	1.4	32	--	700	--	Detected in ≥5% of samples and max detect <VISL
o-Xylene	37	36	97	0.048	71	--	3,333	--	Detected in ≥5% of samples and max detect <VISL
Propionaldehyde	37	3	8.1	0.048	0.29	--	277	--	Detected in ≥5% of samples and max detect <VISL
Propyl benzene	37	17	46	1.2	22	--	33,333	--	Detected in ≥5% of samples and max detect <VISL
Propylene	37	37	100	--	2,900	--	103,333	--	Detected in ≥5% of samples and max detect <VISL
Styrene	37	35	95	0.25	3.5	--	33,333	--	Detected in ≥5% of samples and max detect <VISL
Tetrachloroethylene	37	37	100	--	7.8	367	1,400	--	Detected in ≥5% of samples and max detect <VISL
Tetrahydrofuran	37	15	41	4.5	5.2	--	70,000	--	Detected in ≥5% of samples and max detect <VISL
Toluene	37	37	100	--	57	--	173,333	--	Detected in ≥5% of samples and max detect <VISL
Trichloroethylene	37	24	65	0.29	2.0	16	70	--	Detected in ≥5% of samples and max detect <VISL
Vinyl Acetate	37	8	22	81	12	--	7,000	--	Detected in ≥5% of samples and max detect <VISL
Chlorodifluoromethane	37	0	0.0	17	--	--	1,733,333	--	ND in each sample and max ND <10x VISL
Vinyl Bromide	37	0	0.0	14	--	2.9	103	--	ND in each sample and max ND <10x VISL
2,5-Dimethylbenzaldehyde	37	0	0.0	0.24	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
cis-1,3-Dichloropropene	37	0	0.0	0.21	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
Isovaleraldehyde	37	0	0.0	0.27	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
m&p-Methylbenzaldehyde	37	0	0.0	0.56	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ
O-Tolualdehyde	37	0	0.0	0.14	--	--	--	--	ND in each sample, no VISL, and max ND <10x Lab LOQ

Notes

[1] SG-to-IA VISLs are derived from May 2019 USEPA VISLs for ambient air

[2] COPC Reason Codes

'Detected in ≥5% of samples and >VISL - Constituent was identified as a COPC because it was detected in ≥5% of samples and exceeded the VISL

'ND in each sample, no VISL, and maximum ND >10x Lab LOQ - Constituent was identified as a COPC because each sample was non-detect, there was no VISL, and the maximum non-detect value was greater than 10 times the laboratory LOQ identified in the Work Plan

'Detected in ≥5% of samples and no VISL - Constituent was identified as a COPC because it was detected in ≥5% of samples and did not have an VISL

'Detected in ≥5% of samples and max detect <VISL - Constituent was not identified as a COPC because ≥5% of sample results were detected and all detections were less than the VISL

'Detected in <5% of samples and max detect <10x VISL - Constituent was not identified as a COPC because <5% of sample results were detected and all detections were less than 10 times the VISL

'Detected in <5% of samples, no geo correlation, and no VISL - Constituent was not identified as a COPC because <5% of sample results were detected, no geographic correlation existed between detections, and there was no VISL

'ND in each sample and max ND <10x VISL - Constituent was not identified as a COPC because each sample was non-detect and the maximum non-detect value was less than 10 times the VISL

'ND in each sample, no VISL, and max ND <10x Lab LOQ - Constituent was not identified as a COPC because each sample was non-detect, there was no VISL, and the maximum non-detect value was less than 10 times the laboratory LOQ identified in the Work Plan

--: No VISL available, no detections/non-detections were reported, or data group not applicable.

**: Gasoline Range Organics (C3-C12) were compared to VISLs derived from USEPA RSLs for TPH (Aromatic Low).

Full analytical data set is presented in Site Investigation Report (AECOM 2019).

Appendix C

Blood Lead Evaluation

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Blood Lead Evaluation

A blood lead evaluation was performed as part of the Camp Kinser (Site) Human Health Risk Assessment (HHRA). Though lead is a naturally occurring element in nature, industrial activity and human-made products can increase the amount of lead people are exposed to in the workplace and at home – potentially impacting human health. Lead exposure is of particular concern to children and pregnant adult females, as an elevated blood lead level (BLL) can result in health complications in a child or fetus. A BLL of 10 micrograms per deciliter (10 µg/dL) has been the United States Environmental Protection Agency (USEPA) threshold level of concern, requiring intervention if a child's BLL reached or exceeded this concentration (USEPA 2016). The USEPA set a post-remediation goal that the likelihood of a child having an elevated BLL (10 µg/dL or greater) should be no more than five percent (USEPA 2016). More recently, researchers have found that harmful health effects may occur at lower BLLs, leading the Centers for Disease Control and Prevention (CDC) and other organizations to recommend five micrograms per deciliter (5 µg/dL) as the new BLL of concern in adults and children (Agency for Toxic Substances and Disease Registry [ATSDR] 2016). The Department of the Navy policy for children uses the recommended CDC reference level of 5ug/dL (BUMEDINST 6200.14D - 30 Aug 2017).[1]

Based on soil samples collected at the Site in November and December of 2018, lead concentrations in soil ranged from 7.95 micrograms of lead per gram (µg Pb/g) of soil to 197 µg Pb/g (AECOM 2019). No background studies of naturally-occurring lead in soil near or at the Site were available. Therefore, lead concentrations detected in soil at the Site, were assumed to be site related although the concentrations may be consistent with natural background.

To assess whether or not lead concentrations at the Site pose a risk to human health, a lead evaluation was performed using two USEPA lead models: the Integrated Exposure Uptake Biokinetic (IEUBK) model and the Adult Lead Methodology (ALM) model. The IEUBK model was used to evaluate lead risk in children (USEPA 2010). The ALM model was used to evaluate lead risk in adult workers and estimate the probability of a pregnant worker's fetus having a BLL above a specified target value (USEPA 1996, 2017). The modeling results are presented in this appendix. The complete model inputs and outputs are included as Attachment 1.

Lead Exposure Evaluation for Children at the Site

The IEUBK analysis was performed with the assumption that children at the Site would spend the majority of time at the area with the maximum detected lead concentrations, which is a very conservative exposure assumption. The highest reported value for soil lead concentrations was the only site-specific input used in the IEUBK Model; the remainder of parameters were USEPA default values. The results from the IEUBK Model for the BLL for a child are presented in the table on the following page. Based on the worst-case scenario (maximum detected) lead soil concentrations, all projected BLLs are below the 10 µg/dL level of concern, as well as being below the more sensitive 5 µg/dL lead concentration.

[1] https://www.med.navy.mil/sites/nmcphc/Documents/program-and-policy-support/BUMEDINST-6200-14D.pdf

Site-Specific Inputs for IEUBK Model

Parameter	Value	Units
Soil Lead Concentration	197	µg Pb / g

Note: Model inputs that were not site-specific were USEPA default values.

Blood Lead Level for Child (Results from IEUBK Model)

Age of Child (Year)	BLL (µg/dL)	BLL Exceeds 10 µg/dL? (Yes/No)	BLL Exceeds 5 µg/dL? (Yes/No)
0.5-1	3.0	No	No
1-2	3.4	No	No
2-3	3.2	No	No
3-4	3.0	No	No
4-5	2.5	No	No
5-6	2.1	No	No
6-7	1.9	No	No

Note: Full model outputs can be found in Attachment 1.

Lead Exposure Evaluation for a Site Worker

The ALM analysis was performed to evaluate the worst-case lead exposure risks for a Site worker, which would be a host-country contract landscaper (landscaper) and a pregnant worker's fetus. Model inputs included the maximum detected soil concentration, the estimated soil ingestion rate for a landscaper, and the maximum days per year a landscaper would be at the Site. Based on the results of the ALM model presented below, landscapers would have a BLL less than the 10 µg/dL level of concern, and less than the more sensitive 5 µg/dL blood lead concentration. The probability that a fetal blood concentration would exceed 10 µg/dL was zero. The highest probability that a fetal blood concentration would exceed 5 µg/dL was 0.2%.

Site-Specific Inputs for ALM Model

Scenario	Soil Lead Concentration (µg/g)	Soil Ingestion Rate (g/day)	Exposure Frequency (days/year)
Landscaper	197	0.33	50

Note: All other model inputs were USEPA default values.

Blood Lead Level for Adult Worker and Probability of Fetal Blood Lead Level Exceeding Level of Concern (Results from ALM Model)

Scenario	BLL of Adult Worker, Geometric Mean (µg/dL)	Probability that Fetal BLL Exceeds 10 µg/dL	Probability that Fetal BLL Exceeds 5 µg/dL
Landscaper	1.0	0.0%	0.2%

Note: Full model outputs can be found in Attachment 1.

Lead Exposure Conclusion

Based on available data, the results from the USEPA IEUBK and ALM models, and USEPA and ATSDR recommendations regarding BLL, the lead risks to children, workers (landscapers), and pregnant workers' fetuses at the Site are below levels of concern. Additionally, the soil lead concentrations are below the 400 and 1,200 part per million (ppm) residential thresholds that USEPA has established for lead in bare soil in play areas and non-play areas, respectively.

References:

ATSDR. 2016. Lead Toxicity – What Are the U.S. Standards for Lead Levels? https://www.atsdr.cdc.gov/csem/csem.asp?csem=7&po=8.

USEPA. 1996. Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil.

USEPA. 2010. IEUBKwin32 (Lead Model Version 1.1, Build11) [Computer Software]. (2010). Retrieved from https://www.epa.gov/superfund/lead-superfund-sites-software-and-users-manuals#integrated.

USEPA. 2016. Lead at Superfund Sites: Risk Assessment. https://www.epa.gov/superfund/lead-superfund-sites-risk-assessment.

USEPA. 2017. Update of the Adult Lead Methodology's Default Baseline Blood Lead Concentration and Geometric Standard Deviation Parameter [OLEM Directive 9285.6-56]. https://www.epa.gov/superfund/lead-superfund-sites-software-and-users-manuals#recommend. Adult Lead Methodology model accessed May 10, 2019.

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Attachment 1

Model Outputs

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Max Soil - no other changes.txt

LEAD MODEL FOR WINDOWS Version 1.1

==

Model Version: 1.1 Build11
User Name:
Date:
Site Name:
Operable Unit:
Run Mode: Research

==

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m^3)
.5-1	1.000	2.000	32.000	0.100
1-2	2.000	3.000	32.000	0.100
2-3	3.000	5.000	32.000	0.100
3-4	4.000	5.000	32.000	0.100
4-5	4.000	5.000	32.000	0.100
5-6	4.000	7.000	32.000	0.100
6-7	4.000	7.000	32.000	0.100

****** Diet ******

Age	Diet Intake(µg/day)
.5-1	2.260
1-2	1.960
2-3	2.130
3-4	2.040
4-5	1.950
5-6	2.050
6-7	2.220

****** Drinking Water ******

Water Consumption:

Age	Water (L/day)
.5-1	0.200

1-2	0.500
2-3	0.520
3-4	0.530
4-5	0.550
5-6	0.580
6-7	0.590

Drinking Water Concentration: 4.000 µg Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used
Average multiple source concentration: 147.900 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
Outdoor airborne lead to indoor household dust lead concentration: 100.000
Use alternate indoor dust Pb sources? No

Age	Soil (µg Pb/g)	House Dust (µg Pb/g)
.5-1	197.000	147.900
1-2	197.000	147.900
2-3	197.000	147.900
3-4	197.000	147.900
4-5	197.000	147.900
5-6	197.000	147.900
6-7	197.000	147.900

****** Alternate Intake ******

Age	Alternate (µg Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000
5-6	0.000
6-7	0.000

****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 1.000 µg Pb/dL

****
CALCULATED BLOOD LEAD AND LEAD UPTAKES:
****

Max Soil - no other changes.txt

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
.5-1	0.021	1.061	0.000	0.376
1-2	0.034	0.912	0.000	0.930
2-3	0.062	1.000	0.000	0.977
3-4	0.067	0.966	0.000	1.004
4-5	0.067	0.939	0.000	1.059
5-6	0.093	0.993	0.000	1.124
6-7	0.093	1.079	0.000	1.147

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
.5-1	4.071	5.529	3.0
1-2	6.404	8.280	3.4
2-3	6.465	8.504	3.2
3-4	6.523	8.560	3.0
4-5	4.911	6.976	2.5
5-6	4.446	6.656	2.1
6-7	4.213	6.531	1.9

Calculations of Blood Lead Concentrations (PbBs) and Risk in Nonresidential Areas
U.S. EPA Technical Review Workgroup for Lead
Version date 06/14/2017

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009-2014	GSDi and PbBo from Analysis of NHANES 2009-2014
PbS	Soil lead concentration	µg/g or ppm	197	197
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4	0.4
GSD_i	Geometric standard deviation PbB	--	1.8	1.8
PbB_0	Baseline PbB	µg/dL	0.6	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.330	0.330
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--	--
K_{SD}	Mass fraction of soil in dust	--	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	50	50
$AT_{S\ D}$	Averaging time (same for soil and dust)	days/yr	365	365
PbB_{adult}	PbB of adult worker, geometric mean	µg/dL	1.0	1.0
$PbB_{fetal,\ 0.95}$	95th percentile PbB among fetuses of adult workers	µg/dL	2.4	2.4
PbB_t	Target PbB level of concern (e.g., 2-8 ug/dL)	µg/dL	**5.0**	**10.0**
$P(PbB_{fetal} > PbB_t)$	**Probability that fetal PbB exceeds target PbB, assuming lognormal distribution**	**%**	**0.20%**	**0.00%**

Source: U.S. EPA (1996). Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil

Calculations of Preliminary Remediation Goals (PRGs) for Soil in Nonresidential Areas
U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee
Version date 06/14/2017

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009-2014
$PbB_{fetal,\ 0.95}$	Target PbB in fetus (e.g., 2-8 µg/dL)	µg/dL	5
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	µg/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.330
$AF_{S,\ D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S,\ D}$	Exposure frequency (same for soil and dust)	days/yr	50
$AT_{S,\ D}$	Averaging time (same for soil and dust)	days/yr	365
PRG in Soil for no more than 5% probability that fetal PbB exceeds target PbB		**ppm**	**697**

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Appendix D

Vapor Intrusion Pathway Evaluation

July 2019

620 John Paul Jones Circle, Suite 1100
Portsmouth, VA 23708-2103

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Table of Contents

Figures

Tables

List of Acronyms

Acronym	Definition
AA	Ambient Air
COC	Constituent of Concern
COPC	Constituent of Potential Concern
DoD	Department of Defense
GRO	Gasoline Range Organics (C3-C12)
GW-to-IA	Groundwater-to-Indoor Air
HHRA	Human Health Risk Assessment
HQ	Hazard Quotient
MSA	Makiminato Service Area
MSL	Mean Sea Level
NAVFAC	Naval Facilities Engineering Command
NMCPHC	Navy and Marine Corps Public Health Center
PID	Photoionization Detector
RSL	Regional Screening Level
SG-to-IA	Sub-Slab Soil Gas-to-Indoor Air
Site	Camp Kinser
SL	Screening Level
SSDS	Sub-slab Depressurization System
ug/m^3	Micrograms per Cubic Meter
USEPA	United States Environmental Protection Agency
VI	Vapor Intrusion
VISL	Vapor Intrusion Screening Level
VOC	Volatile Organic Compound

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Section 1: Introduction

A vapor intrusion (VI) evaluation was conducted as part of the human health risk assessment (HHRA) for historical storage and fill areas (Southern Area and Northern Area, respectively) within Camp Kinser (Site) in the Okinawa Prefecture of Japan (see Figure D-1). This evaluation was conducted to determine if constituents associated with potential environmental contamination from the former Makiminato Service Area (MSA; now referred to as the Southern Area) and fill area (Northern Area) need to be evaluated in the HHRA. A summary of the multimedia sampling that was conducted to support this evaluation along with the lines-of-evidence evaluation, results, and conclusions are presented in this report.

1.1 Site Overview

Historical releases of constituents to soil and groundwater from the former MSA have been documented. The former MSA was used in the late 1960s to early 1970s to store constituents (including pesticides) from the Vietnam War. The constituents were stored in cardboard and metal containers along an approximately 500,000-square-foot open beach area. Some of the containers deteriorated over time and constituents were released to the former MSA and surrounding tidal basin area. As part of the cleanup action, contaminated soil from the Southern Area was placed near the area of the baseball and soccer fields in the Northern Area (see Figure D-2).

Current land use in the Northern and Southern Areas is commercial/industrial and recreational. No buildings are located within the Northern Area boundary; however, a preschool and elementary school (and related buildings) are located immediately northeast of the area (see Figure D-2). Two regularly-occupied buildings (a medical clinic and a dental clinic) are located within the Southern Area boundary (see Figure D-3).

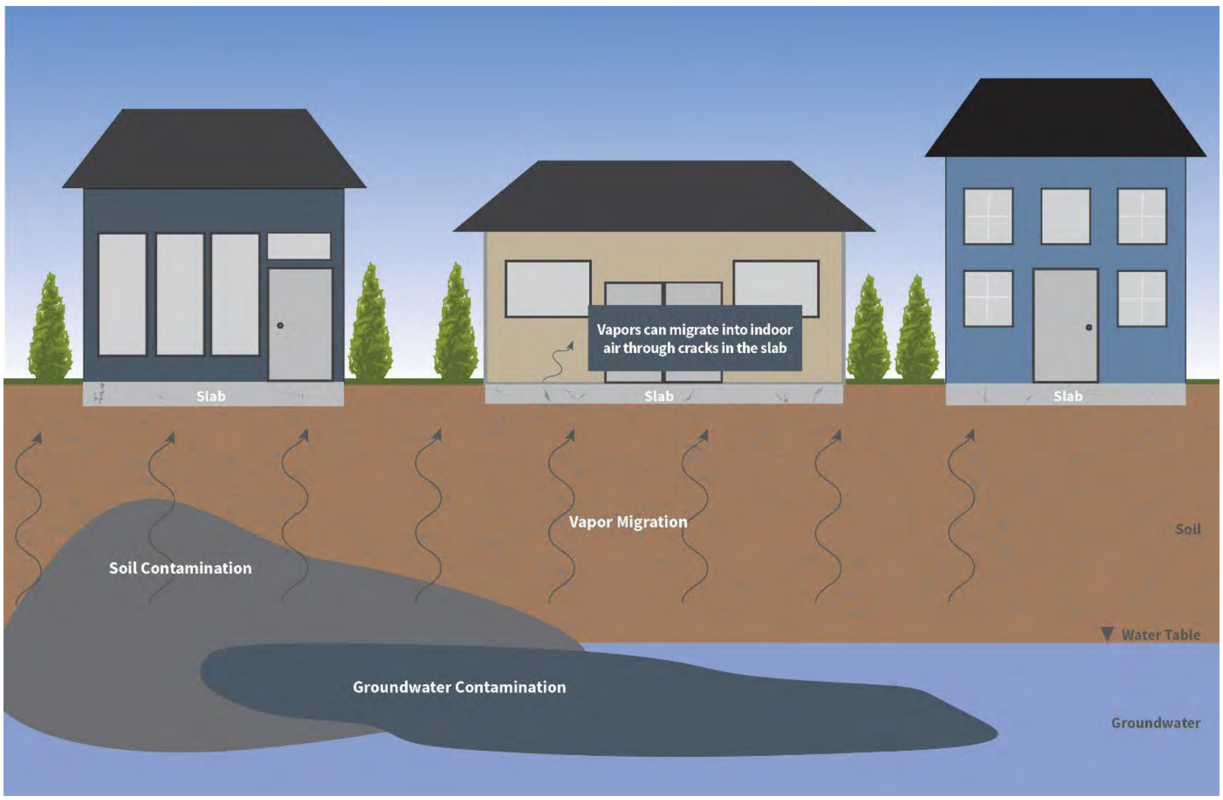
Sub-slab depressurization systems (SSDSs) were installed in five of the seven elementary school buildings in the Northern Area to mitigate radon concentrations. The number of systems installed in each building and the month and year in which they were installed are presented below.

Building	Number of SSDSs Installed	Date Installed
Building 1039 (Preschool)	3	January 1999
Building 1040R (Kindergarten)	1	June 2012
Building 1041A (Maintenance)	1	January 1999
Building 1042 (Art)	4	January 1999
Building 1043 (Gym)	4	January 1999

The systems were operating during sub-slab soil gas sampling to represent actual building conditions (exposures) while occupied and may have impacted sub-slab soil gas results in these buildings.

1.2 Vapor Intrusion Overview

VI occurs when vapor-forming chemicals in soil or groundwater migrate through overlying unsaturated soil into the indoor air of nearby buildings. The vapors, which fill the spaces between soil particles, can migrate into the indoor air of buildings through cracks or perforations in the foundation or slab if the pressure in the building is different than beneath the building (e.g., during the heating season).



According to the United States Environmental Protection Agency (USEPA), five conditions must be met under current conditions for VI to be a complete exposure pathway at a site (USEPA 2015):

1. A vapor-forming chemical must be detected in the subsurface under or near a building;
2. The vapors must have a route/be transported toward the building;
3. The soil gas must be able to enter the building (i.e., via cracks, conduits, perforations, or other openings in the foundation or slab) and conditions must be favorable for VI (e.g., differences in air pressure between the building and subsurface);

4. One or more vapor-forming chemicals must be detected in the subsurface and in indoor air;
5. The building must be occupied by one or more receptors when the chemical is detected in indoor air.

According to the USEPA’s VI guidance, “if one (or more) of the five foregoing conditions is currently absent and is reasonably expected to be absent in the future…the pathway is incomplete” (USEPA 2015).

Lines-of-evidence evaluations were conducted for the Northern and Southern Area buildings in accordance with Department of Defense (DoD) and USEPA VI guidance (DoD 2009; USEPA 2015). The lines-of-evidence evaluation were performed to determine if volatile constituents in groundwater and/or sub-slab soil gas could be related to former MSA releases (i.e., Site-related) and were detected at concentrations that could impact indoor air and need to be evaluated further in the HHRA. The lines-of-evidence evaluation approach is discussed in detail in Section 3 of this report.

1.3 Report Organization

The remainder of this report is organized into the following sections:

- Section 2 – Environmental Sampling Summary
- Section 3 – VI Evaluation Approach
- Section 4 – Results and Discussion
- Section 5 – Conclusions
- Section 6 – References

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Section 2: Environmental Sampling Summary

The groundwater, sub-slab soil gas, and background ambient air samples used in the VI evaluation were collected from the Northern and Southern Areas in November and December of 2018 as part of the Site investigation. Soil samples were also collected during the sampling event but were not included in this VI evaluation. The USEPA does not recommend using bulk soil samples for evaluating VI due, in part, to volatile organic compound (VOC) loss during sampling (USEPA 2014). Accurately measuring VOC concentrations in soil samples can be difficult because the chemicals may volatilize or escape either during collection or from the sample containers prior to analyses (DoD 2009). In addition, using soil concentrations to calculate sub-slab soil gas concentrations is not ideal as the results can differ from measured sub-slab soil gas concentrations by several orders of magnitude (Hartman 2002). All samples used in the VI evaluations were collected in accordance with the Site Investigation Work Plan (NAVFAC 2018).

2.1 Weather Conditions during Sampling

Temperatures during the sampling event (i.e., November 15 - 17, 25, 30, and December 3 - 5, 2018) were between 70 and 80 degrees Fahrenheit throughout the sampling period. The weather was sunny to partly cloudy throughout the sampling period except on November 16 when there was moderate rainfall and December 5 when there were light showers. The predominant wind direction is towards the northeast (Weathercloud 2018).

2.2 Groundwater Flow

Groundwater flow directions in the Northern and Southern Areas likely coincide with rising and falling tides based on the proximity of the Site to the East China Sea. The tide was falling during sampling; therefore, it would be expected that regional groundwater flow would be west, towards the East China Sea. Localized groundwater flow in the Northern Area at the time of sampling was to the northeast, away from the East China Sea (see Figure D-2). The flow direction in the Northern Area was unexpected and may be associated with macro-karst, which has been documented in the region (Yoshimoto et al. 2011). The groundwater elevation in the Northern Area was between 1.6 and 1.8 feet above mean sea level (MSL). Localized groundwater flow in the Southern Area at the time of sampling was to the northwest, towards the East China Sea (see Figure D-3). The groundwater elevation in the Southern Area was between 2.8 and 3.7 feet MSL.

2.3 Northern Area Sample Summary

A summary of the samples collected in the Northern Area and used in the VI evaluation is presented in this section. Groundwater samples were collected from three monitoring wells (CKNA-MW01, CKNA-MW02, and CKNA-MW03) installed near and upgradient of the elementary school buildings. Twenty-three sub-slab soil gas samples were collected from the seven buildings. One background ambient air sample was collected concurrently with the sub-slab soil gas sampling.[1] The Northern Area sample locations are shown on Figure D-4.

Sub-slab depressurization systems were installed in five of the seven Northern Area buildings (systems were not installed in Building 1040 [main elementary school building] and Building 1041 [cafeteria and music room]). The number of systems installed in each building and the month and year in which they were installed are presented below.

Building	Number of SSDSs Installed	Date Installed
Building 1039 (Preschool)	3	January 1999
Building 1040R (Kindergarten)	1	June 2012
Building 1041A (Maintenance)	1	January 1999
Building 1042 (Art)	4	January 1999
Building 1043 (Gym)	4	January 1999

The systems were installed to mitigate the potential for VI due to radon gas, which is common in Okinawa (Naval Facilities Engineering Command [NAVFAC] 2018). These systems, which operate 24 hours a day and 7 days a week, were left on during sub-slab soil gas sampling to ensure concentrations were representative of typical building conditions.

2.4 Southern Area Sample Summary

A summary of the samples collected in the Southern Area and used in the VI evaluation is presented in this section. Groundwater samples were collected from three monitoring wells (CKSA-MW01, CKSA-MW02, and CKSA-MW03) installed near and downgradient of the Southern Area medical and dental clinics. Fourteen sub-slab soil gas samples were collected from the two buildings. One background ambient air sample was collected concurrently with the sub-slab soil gas samples. The dental clinic was vacant and undergoing asbestos abatement in southern portion of the building (abatement was complete in the northern portion) and renovations were underway at the time of sample collection; the medical clinic was occupied and operating as normal. The Southern Area sample locations are shown on Figure D-5.

[1] The background ambient air sample was collected to determine the potential contribution ambient air might have had on sub-slab soil gas concentrations during the sampling event.

2.5 Laboratory Analyses

The groundwater, sub-slab soil gas, and ambient air samples were submitted to McCampbell Analytical, Inc., EMAC Labs Inc., and APPL Inc. for laboratory analyses. Samples were analyzed for the following:

Medium	Analytical Group	USEPA Analytical Method
Groundwater	VOCs	8260C
	Carbonyls	8315A
	Gasoline Range Organics (C3-C12; GRO)	8015C
Sub-Slab Soil Gas and Ambient Air	VOCs	TO-15
	Aldehydes and Carbonyls	TO-11A
	GRO	TO-03 (Mod)

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Section 3: VI Evaluation Approach

A lines-of-evidence approach was used to evaluate the potential for VI at the Site (DoD 2009; USEPA 2015). Summaries of the lines-of-evidence approaches for the Northern and Southern Areas are presented in this section.

3.1 Lines-of-Evidence Approach for the VI Evaluation

Separate lines-of-evidence evaluations were conducted for the Northern and Southern Areas. The Northern Area elementary school buildings were evaluated as a group (not by building) because building uses are relatively uniform and the only potential VI source was Northern Area groundwater migrating beneath the buildings. Conversely, the Southern Area buildings were evaluated individually because the potential VI sources were soil beneath buildings and/or groundwater migrating beneath the buildings. The lines-of-evidence evaluations for the two areas are described in this section.

Northern Area Lines-of-Evidence Approach for the VI Evaluation

The evaluation criteria for VI for the Northern Area and Southern Area are different. The school buildings were not constructed on top of the potentially contaminated soil in the Northern Area; however, an elementary school is located immediately northeast of the area where the potentially-contaminated soil was placed (see Figure D-2). In order for VI associated with releases from the MSA to occur at the elementary school, constituents in soil in the Northern Area must leach to groundwater, the groundwater must migrate proximate to or under the elementary school buildings, and the constituents in groundwater must volatilize and migrate upward, into the overlying buildings. Since the elementary school was not constructed on potentially-contaminated soil, groundwater is the only potential VI source in the Northern Area from the former MSA. Teachers and students could be exposed to vapors in indoor air if constituents in groundwater volatilize and migrate into the indoor air of the buildings at the elementary school. The steps comprising the Northern Area lines-of-evidence approach are summarized below.

Graphic 1: Northern Area Lines-of-Evidence Approach

Step 1
Perform an In tial U.S. Navy Tier 1A Screen of Groundwater and Sub-Slab Soil Gas

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Step 2
Assess Contribution of Ambient Background to Sub-Slab Soil Gas Concentrations

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Step 3
Evaluate Groundwater and Sub-Slab Soil Gas Line of Evidence

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Step 4
Consider Other of Lines of Evidence

↓

Step 5
Document Conclusions Regarding VI Based on Lines of Evidence

1. **Step 1: Perform an Initial US Navy Tier 1A Screen of Groundwater and Sub-Slab Soil Gas**: The purpose of this step is to identify VI constituents

of potential concern (COPCs) for groundwater and sub-slab soil gas to evaluate further in the VI pathway evaluation.

   a. Constituents that were detected in groundwater with maximum concentrations greater than groundwater-to-indoor air (GW-to-IA) VI screening levels (VISLs) were retained for further evaluation via other lines of evidence.
   b. Constituents that were detected in groundwater but did not have VISLs were also retained for further evaluation via other lines-of-evidence.
   c. Constituents that were not detected in groundwater but had VISLs were also retained for further evaluation via other lines of evidence if their maximum detection limits were greater than 10 times the VISLs.
   d. Constituents that were detected sub-slab soil gas with maximum concentrations greater than SG-to-IA VISLs were retained for further evaluation via other lines of evidence.
   e. Constituents that were detected in sub-slab soil gas but did not have VISLs were also retained for further evaluation via other lines of evidence.
   f. Constituents that were not detected in sub-slab soil gas but had VISLs were also retained for further evaluation via other lines of evidence if their maximum detection limits were greater than 10 times the VISLs.
   g. Constituents in groundwater and sub-slab soil gas that did not meet the criteria presented above were eliminated from further evaluation of the VI pathway.

2. **Step 2: Assess Contribution of Ambient Background to Sub-Slab Soil Gas Concentrations:** Background ambient air concentrations were compared to sub-slab soil gas concentrations and the sub-slab soil gas concentrations were "corrected" for the contribution from background ambient air (i.e., the ambient air concentrations were subtracted from the sub-slab soil gas concentrations to get the corrected sub-slab soil gas concentrations). Corrected sub-slab soil gas concentrations that were less than or equal to zero were eliminated from the data set (i.e., ambient air was the sole source of the sub-slab soil gas concentrations).
3. **Step 3: Evaluate Groundwater and Sub-Slab Soil Gas Lines of Evidence:** Perform a detailed evaluation of the groundwater VI COPCs side-by-side with the sub-slab soil gas VI COPCs identified in Step 1 and Step 2.

> Since groundwater (via leaching from soil to groundwater) is considered the only plausible source of VI COPCs associated with the former MSA in the Northern Area, the focus of the lines-of-evidence evaluation is groundwater-to-soil gas. Soil sources of soil gas are not included because the school buildings are not built on top of a contaminated soil source.

a. A sub-slab soil gas VI COPC that is also considered groundwater VI COPC was retained for further evaluation based on the criteria from Step 1 and Step 2 (e.g., the maximum detected groundwater concentration was greater than the VISL and the maximum detected soil gas concentration was greater than the VISL.)
b. A sub-slab soil gas VI COPC was retained for further evaluation if the maximum detected concentration was greater than the VISL and was detected in groundwater and the modeled groundwater concentration (SG-to-GW) was less than the measured groundwater concentration (indicating that the groundwater concentration is high enough to have been responsible for the measured soil gas concentration).
c. For all other constituents, sub-slab soil gas VI COPCs were retained for further evaluation if modeled groundwater concentrations, based on measured soil gas concentrations, were less than the measured groundwater concentrations or less than the maximum detection limits (indicating that the groundwater concentrations were high enough to have been responsible for the measured sub-slab soil gas concentrations).

4. **Step 4: Consider Other Lines-of-Evidence:** Other lines-of-evidence were considered with respect to VI to determine if they are consistent with VI for each VI COPC. Other lines-of-evidence included, but are not limited to:
    a. Previous investigation results
    b. Likely use of the constituent in the area based on historical information
    c. Spatial distribution of the constituent in groundwater, sub-slab soil gas, and ambient air
    d. Half-life of the constituent
    e. Relative potential for VI in the Northern Area to be associated with releases from the former MSA
    f. Background contributions from human activity (e.g., construction/remodeling)
5. **Step 5: Document Conclusions Regarding VI Based on Lines-of-Evidence Evaluation**:
    a. A summary of Steps 1 through 4 will be documented
    b. The VI COPCs that <u>meet all of the criteria</u> in Steps 1 – 4 will be evaluated further in the HHRA when quantitatively assessing the VI pathway.

c. The VI COPCs that did not meet all of the criteria in Steps 1 – 4 were eliminated further evaluation.

Southern Area Lines-of-Evidence Approach for the VI Evaluation

Two buildings (i.e., the medical clinic and dental clinic) were constructed on top of potentially-contaminated soil in the former MSA (see Figure D-3). Therefore, in the Southern Area, both soil and groundwater could be potential sources of VI (associated with releases from the MSA) in this area. Clinic workers and patients could come into contact with potential VI constituents in the indoor air of the medical or dental clinic if VI COPCs in soil and/or groundwater volatilize and migrate into the indoor air of these buildings.[2]

The steps comprising the Southern Area lines-of-evidence approach are summarized below:

Graphic 2: Southern Area Lines of Evidence Approach

Step 1
Perform an Initial U.S. Navy Tier 1A Screen of Groundwater and Sub-Slab Soil Gas

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Step 2
Assess Contribution of Ambient Background to Sub-Slab Soil Gas Concentrations

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Step 3
Evaluate Groundwater and Sub-Slab Soil Gas Line of Evidence

↓

Step 4
Consider Other of Lines of Evidence

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Step 5
Document Conclusions Regarding VI Based on Lines of Evidence

[2] Building 1304 is a maintenance shed and is not regularly occupied; therefore, a VI evaluation was not performed for this building.

1. **Step 1: Perform an Initial U.S. Navy Tier 1A Screen of Groundwater and Sub-Slab Soil Gas**: The purpose of this step is to identify VI constituents of potential concern (COPCs) for groundwater and sub-slab soil gas to evaluate further in the VI pathway evaluation.
    a. Constituents that were detected in groundwater with maximum concentrations greater than GW-to-IA VISLs were retained for further evaluation via other lines of evidence.
    b. Constituents that were detected in groundwater but did not have VISLs were also retained for further evaluation via other lines of evidence.
    c. Constituents that were not detected in groundwater but had VISLs were also retained for further evaluation via other lines of evidence if their maximum detection limit was greater than 10 times the VISL.
    d. Constituents that were detected in sub-slab soil gas with maximum concentrations greater than SG-to-IA VISLs were retained for further evaluation via other lines of evidence.
    e. Constituents that were detected in sub-slab soil gas but did not have VISLs were also retained for further evaluation via other lines-of-evidence.
    f. Constituents that were not detected in sub-slab soil gas but had VISLs were also retained for further evaluation via other lines of evidence if their maximum detection limit was greater than 10 times the VISLs.
    g. Constituents in groundwater and sub-slab soil gas that did not meet the criteria presented above were eliminated from further evaluation of the VI pathway.
2. **Step 2: Assess Contribution of Ambient Background to Sub-Slab Soil Gas Concentrations:** Background ambient air concentrations were compared to sub-slab soil gas concentrations and sub-slab soil gas concentrations were "corrected" for the contribution from background ambient air (i.e., the ambient air concentrations were subtracted from the sub-slab soil gas concentrations). Corrected sub-slab soil gas concentrations that were less or equal to zero were eliminated from the data set (i.e., ambient air was the sole source of the sub-slab soil gas concentrations).
3. **Step 3: Evaluate Groundwater and Sub-Slab Soil Gas Lines-of-Evidence:** Perform a detailed evaluation of <u>groundwater VI COPCs</u> side-by-side with <u>VI sub-slab soil</u> gas VI COPCs identified in Step 1 and Step 2.

   a. A sub-slab soil gas VI COPC that is also considered groundwater VI COPC was retained for further evaluation based on the criteria from Step 1 and Step 2 (i.e., the maximum detected groundwater concentration was greater than the VISL and the maximum detected soil gas concentration was greater than the VISL).
   b. A sub-slab soil gas VI COPC was retained for further evaluation if the maximum detected concentration was greater than the VISL (regardless of the groundwater concentration).
   c. A sub-slab soil gas VI COPC was retained if it was detected but did not have a VISL.
   d. A sub-slab soil gas VI COPC was retained if it was not detected and did not have a VISL but the maximum detection limit was greater than 10 times the VISL.

> Since both groundwater (via leaching from soil to groundwater) and volatilization from a soil source are considered plausible sources of VI COPCs associated with the MSA in the Southern Area, the focus of the line-of-evidence is on groundwater and soil gas. This means that, unlike the Northern Area, constituents that are not detected in groundwater at concentration greater than VISLs can't be ruled out as VI COPCs. There is still a potential for soil sources and further evaluation of soil gas results is required.

4. **Step 4: Consider Other Lines-of-Evidence:** Evaluate other lines-of-evidence with respect to VI to determine if they are consistent with VI for each VI COPC. Other lines of evidence include, but are not limited to:
   a. Previous investigation results
   b. Likely use of the constituent in the area based on historical information
   c. Spatial distribution of the constituent in groundwater, sub-slab soil gas, and ambient air
   d. Half-life of the constituent
   e. Relative potential for VI in the Southern Area to be associated with releases from the former MSA
   f. Background contributions from human activity (e.g., construction/remodeling)
5. **Step 5: Document Conclusions Regarding VI Based on Lines-of-Evidence Evaluation:**
   a. A summary of Steps 1 through 4 will be documented
   b. The VI COPCs that <u>meet all of the criteria</u> in Steps 1 – 4 will be evaluated further in the HHRA when quantitatively assessing the VI pathway.
   c. The VI COPCs that did not meet all of the criteria in Steps 1 – 4 were eliminated from further evaluation.

Section 4: Results and Discussion

The results of the lines-of-evidence evaluations for the Northern and Southern Areas are presented in this section.

4.1 Northern Area VI Evaluation Results

As presented in Section 3.2, no buildings have been constructed on top of the potentially contaminated soil in the Northern Area. Therefore, VI COPCs detected in groundwater are the key to evaluating the VI pathway in the Northern Area. If VI COPCs are not detected in groundwater or are not detected in groundwater at concentrations sufficient to adversely impact indoor air via VI, then the VI COPC does not need to be evaluated further in the HHRA.

Step 1: Initial Screening of Groundwater and Sub-Slab Soil Gas to Identify VI COPCs in the Northern Area

An initial risk-based screening evaluation (i.e., US Navy Tier 1A screening) was conducted on Northern Area groundwater and sub-slab soil gas data to focus the VI evaluation on constituents that may need to be evaluated further in the HHRA. To identify VI COPCs for the Northern Area:

- The maximum detected concentrations in groundwater were compared to GW-to-IA VISLs. The GW-to-IA VISLs were calculated using USEPA residential ambient air regional screening levels (RSLs; USEPA 2019). The GW-to-IA VISLs were calculated by applying the USEPA's default groundwater-to-indoor air attenuation factor of 0.001 (USEPA 2015).
- The maximum detected concentrations in sub-slab soil gas were compared to SG-to-IA VISLs for residential land use. The SG-to-IA VISLs were calculated using USEPA residential ambient air RSLs. The SG-to-IA VISLs were calculated by applying the USEPA's default sub-slab soil gas-to-indoor air attenuation factor of 0.03 (USEPA 2015).

Residential land use parameters were used for the Tier 1A screening evaluations; however, these parameters were overly conservative for the Site, which is not currently used for residential purposes. The residential VISLs are based on an exposure duration and frequency of 26 years and 350 days per year, respectively, while actual maximum exposure at the Site is 25 years and 235 days per year (teachers and clinic workers).

The RSLs/VISLs correspond to a cancer risk of 1E-06 and noncancer hazard quotient (HQ) of 1 using health-protective, residential exposure assumptions (USEPA 2019).

The GW-to-IA and SG-to-IA VISLs are considered protective of indoor air and represent the 95% Upper Confidence Limit of expected concentrations in indoor air from groundwater or sub-slab soil gas, respectively.

Step 1a: Initial Screening of Groundwater to Identify VI COPCs in the Northern Area

Six groundwater VI COPCs were identified for the Northern Area based on the initial screening and were retained for further evaluation. Statistical summaries for the six groundwater VI COPCs are presented in Table D-1 and are summarized below.

Summary of Initial Screening of Groundwater from the Northern Area

VI COPC	Lowest Residential GW-to-IA VISL (ug/L)	Maximum Detection Limit (ug/L)	Maximum Detected Groundwater Concentration (ug/L)	Retain for Further Evaluation in Step 2 of the VI Assessment Process?
Chloro-1,3-butadiene, 2-	0.0041	1	--	Yes. Not detected in groundwater but the maximum detection limit was greater than 10 times the VISL.
Dibromo-3-chloropropane, 1,2-	0.028	0.5	--	Yes. Not detected in groundwater but the maximum detection limit was greater than 10 times the VISL.
Dibromochloromethane	--	0.1	0.15	Yes. Detected in groundwater but no VISL is available.
Dichloro-2-butene, cis-1,4-	0.025	1	--	Yes. Not detected in groundwater but the maximum detection limit was greater than 10 times the VISL.
Tert-Butyl Alcohol	--	2.5	7.9	Yes. Detected in groundwater but no VISL is available.
trans-1,4-Dichloro-2-butene	0.025	1	--	Yes. Not detected in groundwater but the maximum detection limit was greater than 10 times the VISL.

Note: Only three constituents were detected in Northern Area groundwater (dibromochloromethane, isopropanol, and tert-butyl alcohol). These constituents were detected in two of the three monitoring wells (MW-01 and MW-02). No constituents were detected in MW-03, which is located northwest of the elementary school buildings. Only one of the constituents detected in groundwater had a VISL (isopropanol). Isopropanol was detected in MW-01 and MW-02 at concentrations (24 ug/L and 31 ug/L, respectively) well below the GW-to-IA VISL of 634,441 ug/L (i.e., the level at which groundwater would impact indoor air). Consequently, isopropanol was not classified a VI COPC for groundwater in the Northern Area.

Step 1b: Initial Screening of Sub-Slab Soil Gas to Identify VI COPCs in the Northern Area

Twenty-nine constituents were identified in sub-slab soil gas samples collected from the Northern Area; however, only two of those constituents (dibromochloromethane and tert-butyl alcohol) were identified as VI COPCs based on groundwater concentrations (see Table D-2). The 27 constituents in sub-slab soil gas that were not identified as groundwater VI COPCs in the Northern Area were eliminated from further evaluation.

As stated in the lines-of-evidence approach, groundwater is the only potential source of VI in the Northern Area; therefore, the initial screening of sub-slab soil gas was limited to VI COPCs identified in groundwater. A summary of the initial screening of sub-slab soil gas for the Northern Area VI COPCs is presented below.

Summary of Initial Screening of Sub-Slab Soil Gas from the Northern Area

VI COPC	GW VI COPC from STEP 1?	Lowest Residential SG-to-IA VISL (ug/m^3)	Maximum Detection Limit (ug/m^3)	Maximum Detected Sub-Slab Soil Gas Concentration (ug/m^3)	Retained for Further Evaluation for VI in Step 2?
Chloro-1,3-butadiene, 2-	Yes	0.31	Not Analyzed	Not Analyzed	Yes. The VI COPC was not analyzed in sub-slab soil gas so no evaluation could be performed.
Dibromo-3-chloropropane, 1,2-	Yes	0.0057	Not Analyzed	Not Analyzed	Yes. The VI COPC was not analyzed in sub-slab soil gas so not evaluation could be performed.
Dibromochloromethane	Yes	--	0.068	0.13	Yes. Detected in sub-slab soil gas but no VISL is available.
Dichloro-2-butene, cis-1,4-	Yes	0.022	Not Analyzed	Not Analyzed	Yes. The VI COPC was not analyzed in sub-slab soil gas so no evaluation could be performed.
Tert-Butyl Alcohol	Yes	--	2.5	2.8	Yes. Detected in sub-slab soil gas but no VISL is available.
trans-1,4-Dichloro-2-butene	Yes	0.022	Not Analyzed	Not Analyzed	Yes. The VI COPC was not analyzed in sub-slab soil gas so no evaluation could be performed.

Step 2: Assess Contribution of Background Ambient Air to Sub-Slab Soil Gas Concentrations:

The sub-slab soil gas concentrations for Northern Area VI COPCs were compared to background ambient air concentrations to determine the impact of background ambient air concentrations on the measured soil gas concentrations. The results of this step are presented below.

Summary of Comparison of Background Ambient Air to Sub-Slab Soil Gas Concentrations

VI COPC	GW VI COPC from STEP 1?	Lowest Residential SG-to-IA VISL (ug/m^3)	Maximum Detected Sub-Slab Soil Gas Conc. (ug/m^3)	Maximum Detected Ambient Air Conc. (ug/m^3)	Corrected Sub-Slab Soil Gas Conc. (SG minus AA) (ug/m^3)	Retained for Further Evaluation for VI in Step 3?
Chloro-1,3-butadiene, 2-	Yes	0.31	NA	NA	--	Yes. The groundwater VI COPC was not analyzed in sub-slab soil gas so no evaluation could be performed.
Dibromo-3-chloropropane, 1,2-	Yes	0.0057	NA	NA	--	Yes. The groundwater VI COPC was not analyzed in sub-slab soil gas so not evaluation could be performed.

Summary of Comparison of Background Ambient Air to Sub-Slab Soil Gas Concentrations

VI COPC	GW VI COPC from STEP 1?	Lowest Residential SG-to-IA VISL (ug/m^3)	Maximum Detected Sub-Slab Soil Gas Conc. (ug/m^3)	Maximum Detected Ambient Air Conc. (ug/m^3)	Corrected Sub-Slab Soil Gas Conc. (SG minus AA) (ug/m^3)	Retained for Further Evaluation for VI in Step 3?
Dibromochloromethane	Yes	--	0.13	--	0.13	Yes. No contribution from ambient air to the sub-slab soil gas concentration was observed.
Dichloro-2-butene, cis-1,4-	Yes	0.022	NA	NA	--	Yes. The groundwater VI COPC was not analyzed in sub-slab soil gas so no evaluation could be performed.
Tert-Butyl Alcohol	Yes	--	2.8	0.62	2.2	Yes. A minimal contribution of ambient air to the sub-slab soil gas concentration was observed.
trans-1,4-Dichloro-2-butene	Yes	0.022	NA	NA	--	Yes. The groundwater VI COPC was not analyzed in sub-slab soil gas so no evaluation could be performed.

Step 3: Groundwater and Sub-Slab Soil Gas Line-of-Evidence Evaluation

Groundwater and sub-slab soil gas VI COPCs were evaluated holistically to determine if there was a plausible cause and effect relationship between the source in groundwater and presence in sub-slab soil gas. The results of the Step 3 line-of-evidence evaluation are summarized below.

Summary of Groundwater and Sub-Slab Soil Gas Line of Evidence

VI COPC	GW VI COPC from STEP 1?	Lowest Residential Cancer SG-to-IA VISL (ug/m^3)	Maximum Detected Sub-Slab Soil Gas Conc. (ug/m^3)	Maximum Detected Ambient Air Conc. (ug/m^3)	Corrected Sub-Slab Soil Gas Conc. (SG minus AA) (ug/m^3)	Retain for Further Evaluation for VI in Step 4?
Chloro-1,3-butadiene, 2-	Yes	0.31	NA	NA	--	No. The VI COPC was not detected in groundwater and was only retained because the maximum detection limit was higher than the VISL. Sub-slab soil gas samples were not analyzed for Chloro-1,3-butadiene, 2- so it is not possible to conclusively determine whether or not VI associated with Chloro-1,3-butadiene, 2- is occurring in the Northern Area.

Summary of Groundwater and Sub-Slab Soil Gas Line of Evidence

VI COPC	GW VI COPC from STEP 1?	Lowest Residential Cancer SG-to-IA VISL (ug/m^3)	Maximum Detected Sub-Slab Soil Gas Conc. (ug/m^3)	Maximum Detected Ambient Air Conc. (ug/m^3)	Corrected Sub-Slab Soil Gas Conc. (SG minus AA) (ug/m^3)	Retain for Further Evaluation for VI in Step 4?
Dibromo-3-chloropropane, 1,2-	Yes	0.0057	NA	NA	--	No. The VI COPC was not detected in groundwater and was only retained because the maximum detection limit was higher than the VISL. Sub-slab soil gas samples were not analyzed for dibromo-3-chloropropane, 1,2- so it is not possible to conclusively determine whether or not VI associated with dibromo-3-chloropropane, 1,2- is occurring in the Northern Area.
Dibromochloro methane	Yes	--	0.13	--	0.13	Yes (but inconclusive). This VI COPC was detected in groundwater in the Northern Area but at low concentrations (i.e., the maximum detected concentration was 0.15 ug/L); however, a VISL was not available to assess this result. Sub-slab soil gas sample concentrations were also low (i.e., the maximum detected concentration was 0.13 ug/m^3); however a VISL is not available to assess this result.
Dichloro-2-butene, cis-1,4-	Yes	0.022	NA	NA	--	No. The VI COPC was not detected in groundwater and was only retained because the maximum detection limit was higher than the VISL. Sub-slab soil gas samples were not analyzed for dichloro-2-butene, cis-1,4- so it is not possible to conclusively determine whether or not VI associated with dichloro-2-butene, cis-1,4- is occurring in the Northern Area.
Tert-Butyl Alcohol	Yes	--	2.8	0.62	2.2	Yes (but inconclusive). This constituent was detected in groundwater in the Northern Area but at low concentrations (i.e., the maximum detected concentration was 7.9 ug/L); however, a VISL was not available to assess this result. Sub-slab soil gas sample concentrations were also low (i.e., the maximum detected concentration was 2.8 ug/m^3);

Summary of Groundwater and Sub-Slab Soil Gas Line of Evidence

VI COPC	GW VI COPC from STEP 1?	Lowest Residential Cancer SG-to-IA VISL (ug/m^3)	Maximum Detected Sub-Slab Soil Gas Conc. (ug/m^3)	Maximum Detected Ambient Air Conc. (ug/m^3)	Corrected Sub-Slab Soil Gas Conc. (SG minus AA) (ug/m^3)	Retain for Further Evaluation for VI in Step 4?
						however, a VISL is not available to assess this result.
trans-1,4-Dichloro-2-butene	Yes	0.022	NA	NA	--	No. The constituent was not detected in groundwater and was only retained because the maximum detection limit was higher than the VISL. Sub-slab soil gas samples were not analyzed for trans-1,4-dichloro-2-butene so it is not possible to conclusively determine whether or not VI associated with trans-1,4-dichloro-2-butene is occurring in the Northern Area.

Only two of the six VI COPCs were retained for further evaluation (i.e., dibromochloromethane and tert-butyl alcohol). To further evaluate the potential for VI associated with dibromochloromethane and tert-butyl alcohol (i.e., the only VI COPCs retained for further evaluation in Step 3 [see the above table]), groundwater concentrations were modeled from sub-slab soil gas concentrations to determine what concentrations would be expected in groundwater if it were the source of the maximum detected soil gas concentrations. The modeled groundwater concentration for tert-butyl alcohol was significantly higher than the maximum detected groundwater concentration which indicates that Northern Area groundwater is most likely not the source of sub-slab soil gas concentrations in the elementary school buildings (see the table below). Consequently, tert-butyl alcohol was eliminated from further consideration in the VI evaluation. The modeled groundwater concentration for dibromochloromethane was similar to the maximum detected groundwater concentration (i.e., 0.12 ug/L vs. 0.15 ug/L) which indicates that Northern Area groundwater could be the source of sub-slab soil gas concentrations in the elementary school buildings (see the table below).

Line-of-Evidence: Modeled Groundwater Concentration Comparison (Northern Area)

VI COPC Detected in Groundwater	Maximum Detected Sub-Slab Soil Gas Concentration (ug/m³)	Modeled Groundwater Concentration Required to Produce Maximum Measured Sub-Slab Soil Gas Concentration (ug/L)	Maximum Detected Groundwater Concentration (ug/L)	Maximum Detected Groundwater Concentration Large Enough to Result in the Measured Sub-Slab Soil Gas Concentration?	Retain for Further Evaluation for VI in Step 4?
Dibromochloromethane	0.13	0.12	0.15	Yes	Yes. Maximum detected groundwater concentration is large enough to be responsible for measured sub-slab soil gas concentration, which indicates that the source of dibromochloromethane in sub-slab soil gas is possibly groundwater.
Tert-Butyl Alcohol	2.8	227	7.9	No	No. Maximum groundwater concentration is not large enough to be responsible for measured sub-slab soil gas concentration, which indicates that source of tert-butyl alcohol in sub-slab soil gas is not groundwater.

Sub-slab soil gas concentrations were converted to indoor air concentrations using the 0.03 USEPA default SG-to-IA attenuation factor. The calculated indoor air concentrations were then converted to groundwater concentrations using the 0.001 USEPA default GW-to-IA attenuation factor and the dimensionless Henry's Law Constant.

Step 4: Other Lines-of-Evidence for VI in the Northern Area

The other lines of evidence for VI in the Northern Area are summarized in this section. This section focuses on dibromochloromethane because it is the only VI COPC that has not been eliminated from further evaluation based on Steps 1-3.

Summary of Other Lines of Evidence

Other VI Lines-of-Evidence	Assessment of Lines of Evidence Relative Site-Specific Characteristics	Do the Other Lines of Evidence Indicate a Likelihood of VI for this Constituent?
Previous investigation results	Dibromochloromethane was not evaluated in previous investigations. This is not unusual given that dibromochloromethane is typically only included in investigations of the treatment/disinfection of drinking water systems	No
Likely use of the constituent in the area based on historical information	Not likely used and/or stored in the MSA. Most of the dibromochloromethane that enters the environment is formed as byproducts when chlorine is added to drinking water to kill bacteria. Dibromochloromethane is colorless to yellow, heavy, nonflammable, liquid with a sweet odor. Small amounts are formed	No

Summary of Other Lines of Evidence

Other VI Lines-of-Evidence	Assessment of Lines of Evidence Relative Site-Specific Characteristics	Do the Other Lines of Evidence Indicate a Likelihood of VI for this Constituent?
	naturally by plants in the ocean. It is somewhat soluble in water and readily evaporates into the air.	
Spatial distribution of the constituent in groundwater, sub-slab soil gas, and ambient air	Dibromochloromethane was only detected in one of three monitoring wells in the Northern Area (i.e., CKNA-MW01), which is located south (and likely upgradient) of the elementary school. The concentration was very low at 0.15 ug/L. Dibromochloromethane was only detected in six of 23 (i.e., 26%) sub-slab soil gas samples in the Northern Area.	Unlikely. Only one very low detection in groundwater and few detections in sub-slab soil gas. The results are not indicative of VI from a groundwater source.
Half-life of the constituent	The typical half-life in water is 46 hours. When released to air, dibromochloromethane is slowly broken down by reactions with other chemicals and sunlight or can be removed by rain. Dibromochloromethane does not build up in the food chain.	No
Relative potential for VI in the Southern Area to be associated with releases from the MSA	Dibromochloromethane is volatile; however, based on its historical use in treating drinking water and its relatively small production quantities, it is unlikely that dibromochloromethane was stored at the MSA.	No
Background contributions from human activity (e.g., construction/remodeling)	Most of dibromochloromethane that enters the environment is associated with treating drinking water to kill bacteria.	Possibly from non-MSA sources.

Source: ATSDR Toxic Substance Portal – Bromoform & Dibromochloromethane. Accessed on 07/05/19. https://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=712&tid=128

Step 5: VI Conclusions for the Northern Area

Only one VI COPC was identified for the Northern Area—dibromochloromethane. The dibromochloromethane results are summarized below.

Line-of-Evidence Summary: Groundwater to Soil Gas to Indoor Air VI pathway Analysis Summary (Northern Area)

Potential VI Source: VI COPC Detected in Groundwater	Maximum Detected GW Conc. (ug/L)	GW-to-IA VISL (ug/L)	GW Conc. Greater than GW-to-IA VISL?	Maximum Detected Sub-Slab Soil Gas Conc. (ug/m^3)	SG-to-IA VISL (ug/m^3)	Soil Gas Conc. Greater than SG-to-IA VISL?	Maximum Detected GW Conc. Large Enough to Result in the Measured Sub-Slab Soil Gas Conc.?	Does the Lines-of-Evidence Evaluation Indicate a Complete VI Pathway?
Dibromochlor-omethane	0.15	No VISL	No VISL	0.13	No VISL	No VISL	Yes	No. The results of the lines-of-evidence evaluation indicate that the VI exposure pathway is incomplete based on concentrations of dibromochloromethane in groundwater

Overall Conclusion Regarding the Northern Area VI Evaluation: The results of the lines-of-evidence evaluation indicate that it is unlikely that VI of dibromochloromethane from groundwater to indoor air, associated with releases from the MSA, is occurring at the elementary school and; therefore, does not need to be evaluated further in the HHRA.

4.2 Southern Area VI Evaluation Results

Two buildings in the Southern Area (i.e., the medical clinic and dental clinic) were constructed on top of potentially-contaminated soil in the former MSA. Therefore, in the Southern Area both soil and groundwater could be potential sources of VI (associated with releases from the former MSA) into the buildings in this area. Clinic workers and patients could come into contact with VI COPCs in the indoor air of the medical or dental clinic if VI COPCs in soil and/or groundwater volatilize and migrate into the indoor air of these buildings.[3]

Step 1: Initial Screening of Groundwater and Sub-Slab Soil Gas to Identify VI COPCs in the Southern Area

An initial risk-based screening evaluation (i.e., US Navy Tier 1A screening) was conducted on Southern Area groundwater and sub-slab soil gas data to focus the VI evaluation on those constituents that may need to be evaluated further in the HHRA. To identify VI COPCs for the Southern Area:

- Maximum detected groundwater concentrations were compared to GW-to-IA VISLs (VISLs were the same as those used in the Northern Area Initial Screening).
- Maximum detected sub-slab soil gas concentrations were compared to SG-to-IA VISLs (VISLs were the same as those used in the Northern Area Initial Screening).

Step 1a: Initial Screening of Groundwater to Identify VI COPCs in the Southern Area

Four groundwater VI COPCs were identified for the Southern Area based on the initial screening of groundwater and were retained for further evaluation. Statistical summaries for the VI COPCs are presented in Table D-3 and are summarized below.

Summary of Tier 1A Screening of Groundwater from the Southern Area

VI COPC	Residential Cancer GW-to-IA VISL (ug/L)	Residential Noncancer GW-to-IA VISL (ug/L)	Maximum Detection Limit (ug/L)	Maximum Detected Groundwater Conc. (ug/L)	Retain for Further Evaluation in Step 2 of the VI Assessment Process?
Chloro-1,3-butadiene, 2-	0.0041	9.2	1	--	Yes. Not detected in groundwater but the maximum detection limit

[3] Building 1304 is a maintenance shed and is not regularly occupied; therefore, a VI evaluation was not performed for this structure.

Summary of Tier 1A Screening of Groundwater from the Southern Area

VI COPC	Residential Cancer GW-to-IA VISL (ug/L)	Residential Noncancer GW-to-IA VISL (ug/L)	Maximum Detection Limit (ug/L)	Maximum Detected Groundwater Conc. (ug/L)	Retain for Further Evaluation in Step 2 of the VI Assessment Process?
					was greater than 10 times the VISL.
Dibromo-3-chloropropane, 1,2-	0.028	35	0.5	--	Yes. Not detected in groundwater but the maximum detection limit was greater than 10 times the VISL.
Dichloro-2-butene, cis-1,4-	0.025	--	1	--	Yes. Not detected in groundwater but the maximum detection limit was greater than 10 times the VISL.
trans-1,4-Dichloro-2-butene	0.025	--	1	--	Yes. Not detected in groundwater but the maximum detection limit was greater than 10 times the VISL.

Note: Only one constituent was detected in Southern Area groundwater (isopropanol). This constituent was detected in two of the three monitoring wells (MW-01 and MW-03). No constituents were detected in MW-02. Isopropanol was detected in MW-01 and MW-03 at concentrations (57 ug/L and 34 ug/L, respectively) well below the GW-to-IA VISL of 634,441 ug/L (i.e., the level at which groundwater would impact indoor air). Consequently, isopropanol was not classified a VI COPC for groundwater in the Southern Area

Step 1b: Initial Screening of Sub-Slab Soil Gas to Identify VI COPCs in the Southern Area

Twenty-eight constituents were identified as VI COPCs in the Southern Area based on the initial screening of sub-slab soil gas and were retained for further evaluation. Statistical summaries for the sub-slab soil gas data are presented in Table D-4 and are summarized below.

Summary of Initial Screening of Sub-Slab Soil Gas from the Southern Area

VI COPC	GW VI COPC from STEP 1a?	Lowest Cancer SG-to-IA VISL (ug/m^3)	Maximum Detection Limit (ug/m^3)	Maximum Detected Sub-Slab Soil Gas Concentration (ug/m^3)	Retained for Further Evaluation for VI in Step 2?
1,2-cis-Dichloroethylene	No	--	0.31	0.091	Yes. Detected in greater than or equal to 5% of the sub-slab soil gas samples and no VISL was available.
1,2-trans-Dichloroethylene	No	--	0.25	0.027	Yes. Detected in greater than or equal to 5% of the sub-slab soil gas samples and no VISL was available.

Summary of Initial Screening of Sub-Slab Soil Gas from the Southern Area

VI COPC	GW VI COPC from STEP 1a?	Lowest Cancer SG-to-IA VISL (ug/m^3)	Maximum Detection Limit (ug/m^3)	Maximum Detected Sub-Slab Soil Gas Concentration (ug/m^3)	Retained for Further Evaluation for VI in Step 2?
1,3-Dichlorobenzene	No	--	--	510	Yes. Detected in greater than or equal to 5% of the sub-slab soil gas samples and no VISL was available.
1,3-Dichloropropane	No	--	18	--	Yes. Not detected in any sub-slab soil gas sample, no VISL, and maximum detection limit was greater than 10 times the laboratory limit of quantitation (LOQ).
2,2,4-Trimethylpentane	No	--	5.4	0.87	Yes. Detected in greater than or equal to 5% of the sub-slab soil gas samples and no VISL was available.
4-Ethyltoluene	No	--	--	45	Yes. Detected in greater than or equal to 5% of the sub-slab soil gas samples and no VISL was available.
Acetaldehyde	No	43	0.096	94	Yes. The detected sub-slab soil gas concentration was greater than the VISL.
Acrolein	No	0.7	1.3	5.7	Yes. The detected sub-slab soil gas concentration was greater than the VISL.
Decane	No	--	--	69	Yes. Detected in greater than or equal to 5% of the sub-slab soil gas samples and no VISL was available.
Dibromochloromethane	No	--	0.3	0.098	Yes. Detected in greater than or equal to 5% of the sub-slab soil gas samples and no VISL was available.
Dodecane	No	--	10	12	Yes. Detected in greater than or equal to 5% of the sub-slab soil gas samples and no VISL was available.
Ethanol	No	--	0.62	360	Yes. Detected in greater than or equal to 5% of the sub-slab soil gas samples and no VISL was available.
Ethylbenzene	No	37	--	340	Yes. The detected sub-slab soil gas concentration was greater than the VISL.
GRO	No	1,033	1,600	8,800	Yes. The detected sub-slab soil gas concentration was greater than the VISL.
Isopropanol	No	7,000	0.37	28,000	Yes. The detected sub-slab soil gas concentration was greater than the VISL.

Summary of Initial Screening of Sub-Slab Soil Gas from the Southern Area

VI COPC	GW VI COPC from STEP 1a?	Lowest Cancer SG-to-IA VISL (ug/m^3)	Maximum Detection Limit (ug/m^3)	Maximum Detected Sub-Slab Soil Gas Concentration (ug/m^3)	Retained for Further Evaluation for VI in Step 2?
Naphthalene	No	2.8	0.54	4.2	Yes. The detected sub-slab soil gas concentration was greater than the VISL.
n-Butylbenzene	No	--	5.2	0.38	Yes. Detected in greater than or equal to 5% of the sub-slab soil gas samples and no VISL was available.
o-Chlorotoluene	No	--	18	--	Yes. Not detected in any sub-slab soil gas sample, no VISL, and maximum detection limit was greater than 10 times the laboratory limit of quantitation (LOQ).
Octane	No	--	8.1	0.57	Yes. Detected in greater than or equal to 5% of the sub-slab soil gas samples and no VISL was available.
p-Isopropyltoluene	No	--	5.5	12	Yes. Detected in greater than or equal to 5% of the sub-slab soil gas samples and no VISL was available.
sec-Butylbenzene	No	--	4.9	0.18	Yes. Detected in greater than or equal to 5% of the sub-slab soil gas samples and no VISL was available.
Tert-Butyl Alcohol	No	--	0.52	36	Yes. Detected in greater than or equal to 5% of the sub-slab soil gas samples and no VISL was available.
trans-1,3-Dichloropropene	No	--	0.19	--	Yes. Not detected in any sub-slab soil gas sample, no VISL, and maximum detection limit was greater than 10 times the laboratory limit of quantitation (LOQ).
Trichlorofluoromethane	No	--	--	1.2	Yes. Detected in greater than or equal to 5% of the sub-slab soil gas samples and no VISL was available.
Undecane	No	--	9.5	31	Yes. Detected in greater than or equal to 5% of the sub-slab soil gas samples and no VISL was available.
Butraldehyde	No	--	--	0.82	Yes. Detected in greater than or equal to 5% of the sub-slab soil gas samples and no VISL was available.
Crotonaldehyde	No	--	--	1.1	Yes. Detected in greater than or equal to 5% of the sub-slab soil gas samples and no VISL was available.
Hexanal	No	--	--	0.47	Yes. Detected in greater than or equal to 5% of the sub-slab soil gas samples and no VISL was available.

Step 2: Assess Contribution of Background Ambient Air to Sub-Slab Soil Gas Concentrations:

The sub-slab soil gas VI COPCs for the Southern Area (i.e., Building 1460 and Building 1463) were compared to background ambient air concentrations to determine the impact of background ambient air concentrations on the measured soil gas concentrations (see the following table). The results of this step are presented below.

Summary of Comparison of Ambient Background to Sub-Slab Soil Gas Concentrations

VI COPC	Lowest Residential SG-to-IA VISL (ug/m^3)	Maximum Detection Limit (ug/m^3)	Maximum Detected Sub-Slab Soil Gas Conc. (ug/m^3)	Maximum Detected Ambient Air Conc. (ug/m^3)	Corrected Sub-Slab Soil Gas Conc. (SG minus AA) (ug/m^3)	Retained for Further Evaluation for VI in Step 3?
1,2-cis-Dichloroethylene	--	0.31	0.091	0.047	0.044	Yes; however, ambient air potentially contributed approximately 50% of the sub-slab soil gas concentration.
1,2-trans-Dichloroethylene	--	0.25	0.027	--	0.027	Yes. No contribution from ambient background to the sub-slab soil gas concentration was observed.
1,3-Dichlorobenzene	--	--	510	3.6	506	Yes. A minimal contribution of ambient background to the sub-slab soil gas concentration was observed.
1,3-Dichloropropane	--	18	--	--	--	No. The VI COPC was not detected in sub-slab soil gas or in ambient air. The constituent was also not identified as a VI COPC associated with groundwater.
2,2,4-Trimethylpentane	--	5.4	0.87	0.45	0.42	Yes; however, ambient air potentially contributes approximately 50% of the sub-slab soil gas concentration.
4-Ethyltoluene	--	--	45	0.21	45	Yes. A minimal contribution of ambient air to the sub-slab soil gas concentration was observed.
Acetaldehyde	43	0.096	94	5.8	88	Yes; however, ambient air potentially contributed approximately 6% of the sub-slab soil gas concentration.
Acrolein	0.7	1.3	5.7	2.4	3.3	Yes; however, ambient air potentially contributed approximately 40% of the sub-slab soil gas concentration.
Decane	--	--	69	2.1	67	Yes. A minimal contribution of ambient air to the sub-slab soil gas concentration was observed.
Dibromochloromethane	--	0.3	0.098	--	0.098	Yes. No contribution from ambient air to the sub-slab soil gas concentration was observed.
Dodecane	--	10	12	3.2	8.8	Yes; however, ambient air potentially contributed approximately 25% of the sub-slab soil gas concentration.

Summary of Comparison of Ambient Background to Sub-Slab Soil Gas Concentrations

VI COPC	Lowest Residential SG-to-IA VISL (ug/m³)	Maximum Detection Limit (ug/m³)	Maximum Detected Sub-Slab Soil Gas Conc. (ug/m³)	Maximum Detected Ambient Air Conc. (ug/m³)	Corrected Sub-Slab Soil Gas Conc. (SG minus AA) (ug/m³)	Retained for Further Evaluation for VI in Step 3?
Ethanol	--	0.62	360	12	348	Yes. A minimal contribution of ambient air to the sub-slab soil gas concentration was observed.
Ethylbenzene	37	--	340	1.3	339	Yes. A minimal contribution of ambient air to the sub-slab soil gas concentration was observed.
GRO	--	1,600	8,800	--	8,800	Yes. No contribution from ambient air to the sub-slab soil gas concentration was observed.
Isopropanol	--	0.37	28,000	220	27,780	Yes. A minimal contribution of ambient air to the sub-slab soil gas concentration was observed.
Naphthalene	2.8	0.54	4.2	0.13	4.1	Yes. A minimal contribution of ambient air to the sub-slab soil gas concentration was observed.
n-Butylbenzene	--	5.2	0.38	--	0.38	Yes. No contribution from ambient air to the sub-slab soil gas concentration was observed.
o-Chlorotoluene	--	18	--	--	--	No. The VI COPC was not detected in sub-slab soil gas or in ambient air. The VI COPC was also not identified as a VI COPC associated with groundwater.
Octane	--	8.1	0.57	0.37	0.20	Yes; however, ambient air potentially contributed approximately 65% of the sub-slab soil gas concentration.
p-Isopropyltoluene	--	5.5	12	--	12	Yes. No contribution from ambient air to the sub-slab soil gas concentration was observed.
sec-Butylbenzene	--	4.9	0.18	--	0.18	Yes. No contribution from ambient air to the sub-slab soil gas concentration was observed.
Tert-Butyl Alcohol	--	0.52	36	6.9	29	Yes; however, ambient air potentially contributed approximately 20% of the sub-slab soil gas concentration.
trans-1,3-Dichloropropene	--	0.19	--	0.42	--	No. The constituent was not detected in sub-slab soil gas but was detected in ambient air at a concentration that exceeded the maximum sub-slab soil gas detection limit. The constituent was also not identified as a VI COPC associated with groundwater.

Summary of Comparison of Ambient Background to Sub-Slab Soil Gas Concentrations

VI COPC	Lowest Residential SG-to-IA VISL (ug/m3)	Maximum Detection Limit (ug/m3)	Maximum Detected Sub-Slab Soil Gas Conc. (ug/m3)	Maximum Detected Ambient Air Conc. (ug/m3)	Corrected Sub-Slab Soil Gas Conc. (SG minus AA) (ug/m3)	Retained for Further Evaluation for VI in Step 3?
Trichlorofluoromethane	--	--	1.2	0.95	0.25	Yes; however, ambient air potentially contributed approximately 80% of the sub-slab soil gas concentration.
Undecane	--	9.5	31	2.7	28	Yes. A minimal contribution of ambient air to the sub-slab soil gas concentration was observed.
Butraldehyde	--	0.22	0.82	0.49	0.33	Yes; however, ambient air potentially contributes approximately 60% of the sub-slab soil gas concentration.
Crotonaldehyde	--	0.12	1.1	--	1.1	Yes. No contribution from ambient air to the sub-slab soil gas concentration was observed.
Hexanal	--	0.31	0.47	1.6	--	No. The constituent was detected in ambient air at higher concentrations than in sub-slab soil gas. Ambient air is the likely source of hexanal in sub-slab soil gas.

Only 24 of the 28 constituents were retained for further evaluation for VI in Step 3.

Step 3a: Line-of-Evidence Evaluation of Southern Area Groundwater and Sub-Slab Soil Gas

The 28 VI COPCs (i.e., four groundwater VI COPCs and 24 soil gas VI COPCs) were evaluated holistically in this step. In the Southern Area, both soil and groundwater can be a source of VI COPCs in sub-slab soil gas (i.e., a VI COPC does not have to be detected in both groundwater and sub-slab soil gas greater than the VISL to be a VI COPC). The results of Step 3 of the VI evaluation are summarized below.

Summary of Groundwater and Sub-Slab Soil Gas Line of Evidence

VI COPC	GW VI COPC from STEP 1?	Lowest Residential SG-to-IA VISL (ug/m3)	Maximum Detection Limit (ug/m3)	Maximum Detected Sub-Slab Soil Gas Conc. (ug/m3)	Maximum Detected Ambient Air Conc. (ug/m3)	Corrected Sub-Slab Soil Gas Conc. (SG minus AA) (ug/m3)	Retained for Further Evaluation for VI in Step 4?
Chloro-1,3-butadiene, 2-	Yes	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	No. The VI COPC was not detected in groundwater and was only retained because the maximum detection limit was higher than the VISL. Sub-slab soil gas samples were not analyzed for chloro-1,3-butadiene, 2- so it is not possible to conclusively determine

Summary of Groundwater and Sub-Slab Soil Gas Line of Evidence

VI COPC	GW VI COPC from STEP 1?	Lowest Residential SG-to-IA VISL (ug/m³)	Maximum Detection Limit (ug/m³)	Maximum Detected Sub-Slab Soil Gas Conc. (ug/m³)	Maximum Detected Ambient Air Conc. (ug/m³)	Corrected Sub-Slab Soil Gas Conc. (SG minus AA) (ug/m³)	Retained for Further Evaluation for VI in Step 4?
							whether or not VI associated with chloro-1,3-butadiene, 2- is occurring in the Southern Area.
Dibromo-3-chloropropane, 1,2-	Yes	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	No. The VI COPC was not detected in groundwater and was only retained because the maximum detection limit was higher than the VISL. Sub-slab soil gas samples were not analyzed for dibromo-3-chloropropane, 1,2- so it is not possible to conclusively determine whether or not VI associated with dibromo-3-chloropropane, 1,2- is occurring in the Southern Area.
Dichloro-2-butene, cis-1,4-	Yes	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	No. The VI COPC was not detected in groundwater and was only retained because the maximum detection limit was higher than the VISL. Sub-slab soil gas samples were not analyzed for dichloro-2-butene, cis-1,4- so it is not possible to conclusively determine whether or not VI associated with dichloro-2-butene, cis-1,4- is occurring in the Southern Area.
trans-1,4-Dichloro-2-butene	Yes	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	No. The VI COPC was not detected in groundwater and was only retained because the maximum detection limit was higher than the VISL. Sub-slab soil gas samples were not analyzed for trans-1,4-dichloro-2-butene so it is not possible to conclusively determine whether or not VI associated with trans-1,4-dichloro-2-butene is occurring in the Southern Area.
1,2-cis-Dichloroethylene	No	--	0.31	0.091	0.047	0.044	No. This constituent was not identified as a groundwater VI COPC. It was initially retained as a soil gas VI COPC because it was detected in sub-slab soil gas and does not have a VISL. Ambient air potentially contributes approximately 50%

Summary of Groundwater and Sub-Slab Soil Gas Line of Evidence

VI COPC	GW VI COPC from STEP 1?	Lowest Residential SG-to-IA VISL (ug/m^3)	Maximum Detection Limit (ug/m^3)	Maximum Detected Sub-Slab Soil Gas Conc. (ug/m^3)	Maximum Detected Ambient Air Conc. (ug/m^3)	Corrected Sub-Slab Soil Gas Conc. (SG minus AA) (ug/m^3)	Retained for Further Evaluation for VI in Step 4?
							of the sub-slab soil gas concentration. Given the very low corrected/maximum detected sub-slab soil gas concentration (i.e., 0.044 ug/m^3), frequency of detection (detected in only four of 14 samples) and lack of other evidence indicating a VI source, this constituent was eliminated from further consideration in the VI assessment
1,2-trans-Dichloroethylene	No	--	0.25	0.027	--	0.027	No. This constituent was not identified as a groundwater VI COPC. It was initially retained as a VI COPC because it was detected in sub-slab soil gas and does not have a VISL. Ambient does not contribute significantly to the sub-slab soil gas concentration. Given the very low corrected/maximum detected sub-slab soil gas concentration (i.e., 0.027 ug/m^3), frequency of detection (detected in only two of 14 samples) and lack of other evidence indicating a VI source, this constituent was eliminated from further consideration in the VI assessment
1,3-Dichlorobenzene	No	--	--	510	3.6	506	Yes. This constituent was not identified as a groundwater VI COPC; however, it cannot be ruled out because it could be a soil source. It was retained for further assessment because it was detected in 14 of 14 soil gas samples and does not have a VISL. Also, minimal contribution of ambient background to the sub-slab soil gas concentration was observed.
2,2,4-Trimethylpentane	No	--	5.4	0.87	0.45	0.42	No. This constituent was not identified as a groundwater VI COPC in groundwater. It was initially retained as a VI COPC because it was detected in sub-

Summary of Groundwater and Sub-Slab Soil Gas Line of Evidence

VI COPC	GW VI COPC from STEP 1?	Lowest Residential SG-to-IA VISL (ug/m^3)	Maximum Detection Limit (ug/m^3)	Maximum Detected Sub-Slab Soil Gas Conc. (ug/m^3)	Maximum Detected Ambient Air Conc. (ug/m^3)	Corrected Sub-Slab Soil Gas Conc. (SG minus AA) (ug/m^3)	Retained for Further Evaluation for VI in Step 4?
							slab soil gas and does not have a VISL. Ambient air potentially contributes approximately 50% of the sub-slab soil gas concentration. Given the very low corrected/maximum detected sub-slab soil gas concentration (i.e., 0.42 ug/m^3), frequency of detection (detected in only seven of 14 samples) and lack of other evidence indicating a VI source, this constituent was eliminated from further consideration in the VI assessment.
4-Ethyltoluene	No	--	--	45	0.21	45	Yes. This constituent was not identified as a groundwater VI COPC; however, it cannot be ruled out because it could be a soil source. It was retained for further assessment because it was detected in 14 of 14 soil gas samples and does not have a VISL. A minimal contribution of ambient air to the sub-slab soil gas concentration was observed.
Actaldehyde	No	43	0.096	94	5.8	88	Yes. This constituent was not identified as a groundwater VI COPC in groundwater; however, it cannot be ruled out because it could be a soil source. It was retained for further assessment because it was detected in eight of 14 soil gas samples and the maximum detected concentration was greater than the VISL. Ambient air potentially contributed approximately six% of the sub-slab soil gas concentration.
Acrolein	No	0.7	1.3	5.7	2.4	3.3	Yes. This constituent was not identified as a groundwater VI COPC; however, it cannot be ruled out because it could be a soil source. It was retained for further assessment because it was detected in 10 of 14 soil gas samples and the maximum

Summary of Groundwater and Sub-Slab Soil Gas Line of Evidence

VI COPC	GW VI COPC from STEP 1?	Lowest Residential SG-to-IA VISL (ug/m^3)	Maximum Detection Limit (ug/m^3)	Maximum Detected Sub-Slab Soil Gas Conc. (ug/m^3)	Maximum Detected Ambient Air Conc. (ug/m^3)	Corrected Sub-Slab Soil Gas Conc. (SG minus AA) (ug/m^3)	Retained for Further Evaluation for VI in Step 4?
							detected concentration was greater than the VISL. Ambient air potentially contributed approximately 40% of the sub-slab soil gas concentration.
Decane	No	--	--	69	2.1	67	Yes. This constituent was not identified as a groundwater VI COPC; however, it cannot be ruled out because it could be a soil source. It was retained for further assessment because it was detected in 14 of 14 soil gas samples and does not have a VISL. A minimal contribution of ambient air to the sub-slab soil gas concentration was observed.
Dibromochloromethane	No	--	0.3	0.098	--	0.098	No. This constituent was not identified as a groundwater VI COPC. It was initially retained as a VI COPC because it was detected in sub-slab soil gas and does not have a VISL. Ambient air does not contribute significantly to the sub-slab soil gas concentration. Given the very low corrected/maximum detected sub-slab soil gas concentration (i.e., 0.098 ug/m^3), frequency of detection (detected in only six of 14 samples) and lack of other evidence indicating a VI source, this constituent was eliminated from further consideration in the VI assessment.
Dodecane	No	--	10	12	3.2	8.8	Yes. This constituent was not identified as a groundwater VI COPC; however, it can't be ruled out because it could be a soil source. It was retained for further assessment because it was detected in 12 of 14 soil gas samples and does not have a VISL. Ambient air potentially contributes approximately 25% of the sub-slab soil gas concentration.

Summary of Groundwater and Sub-Slab Soil Gas Line of Evidence

VI COPC	GW VI COPC from STEP 1?	Lowest Residential SG-to-IA VISL (ug/m3)	Maximum Detection Limit (ug/m3)	Maximum Detected Sub-Slab Soil Gas Conc. (ug/m3)	Maximum Detected Ambient Air Conc. (ug/m3)	Corrected Sub-Slab Soil Gas Conc. (SG minus AA) (ug/m3)	Retained for Further Evaluation for VI in Step 4?
Ethanol	No	--	0.62	360	12	348	Yes. This constituent was not identified as a VI COPC in groundwater; however, it can't be ruled out because it could be a soil source. It was retained for further assessment because it was detected in 11 of 14 soil gas samples and does not have a VISL. A minimal contribution of ambient air to the sub-slab soil gas concentration was observed.
Ethylbenzene		37	--	340	1.3	339	Yes. This constituent was not identified as a VI COPC in groundwater; however, it can't be ruled out because it could be a soil source. It was retained for further assessment because it was detected in 14 of 14 soil gas samples and the maximum detected concentration was greater than the VISL. A minimal contribution of ambient air to the sub-slab soil gas concentration was observed.
GRO	No	--	1,600	8,800	--	8,800	Yes. This constituent was not identified as a groundwater VI COPC; however, it cannot be ruled out because it could be a soil source. It was retained for further assessment because it was detected in six of 14 soil gas samples and the maximum detected concentration was greater than the VISL. No contribution from ambient air to the sub-slab soil gas concentration was observed.
Isopropanol	No	7,000	0.37	28,000	220	27,780	Yes. This constituent was not identified as a groundwater VI COPC; however, it cannot be ruled out because it could be a soil source. It was retained for further assessment because it was detected in 13 of 14 soil gas samples and the maximum detected concentration was greater than the VISL. A minimal contribution of ambient air to the

Summary of Groundwater and Sub-Slab Soil Gas Line of Evidence

VI COPC	GW VI COPC from STEP 1?	Lowest Residential SG-to-IA VISL (ug/m^3)	Maximum Detection Limit (ug/m^3)	Maximum Detected Sub-Slab Soil Gas Conc. (ug/m^3)	Maximum Detected Ambient Air Conc. (ug/m^3)	Corrected Sub-Slab Soil Gas Conc. (SG minus AA) (ug/m^3)	Retained for Further Evaluation for VI in Step 4?
							sub-slab soil gas concentration was observed.
Naphthalene	No	2.8	0.54	4.2	0.13	4.1	Yes. This constituent was not identified as a groundwater VI COPC; however, it cannot be ruled out because it could be a soil source. It was retained for further assessment because it was detected in 12 of 14 soil gas samples and the maximum detected concentration was greater than the VISL. A minimal contribution of ambient background to the sub-slab soil gas concentration was observed.
n-Butylbenzene	No	--	5.2	0.38	--	0.38	No. This constituent was not identified as a groundwater VI COPC. It was initially retained as VI COPC for further assessment because it was detected in sub-slab soil gas samples and does not have a VISL. Ambient air does not contribute significantly to the sub-slab soil gas concentration. Given the very low corrected/maximum detected sub-slab soil gas concentration (i.e., 0.38 ug/m^3), frequency of detection (detected in only seven of 14 samples), and lack of other evidence indicating a VI source, this constituent was eliminated from further evaluation.
Octane	No	--	8.1	0.57	0.37	0.20	No. This constituent was not identified as a groundwater VI COPC. It was initially retained as a VI COPC because it was detected in sub-slab soil gas and does not have a VISL. Ambient air potentially contributes approximately 65% of the sub-slab soil gas concentration. Given the very low corrected/maximum detected sub-slab soil gas concentration (i.e., 0.20 ug/m^3), frequency of detection (detected in only 10 of

Summary of Groundwater and Sub-Slab Soil Gas Line of Evidence

VI COPC	GW VI COPC from STEP 1?	Lowest Residential SG-to-IA VISL (ug/m³)	Maximum Detection Limit (ug/m³)	Maximum Detected Sub-Slab Soil Gas Conc. (ug/m³)	Maximum Detected Ambient Air Conc. (ug/m³)	Corrected Sub-Slab Soil Gas Conc. (SG minus AA) (ug/m³)	Retained for Further Evaluation for VI in Step 4?
							14 samples) and lack of other evidence indicating a VI source, this constituent was eliminated from further evaluation
p-Isopropyltoluene	No	--	5.5	12	--	12	Yes. This constituent was not identified as a groundwater VI COPC; however, it can't be ruled out because it could be a soil source. It was retained for further assessment because it was detected in 12 of 14 soil gas samples and does not have a VISL. No contribution from ambient air to the sub-slab soil gas concentration was observed.
sec-Butylbenzene	No	--	4.9	0.18	--	0.18	No. This constituent was not identified as a groundwater VI COPC. It was initially retained as a VI COPC because it was detected in sub-slab soil gas samples and does not have a VISL. Ambient air does not contribute significantly to the sub-slab soil gas concentration. Given the very low corrected/maximum detected sub-slab soil gas concentration (i.e., 0.18 ug/m³), frequency of detection (detected in only one of 14 samples), and lack of other evidence indicating a VI source, this constituent was eliminated from further evaluation.
Tert-Butyl Alcohol	No	--	0.52	36	6.9	29	Yes. This constituent was not identified as a groundwater VI COPC; however, it cannot be ruled out because it could be a soil source. It was retained for further assessment because it was detected in nine of 14 soil gas samples and does not have a VISL. Ambient air potentially contributed approximately 20% of the sub-slab soil gas concentration.
Trichlorofluoromethane	No	--	--	1.2	0.95	0.25	No. This constituent was not identified as a groundwater VI COPC. It was initially retained as

Summary of Groundwater and Sub-Slab Soil Gas Line of Evidence

VI COPC	GW VI COPC from STEP 1?	Lowest Residential SG-to-IA VISL (ug/m^3)	Maximum Detection Limit (ug/m^3)	Maximum Detected Sub-Slab Soil Gas Conc. (ug/m^3)	Maximum Detected Ambient Air Conc. (ug/m^3)	Corrected Sub-Slab Soil Gas Conc. (SG minus AA) (ug/m^3)	Retained for Further Evaluation for VI in Step 4?
							a VI COPC because it was detected in sub-slab soil gas samples and does not have a VISL. It was retained for further assessment because it was detected in 14 of 14 soil gas samples), with low corrected/maximum detected sub-slab soil gas concentration of 0.25 ug/m^3. Ambient air contributed significantly to the sub-slab soil gas concentration (approximately 80%). Given the low corrected/maximum detected sub-slab soil gas concentration (i.e., 0.25 ug/m^3) and the significant ambient air background contribution (approximately 80%) to the sub-slab soil gas concentration, and lack of other evidence indicating a VI source, this constituent was eliminated from further evaluation..
Undecane	No	--	9.5	31	2.7	28	Yes. This constituent was not identified as a groundwater VI COPC; however, it can't be ruled out because it could be a soil source. It was retained for further assessment because it was detected in 12 of 14 soil gas samples and does not have a VISL. A minimal contribution of ambient air to the sub-slab soil gas concentration was observed.
Butraldehyde	No	--	0.22	0.82	0.49	0.33	No. This constituent was not identified as a VI COPC in groundwater. It was initially retained as a VI COPC because it was detected in sub-slab soil gas and does not have a VISL. Ambient air potentially contributes approximately 60% of the sub-slab soil gas concentration. Given the very low corrected/maximum detected sub-slab soil gas concentration (i.e., 0.33 ug/m^3), frequency of detection (detected

Summary of Groundwater and Sub-Slab Soil Gas Line of Evidence

VI COPC	GW VI COPC from STEP 1?	Lowest Residential SG-to-IA VISL (ug/m³)	Maximum Detection Limit (ug/m³)	Maximum Detected Sub-Slab Soil Gas Conc. (ug/m³)	Maximum Detected Ambient Air Conc. (ug/m³)	Corrected Sub-Slab Soil Gas Conc. (SG minus AA) (ug/m³)	Retained for Further Evaluation for VI in Step 4?
							in only 4 of 14 samples) and lack of other evidence indicating a VI source, this constituent was eliminated from further consideration in the VI assessment.
Crotonaldehyde	No	--	0.12	1.1	--	1.1	No. This constituent was not identified as a VI COPC in groundwater. It was initially retained as a VI COPC because it was detected in sub-slab soil gas and does not have a VISL. Given the very low maximum detected sub-slab soil gas concentration (i.e., 1.1 ug/m³), frequency of detection (detected in only 3 of 14 samples) and lack of other evidence indicating a VI source, this constituent was eliminated from further consideration in the VI assessment.

Only 14 of the 28 constituents were retained for further evaluation for VI in Step 3, including:

- 1,3-Dichlorobenzene
- 4-Ethyltoluene
- Acetaldehyde
- Acrolein
- Decane
- Dodecane
- Ethanol
- Ethylbenzene
- GRO
- Isopropanol
- Naphthalene
- p-Isopropyltoluene
- Tert-Butyl Alcohol
- Undecane

Step 3b: Line-of-Evidence Evaluation of Building 1460 (Medical Clinic) Groundwater and Sub-Slab Soil Gas

Note: The VI COPCs identified in the Southern Area were evaluated further based on the concentrations in each building (i.e., Building 1460 [Medical Clinic] and Building 1463 [Dental Clinic]).

Northern Area sub-slab soil gas concentrations are unrelated to historical site activities (i.e., the VI pathway is incomplete). Therefore, any detections in sub-slab soil gas in the Northern Area are considered representative of background. Southern Area sub-slab soil gas concentrations were subsequently compared to background concentrations found in the Northern Area to determine if sub-slab soil gas concentrations exceeding background were detected in the Southern Area.

Building 1460 (Medical Clinic)

Fourteen VI COPCs were identified for the Southern Area. The groundwater summary statistics for the Southern Area are presented on Table D-3; the sub-slab soil gas summary statistics for Building 1460 (Medical Clinic) are presented on Table D-5. The lines-of-evidence for samples associated with Building 1460 (Medical Clinic) are summarized below.

1,3-Dichlorobenzene

1,3-Dichlorobenzene was detected in all seven of the sub-slab soil gas samples that were collected from this building but was not detected in groundwater and does not have a VISL for groundwater or soil gas. The concentrations in Building 1460 ranged from 0.20 ug/m^3 to 0.60 ug/m^3, with a mean of 0.36 ug/m^3 and standard deviation of 0.13 ug/m^3. The ambient air background concentration was 3.6 ug/m^3, which indicates that the sub-slab soil gas concentrations in this building are less than ambient background and are not likely associate with VI from a sub-surface source. Therefore, 1,3-dichlorobenzene was eliminated from further evaluation in this building.

4-Ethyltoluene

4-Ethyltoluene was detected in all seven of the sub-slab soil gas samples that were collected from this building but was not analyzed for in groundwater and does not have a VISL for groundwater or soil gas. The concentration in sub-slab soil gas ranged from 0.23 ug/m^3 to 0.89 ug/m^3, with a mean of 0.42 ug/m^3 and standard deviation of 0.22 ug/m^3 which indicates that the sub-slab soil gas results for 4-ethyltoluene in this building are similar. These results are somewhat uncommon for VI unless there is a homogeneous and widespread source of 4-ethyltoluene located in soil beneath the building. It is possible that there also could be a source in groundwater since groundwater was not analyzed for 4-ethyltoluene. Ambient air contributed significantly to the sub-slab soil gas concentration (approximately 24%). The sub-slab soil gas 4-ethyltoluene concentrations in Building 1460 are similar to the sub-slab soil gas concentrations measured in the Northern Area where 4-ethyltoluene was not identified as a VI COPC. For example, the range of sub-slab concentrations for 4-ethyltoluene in the Northern Area buildings was 0.59 ug/m^3 to 1.8 ug/m^3 with a mean of 0.24 ug/m^3, and a standard deviation of 0.39 ug/m^3. These results are similar to the 4-ethyltoluene in sub-slab soil gas observed in Building 1460. These data indicate that there is not a VI signature for 4-ethyltoluene in this building. Therefore, 4-ethyltoluene was eliminated from further consideration as a VI COPC in this building.

Acetaldehyde

Acetaldehyde concentrations exceeded SG-to-IA VISLs in Building 1460 (Medical Clinic) and were detected in ambient air at low concentrations (relative to the sub-slab soil gas concentrations) which indicates that ambient air is most likely not the source of the measured soil gas concentrations. Acetaldehyde was not detected in groundwater which rules out groundwater as a potential source of VI. Acetaldehyde was only detected in one of the seven sub-slab soil gas samples collected from Building 1460 (i.e., sample CK1460-05 in Office 63/64). This result only slightly exceeded the SG-to-IA VISL (i.e., 56 ug/m^3 vs. 43 ug/m^3). The sub-slab soil gas concentrations in Building 1460 are similar to the sub-slab soil gas concentrations measured in the Northern Area where acetaldehyde was not identified as a VI COPC. For example, the range of sub-slab concentrations for acetaldehyde in the Northern Area Buildings was 14 ug/m^3 to 150 ug/m^3 with a mean of 30 ug/m^3, and a standard deviation of 56 ug/m^3. This is similar to the acetaldehyde in sub-slab soil gas observed in Building 1460. These data indicate that there is not a VI signature for acetaldehyde in this building. Therefore, acetaldehyde was eliminated from further consideration as a VI COPC in this building.

Acrolein

Acrolein concentrations exceeded SG-to-IA VISLs in Building 1460 (Medical Clinic). The concentrations ranged from 0.70 ug/m^3 to 2.0 ug/m^3, with a mean of 0.81 ug/m^3, and standard deviation of 0.81 ug/m^3. Ambient air contributes significantly to the sub-slab soil gas concentration (approximately 120%). Acrolein was not detected in groundwater which rules out groundwater as a potential source of VI. The sub-slab soil gas concentrations in Building 1460 are similar to the sub-slab soil gas concentrations measured in the Northern Area where acrolein was not identified as a VI COPC. For example, the range of sub-slab concentrations for acrolein in the Northern Area buildings was 0.44 ug/m^3 to 3.2 ug/m^3 with a mean of 1 ug/m^3, and a standard deviation of 0.74 ug/m^3. This is very similar to the acrolein in sub-slab soil gas observed in Building 1460. These data indicate that there is not a VI signature for acrolein in this building. Therefore, acrolein was eliminated from further consideration as a VI COPC in this building.

Decane

Decane was detected in all seven of the sub-slab soil gas samples that were collected from Building 1460 but does not have a groundwater or soil gas VISL. The sub-slab soil gas concentrations ranged from 1.6 ug/m^3 to 3.5 ug/m^3, with a mean of 2.6 ug/m^3 and standard deviation of 0.77 ug/m^3 which indicates that the sub-slab soil gas results for decane in this building are similar. These results are somewhat uncommon for VI unless there is a homogeneous and widespread source of decane located in soil beneath the building. It is possible that there also could be a source in groundwater since groundwater was not analyzed for decane. Ambient air contributes significantly to the sub-slab soil gas concentration (approximately 60%). The sub-slab soil gas concentrations in Building 1460 are similar to the sub-slab soil gas concentrations measured in the Northern Area where decane was not identified as a VI COPC. For example, the range of sub-slab concentrations for decane in the Northern Area Buildings was 0.34 ug/m^3 to 2.5 ug/m^3 with a mean of 0.79 ug/m^3, and a standard deviation of 0.64 ug/m^3. This is very similar to the decane in sub-slab soil gas observed in Building 1460. These data indicate that there is not a VI signature for decane in this building. Therefore, decane was eliminated from further consideration as a VI COPC in this building.

Dodecane

Dodecane was detected all seven of the sub-slab soil gas samples that were collected from Building 1460 but does not have a VISL for groundwater or soil gas. The sub-slab soil gas concentrations ranged from 2.0 ug/m^3 to 5.2 ug/m^3, with a mean of 4.0 ug/m^3 and standard deviation of 1.0 ug/m^3 which indicates that the sub-slab soil gas results for dodecane in this building are similar. These results are somewhat uncommon for VI unless there is a homogeneous and widespread source of dodecane located in soil beneath the building. It is possible that there also could be a source in groundwater since groundwater was not analyzed for dodecane. Ambient air contributes significantly to the sub-slab soil gas concentration (approximately 62%). The sub-slab soil gas concentrations in Building 1460 are similar to the sub-slab soil gas concentrations measured in the Northern Area where dodecane was not identified as a VI COPC. For example, the range of sub-slab concentrations for dodecane in the Northern Area Buildings was 0.72 ug/m^3 to 4.0 ug/m^3 with a mean of 1.6 ug/m^3, and a standard deviation of 0.98 ug/m^3. This is very similar to the dodecane in sub-slab soil gas observed in Building 1460. These data indicate that there is not a VI signature for dodecane in this building. Therefore, dodecane was eliminated from further consideration as a VI COPC in this building.

Ethanol

Ethanol was detected in four of the seven sub-slab soil gas samples that were collected from Building 1460 but does not have a VISL for groundwater or soil gas. The sub-slab soil gas concentrations ranged from 230 ug/m^3 to 360 ug/m^3, with a mean of 172 ug/m^3 and standard deviation of 165 ug/m^3 which indicates that the sub-slab soil gas results for ethanol in this building are similar. These results are somewhat uncommon for VI unless there is a homogeneous and widespread source of ethanol located in soil beneath the building. It is unlikely that there is a source in groundwater because ethanol was not detected in groundwater. Ambient air does not contribute significantly to the sub-slab soil gas concentration (approximately 4%). The sub-slab soil gas concentrations in Building 1460 are similar to the sub-slab soil gas concentrations measured in the Northern Area where ethanol was not identified as a VI COPC. For example, the range of sub-slab concentrations for ethanol in the Northern Area buildings was 22 ug/m^3 to 260 ug/m^3 with a mean of 81 ug/m^3, and a standard deviation of 59 ug/m^3. This is very similar to the dodecane in sub-slab soil gas observed in Building 1460. These data indicate that there is not a VI signature for ethanol in this building. Therefore, ethanol was eliminated from further consideration as a VI COPC in this building.

Ethylbenzene

Only one of the seven sub-slab soil gas concentrations at this building exceeded SG-to-IA VISLs. Ethylbenzene was also detected in ambient air at low concentrations (relative to the sub-slab soil gas concentrations) which indicates that ambient air is likely not the source of the measured soil gas concentrations. Ethylbenzene was not detected in groundwater which rules out groundwater as a potential source of VI. Ethylbenzene was detected in all seven sub-slab soil gas samples that were collected from this building. The concentrations ranged from 1.2 ug/m^3 to 273 ug/m^3 with a mean of 40 ug/m^3, and standard deviation of 103 ug/m^3. Six of the seven sub-slab soil gas samples that were collected from this building were less than 1.9 ug/m^3 and the SG-to-IA VISL of 37 ug/m^3. GRO (which is a likely source of ethylbenzene) was not detected in groundwater and were not detected in any of the sub-slab soil gas samples collected from this building. This indicates that a fuel spill/release is likely not the source of the ethylbenzene detection. Given that (1) only one of the seven sub-slab soil gas concentrations exceed the SG-to-IA VISL and (2) GRO (which is a likely source of ethylbenzene) was not detected in groundwater and/or sub-slab soil gas samples—it is more likely that an indoor air source is responsible for the elevated soil gas concentration detected in the X-Ray Room 45 (CK1460-01) than VI from groundwater and/or soil (see Table D-6) Therefore, ethylbenzene was eliminated from further consideration as a VI COPC in this building.

GRO

GRO was not detected in any of the sub-slab soil gas samples that were collected from this building. GRO was also not detected in any of the groundwater samples. Therefore, GRO was eliminated from further consideration as a VI COPC in this building.

Isopropanol

Isopropanol was not detected in any of the sub-slab soil gas samples that were collected from this building at concentrations exceeding the SG-to-IA VISL. The maximum detected sub-slab soil gas concentration was 710 ug/m^3 and the SG-to-IA VISL is 7,000 ug/m^3. Therefore, isopropanol was eliminated from further consideration as a VI COPC in this building.

Naphthalene

Naphthalene was not detected in any of the sub-slab soil gas samples that were collected from this building at concentrations exceeding the SG-to-IA VISL. The maximum detected sub-slab soil gas concentration was 0.38 ug/m^3 and the SG-to-IA VISL is 2.8 ug/m^3. Therefore, naphthalene was eliminated from further consideration as a VI COPC in this building.

p-Isopropyltoluene

p-Isopropyltoluene was detected in all seven sub-slab soil gas samples that were collected from Building 1460 (Medical Clinic) but does not have a VISL for groundwater or soil gas and. The sub-slab soil gas concentrations ranged from 0.13 ug/m^3 to 0.20 ug/m^3, with a mean of 0.16 ug/m^3 and standard deviation of 0.026 ug/m^3 which indicates that the sub-slab soil gas results for p-isopropyltoluene in this building are very similar which is somewhat uncommon for VI unless there is a homogeneous and widespread source of isopropyltoluene located in soil beneath the building. It is unlikely that there is a source in groundwater because isopropyltoluene was not detected in groundwater. Ambient air does not contribute significantly to the sub-slab soil gas concentration because isopropyltoluene was not detected in ambient air. The sub-slab soil gas concentrations in Building 1460 are similar to the sub-slab soil gas concentrations measured in the Northern Area where isopropyltoluene was not identified as a VI COPC. For example, the range of sub-slab concentrations for ethanol in the Northern Area Buildings was 0.14 ug/m^3 to 1.3 ug/m^3 with a mean of 0.25 ug/m^3, and a standard deviation of 0.30 ug/m^3. This is very similar to the isopropyltoluene in sub-slab soil gas observed in Building 1460. These data indicate that there is not a VI signature for isopropyltoluene in this building. Therefore, isopropyltoluene was eliminated from further consideration as a VI COPC in this building.

Tert-Butyl Alcohol

Tert-butyl alcohol was detected in six of the seven sub-slab soil gas samples that were collected from Building 1460 (Medical Clinic) but does not have a VISL for groundwater or soil gas. The sub-slab soil gas concentrations ranged from 1.4 ug/m^3 to 14 ug/m^3, with a mean of 5.2 ug/m^3 and standard deviation of 5.3 ug/m^3 which indicates that the sub-slab soil gas results for tert-butyl alcohol in this building are somewhat variable. It is unlikely that there is a source in groundwater because tert-butyl alcohol was not detected in groundwater. Ambient air contributes significantly to the sub-slab soil gas concentration (approximately 50%). The sub-slab soil gas concentrations in Building 1460 are slightly higher that the sub-slab soil gas concentrations measured in the Northern Area where tert-butyl alcohol was not identified as a VI COPC. For example, the range of sub-slab concentrations for tert-butyl alcohol in the

Northern Area Buildings was 0.30 ug/m^3 to 2.8 ug/m^3 with a mean of 0.59 ug/m^3, and a standard deviation of 0.67 ug/m^3. These data indicate that there is not a VI signature for tert-butyl alcohol in this building. Therefore, tert-butyl alcohol was eliminated from further consideration as a VI COPC in this building.

Undecane

Undecane does not have a VISL for groundwater or soil gas and was detected all seven of the sub-slab soil gas samples that were collected from this building. The sub-slab soil gas concentrations ranged from 2.8 ug/m^3 to 4.4 ug/m^3, with a mean of 3.8 ug/m^3 and standard deviation of 0.55 ug/m^3 which indicates that the sub-slab soil gas results for undecane in this building are very similar which is somewhat uncommon for VI unless there is a homogeneous and widespread source of undecane located in soil beneath the building. It is possible that there also could be a source in groundwater since groundwater was not analyzed for undecane. Ambient air contributes significantly to the sub-slab soil gas concentration (approximately 60%). The sub-slab soil gas concentrations in Building 1460 are slightly higher that the sub-slab soil gas concentrations measured in the Northern Area where undecane was not identified as a VI COPC. For example, the range of sub-slab concentrations for undecane in the Northern Area Buildings was 0.20 ug/m^3 to 1.0 ug/m^3 with a mean of 0.44 ug/m^3, and a standard deviation of 0.4 ug/m^3. These data indicate that there is not a VI signature for undecane in this building. Therefore, undecane was eliminated from further consideration as a VI COPC in the building.

Step 3c: Line-of-Evidence Evaluation of Building 1463 (Dental Clinic) Groundwater and Sub-Slab Soil Gas

Fourteen constituents were identified as VI COPCs from previous steps in the VI Evaluation of all buildings in the Southern Area. The sub-slab soil gas summary statistics and sample location results for Building 1463 (Dental Clinic) are presented on Table D-7 and D-8, respectively. The lines-of-evidence for samples associated with Building 1463 (Dental Clinic) are summarized below.

1,3-Dichlorobenzene

1,3-Dichlorobenzene was detected all seven of the sub-slab soil gas samples that were collected from this building but was not detected in groundwater and does not have a VISL for groundwater or soil gas. The concentration ranged from 13 ug/m^3 to 510 ug/m^3, with a mean of 231 ug/m^3 and standard deviation of 255 ug/m^3. The ambient air background concentration was 3.6 ug/m^3, which indicates that ambient air is most likely not the source of the measured soil gas concentrations. Sub-slab soil gas concentrations were variable with the highest concentrations observed at CK1463-04 (510 ug/m^3), CK1463-06 (510 ug/m^3), and CK1463-07 (490 ug/m^3)—in the area of the building where asbestos abatement had been completed but where remodeling was underway. Therefore, 1,3-dichlorobenzene was retained for further evaluation for VI in Step 4.

4-Ethyltoluene

4-Ethyltoluene was detected all seven of the sub-slab soil gas samples that were collected from this building but does not have a VISL for groundwater or soil gas. The concentration ranged from 0.71 ug/m^3 to 45 ug/m^3, with a mean of 14 ug/m^3 and standard deviation of 18 ug/m^3. Ambient air does not contribute significantly to the sub-slab soil gas concentration at this building. Sub-slab soil gas concentrations were variable with the highest concentrations observed at CK1463-04 (29 ug/m^3), CK1463-06 (45 ug/m^3), and CK1463-07 (21 ug/m^3)—in the area of the building where asbestos abatement had been completed but where remodeling was underway. Therefore, 4-Ethyltoluene was retained for further evaluation for VI in Step 4.

Acetaldehyde

Acetaldehyde exceeded the SG-to-IA VISL in four of the seven sub-slab soil gas samples. The sub-slab soil gas concentrations ranged from 4.8 ug/m^3 to 94 ug/m^3, with a mean of 49 ug/m^3 and standard deviation of 40 ug/m^3. The highest sub-slab soil gas concentrations were observed at CK1463-04 (66 ug/m^3), CK1463-06 (70 ug/m^3), and CK1463-07 (94 ug/m^3)—in the area of the building where asbestos abatement had been completed but where remodeling was underway. It was also detected in ambient air at low concentrations (relative to the sub-slab soil gas concentrations) which indicates that ambient air is most likely not the source of the measured soil gas concentrations. Acetaldehyde was not detected in groundwater which rules out groundwater as a potential source of VI. The sub-slab soil gas concentrations in Building 1463 are similar to the sub-slab soil gas concentrations measured in the Northern Area where acetaldehyde was not identified as a VI COPC. For example, the range of sub-slab concentrations for acetaldehyde in the Northern Area buildings was 22 ug/m^3 to 260 ug/m^3 with a mean of 81 ug/m^3, and a standard deviation of 59 ug/m^3. This is very similar to the acetaldehyde in sub-slab soil gas observed in Building 1463. These data indicate that there is not a VI signature for acetaldehyde in this building. Therefore, acetaldehyde was eliminated from further consideration as a VI COPC in this building.

Acrolein

Sub-slab soil gas concentrations exceeded SG-to-IA VISLs but it was also detected in ambient air at high concentrations (relative to the sub-slab soil gas concentrations). The concentrations ranged from 0.44 ug/m^3 to 5.7 ug/m^3, with a mean of 1.9 ug/m^3, and standard deviation of 1.8 ug/m^3. Ambient air contributes significantly to the sub-slab soil gas concentration (approximately 42%). Acrolein was not detected in groundwater which rules out groundwater as a potential source of VI. The sub-slab soil gas concentrations in Building 1463 are similar to the sub-slab soil gas concentrations measured in the Northern Area where acrolein was not identified as a VI COPC. For example, the range of sub-slab concentrations for acrolein in the Northern Area Buildings was 0.44 ug/m^3 to 3.2 ug/m^3 with a mean of 1.0 ug/m^3, and a standard deviation of 0.74 ug/m^3. This is very similar to the acrolein in sub-slab soil gas observed in Building 1463. These data indicate that there is not a VI signature for acrolein in this building. Therefore, acrolein was eliminated from further consideration as a VI COPC in this building.

Decane

Decane does not have a VISL for groundwater or soil gas and was detected all seven of the sub-slab soil gas samples that were collected from this building. The sub-slab soil gas concentrations ranged from 2.1 ug/m^3 to 69 ug/m^3, with a mean of 20 ug/m^3 and standard deviation of 25 ug/m^3. It is possible that there also could be a source in groundwater since groundwater was not analyzed for decane. Ambient air does not contribute significantly to the sub-slab soil gas concentration at this building. Sub-slab soil gas concentrations were variable with the highest concentrations observed at CK1463-04 (31 ug/m^3), CK1463-06 (69 ug/m^3), and CK1463-07 (27 ug/m^3)—in the area of the building where asbestos abatement had been completed but where remodeling was underway. Therefore, decane was retained for further evaluation for VI in Step 4.

Dodecane

Dodecane does not have a VISL for groundwater or soil gas and was detected all seven of the sub-slab soil gas samples that were collected from this building. The sub-slab soil gas concentrations ranged from 3.2 ug/m^3 to 12 ug/m^3, with a mean of 5.3 ug/m^3 and standard deviation of 3.0 ug/m^3 which indicates that the sub-slab soil gas results for dodecane in this building are very similar which is somewhat uncommon for VI unless there is a homogeneous and widespread source of dodecane located in soil beneath the building. It is possible that there also could be a source in groundwater since groundwater was not analyzed for dodecane. Ambient air contributes to the sub-slab soil gas concentration (approximately 27%). The sub-slab soil gas concentrations in Building 1463 are similar to the sub-slab soil gas concentrations measured in the Northern Area where dodecane was not identified as a VI COPC. For example, the range of sub-slab concentrations for dodecane in the Northern Area Buildings was 0.72 ug/m^3 to 4.0 ug/m^3 with a mean of 1.6 ug/m^3, and a standard deviation of 0.98 ug/m^3. This is very similar to the dodecane in sub-slab soil gas observed in Building 1463. These data indicate that there is not a VI signature for dodecane in this building. Therefore, dodecane was eliminated from further consideration as a VI COPC in this building.

Ethanol

Ethanol does not have a VISL for groundwater or soil gas and was detected in all seven sub-slab soil gas samples that were collected from this building. The sub-slab soil gas concentrations ranged from 12 ug/m^3 to 190 ug/m^3, with a mean of 55 ug/m^3 and standard deviation of 65 ug/m^3. The highest sub-slab soil gas concentrations were observed at CK1463-04 (190 ug/m^3), CK1463-06 (72 ug/m^3), and CK1463-07 (68 ug/m^3)—in the area of the building where asbestos abatement had been completed but where remodeling was underway. It is unlikely that there is a source in groundwater because ethanol was not detected in groundwater. Ambient air does not contribute significantly to the sub-slab soil gas concentration (approximately 6%). The sub-slab soil gas concentrations in Building 1463 are similar to the sub-slab soil gas concentrations measured in the Northern Area where ethanol was not identified as a VI COPC. For example, the range of sub-slab concentrations for ethanol in the Northern Area Buildings was 22.0 ug/m^3 to 260 ug/m^3 with a mean of 81 ug/m^3, and a standard deviation of 59 ug/m^3. This is very similar to the ethanol in sub-slab soil gas observed in Building 1463. These data indicate that there is not a VI signature for ethanol in this building. Therefore, ethanol was eliminated from further consideration as a VI COPC in this building.

Ethylbenzene

Ethylbenzene exceeded the SG-to-IA VISL in three of the seven sub-slab soil gas samples. The concentrations ranged from 3.2 ug/m^3 to 340 ug/m^3, with a mean of 115 ug/m^3, and standard deviation of 144 ug/m^3. Ethylbenzene was also detected in ambient air at low concentrations (relative to the sub-slab soil gas concentrations) which indicates that ambient air is most likely not the source of the measured soil gas concentrations. Ethylbenzene was not detected in groundwater which rules out groundwater as a potential source of VI. Sub-slab soil gas concentrations were variable with the highest concentrations observed at CK1463-04 (220 ug/m^3), CK1463-06 (340 ug/m^3), and CK1463-07 (230 ug/m^3)—in the area of the building where asbestos abatement had been completed but where remodeling was underway. Therefore, ethylbenzene was retained for further evaluation for VI in Step 4.

GRO (C3-C12)

GRO exceeded the SG-to-IA VISL in four of the seven sub-slab soil gas samples. The sub-slab soil gas concentrations ranged from 2,900 ug/m^3 to 8,800 ug/m^3, with a mean of 4,360 ug/m^3 and standard deviation of 2,583 ug/m^3. The highest sub-slab soil gas concentrations were observed at CK1463-04 (5,200 ug/m^3), CK1463-06 (8,800 ug/m^3), and CK1463-07 (5,900 ug/m^3)—in the area of the building where asbestos abatement had been completed but where remodeling was underway. It was also detected in ambient air at low concentrations (relative to the sub-slab soil gas concentrations) which indicates that ambient air is most likely not the source of the measured soil gas concentrations. GRO was not detected in groundwater which rules out groundwater as a potential source of VI. The sub-slab soil gas concentrations in Building 1463 are similar to the sub-slab soil gas concentrations measured in the Northern Area where GRO was not identified as a VI COPC. For example, the range of sub-slab concentrations for GRO in the Northern Area Buildings was 2,800 ug/m^3 to 5,900 ug/m^3 with a mean of 1,322 ug/m^3, and a standard deviation of 1,346 ug/m^3. This is very similar to the GRO in sub-slab soil gas observed in Building 1463. These data indicate that there is not a VI signature for GRO in this building. Therefore, GRO was eliminated from further consideration as a VI COPC in this building.

Isopropanol

Isopropanol was detected in three of the seven sub-slab soil gas samples at concentrations that exceeded the SG-to-IA VISL. The sub-slab soil gas concentrations ranged from 850 ug/m^3 to 28,000 ug/m^3, with a mean of 10,601 ug/m^3 and standard deviation of 12,151 ug/m^3. It is unlikely that there is a source in groundwater because isopropanol was not detected in groundwater at concentrations exceeding the GW-to-IA VISL. Ambient air does not contribute significantly to the sub-slab soil gas concentration (< 1%). Sub-slab soil gas concentrations were variable with the highest concentrations observed at CK1463-04 (20,000 ug/m^3), CK1463-06 (28,000 ug/m^3), and CK1463-07 (22,000 ug/m^3)—in the area of the building where asbestos abatement had been completed but where remodeling was underway. Therefore, isopropanol was retained for further evaluation for VI in Step 4.

Naphthalene

Naphthalene was detected in one of the seven sub-slab soil gas samples at a concentration that exceed the SG-to-IA VISL. The sub-slab soil gas concentrations ranged from 0.18 ug/m^3 to 4.2 ug/m^3, with a mean of 0.80 ug/m^3 and standard deviation of 1.5 ug/m^3. It is unlikely that there is a source in groundwater because naphthalene was not detected in groundwater at concentrations exceeding the GW-to-IA VISL. Ambient air does not contribute significantly to the sub-slab soil gas concentration (approximately 3%). Sub-slab soil gas concentrations were variable with the highest concentration observed at CK1463-04 (4.2 ug/m^3)—in the area of the building where asbestos abatement had been completed but where remodeling was underway. Therefore, naphthalene was retained for further evaluation for VI in Step 4.

p-Isopropyltoluene

p-Isopropyltoluene does not have a VISL for groundwater or soil gas and was detected in five of the seven sub-slab soil gas samples that were collected from this building. The sub-slab soil gas concentrations ranged from 0.21 ug/m^3 to 12 ug/m^3, with a mean of 2.8 ug/m^3 and standard deviation of 4.2 ug/m^3. It is unlikely that there is a source in groundwater because p-isopropyltoluene was not detected in groundwater. Ambient air does not contribute significantly to the sub-slab soil gas concentration because p-isopropyltoluene was not detected in ambient air. Sub-slab soil gas concentrations were variable with the highest concentration observed at CK1463-04 (12 ug/m^3)—in the area of the building where asbestos abatement had been completed but where remodeling was underway. Therefore, p-isopropyltoluene was retained for further evaluation for VI in Step 4.

Tert-Butyl Alcohol

Tert-butyl alcohol does not have a VISL for groundwater or soil gas and was detected in three of the seven sub-slab soil gas samples that were collected from this building. The sub-slab soil gas concentrations ranged from 12 ug/m^3 to 36 ug/m^3, with a mean of 12 ug/m^3 and standard deviation of 16 ug/m^3 which indicates that the sub-slab soil gas results for tert-butyl alcohol in this building are somewhat variable. It is unlikely that there is a source in groundwater because tert-butyl alcohol was not detected in groundwater. Ambient air contributes significantly to the sub-slab soil gas concentration (approximately 19%). The sub-slab soil gas concentrations in Building 1463 are slightly higher that the sub-slab soil gas concentrations measured in the Northern Area where tert-butyl alcohol was not identified as a VI COPC. For example, the range of sub-slab concentrations for tert-butyl alcohol in the Northern Area buildings was 0.30 ug/m^3 to 2.8 ug/m^3 with a mean of 0.59 ug/m^3, and a standard deviation of 0.67 ug/m^3. Sub-slab soil gas concentrations were variable with the highest concentrations observed at CK1463-04 (32 ug/m^3), CK1463-06 (12 ug/m^3), and CK1463-07 (36 ug/m^3)—in the area of the building where asbestos abatement had been completed but where remodeling was underway. Therefore, tert-butyl alcohol was retained for further evaluation for VI in Step 4.

Undecane

Undecane does not have a VISL for groundwater or soil gas and was detected five of the seven sub-slab soil gas samples that were collected from this building. The sub-slab soil gas concentrations ranged from 2.8 ug/m^3 to 31 ug/m^3, with a mean of 9.7 ug/m^3 and standard deviation of 12 ug/m^3 which indicates that the sub-slab soil gas results for undecane in this building are somewhat variable. It is possible that there also could be a source in groundwater since groundwater was not analyzed for undecane. Ambient air contributes significantly to the sub-slab soil gas concentration (approximately 9%). The sub-slab soil gas concentrations in Building 1463 are slightly higher that the sub-slab soil gas concentrations measured in the Northern Area where undecane was not identified as a VI COPC. For example, the range of sub-slab concentrations for undecane in the Northern Area Buildings was 0.18 ug/m^3 to 1.0 ug/m^3 with a mean of 0.44 ug/m^3, and a standard deviation of 0.35 ug/m^3. Sub-slab soil gas concentrations were variable with the highest concentrations observed at CK1463-04 (23 ug/m^3) and CK1463-06 (31 ug/m^3)—in the area of the building where asbestos abatement had been completed but where remodeling was underway. Therefore, undecane was retained for further evaluation for VI in Step 4.

Step 4: Other Lines-of -Evidence for VI in the Southern Area

The other lines-of-evidence for VI in the Southern Area are summarized in this section. No VI COPCs were retained for further evaluation for VI for Building 1460 (Medical Clinic)—all were eliminated from further consideration during Step 3. The following VI COPCs were retained for further evaluation for VI for Building 1463 (Dental Clinic):

- 1,3-Dichlorobenzene: an organic compound and is used to make herbicides, insecticides, medicine, and dyes
- 4-Ethyltoluene: an organic compound that is typically used in the production of specialty polystyrenes
- Decane: an alkane hydrocarbon and is a component of gasoline and kerosene
- Ethylbenzene: an organic compound that is found in gasoline. Ethylbenzene is often found in other products, including pesticides, cellulose acetate, synthetic rubber, paints, and inks
- Isopropanol: an alcohol that used in the manufacture of antiseptics, disinfectants, and detergents. It is commonly known as rubbing alcohol
- Naphthalene: an aromatic hydrocarbon that is made from crude oil or coal tar. It is best known as the main ingredient of traditional mothballs and is often used as an insecticide/pest repellent
- p-Isopropyltoluene: a number of essential oils, most commonly the oil of cumin and thyme. Significant amounts are formed in sulfite pulping process from the wood terpenes.
- Tert-Butyl Alcohol: used as a solvent, ethanol denaturant, paint remover ingredient, and gasoline octane booster and oxygenate
- Undecane: found in allspice; used as a mild sex attractant for various types of moths and cockroaches, and an alert signal for a variety of ants

Summary of Other Lines of Evidence		
Other Lines-of Evidence for VI	Assessment of Line-of-Evidence Relative Site-Specific Characteristics	Do the Other Lines-of-Evidence Indicate a Likelihood of VI for this Constituent?
Previous investigation results.	• 1,3-Dichlorobenzene: Not assessed • 4-Ethyltoluene: Not assessed • Decane: Not assessed • Ethylbenzene: Not assessed • Isopropanol: Not assessed • Naphthalene: Not assessed • p-Isopropyltoluene: Not assessed • Tert-Butyl Alcohol: Not assessed • Undecane: Not assessed	Inconclusive
Likely use of the constituent in the area based on historical information.	• 1,3-Dichlorobenzene: Possibly since this constituent was used to make herbicides/insecticides • 4-Ethyltoluene: Unlikely • Decane: Unlikely	No for: • 4-Ethyltoluene • Decane • Isopropanol

Summary of Other Lines of Evidence		
Other Lines-of Evidence for VI	Assessment of Line-of-Evidence Relative Site-Specific Characteristics	Do the Other Lines-of-Evidence Indicate a Likelihood of VI for this Constituent?
	• Ethylbenzene: Possibly if gasoline or ethylbenzene containing solvents were stored at the MSA • Isopropanol: Unlikely • Naphthalene: Possibly if petroleum products were stored at the MSA • p-Isopropyltoluene: Unlikely • Tert-Butyl Alcohol: Possibly • Undecane: Unlikely	• p-Isopropyltoluene • Undecane Possibly for: • 1,3-Dichlorobenzene • Ethylbenzene • Naphthalene • Tert-Butyl Alcohol
Spatial distribution of the constituent in groundwater, sub-slab soil gas, and ambient air.	As summarized for Building 1463, these constituents were detected in sub-slab soil gas with the majority of the highest concentrations occurring at sampling stations: CK1463-04, CK1463-06, and CK1463-07, which are located in the area of Building 1463 where asbestos abatement has been completed. These constituents were not analyzed, or were not detected in groundwater at concentrations that indicate a potential groundwater source for VI. Therefore, it is unlikely that groundwater is a source of the measured sub-slab soil gas concentrations.	Inconclusive
Half-life of the constituent[4].	• 1,3-Dichlorobenzene: 0.62 days (<1 day) • 4-Ethyltoluene: 4 days • Decane: 9 days • Ethylbenzene: 8 days • Isopropanol: 2.5 to 16.2 hours (<1 day) • Naphthalene: 3 days • p-Isopropyltoluene: 3.5 hours to 4.6 days • Tert-Butyl Alcohol: 5 to 9 hours (<1 day) • Undecane: 7 days	No
Relative potential for VI in the Southern Area to be associated with releases from the MSA.	• 1,3-Dichlorobenzene: Possibly since this constituent was used to make herbicides/insecticides. • 4-Ethyltoluene - Unlikely • Decane: Unlikely • Ethylbenzene: Possibly if gasoline or ethylbenzene containing solvents were stored at the MSA. • Isopropanol: Unlikely • Naphthalene: Possibly if petroleum products were stored at the MSA. • p-Isopropyltoluene: Unlikely • Tert-Butyl Alcohol: Possibly • Undecane: Unlikely	No for: • 4-Ethyltoluene • Decane • Isopropanol • p-Isopropyltoluene • Undecane Possibly for: • 1,3-Dichlorobenzene • Ethylbenzene • Naphthalene

[4] Source: U.S. National Library of Medicine. National Center for Biotechnology Information. Accesses July 7, 2019.

Summary of Other Lines of Evidence		
Other Lines-of Evidence for VI	Assessment of Line-of-Evidence Relative Site-Specific Characteristics	Do the Other Lines-of-Evidence Indicate a Likelihood of VI for this Constituent?
		• Tert-Butyl Alcohol
Background contributions from human activity (e.g., construction/remodeling)	As summarized for Building 1463, these constituents were detected in sub-slab soil gas with the majority of the highest concentrations occurring at sampling stations: CK1463-04, CK1463-06, and CK1463-07, which are located in the northern portion of Building 1463 where asbestos abatement has been completed. This may be a coincidence but it is very unusual for the maximum detected concentrations of multiple, unrelated constituents to occur at the same location. This may be indicative of indoor air sources and/or potential laboratory/analytical issues associated with these samples.	No

A key finding is that highest concentrations of these VI COPCs in soil gas occurred at the same three sample stations (i.e., CK1463-04, CK1463-06, and CK1463-07), which are all located in the northern portion of Building 1463 where asbestos abatement has been completed. The concentrations observed at these locations were typically one to two orders of magnitude greater than the sub-slab soil gas concentrations observed at CK1463-02, and CK1463-05, which were located in the area of the building where asbestos abatement had not been completed. This may be a coincidence but it is very unusual for the maximum detected concentrations of multiple, unrelated constituents to occur at the same location. This may be indicative of indoor air sources (e.g., constituents/solvents used during asbestos abatement or during renovation) and/or potential laboratory/analytical issues associated with these samples. If sample stations CK1463-04, CK1463-06, and CK1463-07 were eliminated from the VI assessment, then the assessment of the sub-slab soil gas concentration from Building 1463 would significantly change as the majority of the remaining concentration would be very low and consistent with the results from the Northern Area buildings and Building 1460.

A photoionization detector (PID) was used during sub-slab soil gas sampling to determine concentrations of VOCs in air. Inconsistent PID readings were collected in this building, indicating that an indoor air source may have been introduced in the building after sampling started. PID readings in several areas of the building increased by at least one order of magnitude over the sampling period (0.0 parts per million [ppm] to 162.8 ppm; 0.8 ppm to 74.3 ppm; 24.5 ppm to 87.5 ppm) and will be presented in the Site Investigation Report which is currently in production.

VI Conclusions for the Southern Area

No VI COPCs for Building 1460 (Medical Clinic) need to be included in the HHRA. Nine VI COPCs were identified in Building 1463 (Dental Clinic; 1,3-dichlorobenzene, 4-ethyltoluene, decane, ethylbenzene, isopropanol, naphthalene, p-isopropyltoluene, tert-butyl alcohol, undecane). These VI COPCs were generally unrelated (with respect to use/purpose) and it is unlikely that many of them would have been stored at the MSA. For example, they are not chemically-related (breakdown/daughter products), they are not class-/purpose-related (not all petroleum-related or pesticide/herbicide-related), or not chlorinated. A summary of the VI lines-of-evidence for Building 1463 is presented below.

Line-of-Evidence Summary: Groundwater and/or Soil Gas to Indoor Air VI Pathway Analysis Summary for Building 1463 (Dental Clinic)

Potential VI Source	Maximum Detected GW Conc. (ug/L)	GW-to-IA VISL (ug/L)	GW Conc. Greater than GW-to-IA VISL?	Maximum Detected Sub-Slab Soil Gas Conc. (ug/m³)	SG-to-IA VISL (ug/m³)	Soil Gas Conc. Greater than SG-to-IA VISL?	Location of Maximum Sub-Slab Soil Gas Conc.?	Does the Overall Lines of-Evidence Assessment Indicate VI pathway Complete?
1,3-Dichlorobenzene	Not Detected	No VISL	No VISL	510	No VISL	No VISL	CK1463-06	No. The results of the lines-of-evidence evaluation indicate that it is unlikely that VI of 1,3-dichlorobenzene in sub-slab gas to indoor air at Building 1463 is occurring.
4-Ethyltoluene	Not Analyzed	No VISL	No VISL	45	No VISL	No VISL	CK1463-06	No. The results of the lines-of-evidence evaluation indicate that it is unlikely that VI of 4-ethyltoluene in sub-slab gas to indoor air at Building 1463 is occurring.
Decane	Not Analyzed	No VISL	No VISL	69	No VISL	No VISL	CK1463-06	No. The results of the lines-of-evidence evaluation indicate that it is unlikely that VI of decane in sub-slab gas to indoor air at Building 1463 is occurring.
Ethylbenzene	Not Detected	3.4	No	340	37	Yes	CK1463-06	No. The results of the lines-of-evidence evaluation indicate that it is unlikely that VI of ethylbenzene in sub-slab gas to indoor air at Building 1463 is occurring.

Line-of-Evidence Summary: Groundwater and/or Soil Gas to Indoor Air VI Pathway Analysis Summary for Building 1463 (Dental Clinic)

Potential VI Source	Maximum Detected GW Conc. (ug/L)	GW-to-IA VISL (ug/L)	GW Conc. Greater than GW-to-IA VISL?	Maximum Detected Sub-Slab Soil Gas Conc. (ug/m³)	SG-to-IA VISL (ug/m³)	Soil Gas Conc. Greater than SG-to-IA VISL?	Location of Maximum Sub-Slab Soil Gas Conc.?	Does the Overall Lines of-Evidence Assessment Indicate VI pathway Complete?
Isopropanol	57	634,441	No	28,000	7,000	Yes	CK1463-06	No. The results of the lines-of-evidence evaluation indicate that it is unlikely that VI of isopropanol in sub-slab gas to indoor air at Building 1463 is occurring.
Naphthalene	Not Analyzed	4.6	Not Analyzed	4.2	2.8	Yes	CK1463-04	No. The results of the lines-of-evidence evaluation indicate that it is unlikely that VI of naphthalene in sub-slab gas to indoor air at Building 1463 is occurring.
p-Isopropyltoluene	Not Detected	No VISL	No VISL	12	No VISL	No VISL	CK1463-04	No. The results of the lines-of-evidence evaluation indicate that it is unlikely that VI of p-isopropyltoluene in sub-slab gas to indoor air at Building 1463 is occurring.
Tert-Butyl Alcohol	Not Detected	No VISL	No VISL	36	No VISL	No VISL	CK1463-07	No. The results of the lines-of-evidence evaluation indicate that it is unlikely that VI of tert-butyl alcohol in sub-slab gas to indoor air at Building 1463 is occurring.
Undecane	Not Analyzed	No VISL	No VISL	31	No VISL	No VISL	CK1463-06	No. The results of the lines-of-evidence evaluation indicate that it is unlikely that VI of undecane in sub-slab gas to indoor air at Building 1463 is occurring.

Overall Conclusion Regarding VI from Groundwater and/or Sub-Slab Soil Gas to Indoor Air in the Building 1460 (Medical Clinic) and Building 1463 (Dental Clinic) in the Southern Area: The results of the lines-of-evidence evaluation indicate that it is unlikely that VI from groundwater and/or sub-slab soil gas to indoor air, associated with releases from the MSA, is occurring at

Building 1460 (Medical Clinic) and Building 1463 (Dental Clinic). Therefore, VI from groundwater and/or sub-slab soil gas to indoor air in Building 1460 (Medical Clinic) and Building 1463 (Dental Clinic), associated with releases from the MSA, does not need to evaluated further in the HHRA.

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Section 5: Conclusions

Based on the results of the lines-of-evidence evaluations, the VI pathway (associated with releases from the MSA) is not complete in the Northern or Southern Area. Since the VI pathway is not complete, there is no risk (associated with releases from the MSA) to people in the Elementary School, Building 1460 (Medical Clinic), or Building 1463 (Dental Clinic). Therefore, the VI pathway does not need to be evaluated further in the HHRA.

The VI evaluation for the Northern Area and Building 1460 in the Southern Area were straightforward and the groundwater and sub-slab soil gas data did not indicate that VI associated with releases from the MSA was occurring at these locations.

However, the VI evaluation for Building 1463 (Dental Clinic), located in the Southern Area, was more complex due to numerous detections of constituents in sub-slab soil gas that exceeded SG-to-IA VISLs. Based on the groundwater sampling results from the Southern Area, it was concluded that groundwater was not a potential source of VI (associated with releases from the MSA) in the Southern Area.

Five VI COPCs (acetaldehyde, ethylbenzene, GRO, isopropanol, and naphthalene) were detected in sub-slab soil gas in Building 1463 (Dental Clinic) at concentrations greater than background ambient air concentrations and SG-to-IA VISLs. During sub-slab soil gas sampling, the northern portion of Building 1463 (Dental Clinic) was being renovated (i.e., asbestos abatement followed by a full interior remodel).[5] This work may have affected the sub-slab soil gas results. For example, the highest concentrations of these constituents were observed at the following sample locations: CK1463-04, CK1463-06, and CK1463-07—in the area of the building where asbestos abatement had been completed but where remodeling activities were taking place. These sample locations were also where the highest concentrations of the eight VI COPCs (1,3-dichlorobenzene, 4-ethyltoluene, decane, dodecane, ethanol, p-isopropyltoluene, tert-butyl alcohol, and undecane) were detected in sub-slab soil gas but did not have a SG-to-IA VISLs. It is extremely unusual for the highest detected concentrations of 13, unrelated constituents to be co-located, especially when the other sub-slab soil gas concentrations in the building were typically orders of magnitude less than these concentrations. These conditions would require a homogenous source and homogenous transport mechanism for VI in only this part of Building 1463. While possible, these conditions are unlikely given that the 13 VI COPCs are not related. For example, they are not chemically-related (breakdown/daughter products), they are not class/purpose-related (e.g., not all petroleum-related or pesticide/herbicide-related or chlorinated solvents). The only relationship between these VI COPCs is that they were all detected in the same samples collected from the area of Building 1463 where asbestos

[5] The dental clinic was vacant and undergoing asbestos abatement in southern portion of the building (abatement was complete in the northern portion) and renovations were underway at the time of sample collection.

abatement was completed and remodeling was occurring. Consequently, the use of solvents/equipment during asbestos abatement and interior remodeling activities in Building 1463 may have affected the sampling results at CK1463-04, CK1463-06, and CK1463-07.

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Tables

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Table D-1: Northern Area Groundwater COPC Statistics

CAS No.	VI COPC	Number of Samples	Number of Detections	% Detected	Minimum Nondetected Concentration (ug/L)	Maximum Nondetected Concentration (ug/L)	Minimum Detected Concentration (ug/L)	Maximum Detected Concentration (ug/L)	Mean (ug/L)	Standard Deviation	Residential Carcinogenic GW-to-IA VISL (ug/L)	Residential Non-Carcinogenic GW-to-IA VISL (ug/L)
126-99-8	Chloro-1,3-butadiene, 2-	3	0	0.0	1.0	1.0	0.0	0.0	0.50	--	0.0041	9.2
96-12-8	Dibromo-3-chloropropane, 1,2-	3	0	0.0	0.50	0.50	0.0	0.0	0.25	--	0.028	35
124-48-1	Dibromochloromethane	3	1	33	0.10	0.10	0.15	0.15	0.083	0.058	--	--
1476-11-5	Dichloro-2-butene, cis-1,4-	3	0	0.0	1.0	1.0	0.0	0.0	0.50	--	0.025	--
75-65-0	Tert-Butyl Alcohol	3	1	33	2.5	2.5	7.9	7.9	3.5	3.8	--	--
110-57-6	trans-1,4-Dichloro-2-butene	3	0	0.0	1.0	1.0	0.0	0.0	0.50	--	0.025	--

Notes

--: No standard deviation or screening level available

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Table D-2: Northern Area Sub-slab Soil Gas COPC Statistics

CAS No.	VI COPC	Number of Samples	Number of Detections	% Detected	Minimum Nondetected Concentration (ug/m^3)	Maximum Nondetected Concentration (ug/m^3)	Minimum Detected Concentration (ug/m^3)	Maximum Detected Concentration (ug/m^3)	Mean (ug/m^3)	Standard Deviation	Maximum Detected Ambient Air Concentration (ug/m^3)	Corrected SG Concentration (SG-AA)	Residential Carcinogenic SG-to-IA VISL (ug/m^3)	Residential Non-Carcinogenic SG-to-IA VISL (ug/m^3)
541-73-1	1,3-Dichlorobenzene	24	24	100	0.0	0.0	0.20	550	58	132	3.6	546	--	--
540-84-1	2,2,4-Trimethylpentane	23	1	4.3	0.098	1.2	0.60	0.60	0.18	0.19	0.45	0.15	--	--
622-96-8	4-Ethyltoluene	23	2	8.7	0.10	1.3	0.59	1.8	0.24	0.39	0.21	1.6	--	--
75-07-0	Acetaldehyde	37	15	41	0.096	0.096	4.8	150	29	49	5.8	144	43	313
107-02-8	Acrolein	23	21	91	0.065	0.066	0.44	3.2	1.0	0.74	2.4	0.80	--	0.70
123-72-8	Butraldahyde	37	4	11	0.22	0.22	0.41	0.82	0.16	0.16	0.49	0.33	--	--
104-51-8	Butylbenzene, n-	23	1	4.3	0.095	1.2	0.32	0.32	0.16	0.17	--	0.32	--	--
135-98-8	Butylbenzene, sec-	23	1	4.3	0.090	1.1	0.32	0.32	0.15	0.16	--	0.32	--	--
56-23-5	Carbon Tetrachloride	23	21	91	0.066	0.071	0.34	18	2.0	4.5	0.59	17	16	3,333
95-49-8	Chlorotoluene, o-	23	0	0.0	0.32	4.0	0.0	0.0	0.50	0.56	--	0.0	--	--
4170-30-3	Crotonaldehyde, Total	37	3	8.1	0.12	0.12	0.36	1.1	0.11	0.19	--	1.1	--	--
124-18-5	Decane	23	18	78	0.60	1.1	0.34	2.5	0.79	0.64	2.1	0.40	--	--
124-48-1	Dibromochloromethane	23	6	26	0.013	0.068	0.014	0.13	0.025	0.035	--	0.13	--	--
156-59-2	Dichloroethylene, 1,2-cis-	23	2	8.7	0.011	0.071	0.055	1.8	0.090	0.37	0.047	1.8	--	--
156-60-5	Dichloroethylene, 1,2-trans-	23	0	0.0	0.0090	0.057	0.0	0.0	0.0094	0.0066	--	0.0	--	--
142-28-9	Dichloropropane, 1,3-	23	0	0.0	0.32	4.0	0.0	0.0	0.50	0.56	--	0.0	--	--
112-40-3	Dodecane	23	21	91	1.4	1.8	0.72	4.0	1.6	0.98	3.2	0.80	--	--
64-17-5	Ethanol	23	23	100	0.0	0.0	22	260	81	59	12	248	--	--
100-41-4	Ethylbenzene	23	23	100	0.0	0.0	0.071	30	3.7	5.9	1.3	29	37	33,333
PTC_204	Gasoline Range Organics	23	4	17	1,100	1,900	2,800	5,900	1,322	1,346	--	5,900	--	1,033
66-25-1	Hexanal	37	7	19	0.31	0.31	0.35	0.50	0.20	0.10	1.6	0.0	--	--
67-63-0	Isopropanol	23	23	100	0.0	0.0	31	8,600	1,433	2,684	220	8,380	--	7,000
91-20-3	Naphthalene	23	19	83	0.031	0.12	0.039	0.40	0.085	0.079	0.13	0.27	2.8	103
111-65-9	Octane	23	10	43	0.20	1.9	0.20	0.62	0.33	0.25	0.37	0.25	--	--
99-87-6	p-Isopropyltoluene	23	7	30	0.10	1.3	0.14	1.3	0.25	0.30	--	1.3	--	--
75-65-0	Tert-Butyl Alcohol	23	11	48	0.27	2.5	0.30	2.8	0.59	0.67	6.9	0.0	--	--
10061-02-6	trans-1,3-Dichloropropene	23	3	13	0.0068	0.043	0.027	0.34	0.035	0.088	0.42	0.0	--	--
75-69-4	Trichlorofluoromethane	23	23	100	0.0	0.0	0.98	48	7.1	11	0.95	47	--	--
1120-21-4	Undecane	23	8	35	0.21	2.2	0.18	1.0	0.44	0.35	2.7	0.0	--	--

Notes

--: No screening level available

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Table D-3: Southern Area Groundwater COPC Statistics

CAS No.	VI COPC	Number of Samples	Number of Detections	% Detected	Minimum Nondetected Concentration (ug/L)	Maximum Nondetected Concentration (ug/L)	Minimum Detected Concentration (ug/L)	Maximum Detected Concentration (ug/L)	Mean (ug/L)	Standard Deviation	Residential Carcinogenic GW-to-IA VISL (ug/L)	Residential Non-Carcinogenic GW-to-IA VISL (ug/L)
126-99-8	Chloro-1,3-butadiene, 2-	3	0	0.0	1.0	1.0	0.0	0.0	0.50	--	0.0041	9.2
96-12-8	Dibromo-3-chloropropane, 1,2-	3	0	0.0	0.50	0.50	0.0	0.0	0.25	--	0.028	35
1476-11-5	Dichloro-2-butene, cis-1,4-	3	0	0.0	1.0	1.0	0.0	0.0	0.50	--	0.025	--
110-57-6	trans-1,4-Dichloro-2-butene	3	0	0.0	1.0	1.0	0.0	0.0	0.50	--	0.025	--

Notes

--: No standard deviation or screening level available

Table D-4: Southern Area Sub-slab Soil Gas COPC Statistics

CAS No.	VI COPC	Number of Samples	Number of Detections	% Detected	Minimum Nondetected Concentration (ug/m^3)	Maximum Nondetected Concentration (ug/m^3)	Minimum Detected Concentration (ug/m^3)	Maximum Detected Concentration (ug/m^3)	Mean (ug/m^3)	Standard Deviation	Maximum Detected Ambient Air Concentration (ug/m^3)	Corrected SG Concentration (SG-AA)	Residential Carcinogenic SG-to-IA VISL (ug/m^3)	Residential Non-Carcinogenic SG-to-IA VISL (ug/m^3)
541-73-1	1,3-Dichlorobenzene	14	14	100	0.0	0.0	0.20	510	116	211	3.6	506	--	--
540-84-1	2,2,4-Trimethylpentane	14	7	50	0.13	5.4	0.39	0.87	0.90	1.0	0.45	0.42	--	--
622-96-8	4-Ethyltoluene	14	14	100	0.0	0.0	0.23	45	7.2	14	0.21	45	--	--
75-07-0	Acetaldehyde	14	8	57	0.096	0.096	4.8	94	28	37	5.8	88	43	313
107-02-8	Acrolein	14	10	71	0.064	1.3	0.44	5.7	1.4	1.5	2.4	3.3	--	0.70
123-72-8	Butraldahyde	14	4	29	0.22	0.22	0.41	0.82	0.25	0.24	0.49	0.53	--	--
104-51-8	Butylbenzene, n-	14	7	50	0.13	5.2	0.13	0.38	0.68	1.0	--	0.38	--	--
135-98-8	Butylbenzene, sec-	14	1	7.1	0.10	4.9	0.18	0.18	0.58	1.0	--	0.18	--	--
95-49-8	Chlorotoluene, o-	14	0	0.0	0.36	18	0.0	0.0	2.0	3.6	--	0.0	--	--
4170-30-3	Crotonaldehyde, Total	14	3	21	0.12	0.12	0.36	1.1	0.18	0.29	--	1.1	--	--
124-18-5	Decane	14	14	100	0.0	0.0	1.6	69	11	19	2.1	67	--	--
124-48-1	Dibromochloromethane	14	6	43	0.015	0.30	0.017	0.098	0.054	0.056	--	0.098	--	--
156-59-2	Dichloroethylene, 1,2-cis-	14	4	29	0.015	0.31	0.016	0.091	0.050	0.061	0.047	0.044	--	--
156-60-5	Dichloroethylene, 1,2-trans-	14	2	14	0.012	0.25	0.013	0.027	0.036	0.048	--	0.027	--	--
142-28-9	Dichloropropane, 1,3-	14	0	0.0	0.36	18	0.0	0.0	2.0	3.6	--	0.0	--	--
112-40-3	Dodecane	14	12	86	10.0	10.0	2.0	12	4.6	2.3	3.2	8.8	--	--
64-17-5	Ethanol	14	11	79	0.61	0.62	12	360	113	135	12	348	--	--
100-41-4	Ethylbenzene	14	14	100	0.0	0.0	1.2	340	78	126	1.3	339	37	33,333
PTC_204	Gasoline Range Organics	14	6	43	1,300	1,600	2,900	8,800	2,551	2,569	--	8,800	--	1,033
66-25-1	Hexanal	14	2	14	0.31	0.31	0.35	0.47	0.19	0.096	1.6	0.0	--	--
67-63-0	Isopropanol	14	13	93	0.37	0.37	560	28,000	5,574	9,767	220	27,780	--	7,000
91-20-3	Naphthalene	14	12	86	0.54	0.54	0.15	4.2	0.51	1.1	0.13	4.1	2.8	103
111-65-9	Octane	14	10	71	0.39	8.1	0.23	0.57	1.1	1.6	0.37	0.20	--	--
99-87-6	p-Isopropyltoluene	14	12	86	5.4	5.5	0.13	12	1.5	3.2	--	12	--	--
75-65-0	Tert-Butyl Alcohol	14	9	64	0.26	0.52	1.4	36	8.3	12	6.9	29	--	--
10061-02-6	trans-1,3-Dichloropropene	14	0	0.0	0.0090	0.19	0.0	0.0	0.025	0.036	0.42	0.0	--	--
75-69-4	Trichlorofluoromethane	14	14	100	0.0	0.0	0.91	1.2	1.1	0.070	0.95	0.25	--	--
1120-21-4	Undecane	14	12	86	0.23	9.5	2.8	31	6.7	8.8	2.7	28	--	--

Notes

--: No screening level available

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Table D-5: Step 3 Sub-slab Soil Gas COPC Statistics for Building 1460

CAS No.	VI COPC	Number of Samples	Number of Detections	% Detected	Minimum Nondetected Concentration (ug/m^3)	Maximum Nondetected Concentration (ug/m^3)	Minimum Detected Concentration (ug/m^3)	Maximum Detected Concentration (ug/m^3)	Mean (ug/m^3)	Standard Deviation	Residential Carcinogenic SG-to-IA VISL (ug/m^3)	Residential Non-Carcinogenic SG-to-IA VISL (ug/m^3)
541-73-1	1,3-Dichlorobenzene	7	7	100	0.0	0.0	0.20	0.60	0.36	0.13	--	--
622-96-8	4-Ethyltoluene	7	7	100	0.0	0.0	0.23	0.89	0.42	0.22	--	--
75-07-0	Acetaldehyde	7	1	14	0.096	0.096	56	56	8.0	21	43	313
107-02-8	Acrolein	7	4	57	0.064	0.21	0.70	2.0	0.81	0.81	--	0.70
124-18-5	Decane	7	7	100	0.0	0.0	1.6	3.5	2.6	0.77	--	--
112-40-3	Dodecane	7	7	100	0.0	0.0	2.0	5.2	4.0	1.0	--	--
64-17-5	Ethanol	7	4	57	0.61	0.62	230	360	172	165	--	--
100-41-4	Ethylbenzene	7	7	100	0.0	0.0	1.2	273	40	103	37	33,333
PTC_204	Gasoline Range Organics	7	0	0.0	1,300	1,600	0.0	0.0	743	45	--	1,033
67-63-0	Isopropanol	7	6	86	0.37	0.37	560	710	546	246	--	7,000
91-20-3	Naphthalene	7	7	100	0.0	0.0	0.15	0.38	0.22	0.075	2.8	103
99-87-6	p-Isopropyltoluene	7	7	100	0.0	0.0	0.13	0.20	0.16	0.026	--	--
75-65-0	Tert-Butyl Alcohol	7	6	86	0.26	0.26	1.4	14	5.2	5.3	--	--
1120-21-4	Undecane	7	7	100	0.0	0.0	2.8	4.4	3.8	0.55	--	--

Notes

--: No screening level available

Table D-6: Southern Area Building 1460 Sub-Slab Soil Gas Results

VI COPC	Residential Cancer SG-to-IA VISL (ug/m^3)	Residential Noncancer SG-to-IA VISL (ug/m^3)	Medical Clinic (Building 1460)													
			CK1460-01 (X-Ray Room 45)		CK1460-02 (Laboratory 40)		CK1460-03 (Waiting Hall 2)		CK1460-04 (Office 23/26)		CK1460-05 (Office 63/64)		CK1460-06 (Office 69)		CK1460-07 (Pharmacy 37)	
			Result	Qualifier	Result	Qualifier	Result	Qualifier	Results	Qualifier	Results	Qualifier	Results	Qualifier	Results	Qualifier
1,3-Dichlorobenzene	--	--	0.20	J	0.26		0.46		0.39		0.60		0.32		0.32	
2,2,4-Trimethylpentane	--	--	0.39	J	0.46	J	0.87		0.55	J	0.49	J	0.62	J	0.83	J
4-Ethyltoluene	--	--	0.89	J	0.23	J	0.45	J	0.41	J	0.30	J	0.31	J	0.33	J
Acetaldehyde	43	313	--	--	--	--	--	--	--	--	**56**		--	--	--	--
Acrolein	--	0.70	--	--	--	--	**2.0**		**1.7**		0.70		--	--	**1.1**	
Butraldahyde	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Butylbenzene, n-	--	--	0.38	J	0.14	J	0.22	J	0.21	J	0.19	J	0.13	J	0.16	J
Butylbenzene, sec-	--	--	--	--	--	--	--	--	0.18	J	--	--	--	--	--	--
Carbon Tetrachloride	16	3,333	--	--	--	--	--	--	--	--	--	--	1.6		0.72	
Chloro-1,3-butadiene, 2-	0.31	700	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chlorotoluene, o-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Crotonaldehyde, Total	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decane	--	--	2.4		3.5		2.2		3.4		3.1		1.6		1.8	
Dibromo-3-chloropropane, 1,2-	0.0057	7.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibromochloromethane	--	--	--	--	0.020	J	--	--	--	--	--	--	--	--	0.017	J
Dichloro-2-butene, cis-1,4-	0.022	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dichloroethylene, 1,2-cis-	--	--	0.091	J	--	--	--	--	--	--	--	--	--	--	0.018	J
Dichloroethylene, 1,2-trans-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dichloropropane, 1,3-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dodecane	--	--	2.0	J	4.2		5.2		3.5		4.5		4.7		3.8	
Ethanol	--	--	230		--	--	360		--	--	300		--	--	310	
Ethylbenzene	37	33,333	**273**		1.2		1.9		1.4		1.5		1.2		1.6	
Gasoline Range Organics	--	1,033	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexanal	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Isopropanol	--	7,000	673		590		710		--	--	560		650		640	
Naphthalene	2.8	103	0.38	J	0.21		0.22	J	0.22		0.16	J	0.15	J	0.23	
Octane	--	--	0.46	J	0.32	J	0.57	J	0.35	J	0.32	J	0.32	J	0.46	J
p-Isopropyltoluene	--	--	0.20	J	0.13	J	0.19	J	0.18	J	0.16	J	0.14	J	0.15	J
Tert-Butyl Alcohol	--	--	11		--	--	14		4.0		1.4	J	1.8	J	3.9	
trans-1,3-Dichloropropene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
trans-1,4-Dichloro-2-butene	0.022	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichlorofluoromethane	--	--	1.1		0.98		1.1		1.0		1.1		0.91		1.1	
Undecane	--	--	2.8		4.0		4.4		3.8		4.3		3.5		3.5	

Notes:

VI COPC with a VISL exceedance; concentration hat exceeds the VISL is **bold.**

--: No VISL available or constituent not detected

SG:Sub-slab soil gas

IA: Indoor air

NA: Not analyzed

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Table D-7: Step 3 Sub-slab Soil Gas COPC Statistics for Building 1463

CAS No.	VI COPC	Number of Samples	Number of Detections	% Detected	Minimum Nondetected Concentration (ug/m^3)	Maximum Nondetected Concentration (ug/m^3)	Minimum Detected Concentration (ug/m^3)	Maximum Detected Concentration (ug/m^3)	Mean (ug/m^3)	Standard Deviation	Residential Carcinogenic SG-to-IA VISL (ug/m^3)	Residential Non-Carcinogenic SG-to-IA VISL (ug/m^3)
541-73-1	1,3-Dichlorobenzene	7	7	100	0.0	0.0	13	510	231	255	--	--
622-96-8	4-Ethyltoluene	7	7	100	0.0	0.0	0.72	45	14	18	--	--
75-07-0	Acetaldehyde	7	7	100	0.0	0.0	4.8	94	49	40	43	313
107-02-8	Acrolein	7	6	86	1.3	1.3	0.44	5.7	2.0	1.8	--	0.70
124-18-5	Decane	7	7	100	0.0	0.0	2.1	69	20	25	--	--
112-40-3	Dodecane	7	5	71	10.0	10.0	3.2	12	5.3	3.0	--	--
64-17-5	Ethanol	7	7	100	0.0	0.0	12	190	55	65	--	--
100-41-4	Ethylbenzene	7	7	100	0.0	0.0	3.2	340	115	144	37	33,333
PTC_204	Gasoline Range Organics	7	6	86	1,500	1,500	2,900	8,800	4,360	2,583	--	1,033
67-63-0	Isopropanol	7	7	100	0.0	0.0	850	28,000	10,601	12,151	--	7,000
91-20-3	Naphthalene	7	5	71	0.54	0.54	0.18	4.2	0.80	1.5	2.8	103
99-87-6	p-Isopropyltoluene	7	5	71	5.4	5.5	0.21	12	2.8	4.2	--	--
75-65-0	Tert-Butyl Alcohol	7	3	43	0.26	0.52	12	36	12	16	--	--
1120-21-4	Undecane	7	5	71	0.23	9.5	2.8	31	9.7	12	--	--

Notes

--: No screening level available

Table D-8: Southern Area Building 1463 Sub-Slab Soil Gas Results

VI COPC	Residential Cancer SG-to-IA VISL (ug/m^3)	Residential Noncancer SG-to-IA VISL (ug/m^3)	Dental Clinic (Building 1463)													
			CK1463-01 (Corridor Hatch)		CK1463-02 (Corridor Hatch)		CK1463-03 (Corridor Hatch)		CK1463-04 (Corridor Hatch)		CK1463-05 (Lounge 12)		CK1463-06 (Waiting Area)		CK1463-07 (Admin/Records 3)	
			Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifer	Result	Qualifier	Result	Qualifier
1,3-Dichlorobenzene	--	--	27		25		41		510		13		510		490	
2,2,4-Trimethylpentane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Ethyltoluene	--	--	0.72	J	0.72	J	0.76	J	29	J	0.83	J	45		21	J
Acetaldehyde	43	313	4.8		6.6	J	9.8		**66**	J	**90**		**70**	J	**94**	J
Acrolein	--	0.70	**1.9**		0.77		**2.8**		**5.7**	J	0.44		--	--	**1.6**	J
Butraldahyde	--	--	0.82	J	0.41	J	0.51	J	--	--	0.63	J	--	--	--	--
Butylbenzene, n-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Butylbenzene, sec-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon Tetrachloride	16	3,333	1.2		--	--	--	--	--	--	--	--	--	--	--	--
Chloro-1,3-butadiene, 2-	0.31	700	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chlorotoluene, o-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Crotonaldehyde, Total	--	--	1.1	J	0.36	J	--	--	--	--	--	--	--	--	0.46	J
Decane	--	--	4.4		2.5		3.6		31	J	2.1		69		27	J
Dibromo-3-chloropropane, 1,2-	0.0057	7.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibromochloromethane	--	--	0.098		0.021	J	0.057	J	--	--	0.034	J	--	--	--	--
Dichloro-2-butene, cis-1,4-	0.022	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dichloroethylene, 1,2-cis-	--	--	0.030	J	--	--	--	--	--	--	0.016	J	--	--	--	--
Dichloroethylene, 1,2-trans-	--	--	0.027	J	--	--	--	--	--	--	0.013	J	--	--	--	--
Dichloropropane, 1,3-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dodecane	--	--	3.6		3.2		4.1		12	J	3.9		--	--	--	--
Ethanol	--	--	13	J	12	J	14	J	190	J	15	J	72	J	68	J
Ethylbenzene	37	33,333	4.5		6.8		3.2		**220**		3.6		**340**		**230**	
Gasoline Range Organics	--	1,033	2,967	J	**4,000**	J	**2,900**	J	**5,200**	J	--	--	**8,800**	J	**5,900**	J
Hexanal	--	--	--	--	0.47	J	0.35	J	--	--	--	--	--	--	--	--
Isopropanol	--	7,000	850		960		1,300		**20,000**		1,100		**28,000**		**22,000**	
Naphthalene	2.8	103	0.25		0.24		0.18	J	**4.2**		0.21		--	--	--	--
Octane	--	--	0.29	J	0.34	J	--	--	--	--	0.23	J	--	--	--	--
p-Isopropyltoluene	--	--	1.7		0.21	J	0.27	J	12	J	0.24	J	--	--	--	--
Tert-Butyl Alcohol	--	--	--	--	--	--	--	--	32	J	--	--	12	J	36	J
trans-1,3-Dichloropropene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
trans-1,4-Dichloro-2-butene	0.022	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichlorofluoromethane	--	--	1.1		1.1		1.1		1.2	J	1.1		1.1	J	1.1	J
Undecane	--	--	2.8		--	--	3.0		23	J	3.2		31	J	--	--

Notes:

VI COPC with a VISL exceedance; concentra ion that exceeds the VISL is **bold**.

--: No VISL available or constituent not detected

SG: Sub-slab soil gas

IA: Indoor air

NA: Not analyzed

Figures

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Site Location Map with Northern and Southern Areas
Vapor Intrusion Pathway Evaluation
Camp Kinser, Okinawa Prefecture, Japan

Figure D-1

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PIONEER TECHNOLOGIES CORPORATION

Northern Area Site Features and Groundwater Flow Map
Vapor Intrusion Pathway Evaluation
Camp Kinser, Okinawa Prefecture, Japan

Figure D-2

Legend

- Groundwater Sample
- Groundwater Contour (Contour Interval = 0.1 Feet)
- Approximate Groundwater Flow Direction at Time of Groundwater Sampling
- Prevailing Wind Direction

Other Site Features

- Fencing
- Site Features
- Camp Kinser Boundary
- Southern Area Boundary

Notes:
MSL: Mean Sea Level

0 200 400 600 Feet

PIONEER TECHNOLOGIES CORPORATION

Southern Area Site Features and Groundwater Flow Map
Vapor Intrusion Pathway Evaluation
Camp Kinser, Okinawa Prefecture, Japan

Figure D-3

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PIONEER TECHNOLOGIES CORPORATION

Northern Area Sample Locations
Vapor Intrusion Pathway Evaluation
Camp Kinser, Okinawa Prefecture, Japan

Figure D-4

PIONEER TECHNOLOGIES CORPORATION

Southern Area Sample Locations
Vapor Intrusion Pathway Evaluation
Camp Kinser, Okinawa Prefecture, Japan

Figure D-5

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Appendix E

Cancer Risk and Hazard Indices by Decision Unit, COPC, and Exposure Pathway

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Table E-1: DU-N1 Sample Results and Risk Estimates

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 6-Year Child Recreator – Cancer Risk: Dermal Contact	Ingestion	Inhalation	Total Cancer Risk	Noncancer Hazard: Dermal Contact	Ingestion	Inhalation	Total Hazard Index
Arsenic	19	2.99E-07	2.52E-06	1.11E-10	2.82E-06	0.0077	0.065	0.000020	0.073
Chromium (VI)	0.15	--	5.91E-08	9.13E-11	5.92E-08	--	0.000086	0.000000024	0.000086
DDE	0.0041	1.48E-11	2.07E-10	5.44E-16	2.22E-10	0.0000017	0.000024	--	0.000025
DDT	0.036	1.31E-10	1.84E-09	4.82E-15	1.97E-09	0.0000090	0.00013	--	0.00014
Total Carcinogenic PAHs (BaP TEQs)	0.030	7.48E-09	2.43E-08	1.34E-13	3.17E-08	--	--	--	
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000016	2.20E-08	3.10E-07	8.32E-13	3.32E-07	0.0028	0.040	0.0000044	0.043
Benzo(a)pyrene	0.022	--	--	--	--	0.000039	0.00013	0.00000017	0.00016
		3.28E-07	**2.91E-06**	**2.03E-10**	**3.24E-06**	**0.011**	**0.11**	**0.000025**	**0.12**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk > 1E-06

Table E-1: DU-N1 Sample Results and Risk Estimates

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios — 6-Year Adult Recreator — Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	19	4.98E-08	2.36E-07	1.11E-10	2.86E-07	0.0013	0.0061	0.000020	0.0074
Chromium (VI)	0.15	--	1.04E-09	1.71E-11	1.06E-09	--	0.0000081	0.000000024	0.0000081
DDE	0.0041	2.46E-12	1.94E-11	3.53E-13	2.22E-11	0.00000028	0.0000022	--	0.0000025
DDT	0.036	2.18E-11	1.72E-10	4.82E-15	1.94E-10	0.0000015	0.000012	--	0.000013
Total Carcinogenic PAHs (BaP TEQs)	0.030	2.34E-10	4.27E-10	2.51E-14	6.61E-10	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000016	3.68E-09	2.90E-08	5.78E-10	3.33E-08	0.00047	0.0037	0.0000044	0.0042
Benzo(a)pyrene	0.022	--	--	--	--	0.0000065	0.000012	0.00000017	0.000018
		5.38E-08	**2.67E-07**	**7.06E-10**	**3.21E-07**	**0.0018**	**0.0099**	**0.000025**	**0.012**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk > 1E-06

Table E-1: DU-N1 Sample Results and Risk Estimates

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 25-Year Adult Landscaper – Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	19	2.40E-07	3.38E-06	4.80E-10	3.62E-06	0.0015	0.021	0.000021	0.023
Chromium (VI)	0.15	--	1.49E-08	7.43E-11	1.50E-08	--	0.000028	0.000000025	0.000028
DDE	0.0041	1.19E-11	2.78E-10	1.53E-12	2.92E-10	0.00000033	0.0000076	--	0.0000080
DDT	0.036	1.05E-10	2.47E-09	2.09E-14	2.58E-09	0.0000017	0.000041	--	0.000042
Total Carcinogenic PAHs (BaP TEQs)	0.030	1.13E-09	6.11E-09	1.09E-13	7.24E-09	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000016	1.77E-08	4.16E-07	2.51E-09	4.36E-07	0.00055	0.013	0.0000046	0.013
Benzo(a)pyrene	0.022	--	--	--	--	0.0000075	0.000041	0.00000018	0.000048
		2.59E-07	**3.82E-06**	**3.06E-09**	**4.08E-06**	**0.0021**	**0.034**	**0.000026**	**0.036**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk > 1E-06

Table E-2: DU-N2 Sample Results and Risk Estimates

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 6-Year Child Recreator: Cancer Risk – Dermal Contact	Cancer Risk – Ingestion	Cancer Risk – Inhalation	Cancer Risk – Total Cancer Risk	Noncancer Hazard – Dermal Contact	Noncancer Hazard – Ingestion	Noncancer Hazard – Inhalation	Noncancer Hazard – Total Hazard Index
Arsenic	16	2.58E-07	2.17E-06	9.54E-11	2.43E-06	0.0067	0.056	0.000017	0.063
Chlordane, gamma	0.0012	6.11E-12	6.44E-11	1.69E-16	7.05E-11	0.00000041	0.0000043	2.8E-11	0.0000047
Chromium (VI)	0.44	--	1.75E-07	2.70E-10	1.75E-07	--	0.00025	0.000000070	0.00025
Dieldrin	0.0030	1.71E-09	7.22E-09	1.91E-15	8.93E-09	0.000025	0.00011	--	0.00013
DDE	0.0035	1.28E-11	1.80E-10	4.73E-16	1.93E-10	0.0000015	0.000021	--	0.000022
DDT	0.24	8.73E-10	1.23E-08	3.22E-14	1.31E-08	0.000060	0.00084	--	0.00090
Total Carcinogenic PAHs (BaP TEQs)	0.036	8.93E-09	2.89E-08	1.60E-13	3.79E-08	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000042	5.88E-08	8.26E-07	2.22E-12	8.85E-07	0.0075	0.11	0.000000017	0.11
Benzo(a)pyrene	0.027	--	--	--	--	0.000049	0.00016	0.00000022	0.00021
		3.28E-07	**3.22E-06**	**3.67E-10**	**3.55E-06**	**0.014**	**0.16**	**0.000018**	**0.18**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk > 1E-06

Table E-2: DU-N2 Sample Results and Risk Estimates

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios							
		6-Year Adult Recreator							
		Cancer Risk				Noncancer Hazard			
		Dermal Contact	Ingestion	Inhalation	Total Cancer Risk	Dermal Contact	Ingestion	Inhalation	Total Hazard Index
Arsenic	16	4.30E-08	2.04E-07	9.54E-11	2.47E-07	0.0011	0.0053	0.000017	0.0064
Chlordane, gamma	0.0012	1.02E-12	6.04E-12	1.69E-16	7.06E-12	0.000000068	0.00000040	2.8E-11	0.00000047
Chromium (VI)	0.44	--	3.07E-09	5.06E-11	3.12E-09	--	0.000024	0.000000070	0.000024
Dieldrin	0.0030	2.86E-10	6.77E-10	1.91E-15	9.63E-10	0.0000042	0.0000099	--	0.000014
DDE	0.0035	2.14E-12	1.69E-11	4.73E-16	1.91E-11	0.00000025	0.0000019	--	0.0000022
DDT	0.24	1.46E-10	1.15E-09	3.22E-14	1.30E-09	0.000010	0.000079	--	0.000089
Total Carcinogenic PAHs (BaP TEQs)	0.036	2.79E-10	5.09E-10	2.99E-14	7.89E-10	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000042	9.81E-09	7.75E-08	2.22E-12	8.73E-08	0.0013	0.0099	0.000000017	0.011
Benzo(a)pyrene	0.027	--	--	--	--	0.0000081	0.000015	0.00000022	0.000023
		5.35E-08	**2.87E-07**	**1.48E-10**	**3.40E-07**	**0.0024**	**0.015**	**0.000018**	**0.018**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk > 1E-06

Table E-2: DU-N2 Sample Results and Risk Estimates

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 25-Year Adult Landscaper – Cancer Risk: Dermal Contact	Ingestion	Inhalation	Total Cancer Risk	Noncancer Hazard: Dermal Contact	Ingestion	Inhalation	Total Hazard Index
Arsenic	16	2.07E-07	2.92E-06	4.14E-10	3.12E-06	0.0013	0.018	0.000018	0.019
Chlordane, gamma	0.0012	4.92E-12	8.65E-11	7.34E-16	9.14E-11	0.000000079	0.0000014	2.9E-11	0.0000015
Chromium (VI)	0.44	--	4.40E-08	2.20E-10	4.42E-08	--	0.000082	0.000000073	0.000082
Dieldrin	0.0030	1.38E-09	9.69E-09	8.28E-15	1.11E-08	0.0000048	0.000034	--	0.000039
DDE	0.0035	1.03E-11	2.42E-10	2.05E-15	2.53E-10	0.00000028	0.0000067	--	0.0000069
DDT	0.24	7.02E-10	1.65E-08	1.40E-13	1.72E-08	0.000012	0.00027	--	0.00028
Total Carcinogenic PAHs (BaP TEQs)	0.036	1.35E-09	7.29E-09	1.30E-13	8.64E-09	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000042	4.73E-08	1.11E-06	9.64E-12	1.16E-06	0.0015	0.034	0.000000018	0.036
Benzo(a)pyrene	0.027	--	--	--	--	0.0000094	0.000051	0.00000023	0.000060
		2.58E-07	**4.10E-06**	**6.43E-10**	**4.36E-06**	**0.0028**	**0.053**	**0.000018**	**0.056**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk > 1E-06

Table E-3: DU-N3 Sample Results and Risk Estimates

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios — 6-Year Child Recreator — Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Total Hazard Index
Arsenic	27	4.30E-07	3.62E-06	1.59E-10	4.05E-06	0.011	0.094	0.000029	0.11
Chromium (VI)	0.17	--	6.93E-08	1.07E-10	6.94E-08	--	0.00010	0.000000028	0.00010
Dieldrin	0.00086	4.91E-10	2.07E-09	5.47E-16	2.56E-09	0.0000072	0.000030	--	0.000037
DDD	0.0034	2.90E-11	1.22E-10	3.23E-16	1.51E-10	0.000047	0.00020	--	0.00024
DDE	0.013	4.56E-11	6.41E-10	1.68E-15	6.86E-10	0.0000052	0.000073	--	0.000079
DDT	0.17	6.18E-10	8.69E-09	2.28E-14	9.31E-09	0.000042	0.00060	--	0.00064
Total Carcinogenic PAHs (BaP TEQs)	0.084	2.07E-08	6.71E-08	3.70E-13	8.78E-08	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000018	2.46E-08	3.46E-07	9.30E-13	3.71E-07	0.0032	0.044	7.1E-9	0.048
Total PCBs (Aroclor Method)	0.032	3.22E-09	9.69E-09	2.54E-14	1.29E-08	--	--	--	--
Benzo(a)pyrene	0.076	--	--	--	--	0.00014	0.00045	0.00000061	0.00058
		4.80E-07	**4.13E-06**	**2.67E-10**	**4.61E-06**	**0.015**	**0.14**	**0.000029**	**0.15**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk > 1E-06

Table E-3: DU-N3 Sample Results and Risk Estimates

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 6-Year Adult Recreator – Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	27	7.17E-08	3.40E-07	1.59E-10	4.11E-07	0.0019	0.0088	0.000029	0.011
Chromium (VI)	0.17	--	1.22E-09	2.01E-11	1.24E-09	--	0.0000095	0.000000028	0.0000095
Dieldrin	0.00086	8.20E-11	1.94E-10	5.47E-16	2.76E-10	0.0000012	0.0000028	--	0.0000040
DDD	0.0034	4.84E-12	1.15E-11	3.23E-16	1.63E-11	0.0000078	0.000019	--	0.000026
DDE	0.013	7.61E-12	6.01E-11	1.68E-15	6.77E-11	0.00000087	0.0000069	--	0.0000077
DDT	0.17	1.03E-10	8.14E-10	2.28E-14	9.18E-10	0.0000071	0.000056	--	0.000063
Total Carcinogenic PAHs (BaP TEQs)	0.084	6.48E-10	1.18E-09	6.95E-14	1.83E-09	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000018	4.11E-09	3.25E-08	9.30E-13	3.66E-08	0.00053	0.0042	7.1E-9	0.0047
Total PCBs (Aroclor Method)	0.032	5.37E-10	9.08E-10	2.54E-14	1.45E-09	--	--	--	--
Benzo(a)pyrene	0.076	--	--	--	--	0.000023	0.000042	0.00000061	0.000065
		7.72E-08	**3.76E-07**	**1.80E-10**	**4.54E-07**	**0.0024**	**0.013**	**0.000029**	**0.016**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk > 1E-06

Table E-3: DU-N3 Sample Results and Risk Estimates

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 25-Year Adult Landscaper – Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	27	3.46E-07	4.86E-06	6.90E-10	5.21E-06	0.0022	0.030	0.000030	0.032
Chromium (VI)	0.17	--	1.75E-08	8.72E-11	1.75E-08	--	0.000033	0.000000029	0.000033
Dieldrin	0.00086	3.95E-10	2.78E-09	2.38E-15	3.18E-09	0.0000014	0.0000097	--	0.000011
DDD	0.0034	2.33E-11	1.64E-10	1.40E-15	1.87E-10	0.0000091	0.000064	--	0.000073
DDE	0.013	3.67E-11	8.60E-10	7.29E-15	8.97E-10	0.0000010	0.000024	--	0.000025
DDT	0.17	4.98E-10	1.17E-08	9.89E-14	1.22E-08	0.0000082	0.00019	--	0.00020
Total Carcinogenic PAHs (BaP TEQs)	0.084	3.13E-09	1.69E-08	3.01E-13	2.00E-08	--	--	--	0.0
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000018	1.98E-08	4.65E-07	4.04E-12	4.85E-07	0.00061	0.014	7.4E-9	0.015
Total PCBs (Aroclor Method)	0.032	2.59E-09	1.30E-08	1.10E-13	1.56E-08	--	--	--	--
Benzo(a)pyrene	0.076	--	--	--	--	0.000027	0.00014	0.00000064	0.00017
		3.72E-07	**5.39E-06**	**7.82E-10**	**5.76E-06**	**0.0028**	**0.045**	**0.000031**	**0.048**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk > 1E-06

Table E-4: DU-N4 Sample Results and Risk Estimates

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios							
		6-Year Child Recreator							
		Cancer Risk				Noncancer Hazard			
		Dermal Contact	Ingestion	Inhalation	Total Cancer Risk	Dermal Contact	Ingestion	Inhalation	Total Hazard Index
Arsenic	24	3.90E-07	3.29E-06	1.44E-10	3.68E-06	0.010	0.085	0.000026	0.095
Chlordane, Technical	17	8.49E-08	8.94E-07	2.35E-12	9.79E-07	0.0057	0.060	0.00000039	0.065
Chlordane, alpha	2.3	1.15E-08	1.21E-07	3.18E-13	1.32E-07	0.00077	0.0081	0.000000053	0.0088
Chlordane, gamma	2.3	1.15E-08	1.21E-07	3.18E-13	1.32E-07	0.00077	0.0081	0.000000053	0.0088
DDE	0.13	4.73E-10	6.64E-09	1.74E-14	7.12E-09	0.000054	0.00076	--	0.00081
DDT	0.42	1.53E-09	2.15E-08	5.63E-14	2.30E-08	0.00010	0.0015	--	0.0016
Dieldrin	2.0	1.14E-06	4.81E-06	1.27E-12	5.95E-06	0.017	0.070	--	0.087
Total Carcinogenic PAHs (BaP TEQs)	1.4	3.39E-07	1.10E-06	6.07E-12	1.44E-06	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000012	1.71E-08	2.41E-07	6.46E-13	2.58E-07	0.0022	0.031	5.0E-9	0.033
Total PCBs (Aroclor Method)	0.70	7.01E-08	2.11E-07	5.53E-13	2.81E-07	--	--	--	--
Benzo(a)pyrene	0.97	--	--	--	--	0.0017	0.0057	0.0000078	0.0074
		2.07E-06	**1.08E-05**	**1.56E-10**	**1.29E-05**	**0.038**	**0.27**	**0.000034**	**0.31**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk >1E-05

Cancer Risk > 1E-06

Table E-4: DU-N4 Sample Results and Risk Estimates

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 6-Year Adult Recreator – Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	24	6.51E-08	3.08E-07	1.44E-10	3.73E-07	0.0017	0.0080	0.000026	0.0097
Chlordane, Technical	17	1.42E-08	8.38E-08	2.35E-12	9.80E-08	0.00094	0.0056	0.00000039	0.0065
Chlordane, alpha	2.3	1.92E-09	1.13E-08	3.18E-13	1.33E-08	0.00013	0.00076	0.000000053	0.00088
Chlordane, gamma	2.3	1.92E-09	1.13E-08	3.18E-13	1.33E-08	0.00013	0.00076	0.000000053	0.00088
DDE	0.13	7.89E-11	6.23E-10	1.74E-14	7.02E-10	0.0000090	0.000071	--	0.000080
DDT	0.42	2.55E-10	2.01E-09	5.63E-14	2.27E-09	0.000017	0.00014	--	0.00016
Dieldrin	2.0	1.90E-07	4.51E-07	1.27E-12	6.41E-07	0.0028	0.0066	--	0.0094
Total Carcinogenic PAHs (BaP TEQs)	1.4	1.06E-08	1.94E-08	1.14E-12	3.00E-08	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000012	2.86E-09	2.26E-08	6.46E-13	2.54E-08	0.00037	0.0029	5.0E-9	0.0033
Total PCBs (Aroclor Method)	0.70	1.17E-08	1.98E-08	5.53E-13	3.15E-08	--	--	--	--
Benzo(a)pyrene	0.97	--	--	--	--	0.00029	0.00053	0.0000078	0.00083
		2.99E-07	**9.30E-07**	**1.51E-10**	**1.23E-06**	**0.0063**	**0.025**	**0.000034**	**0.032**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk >1E-05

Cancer Risk > 1E-06

Table E-4: DU-N4 Sample Results and Risk Estimates

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 25-Year Adult Landscaper – Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Total Hazard Index
Arsenic	24	3.14E-07	4.41E-06	6.26E-10	4.73E-06	0.0020	0.027	0.000027	0.029
Chlordane, Technical	17	6.83E-08	1.20E-06	1.02E-11	1.27E-06	0.0011	0.019	0.00000041	0.020
Chlordane, alpha	2.3	9.24E-09	1.62E-07	1.38E-12	1.72E-07	0.00015	0.0026	0.000000055	0.0027
Chlordane, gamma	2.3	9.24E-09	1.62E-07	1.38E-12	1.72E-07	0.00015	0.0026	0.000000055	0.0027
DDE	0.13	3.80E-10	8.92E-09	7.56E-14	9.30E-09	0.000010	0.00024	--	0.00026
DDT	0.42	1.23E-09	2.88E-08	2.44E-13	3.00E-08	0.000020	0.00047	--	0.00049
Dieldrin	2.0	9.18E-07	6.46E-06	5.52E-12	7.38E-06	0.0032	0.023	--	0.026
Total Carcinogenic PAHs (BaP TEQs)	1.4	5.12E-08	2.77E-07	4.94E-12	3.28E-07	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000012	1.38E-08	3.23E-07	2.81E-12	3.37E-07	0.00042	0.0099	5.2E-9	0.010
Total PCBs (Aroclor Method)	0.70	5.64E-08	2.83E-07	2.40E-12	3.40E-07	--	--	--	--
Benzo(a)pyrene	0.97	--	--	--	--	0.00034	0.0018	0.0000081	0.0022
		1.44E-06	**1.33E-05**	**6.55E-10**	**1.48E-05**	**0.0073**	**0.087**	**0.000036**	**0.094**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk >1E-05

Cancer Risk > 1E-06

Table E-5: DU-S1 Sample Results and Risk Estimates

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios							
		6-Year Child Recreator							
		Cancer Risk				Noncancer Hazard			
		Dermal Contact	Ingestion	Inhalation	Total Cancer Risk	Dermal Contact	Ingestion	Inhalation	Total Hazard Index
Arsenic	20	3.22E-07	2.71E-06	1.19E-10	3.04E-06	0.0083	0.070	0.000022	0.079
Chlordane, alpha	0.057	2.85E-10	3.00E-09	7.87E-15	3.28E-09	0.000019	0.00020	1.3E-9	0.00022
Chlordane, gamma	0.15	7.34E-10	7.73E-09	2.03E-14	8.47E-09	0.000049	0.00052	3.4E-9	0.00056
Chromium (VI)	0.14	--	5.59E-08	8.64E-11	5.60E-08	--	0.000082	0.000000023	0.000082
DDE	0.017	6.18E-11	8.69E-10	2.28E-15	9.31E-10	0.0000071	0.000099	--	0.00011
DDT	0.028	1.02E-10	1.43E-09	3.75E-15	1.53E-09	0.0000070	0.000098	--	0.00011
Dieldrin	0.0066	3.79E-09	1.60E-08	4.22E-15	1.98E-08	0.000055	0.00023	--	0.00029
Total Carcinogenic PAHs (BaP TEQs)	0.48	1.20E-07	3.88E-07	2.14E-12	5.08E-07	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.0025	3.45E-06	4.85E-05	1.30E-10	5.20E-05	0.44	6.2	0.0000010	6.7
Total PCBs (Aroclor Method)	0.042	4.21E-09	1.27E-08	3.32E-14	1.69E-08	--	--	--	--
Benzo(a)pyrene	0.39	--	--	--	--	0.00071	0.0023	0.0000032	0.0030
		3.91E-06	**5.17E-05**	**3.38E-10**	**5.56E-05**	**0.45**	**6.3**	**0.000026**	**6.7**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk >1E-05

Cancer Risk > 1E-06

Hazard Index >1

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Table E-5: DU-S1 Sample Results and Risk Estimates

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios — 6-Year Adult Recreator — Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	20	5.37E-08	2.54E-07	1.19E-10	3.08E-07	0.0014	0.0066	0.000022	0.0080
Chlordane, alpha	0.057	4.75E-11	2.81E-10	7.87E-15	3.29E-10	0.0000032	0.000019	1.3E-9	0.000022
Chlordane, gamma	0.15	1.22E-10	7.25E-10	2.03E-14	8.48E-10	0.0000082	0.000048	3.4E-9	0.000057
Chromium (VI)	0.14	--	9.84E-10	1.62E-11	1.00E-09	--	0.0000077	0.000000023	0.0000077
DDE	0.017	1.03E-11	8.14E-11	2.28E-15	9.18E-11	0.0000012	0.0000093	--	0.000010
DDT	0.028	1.70E-11	1.34E-10	3.75E-15	1.51E-10	0.0000012	0.0000092	--	0.000010
Dieldrin	0.0066	6.32E-10	1.50E-09	4.22E-15	2.13E-09	0.0000092	0.000022	--	0.000031
Total Carcinogenic PAHs (BaP TEQs)	0.48	3.75E-09	6.83E-09	4.02E-13	1.06E-08	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.0025	5.76E-07	4.55E-06	1.30E-10	5.13E-06	0.074	0.58	0.0000010	0.66
Total PCBs (Aroclor Method)	0.042	7.01E-10	1.19E-09	3.32E-14	1.89E-09	--	--	--	--
Benzo(a)pyrene	0.39	--	--	--	--	0.00012	0.00022	0.0000032	0.00034
		6.35E-07	**4.82E-06**	**2.66E-10**	**5.45E-06**	**0.075**	**0.59**	**0.000026**	**0.67**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk >1E-05

Cancer Risk > 1E-06

Hazard Index >1

Table E-5: DU-S1 Sample Results and Risk Estimates

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 25-Year Adult Landscaper – Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	20	2.59E-07	3.64E-06	5.17E-10	3.90E-06	0.0016	0.023	0.000022	0.024
Chlordane, alpha	0.057	2.29E-10	4.03E-09	3.42E-14	4.26E-09	0.0000037	0.000064	1.4E-9	0.000068
Chlordane, gamma	0.15	5.91E-10	1.04E-08	8.82E-14	1.10E-08	0.0000095	0.00017	3.5E-9	0.00018
Chromium (VI)	0.14	--	1.41E-08	7.03E-11	1.42E-08	--	0.000026	0.000000023	0.000026
DDE	0.017	4.98E-11	1.17E-09	6.41E-12	1.22E-09	0.0000014	0.000032	--	0.000033
DDT	0.028	8.19E-11	1.92E-09	1.63E-14	2.00E-09	0.0000013	0.000032	--	0.000033
Dieldrin	0.0066	3.05E-09	2.14E-08	1.83E-14	2.45E-08	0.000011	0.000075	--	0.000086
Total Carcinogenic PAHs (BaP TEQs)	0.48	1.81E-08	9.78E-08	1.74E-12	1.16E-07	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.0025	2.78E-06	6.52E-05	3.93E-07	6.83E-05	0.086	2.0	0.0000010	2.1
Total PCBs (Aroclor Method)	0.042	3.38E-09	1.70E-08	1.44E-13	2.04E-08	--	--	--	--
Benzo(a)pyrene	0.39	--	--	--	--	0.00014	0.00074	0.0000033	0.00088
		3.06E-06	**6.90E-05**	**3.94E-07**	**7.24E-05**	**0.087**	**2.0**	**0.000027**	**2.1**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk >1E-05

Cancer Risk > 1E-06

Hazard Index >1

Table E-6: DU-S2 Sample Results and Risk Estimates

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 6-Year Child Recreator – Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	17	2.80E-07	2.36E-06	1.04E-10	2.64E-06	0.0073	0.061	0.000019	0.068
Chlordane, Technical	9.1	4.54E-08	4.79E-07	1.26E-12	5.24E-07	0.0030	0.032	0.00000021	0.035
Chlordane, alpha	1.3	6.49E-09	6.84E-08	1.80E-13	7.49E-08	0.00043	0.0046	0.000000030	0.0050
Chlordane, gamma	1.2	5.99E-09	6.31E-08	1.66E-13	6.91E-08	0.00040	0.0042	0.000000028	0.0046
Chromium (VI)	0.55	--	2.20E-07	3.40E-10	2.21E-07	--	0.00032	0.000000089	0.00032
DDE	1.2	4.37E-09	6.13E-08	1.61E-13	6.57E-08	0.00050	0.0070	--	0.0075
DDT	0.20	7.28E-10	1.02E-08	2.68E-14	1.09E-08	0.000050	0.00070	--	0.00075
Dieldrin	15	8.56E-06	3.61E-05	9.53E-12	4.46E-05	0.12	0.53	--	0.65
Total Carcinogenic PAHs (BaP TEQs)	0.37	9.07E-08	2.94E-07	1.62E-12	3.85E-07	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.00066	9.16E-07	1.29E-05	3.46E-11	1.38E-05	0.12	1.6	0.00000027	1.8
Total PCBs (Aroclor Method)	0.23	2.33E-08	7.01E-08	1.84E-13	9.34E-08	--	--	--	--
Benzo(a)pyrene	0.26	--	--	--	--	0.00047	0.0015	0.0000021	0.0020
		9.93E-06	**5.26E-05**	**4.92E-10**	**6.25E-05**	**0.25**	**2.3**	**0.000021**	**2.5**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk >1E-05

Cancer Risk > 1E-06

Hazard Index >1

Table E-6: DU-S2 Sample Results and Risk Estimates

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 6-Year Adult Recreator – Cancer Risk: Dermal Contact	Ingestion	Inhalation	Total Cancer Risk	Noncancer Hazard: Dermal Contact	Ingestion	Inhalation	Total Hazard Index
Arsenic	17	4.67E-08	2.21E-07	1.04E-10	2.68E-07	0.0012	0.0057	0.000019	0.0070
Chlordane, Technical	9.1	7.58E-09	4.49E-08	1.26E-12	5.25E-08	0.00051	0.0030	0.00000021	0.0035
Chlordane, alpha	1.3	1.08E-09	6.41E-09	1.80E-13	7.49E-09	0.000072	0.00043	0.000000030	0.00050
Chlordane, gamma	1.2	9.99E-10	5.92E-09	1.66E-13	6.92E-09	0.000067	0.00039	0.000000028	0.00046
Chromium (VI)	0.55	--	3.88E-09	6.39E-11	3.94E-09	--	0.000030	0.000000089	0.000030
DDE	1.2	7.28E-10	5.75E-09	1.61E-13	6.48E-09	0.000083	0.00066	--	0.00074
DDT	0.20	1.21E-10	9.58E-10	2.68E-14	1.08E-09	0.0000083	0.000066	--	0.000074
Dieldrin	15	1.43E-06	3.38E-06	9.53E-12	4.81E-06	0.021	0.049	--	0.070
Total Carcinogenic PAHs (BaP TEQs)	0.37	2.84E-09	5.17E-09	3.04E-13	8.01E-09	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.00066	1.53E-07	1.21E-06	3.46E-11	1.36E-06	0.020	0.15	0.00000027	0.17
Total PCBs (Aroclor Method)	0.23	3.89E-09	6.57E-09	1.84E-13	1.05E-08	--	--	--	--
Benzo(a)pyrene	0.26	--	--	--	--	0.000078	0.00014	0.0000021	0.00022
		1.64E-06	**4.89E-06**	**2.14E-10**	**6.53E-06**	**0.042**	**0.21**	**0.000021**	**0.26**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk >1E-05

Cancer Risk > 1E-06

Hazard Index >1

Table E-6: DU-S2 Sample Results and Risk Estimates

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 25-Year Adult Landscaper – Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	17	2.25E-07	3.17E-06	4.49E-10	3.39E-06	0.0014	0.020	0.000020	0.021
Chlordane, Technical	9.1	3.66E-08	6.43E-07	5.46E-12	6.79E-07	0.00058	0.010	0.00000022	0.011
Chlordane, alpha	1.3	5.22E-09	9.18E-08	7.79E-13	9.70E-08	0.000084	0.0015	0.000000031	0.0016
Chlordane, gamma	1.2	4.82E-09	8.48E-08	7.19E-13	8.96E-08	0.000077	0.0014	0.000000029	0.0014
Chromium (VI)	0.55	--	5.55E-08	2.77E-10	5.58E-08	--	0.00010	0.000000092	0.00010
DDE	1.2	3.51E-09	8.23E-08	6.98E-13	8.59E-08	0.000096	0.0023	--	0.0024
DDT	0.20	5.85E-10	1.37E-08	1.16E-13	1.43E-08	0.0000096	0.00023	--	0.00024
Dieldrin	15	6.89E-06	4.84E-05	4.14E-11	5.53E-05	0.024	0.17	--	0.19
Total Carcinogenic PAHs (BaP TEQs)	0.37	1.37E-08	7.41E-08	1.32E-12	8.78E-08	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.00066	7.37E-07	1.73E-05	1.50E-10	1.80E-05	0.023	0.53	0.00000028	0.55
Total PCBs (Aroclor Method)	0.23	1.87E-08	9.42E-08	7.97E-13	1.13E-07	--	--	--	--
Benzo(a)pyrene	0.26	--	--	--	--	0.000091	0.00049	0.0000022	0.00058
		7.93E-06	**7.00E-05**	**9.28E-10**	**7.79E-05**	**0.049**	**0.74**	**0.000022**	**0.79**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk >1E-05

Cancer Risk > 1E-06

Hazard Index >1

Table E-7: DU-S3 Sample Results and Risk Estimates

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 6-Year Child Recreator – Cancer Risk: Dermal Contact	Ingestion	Inhalation	Total Cancer Risk	Noncancer Hazard: Dermal Contact	Ingestion	Inhalation	Total Hazard Index
Arsenic	15	2.42E-07	2.04E-06	8.95E-11	2.28E-06	0.0063	0.053	0.000016	0.059
Chlordane, Technical	13	6.49E-08	6.84E-07	1.80E-12	7.49E-07	0.0043	0.046	0.00000030	0.050
Chlordane, alpha	2.3	1.15E-08	1.21E-07	3.18E-13	1.32E-07	0.00077	0.0081	0.000000053	0.0088
Chlordane, gamma	1.8	8.99E-09	9.47E-08	2.49E-13	1.04E-07	0.00060	0.0063	0.000000041	0.0069
Chromium (VI)	0.13	--	5.15E-08	7.95E-11	5.16E-08	--	0.000075	0.000000021	0.000075
DDD	0.016	1.35E-10	5.70E-10	1.51E-15	7.06E-10	0.00022	0.00092	--	0.0011
DDE	0.19	6.91E-10	9.71E-09	2.55E-14	1.04E-08	0.000079	0.0011	--	0.0012
DDT	0.36	1.31E-09	1.84E-08	4.82E-14	1.97E-08	0.000090	0.0013	--	0.0014
Dieldrin	1.1	6.28E-07	2.65E-06	6.99E-13	3.27E-06	0.0092	0.039	--	0.048
Total Carcinogenic PAHs (BaP TEQs)	0.11	2.74E-08	8.88E-08	4.89E-13	1.16E-07	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000045	6.24E-08	8.76E-07	2.35E-12	9.38E-07	0.0080	0.11	0.000000018	0.12
Total PCBs	0.15	1.46E-08	4.39E-08	1.15E-13	5.85E-08	--	--	--	--
Benzo(a)pyrene	0.080	--	--	--	--	0.00014	0.00047	0.00000064	0.00061
		1.06E-06	**6.67E-06**	**1.75E-10**	**7.73E-06**	**0.030**	**0.27**	**0.000017**	**0.30**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk > 1E-06

Table E-7: DU-S3 Sample Results and Risk Estimates

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios — 6-Year Adult Recreator — Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Total Hazard Index
Arsenic	15	4.03E-08	1.91E-07	8.95E-11	2.32E-07	0.0010	0.0050	0.000016	0.0060
Chlordane, Technical	13	1.08E-08	6.41E-08	1.80E-12	7.49E-08	0.00072	0.0043	0.00000030	0.0050
Chlordane, alpha	2.3	1.92E-09	1.13E-08	3.18E-13	1.33E-08	0.00013	0.00076	0.000000053	0.00088
Chlordane, gamma	1.8	1.50E-09	8.88E-09	2.49E-13	1.04E-08	0.00010	0.00059	0.000000041	0.00069
Chromium (VI)	0.13	--	9.06E-10	1.49E-11	9.21E-10	--	0.0000070	0.000000021	0.0000071
DDD	0.016	2.26E-11	5.35E-11	1.51E-15	7.61E-11	0.000037	0.000087	--	0.00012
DDE	0.19	1.15E-10	9.10E-10	2.55E-14	1.03E-09	0.000013	0.00010	--	0.00012
DDT	0.36	2.18E-10	1.72E-09	4.82E-14	1.94E-09	0.000015	0.00012	--	0.00013
Dieldrin	1.1	1.05E-07	2.48E-07	6.99E-13	3.53E-07	0.0015	0.0036	--	0.0051
Total Carcinogenic PAHs (BaP TEQs)	0.11	8.57E-10	1.56E-09	9.18E-14	2.42E-09	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000045	1.04E-08	8.21E-08	2.35E-12	9.25E-08	0.0013	0.011	0.000000018	0.012
Total PCBs	0.15	2.43E-09	4.12E-09	1.15E-13	6.55E-09	--	--	--	--
Benzo(a)pyrene	0.080	--	--	--	--	0.000024	0.000044	0.00000064	0.000069
		1.73E-07	**6.15E-07**	**1.10E-10**	**7.88E-07**	**0.0049**	**0.025**	**0.000017**	**0.030**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk > 1E-06

Table E-7: DU-S3 Sample Results and Risk Estimates

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios							
		25-Year Adult Landscaper							
		Cancer Risk				Noncancer Hazard			
		Dermal Contact	Ingestion	Inhalation	Total Cancer Risk	Dermal Contact	Ingestion	Inhalation	Total Hazard Index
Arsenic	15	1.95E-07	2.74E-06	3.89E-10	2.93E-06	0.0012	0.017	0.000017	0.018
Chlordane, Technical	13	5.22E-08	9.18E-07	7.79E-12	9.70E-07	0.00084	0.015	0.00000031	0.016
Chlordane, alpha	2.3	9.24E-09	1.62E-07	1.38E-12	1.72E-07	0.00015	0.0026	0.000000055	0.0027
Chlordane, gamma	1.8	7.23E-09	1.27E-07	1.08E-12	1.34E-07	0.00012	0.0020	0.000000043	0.0021
Chromium (VI)	0.13	--	1.30E-08	6.47E-11	1.30E-08	--	0.000024	0.000000022	0.000024
DDD	0.016	1.09E-10	7.66E-10	6.54E-15	8.75E-10	0.000042	0.00030	--	0.00034
DDE	0.19	5.56E-10	1.30E-08	1.10E-13	1.36E-08	0.000015	0.00036	--	0.00037
DDT	0.36	1.05E-09	2.47E-08	2.09E-13	2.58E-08	0.000017	0.00041	--	0.00042
Dieldrin	1.1	5.05E-07	3.55E-06	3.03E-12	4.06E-06	0.0018	0.012	--	0.014
Total Carcinogenic PAHs (BaP TEQs)	0.11	4.13E-09	2.24E-08	3.99E-13	2.65E-08	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000045	5.02E-08	1.18E-06	1.02E-11	1.23E-06	0.0015	0.036	0.000000019	0.038
Total PCBs	0.15	1.17E-08	5.90E-08	4.99E-13	7.07E-08	--	--	--	--
Benzo(a)pyrene	0.080	--	--	--	--	0.000028	0.00015	0.00000067	0.00018
		8.36E-07	**8.81E-06**	**4.78E-10**	**9.64E-06**	**0.0057**	**0.086**	**0.000018**	**0.092**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk > 1E-06

Table E-8: DU-S4 Sample Results and Risk Estimates

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios - 6-Year Child Recreator - Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	14	2.24E-07	1.88E-06	8.27E-11	2.11E-06	0.0058	0.049	0.000015	0.055
Chromium(VI)	0.26	--	1.05E-07	1.62E-10	1.05E-07	--	0.00015	0.000000042	0.00015
DDE	0.0043	1.56E-11	2.20E-10	5.76E-16	2.35E-10	0.0000018	0.000025	--	0.000027
DDT	0.0036	1.31E-11	1.84E-10	4.83E-16	1.97E-10	0.00000090	0.000013	--	0.000014
Dieldrin	0.011	6.10E-09	2.57E-08	6.79E-15	3.18E-08	0.000089	0.00037	--	0.00046
Total Carcinogenic PAHs (BaP TEQs)	0.095	2.34E-08	7.59E-08	4.18E-13	9.93E-08	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000030	4.21E-08	5.92E-07	1.59E-12	6.34E-07	0.0054	0.076	0.000000012	0.081
Total PCBs	0.044	4.43E-09	1.33E-08	3.49E-14	1.78E-08	--	--	--	--
Benzo(a)pyrene	0.064	--	--	--	--	0.00012	0.00037	0.00000052	0.00049
		3.00E-07	**2.70E-06**	**2.46E-10**	**3.00E-06**	**0.011**	**0.13**	**0.000016**	**0.14**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk > 1E-06

Table E-8: DU-S4 Sample Results and Risk Estimates

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 6-Year Adult Recreator – Cancer Risk: Dermal Contact	Ingestion	Inhalation	Total Cancer Risk	Noncancer Hazard: Dermal Contact	Ingestion	Inhalation	Total Hazard Index
Arsenic	14	3.73E-08	1.77E-07	8.27E-11	2.14E-07	0.0010	0.0046	0.000015	0.0056
Chromium(VI)	0.26	--	1.84E-09	3.03E-11	1.87E-09	--	0.000014	0.000000042	0.000014
DDE	0.0043	2.61E-12	2.06E-11	5.76E-16	2.32E-11	0.00000030	0.0000024	--	0.0000027
DDT	0.0036	2.19E-12	1.73E-11	4.83E-16	1.95E-11	0.00000015	0.0000012	--	0.0000013
Dieldrin	0.011	1.02E-09	2.41E-09	6.79E-15	3.43E-09	0.000015	0.000035	--	0.000050
Total Carcinogenic PAHs (BaP TEQs)	0.095	7.32E-10	1.33E-09	7.85E-14	2.07E-09	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000030	7.02E-09	5.55E-08	1.59E-12	6.25E-08	0.00090	0.00711	0.000000012	0.0080
Total PCBs	0.044	7.38E-10	1.25E-09	3.49E-14	1.99E-09	--	--	--	--
Benzo(a)pyrene	0.064	--	--	--	--	0.000019	0.000035	0.00000052	0.000055
		4.68E-08	**2.39E-07**	**1.15E-10**	**2.86E-07**	**0.0019**	**0.012**	**0.000016**	**0.014**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk > 1E-06

Table E-8: DU-S4 Sample Results and Risk Estimates

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios — 25-Year Adult Landscaper — Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	14	1.80E-07	2.53E-06	3.59E-10	2.71E-06	0.0011	0.016	0.000016	0.017
Chromium(VI)	0.26	--	2.64E-08	1.32E-10	2.65E-08	--	0.000049	0.000000044	0.000049
DDE	0.0043	1.26E-11	2.95E-10	2.50E-15	3.07E-10	0.00000035	0.0000081	--	0.0000084
DDT	0.0036	1.06E-11	2.47E-10	2.10E-15	2.58E-10	0.00000017	0.0000041	--	0.0000042
Dieldrin	0.011	4.90E-09	3.45E-08	2.95E-14	3.94E-08	0.000017	0.00012	--	0.00014
Total Carcinogenic PAHs (BaP TEQs)	0.095	3.53E-09	1.91E-08	3.41E-13	2.26E-08	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000030	3.39E-08	7.94E-07	6.90E-12	8.28E-07	0.0010	0.024	0.000000013	0.025
Total PCBs	0.044	3.56E-09	1.79E-08	1.52E-13	2.15E-08	--	--	--	--
Benzo(a)pyrene	0.064	--	--	--	--	0.000022	0.00012	0.00000054	0.00014
		2.26E-07	**3.42E-06**	**4.98E-10**	**3.65E-06**	**0.0022**	**0.040**	**0.000016**	**0.043**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk > 1E-06

Table E-9: DU-S5 Sample Results and Risk Estimates (Including Sample CKSA-SS40)

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios							
		6-Year Child Recreator							
		Cancer Risk				Noncancer Hazard			
		Dermal Contact	Ingestion	Inhalation	Total Cancer Risk	Dermal Contact	Ingestion	Inhalation	Total Hazard Index
Arsenic	15	2.44E-07	2.05E-06	9.02E-11	2.30E-06	0.0063	0.053	0.000016	0.060
Chlordane, Technical	10	4.99E-08	5.26E-07	1.38E-12	5.76E-07	0.0033	0.035	0.00000023	0.038
Chlordane, alpha	1.1	5.49E-09	5.79E-08	1.52E-13	6.34E-08	0.00037	0.0039	0.000000025	0.0042
Chlordane, gamma	1.9	9.49E-09	9.99E-08	2.62E-13	1.09E-07	0.00063	0.0067	0.000000044	0.0073
Chromium (VI)	0.38	--	1.52E-07	2.34E-10	1.52E-07	--	0.00022	0.000000061	0.00022
DDD	24	2.05E-07	8.66E-07	2.29E-12	1.07E-06	0.33	1.4	--	1.7
DDE	4.6	1.67E-08	2.35E-07	6.16E-13	2.52E-07	0.0019	0.027	--	0.0288
DDT	5.5	2.00E-08	2.81E-07	7.37E-13	3.01E-07	0.0014	0.019	--	0.021
Dieldrin	2.6	1.48E-06	6.25E-06	1.65E-12	7.74E-06	0.022	0.091	--	0.11
Total Carcinogenic PAHs (BaP TEQs)	0.11	2.73E-08	8.86E-08	4.89E-13	1.16E-07	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.00018	2.47E-07	3.47E-06	9.32E-12	3.72E-06	0.032	0.44	0.000000072	0.48
Total PCBs (Aroclor Method)	1.7	1.71E-07	5.15E-07	1.35E-12	6.86E-07	--	--	--	--
Benzo(a)pyrene	0.079	--	--	--	--	0.00014	0.00046	0.00000064	0.00060
		2.48E-06	**1.46E-05**	**3.43E-10**	**1.71E-05**	**0.40**	**2.1**	**0.000017**	**2.5**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentra ions.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk >1E-05

Cancer Risk > 1E-06

Hazard Index >1

Table E-9: DU-S5 Sample Results and Risk Estimates (Including Sample CKSA-SS40)

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 6-Year Adult Recreator – Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	15	4.06E-08	1.92E-07	9.02E-11	2.33E-07	0.0011	0.0050	0.000016	0.0061
Chlordane, Technical	10	8.33E-09	4.93E-08	1.38E-12	5.76E-08	0.00056	0.0033	0.00000023	0.0038
Chlordane, alpha	1.1	9.16E-10	5.42E-09	1.52E-13	6.34E-09	0.000061	0.00036	0.000000025	0.00042
Chlordane, gamma	1.9	1.58E-09	9.37E-09	2.62E-13	1.10E-08	0.00011	0.00062	0.000000044	0.00073
Chromium (VI)	0.38	--	2.67E-09	4.40E-11	2.71E-09	--	0.000021	0.000000061	0.000021
DDD	24	3.43E-08	8.12E-08	2.29E-12	1.15E-07	0.056	0.13	--	0.19
DDE	4.6	2.79E-09	2.20E-08	6.16E-13	2.48E-08	0.00032	0.0025	--	0.0028
DDT	5.5	3.34E-09	2.63E-08	7.37E-13	2.97E-08	0.00023	0.0018	--	0.0020
Dieldrin	2.6	2.47E-07	5.86E-07	1.65E-12	8.34E-07	0.0036	0.0085	--	0.012
Total Carcinogenic PAHs (BaP TEQs)	0.11	8.56E-10	1.56E-09	9.17E-14	2.42E-09	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.00018	4.12E-08	3.25E-07	9.32E-12	3.66E-07	0.0053	0.042	0.000000072	0.047
Total PCBs (Aroclor Method)	1.7	2.85E-08	4.83E-08	1.35E-12	7.68E-08	--	--	--	--
Benzo(a)pyrene	0.079	--	--	--	--	0.000024	0.000043	0.00000064	0.000068
		4.10E-07	**1.35E-06**	**1.52E-10**	**1.76E-06**	**0.067**	**0.20**	**0.000017**	**0.26**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentra ions.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk > 1E-06

Table E-9: DU-S5 Sample Results and Risk Estimates (Including Sample CKSA-SS40)

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 25-Year Adult Landscaper – Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	15	1.96E-07	2.76E-06	3.91E-10	2.95E-06	0.0012	0.017	0.000017	0.018
Chlordane, Technical	10	4.02E-08	7.06E-07	6.00E-12	7.47E-07	0.00064	0.011	0.00000024	0.012
Chlordane, alpha	1.1	4.42E-09	7.77E-08	6.60E-13	8.21E-08	0.000071	0.0012	0.000000026	0.0013
Chlordane, gamma	1.9	7.63E-09	1.34E-07	1.14E-12	1.42E-07	0.00012	0.0021	0.000000046	0.0023
Chromium (VI)	0.38	--	3.82E-08	1.91E-10	3.84E-08	--	0.000071	0.000000064	0.000071
DDD	24	1.65E-07	1.16E-06	9.93E-12	1.33E-06	0.064	0.45	--	0.51633
DDE	4.6	1.35E-08	3.16E-07	2.68E-12	3.29E-07	0.00037	0.0087	--	0.0090
DDT	5.5	1.61E-08	3.77E-07	3.20E-12	3.93E-07	0.00027	0.0062	--	0.0065
Dieldrin	2.6	1.19E-06	8.40E-06	7.17E-12	9.59E-06	0.0042	0.029	--	0.034
Total Carcinogenic PAHs (BaP TEQs)	0.11	4.13E-09	2.23E-08	3.98E-13	2.65E-08	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.00018	1.99E-07	4.66E-06	4.04E-11	4.86E-06	0.0061	0.14	0.000000074	0.15
Total PCBs (Aroclor Method)	1.7	1.38E-07	6.91E-07	5.85E-12	8.29E-07	--	--	--	--
Benzo(a)pyrene	0.079	--	--	--	--	0.000027	0.00015	0.00000066	0.00018
		1.98E-06	**1.93E-05**	**6.60E-10**	**2.13E-05**	**0.077**	**0.67**	**0.000018**	**0.75**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentra ions.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk >1E-05

Cancer Risk > 1E-06

Table E-10: DU-S5 Sample Results and Risk Estimates (Excluding Sample CKSA-SS40)

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 6-Year Child Recreator – Cancer Risk: Dermal Contact	Ingestion	Inhalation	Total Cancer Risk	Noncancer Hazard: Dermal Contact	Ingestion	Inhalation	Total Hazard Index
Arsenic	16	2.60E-07	2.19E-06	9.60E-11	2.45E-06	0.0067	0.057	0.000017	0.063
Chlordane, Technical	10.0	4.99E-08	5.26E-07	1.38E-12	5.76E-07	0.0033	0.035	0.00000023	0.038
Chlordane, alpha	1.1	5.49E-09	5.79E-08	1.52E-13	6.34E-08	0.00037	0.0039	0.000000025	0.0042
Chlordane, gamma	1.9	9.49E-09	9.99E-08	2.62E-13	1.09E-07	0.00063	0.0067	0.000000044	0.0073
Chromium (VI)	0.42	--	1.68E-07	2.60E-10	1.69E-07	--	0.00025	0.000000068	0.00025
DDE	0.33	1.20E-09	1.69E-08	4.42E-14	1.81E-08	0.00014	0.0019	--	0.0021
DDT	0.24	8.73E-10	1.23E-08	3.22E-14	1.31E-08	0.000060	0.00084	--	0.00090
Dieldrin	0.10	5.71E-08	2.40E-07	6.35E-14	2.98E-07	0.00083	0.0035	--	0.0043
Total Carcinogenic PAHs (BaP TEQs)	0.12	3.04E-08	9.86E-08	5.44E-13	1.29E-07	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.00012	1.63E-07	2.30E-06	6.17E-12	2.46E-06	0.021	0.29	0.000000047	0.32
Benzo(a)pyrene	0.087	--	--	--	--	0.00016	0.00051	0.00000070	0.00067
Notes:		**5.77E-07**	**5.70E-06**	**3.65E-10**	**6.28E-06**	**0.033**	**0.40**	**0.000018**	**0.44**

--: No risk associated with the exposure pathway

Sample CKSA-SS40 is excluded from the risk calculations (see Section 5 of the HHRA).

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk > 1E-06

Table E-10: DU-S5 Sample Results and Risk Estimates (Excluding Sample CKSA-SS40)

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 6-Year Adult Recreator – Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	16	4.33E-08	2.05E-07	9.60E-11	2.48E-07	0.0011	0.0053	0.000017	0.0065
Chlordane, Technical	10.0	8.33E-09	4.93E-08	1.38E-12	5.76E-08	0.00056	0.0033	0.00000023	0.0038
Chlordane, alpha	1.1	9.16E-10	5.42E-09	1.52E-13	6.34E-09	0.000061	0.00036	0.000000025	0.00042
Chlordane, gamma	1.9	1.58E-09	9.37E-09	2.62E-13	1.10E-08	0.00011	0.00062	0.000000044	0.00073
Chromium (VI)	0.42	--	2.96E-09	4.88E-11	3.01E-09	--	0.000023	0.000000068	0.000023
DDE	0.33	2.00E-10	1.58E-09	4.42E-14	1.78E-09	0.000023	0.00018	--	0.00020
DDT	0.24	1.46E-10	1.15E-09	3.22E-14	1.30E-09	0.000010	0.000079	--	0.000089
Dieldrin	0.10	9.52E-09	2.25E-08	6.35E-14	3.21E-08	0.00014	0.00033	--	0.00047
Total Carcinogenic PAHs (BaP TEQs)	0.12	9.52E-10	1.73E-09	1.02E-13	2.69E-09	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.00012	2.73E-08	2.15E-07	6.17E-12	2.42E-07	0.0035	0.028	0.000000047	0.031
Benzo(a)pyrene	0.087	--	--	--	--	0.000026	0.000048	0.00000070	0.000075
		9.22E-08	**5.14E-07**	**1.53E-10**	**6.07E-07**	**0.0055**	**0.038**	**0.000018**	**0.043**

Notes:

--: No risk associated with the exposure pathway

Sample CKSA-SS40 is excluded from the risk calculations (see Section 5 of the HHRA).

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk > 1E-06

Table E-10: DU-S5 Sample Results and Risk Estimates (Excluding Sample CKSA-SS40)

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 25-Year Adult Landscaper – Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	16	2.09E-07	2.94E-06	4.17E-10	3.15E-06	0.0013	0.018	0.000018	0.020
Chlordane, Technical	10.0	4.02E-08	7.06E-07	6.00E-12	7.47E-07	0.0006	0.011	0.00000024	0.012
Chlordane, alpha	1.1	4.42E-09	7.77E-08	6.60E-13	8.21E-08	0.00007	0.0012	0.000000026	0.0013
Chlordane, gamma	1.9	7.63E-09	1.34E-07	1.14E-12	1.42E-07	0.00012	0.0021	0.000000046	0.0023
Chromium (VI)	0.42	--	4.24E-08	2.12E-10	4.26E-08	--	0.00008	0.000000071	0.00008
DDE	0.33	9.66E-10	2.26E-08	1.92E-13	2.36E-08	0.00003	0.0006	--	0.0006
DDT	0.24	7.02E-10	1.65E-08	1.40E-13	1.72E-08	0.000012	0.00027	--	0.00028
Dieldrin	0.10	4.59E-08	3.23E-07	2.76E-13	3.69E-07	0.00016	0.0011	--	0.0013
Total Carcinogenic PAHs (BaP TEQs)	0.12	4.59E-09	2.48E-08	4.43E-13	2.94E-08	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.00012	1.31E-07	3.08E-06	2.68E-11	3.21E-06	0.004	0.09	0.000000049	0.10
Benzo(a)pyrene	0.087	--	--	--	--	0.00003	0.00016	0.00000073	0.00020
		4.45E-07	**7.37E-06**	**6.64E-10**	**7.81E-06**	**0.0064**	**0.13**	**0.000019**	**0.14**

Notes:

--: No risk associated with the exposure pathway

Sample CKSA-SS40 is excluded from the risk calculations (see Section 5 of the HHRA).

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Color scale:

Cancer Risk > 1E-06

Table E-11: Sample CKSA-SS40 (Located in DU-S5) Results and Risk Estimates

COPC	Concentration (mg/kg)	Surface Soil Exposure Scenarios — 6-Year Child Recreator — Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	6.0	9.63E-08	8.12E-07	3.56E-11	9.08E-07	0.0025	0.021	0.0000064	0.024
DDD	24	2.05E-07	8.66E-07	2.29E-12	1.07E-06	0.33	1.4	--	1.7
DDE	4.6	1.67E-08	2.35E-07	6.16E-13	2.52E-07	0.0019	0.027	--	0.029
DDT	5.5	2.00E-08	2.81E-07	7.37E-13	3.01E-07	0.0014	0.019	--	0.021
Dieldrin	2.6	1.48E-06	6.25E-06	1.65E-12	7.74E-06	0.022	0.091	--	0.11
Total Carcinogenic PAHs (BaP TEQs)	0.052	1.28E-08	4.16E-08	2.29E-13	5.44E-08	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.00018	2.54E-07	3.56E-06	9.57E-12	3.82E-06	0.033	0.46	0.000000073	0.49
Total PCBs (Aroclor Method)	9.5	9.51E-07	2.86E-06	7.50E-12	3.81E-06	--	--	--	--
Benzo(a)pyrene	0.038	--	--	--	--	0.000069	0.00022	0.00000031	0.00029
		3.04E-06	**1.49E-05**	**5.82E-11**	**1.80E-05**	**0.39**	**2.0**	**0.0000068**	**2.4**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected) are not shown.

Color scale:

Cancer Risk >1E-05

Cancer Risk > 1E-06

Hazard Index >1

Table E-11: Sample CKSA-SS40 (Located in DU-S5) Results and Risk Estimates

COPC	Concentration (mg/kg)	Surface Soil Exposure Scenarios							
		6-Year Adult Recreator							
		Cancer Risk				Noncancer Hazard			
		Dermal Contact	Ingestion	Inhalation	Total Cancer Risk	Dermal Contact	Ingestion	Inhalation	Total Hazard Index
Arsenic	6.0	1.61E-08	7.61E-08	3.56E-11	9.22E-08	0.00042	0.0020	0.0000064	0.0024
DDD	24	3.43E-08	8.12E-08	2.29E-12	1.15E-07	0.056	0.13	--	0.19
DDE	4.6	2.79E-09	2.20E-08	6.16E-13	2.48E-08	0.00032	0.0025	--	0.0028
DDT	5.5	3.34E-09	2.63E-08	7.37E-13	2.97E-08	0.00023	0.0018	--	0.0020
Dieldrin	2.6	2.47E-07	5.86E-07	1.65E-12	8.34E-07	0.0036	0.0085	--	0.012
Total Carcinogenic PAHs (BaP TEQs)	0.052	4.02E-10	7.31E-10	4.30E-14	1.13E-09	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.00018	4.23E-08	3.34E-07	9.57E-12	3.76E-07	0.0054	0.043	0.000000073	0.0482
Total PCBs (Aroclor Method)	9.5	1.59E-07	2.68E-07	7.50E-12	4.27E-07	--	--	--	--
Benzo(a)pyrene	0.038	--	--	--	--	0.000011	0.000021	0.00000031	0.000033
		5.05E-07	**1.39E-06**	**5.80E-11**	**1.90E-06**	**0.066**	**0.19**	**0.0000068**	**0.25**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected) are not shown.

Color scale:

Cancer Risk >1E-05

Cancer Risk > 1E-06

Hazard Index >1

Table E-11: Sample CKSA-SS40 (Located in DU-S5) Results and Risk Estimates

COPC	Concentration (mg/kg)	Surface Soil Exposure Scenarios – 25-Year Adult Landscaper – Cancer Risk				Noncancer Hazard			
		Dermal Contact	Ingestion	Inhalation	Total Cancer Risk	Dermal Contact	Ingestion	Inhalation	Total Hazard Index
Arsenic	6.0	7.75E-08	1.09E-06	1.55E-10	1.17E-06	0.00048	0.0068	0.0000067	0.0073
DDD	24	1.65E-07	1.16E-06	9.93E-12	1.33E-06	0.064	0.45	--	0.52
DDE	4.6	1.35E-08	3.16E-07	2.68E-12	3.29E-07	0.00037	0.0087	--	0.0090
DDT	5.5	1.61E-08	3.77E-07	3.20E-12	3.93E-07	0.00027	0.0062	--	0.0065
Dieldrin	2.6	1.19E-06	8.40E-06	7.17E-12	9.59E-06	0.0042	0.029	--	0.034
Total Carcinogenic PAHs (BaP TEQs)	0.052	1.94E-09	1.05E-08	1.87E-13	1.24E-08	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.00018	2.04E-07	4.78E-06	4.15E-11	4.99E-06	0.0063	0.15	0.000000077	0.15
Total PCBs (Aroclor Method)	9.5	7.65E-07	3.84E-06	3.25E-11	4.61E-06	--	--	--	--
Benzo(a)pyrene	0.038	--	--	--	--	0.000013	0.000072	0.00000032	0.000085
		2.44E-06	**2.00E-05**	**2.52E-10**	**2.24E-05**	**0.076**	**0.65**	**0.0000071**	**0.73**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected) are not shown.

Color scale:

Cancer Risk >1E-05

Cancer Risk > 1E-06

Hazard Index >1

Table E-12: DU-N1 COPC Risk Drivers

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios — 6-Year Child Recreator — Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	19	9.2%	78%	0.0%	87%	6.7%	56%	0.0%	63%
Chromium (VI)	0.15	--	1.8%	0.0%	1.8%	--	0.074%	0.0%	0.074%
DDE	0.0041	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	--	0.0%
DDT	0.036	0.0%	0.057%	0.0%	0.061%	0.0%	0.11%	--	0.12%
Total Carcinogenic PAHs (BaP TEQs)	0.030	0.23%	0.75%	0.0%	1.0%	--	--	--	0.0%
Total Dioxin/Furans (2,3,7,8-TCDD TEQs)	0.000016	0.68%	9.6%	0.0%	10%	2.4%	34%	0.0%	37%
Benzo(a)pyrene	0.022	--	--	--	--	0.0%	0.11%	0.0%	0.14%
		10%	**90%**	**0.0063%**	**100%**	**9.2%**	**90.8%**	**0.021%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Table E-12: DU-N1 COPC Risk Drivers

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 6-Year Adult Recreator – Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	19	16%	73%	0.034%	89%	11%	52%	0.17%	64%
Chromium (VI)	0.15	--	0.32%	0.0%	0.33%	--	0.069%	0.0%	0.069%
DDE	0.0041	0.00%	0.0%	0.0%	0.0%	0.0%	0.019%	--	0.021%
DDT	0.036	0.0%	0.054%	0.0%	0.061%	0.0%	0.10%	--	0.11%
Total Carcinogenic PAHs (BaP TEQs)	0.030	0.073%	0.13%	0.0%	0.21%	--	--	--	--
Total Dioxin/Furans (2,3,7,8-TCDD TEQs)	0.000016	1.1%	9.0%	0.18%	10%	4.0%	32%	0.0%	36%
Benzo(a)pyrene	0.022	--	--	--	--	0.055%	0.10%	0.0%	0.16%
		17%	**83%**	**0.22%**	**100%**	**15%**	**85%**	**0.21%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Table E-12: DU-N1 COPC Risk Drivers

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios							
		25-Year Adult Landscaper							
		Cancer Risk				Noncancer Hazard			
		Dermal Contact	Ingestion	Inhalation	Total Cancer Risk	Dermal Contact	Ingestion	Inhalation	Total Hazard Index
Arsenic	19	5.9%	83%	0.0%	89%	4.2%	58%	0.058%	63%
Chromium (VI)	0.15	--	0.36%	0.0%	0.37%	--	0.077%	0.0%	0.077%
DDE	0.0041	0.0%	0.0%	0.0%	0.0%	0.0%	0.021%	--	0.022%
DDT	0.036	0.0%	0.061%	0.0%	0.063%	0.0%	0.11%	--	0.12%
Total Carcinogenic PAHs (BaP TEQs)	0.030	0.0%	0.15%	0.0%	0.18%	--	--	--	--
Total Dioxin/Furans (2,3,7,8-TCDD TEQs)	0.000016	0.43%	10%	0.061%	11%	1.5%	36%	0.0%	37%
Benzo(a)pyrene	0.022	--	--	--	--	0.0%	0.11%	0.0%	0.13%
		6.4%	**94%**	**0.075%**	**100%**	**5.7%**	**94.2%**	**0.071%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Table E-13: DU-N2 COPC Risk Drivers

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios 6-Year Child Recreator: Cancer Risk – Dermal Contact	Cancer Risk – Ingestion	Cancer Risk – Inhalation	Cancer Risk – Total Cancer Risk	Noncancer Hazard – Dermal Contact	Noncancer Hazard – Ingestion	Noncancer Hazard – Inhalation	Noncancer Hazard – Total Hazard Index
Arsenic	16	7.3%	61%	0.0%	68%	3.8%	32%	0.0%	35%
Chlordane, gamma	0.0012	0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Chromium (VI)	0.44	--	4.9%	0.0%	4.9%	--	0.14%	0.0%	0.14%
Dieldrin	0.0030	0.0%	0.20%	0.0%	0.25%	0.0%	0.059%	--	0.073%
DDE	0.0035	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	--	0.0%
DDT	0.24	0.0%	0.35%	0.0%	0.37%	0.0%	0.47%	--	0.51%
Total Carcinogenic PAHs (BaP TEQs)	0.036	0.25%	0.82%	0.0%	1.1%	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000042	1.7%	23%	0.0%	25%	4.2%	60%	0.0%	64%
Benzo(a)pyrene	0.027	--	--	--	--	0.0%	0.089%	0.0%	0.12%
		9.2%	**91%**	**0.010%**	**100%**	**8.1%**	**92%**	**0.010%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Table E-13: DU-N2 COPC Risk Drivers

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 6-Year Adult Recreator – Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	16	13%	60%	0.0%	73%	6.3%	30%	0.10%	36%
Chlordane, gamma	0.0012	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Chromium (VI)	0.44	--	0.90%	0.0%	0.92%	--	0.13%	0.0%	--
Dieldrin	0.0030	0.084%	0.20%	0.0%	0.28%	0.0%	0.056%	--	--
DDE	0.0035	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	--	0.012%
DDT	0.24	0.0%	0.34%	0.0%	0.38%	0.056%	0.44%	--	0.50%
Total Carcinogenic PAHs (BaP TEQs)	0.036	0.082%	0.15%	0.0%	0.23%	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000042	2.9%	23%	0.0%	26%	7.1%	56%	0.0%	63%
Benzo(a)pyrene	0.027	--	--	--	--	0.0%	0.083%	0.0%	0.13%
		16%	**84%**	**0.044%**	**100%**	**13.5%**	**86%**	**0.10%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Table E-13: DU-N2 COPC Risk Drivers

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 25-Year Adult Landscaper – Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	16	4.8%	67%	0.0%	72%	2.3%	33%	0.0%	35%
Chlordane, gamma	0.0012	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Chromium (VI)	0.44	--	1.0%	0.0%	1.0%	--	0.15%	0.0%	0.15%
Dieldrin	0.0030	0.0%	0.22%	0.0%	0.25%	0.0%	0.061%	--	0.070%
DDE	0.0035	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	--	0.0%
DDT	0.24	0.0%	0.38%	0.0%	0.39%	0.0%	0.49%	--	0.51%
Total Carcinogenic PAHs (BaP TEQs)	0.036	0.0%	0.17%	0.0%	0.20%	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000042	1.1%	25%	0.0%	27%	2.6%	61%	0%	64%
Benzo(a)pyrene	0.027	--	--	--	--	0.0%	0.092%	0.0%	0.11%
		5.9%	**94%**	**0.015%**	**100%**	**5.0%**	**95%**	**0.033%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Table E-14: DU-N3 COPC Risk Drivers

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios							
		6-Year Child Recreator							
		Cancer Risk				Noncancer Hazard			
		Dermal Contact	Ingestion	Inhalation	Total Cancer Risk	Dermal Contact	Ingestion	Inhalation	Total Hazard Index
Arsenic	27	9.3%	79%	0.0%	88%	7.2%	61%	0.0%	68%
Chromium (VI)	0.17	--	1.5%	0.0%	1.5%	--	0.066%	0.0%	0.066%
Dieldrin	0.00086	0.0%	0.0%	0.0%	0.056%	0.0%	0.0%	--	0.024%
DDD	0.0034	0.0%	0.0%	0.0%	0.0%	0.0%	0.13%	--	0.16%
DDE	0.013	0.0%	0.0%	0.0%	0.015%	0.0%	0.0%	--	0.051%
DDT	0.17	0.0%	0.19%	0.0%	0.20%	0.0%	0.39%	--	0.41%
Total Carcinogenic PAHs (BaP TEQs)	0.084	0.45%	1.5%	0.0%	1.9%	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000018	0.5%	7.5%	0.0%	8.1%	2.0%	29%	0.0%	31%
Total PCBs (Aroclor Method)	0.032	0.070%	0.21%	0.0%	0.28%	--	--	--	--
Benzo(a)pyrene	0.076	--	--	--	--	0.089%	0.29%	0.0%	0.38%
		10%	**90%**	**0.0058%**	**100%**	**9.4%**	**91%**	**0.019%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Table E-14: DU-N3 COPC Risk Drivers

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 6-Year Adult Recreator – Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	27	16%	75%	0.0%	91%	12%	57%	0.18%	69%
Chromium (VI)	0.17	--	0.27%	0.0%	0.27%	--	0.061%	0.0%	0.061%
Dieldrin	0.00086	0.0%	0.043%	0.0%	0.061%	0.0%	0.0%	--	0.026%
DDD	0.0034	0.0%	0.0%	0.0%	0.0%	0.050%	0.12%	--	0.17%
DDE	0.013	0.0%	0.013%	0.0%	0.0%	0.0%	0.0%	--	0.050%
DDT	0.17	0.0%	0.18%	0.0%	0.20%	0.0%	0.36%	--	0.40%
Total Carcinogenic PAHs (BaP TEQs)	0.084	0.14%	0.26%	0.0%	0.40%	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000018	0.91%	7.2%	0.0%	8.1%	3.4%	27%	0.0%	30%
Total PCBs (Aroclor Method)	0.032	0.12%	0.20%	0.0%	0.32%	--	--	--	--
Benzo(a)pyrene	0.076	--	--	--	--	0.15%	0.27%	0.0%	0.42%
		17%	**83%**	**0.040%**	**100%**	**16%**	**84%**	**0.19%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Table E-14: DU-N3 COPC Risk Drivers

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios — 25-Year Adult Landscaper — Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	27	6.0%	84%	0.0%	90%	4.5%	63%	0.063%	68%
Chromium (VI)	0.17	--	0.30%	0.0%	0.30%	--	0.068%	0.0%	0.07%
Dieldrin	0.00086	0.0%	0.0%	0.0%	0.055%	0.0%	0.020%	--	0.0%
DDD	0.0034	0.0%	0.0%	0.0%	0.0%	0.0%	0.13%	--	0.15%
DDE	0.013	0.0%	0.0%	0.0%	0.016%	0.0%	0.049%	--	0.05%
DDT	0.17	0.0%	0.20%	0.0%	0.21%	0.0%	0.40%	--	0.42%
Total Carcinogenic PAHs (BaP TEQs)	0.084	0.054%	0.29%	0.0%	0.35%	--	--	--	0.0%
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000018	0.34%	8.1%	0.0%	8.4%	1.3%	30%	0.0%	31%
Total PCBs (Aroclor Method)	0.032	0.0%	0.23%	0.0%	0.27%	--	--	--	--
Benzo(a)pyrene	0.076	--	--	--	--	0.055%	0.30%	0.0%	0%
		6.5%	**94%**	**0.014%**	**100%**	**5.9%**	**94%**	**0.064%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Table E-15: DU-N4 COPC Risk Drivers

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 6-Year Child Recreator – Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	24	3.0%	26%	0.0%	29%	3.3%	28%	0.0%	31%
Chlordane, Technical	17	0.66%	6.9%	0.0%	7.6%	1.8%	19%	0.0%	21%
Chlordane, alpha	2.3	0.089%	0.94%	0.0%	1.0%	0.25%	3%	0.0%	2.9%
Chlordane, gamma	2.3	0.089%	0.9%	0.0%	1.0%	0.25%	3%	0.0%	2.9%
DDE	0.13	0.0%	0.052%	0.0%	0.055%	0.018%	0.25%	--	0.26%
DDT	0.42	0.0%	0.17%	0.0%	0.18%	0.034%	0.48%	--	0.51%
Dieldrin	2.0	8.9%	37%	0.0%	46%	5.4%	23%	--	28%
Total Carcinogenic PAHs (BaP TEQs)	1.4	2.6%	8.5%	0.0%	11%	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000012	0.13%	1.9%	0.0%	2.0%	0.71%	10%	0.0%	11%
Total PCBs (Aroclor Method)	0.70	0.54%	1.6%	0.0%	2.2%	--	--	--	--
Benzo(a)pyrene	0.97	--	--	--	--	0.57%	1.8%	0.0%	2.4%
		16%	**84%**	**0.0012%**	**100%**	**12%**	**88%**	**0.011%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Table E-15: DU-N4 COPC Risk Drivers

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios — 6-Year Adult Recreator — Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	24	5.3%	25%	0.0%	30%	5.3%	25%	0.082%	31%
Chlordane, Technical	17	1.2%	6.8%	0.0%	8.0%	3.0%	18%	0.0%	21%
Chlordane, alpha	2.3	0.16%	0.92%	0.0%	1.1%	0.40%	2.4%	0.0%	2.8%
Chlordane, gamma	2.3	0.16%	0.92%	0.0%	1.1%	0.40%	2%	0.0%	2.8%
DDE	0.13	0.0%	0.051%	0.0%	0.057%	0.0%	0.22%	--	0.25%
DDT	0.42	0.0%	0.16%	0.0%	0.18%	0.055%	0.44%	--	0.49%
Dieldrin	2.0	15%	37%	0.0%	52%	8.8%	21%	--	30%
Total Carcinogenic PAHs (BaP TEQs)	1.4	0.86%	1.6%	0.0%	2.4%	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000012	0.23%	1.8%	0.0%	2.1%	1.2%	9.1%	0.0%	10%
Total PCBs (Aroclor Method)	0.70	1.0%	1.6%	0.0%	2.6%	--	--	--	--
Benzo(a)pyrene	0.97	--	--	--	--	0.92%	1.7%	0.0%	2.6%
		24%	**76%**	**0.012%**	**100%**	**20%**	**80%**	**0.11%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Table E-15: DU-N4 COPC Risk Drivers

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios — 25-Year Adult Landscaper — Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	24	2.1%	30%	0.0%	32%	2.1%	29%	0.0%	31%
Chlordane, Technical	17	0.46%	8.1%	0.0%	8.6%	1.2%	20%	0.0%	22%
Chlordane, alpha	2.3	0.063%	1.1%	0.0%	1.2%	0.16%	2.8%	0.0%	2.9%
Chlordane, gamma	2.3	0.063%	1.1%	0.0%	1.2%	0.16%	2.8%	0.0%	2.9%
DDE	0.13	0.0%	0.060%	0.0%	0.063%	0.0%	0.26%	--	0%
DDT	0.42	0.0%	0.20%	0.0%	0.20%	0.0%	0.50%	--	0.5%
Dieldrin	2.0	6.2%	44%	0.0%	50%	3.4%	24%	--	27%
Total Carcinogenic PAHs (BaP TEQs)	1.4	0.35%	1.9%	0.0%	2.2%	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000012	0.093%	2.2%	0.0%	2.3%	0.45%	11%	0.0%	11%
Total PCBs (Aroclor Method)	0.70	0.38%	1.9%	0.0%	2.3%	--	--	--	--
Benzo(a)pyrene	0.97	--	--	--	--	0.36%	1.9%	0.0%	2.3%
		9.8%	**90%**	**0.0044%**	**100%**	**7.8%**	**92%**	**0.038%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

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Table E-16: DU-S1 COPC Risk Drivers

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 6-Year Child Recreator – Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Total Hazard Index
Arsenic	20	0.58%	4.9%	0.0%	5.5%	0.12%	1.0%	0.0%	1.2%
Chlordane, alpha	0.057	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Chlordane, gamma	0.15	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Chromium (VI)	0.14	--	0.10%	0.0%	0.10%	--	0.0%	0.0%	0.0%
DDE	0.017	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	--	0.0%
DDT	0.028	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	--	0.0%
Dieldrin	0.0066	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	--	0.0%
Total Carcinogenic PAHs (BaP TEQs)	0.48	0.22%	0.70%	0.0%	0.91%	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.0025	6.2%	87%	0.0%	93%	6.6%	92%	0.0%	99%
Total PCBs (Aroclor Method)	0.042	0.0%	0.0%	0.0%	0.0%	--	--	--	--
Benzo(a)pyrene	0.39	--	--	--	--	0.0%	0.0%	0.0%	0%
		7.0%	**93%**	**0.00061%**	**100%**	**6.7%**	**93%**	**0.00038%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Table E-16: DU-S1 COPC Risk Drivers

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios - 6-Year Adult Recreator - Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	20	1.0%	4.7%	0.0%	5.7%	0.21%	1.0%	0.0%	1.2%
Chlordane, alpha	0.057	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Chlordane, gamma	0.15	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Chromium (VI)	0.14	--	0.0%	0.0%	0.0%	--	0.0%	0.0%	0.0%
DDE	0.017	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	--	0.0%
DDT	0.028	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	--	0.0%
Dieldrin	0.0066	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	--	0.0%
Total Carcinogenic PAHs (BaP TEQs)	0.48	0.069%	0.13%	0.0%	0.19%	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.0025	11%	83%	0.0%	94%	11%	88%	0.0%	99%
Total PCBs (Aroclor Method)	0.042	0.0%	0.0%	0.0%	0.0%	--	--	--	--
Benzo(a)pyrene	0.39	--	--	--	--	0.0%	0.0%	0.0%	0.051%
		12%	**88%**	**0.0049%**	**100%**	**11%**	**89%**	**0.0039%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Table E-16: DU-S1 COPC Risk Drivers

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 25-Year Adult Landscaper – Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	20	0.36%	5.0%	0.0%	5.4%	0.076%	1.1%	0.0%	1.1%
Chlordane, alpha	0.057	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Chlordane, gamma	0.15	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Chromium (VI)	0.14	--	0.0%	0.0%	0.0%	--	0.0%	0.0%	0.0%
DDE	0.017	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	--	0.0%
DDT	0.028	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	--	0.0%
Dieldrin	0.0066	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	--	0.0%
Total Carcinogenic PAHs (BaP TEQs)	0.48	0.0%	0.14%	0.0%	0.16%	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.0025	3.8%	90%	0.54%	94%	4.0%	95%	0.0%	99%
Total PCBs (Aroclor Method)	0.042	0.0%	0.0%	0.0%	0.0%	--	--	--	--
Benzo(a)pyrene	0.39	--	--	--	--	0.0%	0.0%	0.0%	0.0%
		4.2%	**95%**	**0.5%**	**100%**	**4.1%**	**96%**	**0.0013%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Table E-17: DU-S2 COPC Risk Drivers

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios — 6-Year Child Recreator — Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	17	0.45%	3.8%	0.0%	4.2%	0.29%	2.4%	0.0%	2.7%
Chlordane, Technical	9.1	0.073%	0.77%	0.0%	0.84%	0.12%	1.3%	0.0%	1.4%
Chlordane, alpha	1.3	0.0%	0.11%	0.0%	0.12%	0.0%	0.18%	0.0%	0.20%
Chlordane, gamma	1.2	0.0%	0.10%	0.0%	0.11%	0.0%	0.17%	0.0%	0.18%
Chromium (VI)	0.55	--	0.35%	0.0%	0.35%	--	0.0%	0.0%	0.0%
DDE	1.2	0.0%	0.10%	0.0%	0.11%	0.0%	0.28%	--	0.30%
DDT	0.20	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	--	0.0%
Dieldrin	15	14%	58%	0.0%	71%	4.9%	21%	--	26%
Total Carcinogenic PAHs (BaP TEQs)	0.37	0.15%	0.47%	0.0%	0.62%	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.00066	1.5%	21%	0.0%	22%	4.6%	65%	0.0%	70%
Total PCBs (Aroclor Method)	0.23	0.0%	0.11%	0.0%	0.15%	--	--	--	--
Benzo(a)pyrene	0.26	--	--	--	--	0.018%	0.060%	0.00%	0.078%
		16%	**84%**	**0.00079%**	**100%**	**10%**	**90%**	**0.00084%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Table E-17: DU-S2 COPC Risk Drivers

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 6-Year Adult Recreator – Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	17	0.71%	3.4%	0.0%	4.1%	0.47%	2.2%	0.0%	2.7%
Chlordane, Technical	9.1	0.12%	0.69%	0.0%	0.80%	0.20%	1.2%	0.0%	1.4%
Chlordane, alpha	1.3	0.0%	0.10%	0.0%	0.11%	0.0%	0.17%	0.0%	0.19%
Chlordane, gamma	1.2	0.0%	0.091%	0.0%	0.11%	0.0%	0.15%	0.0%	0.18%
Chromium (VI)	0.55	--	0.059%	0.0%	0.060%	--	0.0%	0.0%	0.0%
DDE	1.2	0.0%	0.09%	0.0%	0.10%	0.0%	0.26%	--	0.29%
DDT	0.20	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	--	0.0%
Dieldrin	15	22%	52%	0.0%	74%	8.1%	19%	--	27%
Total Carcinogenic PAHs (BaP TEQs)	0.37	0.0%	0.079%	0.0%	0.12%	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.00066	2.3%	18%	0.0%	21%	7.6%	60%	0.0%	68%
Total PCBs (Aroclor Method)	0.23	0.059%	0.10%	0.0%	0.16%	--	--	--	--
Benzo(a)pyrene	0.26	--	--	--	--	0.0%	0.055%	0.0%	0.087%
		25%	**75%**	**0.0033%**	**100%**	**17%**	**83%**	**0.0083%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Table E-17: DU-S2 COPC Risk Drivers

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios — 25-Year Adult Landscaper — Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	17	0.29%	4.1%	0.0%	4.4%	0.18%	2.5%	0.0%	2.7%
Chlordane, Technical	9.1	0.0%	0.82%	0.0%	0.87%	0.074%	1.3%	0.0%	1.4%
Chlordane, alpha	1.3	0.0%	0.12%	0.0%	0.12%	0.0%	0.19%	0.0%	0.20%
Chlordane, gamma	1.2	0.0%	0.11%	0.0%	0.11%	0.0%	0.17%	0.0%	0.18%
Chromium (VI)	0.55	--	0.071%	0.0%	0.072%	--	0.0%	0.0%	0.0%
DDE	1.2	0.0%	0.11%	0.0%	0.11%	0.0%	0.29%	--	0.30%
DDT	0.20	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	--	0.0%
Dieldrin	15	8.8%	62%	0.0%	71%	3.1%	22%	--	25%
Total Carcinogenic PAHs (BaP TEQs)	0.37	0.0%	0.10%	0.0%	0.11%	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.00066	0.95%	22%	0.0%	23%	2.9%	68%	0.0%	71%
Total PCBs (Aroclor Method)	0.23	0.0%	0.12%	0.0%	0.14%	--	--	--	--
Benzo(a)pyrene	0.26	--	--	--	--	0.0%	0.062%	0.0%	0.074%
		10%	**90%**	**0.0012%**	**100%**	**6.2%**	**94%**	**0.0028%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Table E-18: DU-S3 COPC Risk Drivers

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 6-Year Child Recreator – Cancer Risk: Dermal Contact	Ingestion	Inhalation	Total Cancer Risk	Noncancer Hazard: Dermal Contact	Ingestion	Inhalation	Total Hazard Index
Arsenic	15	3.1%	26%	0.0%	29%	2.1%	18%	0.0%	20%
Chlordane, Technical	13	0.84%	8.8%	0.0%	9.7%	1.5%	15%	0.0%	17%
Chlordane, alpha	2.3	0.15%	1.6%	0.0%	1.7%	0.26%	2.7%	0.0%	3.0%
Chlordane, gamma	1.8	0.12%	1.2%	0.0%	1.3%	0.20%	2.1%	0.0%	2.3%
Chromium (VI)	0.13	--	0.67%	0.0%	0.67%	--	0.0%	0.0%	0.0%
DDD	0.016	0.0%	0.0%	0.0%	0.0%	0.074%	0.31%	--	0.38%
DDE	0.19	0.0%	0.13%	0.0%	0.13%	0.0%	0.37%	--	0.40%
DDT	0.36	0.0%	0.24%	0.0%	0.25%	0.0%	0.42%	--	0.46%
Dieldrin	1.1	8.1%	34%	0.0%	42%	3.1%	13%	--	16%
Total Carcinogenic PAHs (BaP TEQs)	0.11	0.35%	1.1%	0.0%	1.5%	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000045	0.81%	11%	0.0%	12%	2.7%	38%	0.0%	40%
Total PCBs	0.15	0.19%	0.57%	0.0%	0.76%	--	--	--	--
Benzo(a)pyrene	0.080	--	--	--	--	0.0%	0.16%	0.0%	0.21%
		14%	**86%**	**0.0023%**	**100%**	**10%**	**90%**	**0.0058%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Table E-18: DU-S3 COPC Risk Drivers

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios — 6-Year Adult Recreator — Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	15	5.1%	24%	0.0%	29%	3.5%	16%	0.054%	20%
Chlordane, Technical	13	1.4%	8.1%	0.0%	9.5%	2.4%	14%	0.0%	17%
Chlordane, alpha	2.3	0.24%	1.4%	0.0%	1.7%	0.43%	2.5%	0.0%	2.9%
Chlordane, gamma	1.8	0.19%	1.1%	0.0%	1.3%	0.33%	2.0%	0.0%	2.3%
Chromium (VI)	0.13	--	0.11%	0.0%	0.12%	--	0.0%	0.0%	0.0%
DDD	0.016	0.0%	0.0%	0.0%	0.0%	0.12%	0.29%	--	0.41%
DDE	0.19	0.0%	0.12%	0.0%	0.13%	0.0%	0.35%	--	0.39%
DDT	0.36	0.0%	0.22%	0.0%	0.25%	0.0%	0.39%	--	0.44%
Dieldrin	1.1	13%	31%	0.0%	45%	5.1%	12%	--	17%
Total Carcinogenic PAHs (BaP TEQs)	0.11	0.11%	0.20%	0.0%	0.31%	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000045	1.3%	10%	0.0%	12%	4.4%	35%	0.0%	39%
Total PCBs	0.15	0.31%	0.52%	0.0%	0.83%	--	--	--	--
Benzo(a)pyrene	0.080	--	--	--	--	0.080%	0.15%	0.0%	0.23%
		22%	**78%**	**0.014%**	**100%**	**16%**	**83%**	**0.057%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Table E-18: DU-S3 COPC Risk Drivers

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 25-Year Adult Landscaper – Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	15	2.0%	28%	0.0%	30%	1.3%	19%	0.0%	20%
Chlordane, Technical	13	0.54%	9.5%	0.0%	10%	0.91%	16%	0.0%	17%
Chlordane, alpha	2.3	0.10%	1.7%	0.0%	1.8%	0.16%	2.8%	0.0%	3.0%
Chlordane, gamma	1.8	0.075%	1.3%	0.0%	1.4%	0.13%	2.2%	0.0%	2.3%
Chromium (VI)	0.13	--	0.13%	0.0%	0.14%	--	0.0%	0.0%	0.0%
DDD	0.016	0.0%	0.0%	0.0%	0.0%	0.0%	0.32%	--	0.37%
DDE	0.19	0.0%	0.14%	0.0%	0.14%	0.0%	0.39%	--	0.41%
DDT	0.36	0.0%	0.26%	0.0%	0.27%	0.0%	0.44%	--	0.46%
Dieldrin	1.1	5.2%	37%	0.0%	42%	1.9%	14%	--	15%
Total Carcinogenic PAHs (BaP TEQs)	0.11	0.0%	0.23%	0.0%	0.27%	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000045	0.52%	12%	0.0%	13%	1.7%	39%	0.0%	41%
Total PCBs	0.15	0.12%	0.61%	0.0%	0.73%	--	--	--	--
Benzo(a)pyrene	0.080	--	--	--	--	0.0%	0.16%	0.0%	0.19%
		8.7%	**91%**	**0.0050%**	**100%**	**6.2%**	**94%**	**0.020%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Table E-19: DU-S4 COPC Risk Drivers

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios — 6-Year Child Recreator — Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	14	7.5%	63%	0.0%	70%	4.2%	36%	0.0%	40%
Chromium(VI)	0.26	--	3.5%	0.0%	3.5%	--	0.11%	0.0%	0.11%
DDE	0.0043	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	--	0.0%
DDT	0.0036	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	--	0.0%
Dieldrin	0.011	0.20%	0.86%	0.0%	1.1%	0.065%	0.27%	--	0.34%
Total Carcinogenic PAHs (BaP TEQs)	0.095	0.78%	2.5%	0.0%	3.3%	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000030	1.4%	20%	0.0%	21%	3.9%	55%	0.0%	59%
Total PCBs	0.044	0.15%	0.44%	0.0%	0.59%	--	--	--	--
Benzo(a)pyrene	0.064	--	--	--	--	0.084%	0.27%	0.0%	0.36%
		10%	**90%**	**0.0082%**	**100%**	**8.3%**	**92%**	**0.011%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Table E-19: DU-S4 COPC Risk Drivers

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 6-Year Adult Recreator – Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	14	13%	62%	0.0%	75%	7.1%	33%	0.11%	41%
Chromium(VI)	0.26	--	0.64%	0.0%	0.65%	--	0.10%	0.0%	0.10%
DDE	0.0043	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	--	0.0%
DDT	0.0036	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	--	0.0%
Dieldrin	0.011	0.36%	0.84%	0.0%	1.2%	0.11%	0.26%	--	0.36%
Total Carcinogenic PAHs (BaP TEQs)	0.095	0.26%	0.47%	0.0%	0.72%	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000030	2.5%	19%	0.0%	22%	6.6%	52%	0.0%	58%
Total PCBs	0.044	0.26%	0.44%	0.0%	0.70%	--	--	--	--
Benzo(a)pyrene	0.064	--	--	--	--	0.14%	0.26%	0.0%	0.40%
		16%	**84%**	**0.040%**	**100%**	**14%**	**86%**	**0.11%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Table E-19: DU-S4 COPC Risk Drivers

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 25-Year Adult Landscaper – Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	14	4.9%	69%	0.0%	74%	2.6%	37%	0.0%	40%
Chromium(VI)	0.26	--	0.72%	0.0%	0.73%	--	0.12%	0.0%	0.12%
DDE	0.0043	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	--	0.0%
DDT	0.0036	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	--	0.0%
Dieldrin	0.011	0.13%	0.95%	0.0%	1.1%	0.0%	0.28%	--	0.32%
Total Carcinogenic PAHs (BaP TEQs)	0.095	0.10%	0.52%	0.0%	0.62%	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.000030	0.93%	22%	0.0%	23%	2.4%	57%	0.0%	60%
Total PCBs	0.044	0.10%	0.49%	0.0%	0.59%	--	--	--	--
Benzo(a)pyrene	0.064	--	--	--	--	0.052%	0.28%	0.0%	0.34%
		6.2%	**94%**	**0.014%**	**100%**	**5.2%**	**95%**	**0.038%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Table E-20: DU-S5 COPC Risk Drivers (Including Sample CKSA-SS40)

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios							
		6-Year Child Recreator							
		Cancer Risk				Noncancer Hazard			
		Dermal Contact	Ingestion	Inhalation	Total Cancer Risk	Dermal Contact	Ingestion	Inhalation	Total Hazard Index
Arsenic	15	1.4%	12.0%	0.0%	13%	0.25%	2.1%	0.0%	2.4%
Chlordane, Technical	10	0.3%	3.1%	0.0%	3.4%	0.13%	1.4%	0.0%	1.5%
Chlordane, alpha	1.1	0.0%	0.34%	0.0%	0.37%	0.015%	0.16%	0.0%	0.17%
Chlordane, gamma	1.9	0.1%	0.59%	0.0%	0.64%	0.025%	0.27%	0.0%	0.29%
Chromium (VI)	0.38	--	0.89%	0.0%	0.89%	--	0.0%	0.0%	0.0%
DDD	24	1.2%	5.1%	0.0%	6.3%	13%	56%	--	70%
DDE	4.6	0.098%	1.4%	0.0%	1.5%	0.077%	1.1%	--	1.2%
DDT	5.5	0.12%	1.6%	0.0%	1.8%	0.055%	0.78%	--	0.83%
Dieldrin	2.6	8.7%	37%	0.0%	45%	0.87%	3.7%	--	4.5%
Total Carcinogenic PAHs (BaP TEQs)	0.11	0.16%	0.5%	0.0%	0.68%	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.00018	1.4%	20%	0.0%	22%	1.3%	18%	0.0%	19%
Total PCBs (Aroclor Method)	1.7	1.0%	3.0%	0.0%	4.0%	--	--	--	--
Benzo(a)pyrene	0.079	--	--	--	--	0.0%	0.0%	0.0%	0.0%
		15%	**85%**	**0.0020%**	**100%**	**16%**	**84%**	**0.00070%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentra ions.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Table E-20: DU-S5 COPC Risk Drivers (Including Sample CKSA-SS40)

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 6-Year Adult Recreator – Cancer Risk: Dermal Contact	Ingestion	Inhalation	Total Cancer Risk	Noncancer Hazard: Dermal Contact	Ingestion	Inhalation	Total Hazard Index
Arsenic	15	2.3%	11%	0.0%	13%	0.40%	1.9%	0.0%	2.3%
Chlordane, Technical	10	0.47%	2.8%	0.0%	3.3%	0.21%	1.3%	0.0%	1.5%
Chlordane, alpha	1.1	0.052%	0.31%	0.0%	0.36%	0.023%	0.14%	0.0%	0.16%
Chlordane, gamma	1.9	0.090%	0.53%	0.0%	0.62%	0.040%	0.24%	0.0%	0.28%
Chromium (VI)	0.38	--	0.15%	0.0%	0.15%	--	0.0%	0.0%	0.0%
DDD	24	1.9%	4.6%	0.0%	6.6%	21%	50%	--	71%
DDE	4.6	0.16%	1.3%	0.0%	1.4%	0.12%	1.0%	--	1.1%
DDT	5.5	0.19%	1.5%	0.0%	1.7%	0.087%	0.69%	--	0.78%
Dieldrin	2.6	14%	33%	0.0%	47%	1.4%	3.3%	--	4.6%
Total Carcinogenic PAHs (BaP TEQs)	0.11	0.049%	0.089%	0.0%	0.14%	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.00018	2.3%	18%	0.0%	21%	2.0%	16%	0.0%	18%
Total PCBs (Aroclor Method)	1.7	1.6%	2.7%	0.0%	4.4%	--	--	--	--
Benzo(a)pyrene	0.079	--	--	--	--	0.0%	0.0%	0.0%	0.0%
		23%	**77%**	**0.0086%**	**100%**	**25%**	**75%**	**0.0066%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentra ions.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Table E-20: DU-S5 COPC Risk Drivers (Including Sample CKSA-SS40)

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios							
		25-Year Adult Landscaper							
		Cancer Risk				Noncancer Hazard			
		Dermal Contact	Ingestion	Inhalation	Total Cancer Risk	Dermal Contact	Ingestion	Inhalation	Total Hazard Index
Arsenic	15	0.92%	13%	0.0%	14%	0.16%	2.3%	0.0%	2.5%
Chlordane, Technical	10	0.19%	3.3%	0.0%	3.5%	0.086%	1.5%	0.0%	1.6%
Chlordane, alpha	1.1	0.0%	0.36%	0.0%	0.39%	0.0%	0.17%	0.0%	0.18%
Chlordane, gamma	1.9	0.0%	0.63%	0.0%	0.67%	0.016%	0.29%	0.0%	0.30%
Chromium (VI)	0.38	--	0.18%	0.0%	0.18%	--	0.0%	0.0%	0.0%
DDD	24	0.78%	5.5%	0.0%	6.2%	8.6%	60%	--	69%
DDE	4.6	0.063%	1.5%	0.0%	1.5%	0.0%	1.2%	--	1.2%
DDT	5.5	0.076%	1.8%	0.0%	1.8%	0.0%	0.83%	--	0.87%
Dieldrin	2.6	5.6%	39%	0.0%	45%	0.56%	3.9%	--	4.5%
Total Carcinogenic PAHs (BaP TEQs)	0.11	0.0%	0%	0.0%	0.12%	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.00018	0.93%	22%	0.0%	23%	0.8%	19%	0.0%	20%
Total PCBs (Aroclor Method)	1.7	0.65%	3.2%	0.0%	3.9%	--	--	--	--
Benzo(a)pyrene	0.079	--	--	--	--	0.0%	0.0%	0.0%	0.0%
		9%	**91%**	**0.0031%**	**100%**	**10%**	**90%**	**0.0024%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentra ions.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Table E-21: DU-S5 COPC Risk Drivers

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios — 6-Year Child Recreator — Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	16	4.1%	35%	0.0%	39%	1.5%	13%	0.0%	15%
Chlordane, Technical	10.0	0.79%	8.4%	0.0%	9.2%	0.76%	8.0%	0.0%	8.8%
Chlordane, alpha	1.1	0.087%	0.92%	0.0%	1.0%	0.084%	0.88%	0.0%	1.0%
Chlordane, gamma	1.9	0.15%	1.6%	0.0%	1.7%	0.14%	1.5%	0.0%	1.7%
Chromium (VI)	0.42	--	2.7%	0.0%	2.7%	--	0.056%	0.0%	0.056%
DDE	0.33	0.0%	0.27%	0.0%	0.29%	0.0%	0.44%	--	0.47%
DDT	0.24	0.0%	0.20%	0.0%	0.21%	0.0%	0.19%	--	0.21%
Dieldrin	0.10	0.91%	3.8%	0.0%	4.7%	0.19%	0.8%	--	1.0%
Total Carcinogenic PAHs (BaP TEQs)	0.12	0.48%	1.6%	0.0%	2.1%	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.00012	2.6%	37%	0.0%	39%	4.8%	67%	0.0%	72%
Benzo(a)pyrene	0.087	--	--	--	--	0.0%	0.12%	0.0%	0.15%
		9.2%	**91%**	**0.0058%**	**100%**	**7.6%**	**92%**	**0.0042%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Sample CKSA-SS40 is excluded from the risk calculations (see Section 5 of the HHRA).

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Table E-21: DU-S5 COPC Risk Drivers

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 6-Year Adult Recreator – Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	16	7.1%	34%	0.0%	41.0%	2.6%	12%	0.0%	15%
Chlordane, Technical	10.0	1.4%	8.1%	0.0%	9.5%	1.3%	7.6%	0.0%	8.9%
Chlordane, alpha	1.1	0.15%	0.89%	0.0%	1.0%	0.14%	0.83%	0.0%	1.0%
Chlordane, gamma	1.9	0.26%	1.5%	0.0%	1.8%	0.24%	1.4%	0.0%	1.7%
Chromium (VI)	0.42	--	0.49%	0.0%	0.50%	--	0.053%	0.0%	0.053%
DDE	0.33	0.0%	0.26%	0.0%	0.29%	0.053%	0.42%	--	0.47%
DDT	0.24	0.0%	0.19%	0.0%	0.21%	0.0%	0.18%	--	0.20%
Dieldrin	0.10	1.6%	3.7%	0.0%	5.3%	0.32%	0.76%	--	1.1%
Total Carcinogenic PAHs (BaP TEQs)	0.12	0.16%	0.29%	0.0%	0.44%	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.00012	4.5%	35%	0.0%	40.0%	8.1%	64%	0.0%	72%
Benzo(a)pyrene	0.087	--	--	--	--	0.061%	0.11%	0.0%	0.17%
Notes:		**15%**	**85%**	**0.025%**	**100%**	**13%**	**87%**	**0.043%**	**100%**

--: No risk associated with the exposure pathway

Sample CKSA-SS40 is excluded from the risk calculations (see Section 5 of the HHRA).

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Table E-21: DU-S5 COPC Risk Drivers

COPC	RME Concentration (mg/kg)	Surface Soil Exposure Scenarios – 25-Year Adult Landscaper – Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	16	2.7%	38%	0.0%	40%	1.0%	13%	0.0%	14%
Chlordane, Technical	10.0	0.51%	9.0%	0.0%	9.6%	0.47%	8.3%	0.0%	8.8%
Chlordane, alpha	1.1	0.06%	1.0%	0.0%	1.1%	0.052%	0.91%	0.0%	1.0%
Chlordane, gamma	1.9	0.10%	1.7%	0.0%	1.8%	0.089%	1.6%	0.0%	1.7%
Chromium (VI)	0.42	--	0.54%	0.0%	0.55%	--	0.058%	0.0%	0.058%
DDE	0.33	0.0%	0.29%	0.0%	0.30%	0.0%	0.46%	--	0.47%
DDT	0.24	0.0%	0.21%	0.0%	0.22%	0.0%	0.20%	--	0.21%
Dieldrin	0.10	0.59%	4.1%	0.0%	4.7%	0.12%	0.83%	--	0.9%
Total Carcinogenic PAHs (BaP TEQs)	0.12	0.059%	0.32%	0.0%	0.38%	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.00012	1.7%	39%	0.0%	41%	3.0%	69%	0.0%	72%
Benzo(a)pyrene	0.087	--	--	--	--	0.0%	0.12%	0.0%	0.14%
Notes:		**5.7%**	**94%**	**0.0085%**	**100%**	**4.7%**	**95%**	**0.014%**	**100%**

--: No risk associated with the exposure pathway
Sample CKSA-SS40 is excluded from the risk calculations (see Section 5 of the HHRA).
Risks shown include arsenic concentrations.
COPCs with no associated risk (i.e., not detected in the DU) are not shown.

Table E-22: Sample CKSA-SS40 (Located in DU-S5) COPC Risk Drivers

COPC	Concentration (mg/kg)	Surface Soil Exposure Scenarios – 6-Year Child Recreator – Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	6.0	0.54%	4.5%	0.0%	5.1%	0.10%	0.87%	0.0%	1.0%
DDD	24	1.1%	4.8%	0.0%	6.0%	14%	58%	--	72%
DDE	4.6	0.093%	1.3%	0.0%	1.4%	0.079%	1.1%	--	1.2%
DDT	5.5	0.11%	1.6%	0.0%	1.7%	0.057%	0.80%	--	0.86%
Dieldrin	2.6	8.3%	35%	0.0%	43%	0.90%	3.8%	--	4.7%
Total Carcinogenic PAHs (BaP TEQs)	0.052	0.071%	0.23%	0.0%	0.30%	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.00018	1.4%	20%	0.0%	21%	1.3%	19%	0.0%	20%
Total PCBs (Aroclor Method)	9.5	5.3%	16%	0.0%	21%	--	--	--	--
Benzo(a)pyrene	0.038	--	--	--	--	0.0%	0.0092%	0.0%	0.012%
		17%	**83%**	**0.00032%**	**100%**	**16%**	**84%**	**0.00028%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected) are not shown.

Table E-22: Sample CKSA-SS40 (Located in DU-S5) COPC Risk Drivers

COPC	Concentration (mg/kg)	Surface Soil Exposure Scenarios – 6-Year Adult Recreator – Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	6.0	0.85%	4.0%	0.0%	4.9%	0.16%	0.77%	0.0%	0.94%
DDD	24	1.8%	4.3%	0.0%	6.1%	22%	52%	--	73%
DDE	4.6	0.15%	1.2%	0.0%	1.3%	0.13%	0.99%	--	1.1%
DDT	5.5	0.18%	1.4%	0.0%	1.6%	0.090%	0.71%	--	0.80%
Dieldrin	2.6	13%	31%	0.0%	44%	1.4%	3.4%	--	4.8%
Total Carcinogenic PAHs (BaP TEQs)	0.052	0.021%	0.0%	0.0%	0.060%	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.00018	2.2%	18%	0.0%	20%	2.1%	17%	0.0%	19%
Total PCBs (Aroclor Method)	9.5	8.3%	14%	0.0%	22%	--	--	--	--
Benzo(a)pyrene	0.038	--	--	--	--	0.0%	0.0082%	0.0%	0.013%
		27%	**73%**	**0.0031%**	**100%**	**26%**	**74%**	**0.0027%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected) are not shown.

Table E-22: Sample CKSA-SS40 (Located in DU-S5) COPC Risk Drivers

COPC	Concentration (mg/kg)	Surface Soil Exposure Scenarios – 25-Year Adult Landscaper – Cancer Risk: Dermal Contact	Cancer Risk: Ingestion	Cancer Risk: Inhalation	Cancer Risk: Total Cancer Risk	Noncancer Hazard: Dermal Contact	Noncancer Hazard: Ingestion	Noncancer Hazard: Inhalation	Noncancer Hazard: Total Hazard Index
Arsenic	6.0	0.35%	4.9%	0.0%	5.2%	0.066%	0.93%	0.0%	1.0%
DDD	24	0.74%	5.2%	0.0%	5.9%	8.9%	62%	--	71%
DDE	4.6	0.060%	1.4%	0.0%	1.5%	0.051%	1.2%	--	1.2%
DDT	5.5	0.072%	1.7%	0.0%	1.8%	0.037%	0.86%	--	0.89%
Dieldrin	2.6	5.3%	37%	0.0%	43%	0.58%	4.0%	--	4.6%
Total Carcinogenic PAHs (BaP TEQs)	0.052	0.0086%	0.0%	0.0%	0.055%	--	--	--	--
Total Dioxins/Furans (2,3,7,8-TCDD TEQs)	0.00018	0.91%	21%	0.0%	22%	0.86%	20%	0.0%	21%
Total PCBs (Aroclor Method)	9.5	3.4%	17%	0.0%	21%	--	--	--	--
Benzo(a)pyrene	0.038	--	--	--	--	0.0%	0.010%	0.0%	0.012%
		11%	**89%**	**0.0011%**	**100%**	**10%**	**90%**	**0.00098%**	**100%**

Notes:

--: No risk associated with the exposure pathway

Risks shown include arsenic concentrations.

COPCs with no associated risk (i.e., not detected) are not shown.

Appendix F

ATSDR ToxFAQs™ for Select COPCs

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ATSDR ToxFAQs™

ATSDR ToxFAQs™ for the following constituents or groups of constituents are included in this appendix:

- Arsenic
- Chlordanes
- Chlorinated dibenzo-p-dioxins (CDD)
- Dichlorodiphenyldichloroethane (DDD), dichlorodiphenyldichloroethylene (DDE), and dichlorodiphenyltrichloroethane (DDT)
- Dieldrin
- Polycyclic aromatic hydrocarbons (PAHs)
- Polychlorinated biphenyls (PCBs)

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Arsenic - ToxFAQs™

CAS # 7440-38-2

This fact sheet answers the most frequently asked health questions (FAQs) about arsenic. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to higher than average levels of arsenic occur mostly in the workplace, near hazardous waste sites, or in areas with high natural levels. At high levels, inorganic arsenic can cause death. Exposure to lower levels for a long time can cause a discoloration of the skin and the appearance of small corns or warts. Arsenic has been found in at least 1,149 of the 1,684 National Priority List (NPL) sites identified by the Environmental Protection Agency (EPA).

What is arsenic?

Arsenic is a naturally occurring element widely distributed in the earth's crust. In the environment, arsenic is combined with oxygen, chlorine, and sulfur to form inorganic arsenic compounds. Arsenic in animals and plants combines with carbon and hydrogen to form organic arsenic compounds.

Inorganic arsenic compounds are mainly used to preserve wood. Copper chromated arsenate (CCA) is used to make "pressure-treated" lumber. CCA is no longer used in the U.S. for residential uses; it is still used in industrial applications. Organic arsenic compounds are used as pesticides, primarily on cotton fields and orchards.

What happens to arsenic when it enters the environment?

- Arsenic occurs naturally in soil and minerals and may enter the air, water, and land from wind-blown dust and may get into water from runoff and leaching.
- Arsenic cannot be destroyed in the environment. It can only change its form.
- Rain and snow remove arsenic dust particles from the air.
- Many common arsenic compounds can dissolve in water. Most of the arsenic in water will ultimately end up in soil or sediment.
- Fish and shellfish can accumulate arsenic; most of this arsenic is in an organic form called arsenobetaine that is much less harmful.

How might I be exposed to arsenic?

- Ingesting small amounts present in your food and water or breathing air containing arsenic.
- Breathing sawdust or burning smoke from wood treated with arsenic.
- Living in areas with unusually high natural levels of arsenic in rock.
- Working in a job that involves arsenic production or use, such as copper or lead smelting, wood treating, or pesticide application.

How can arsenic affect my health?

Breathing high levels of inorganic arsenic can give you a sore throat or irritated lungs.

Ingesting very high levels of arsenic can result in death. Exposure to lower levels can cause nausea and vomiting, decreased production of red and white blood cells, abnormal heart rhythm, damage to blood vessels, and a sensation of "pins and needles" in hands and feet.

Ingesting or breathing low levels of inorganic arsenic for a long time can cause a darkening of the skin and the appearance of small "corns" or "warts" on the palms, soles, and torso.

Skin contact with inorganic arsenic may cause redness and swelling.

Almost nothing is known regarding health effects of organic arsenic compounds in humans. Studies in animals show that some simple organic arsenic compounds are less toxic than inorganic forms. Ingestion of methyl and dimethyl compounds can cause diarrhea and damage to the kidneys.

How likely is arsenic to cause cancer?

Several studies have shown that ingestion of inorganic arsenic can increase the risk of skin cancer and cancer in the liver, bladder, and lungs. Inhalation of inorganic arsenic can cause increased risk of lung cancer. The Department of Health and Human Services (DHHS) and the EPA have determined that inorganic arsenic is a known human carcinogen. The International Agency for Research on Cancer (IARC) has determined that inorganic arsenic is carcinogenic to humans.

How can arsenic affect children?

There is some evidence that long-term exposure to arsenic in children may result in lower IQ scores. There is also some evidence that exposure to arsenic in the womb and early childhood may increase mortality in young adults.

There is some evidence that inhaled or ingested arsenic can injure pregnant women or their unborn babies, although the studies are not definitive. Studies in animals show that large doses of arsenic that cause illness in pregnant females, can also cause low birth weight, fetal malformations, and even fetal death. Arsenic can cross the placenta and has been found in fetal tissues. Arsenic is found at low levels in breast milk.

How can families reduce the risks of exposure to arsenic?

- If you use arsenic-treated wood in home projects, you should wear dust masks, gloves, and protective clothing to decrease exposure to sawdust.
- If you live in an area with high levels of arsenic in water or soil, you should use cleaner sources of water and limit contact with soil.
- If you work in a job that may expose you to arsenic, be aware that you may carry arsenic home on your clothing, skin, hair, or tools. Be sure to shower and change clothes before going home.

Is there a medical test to determine whether I've been exposed to arsenic?

There are tests available to measure arsenic in your blood, urine, hair, and fingernails. The urine test is the most reliable test for arsenic exposure within the last few days. Tests on hair and fingernails can measure exposure to high levels of arsenic over the past 6-12 months. These tests can determine if you have been exposed to above-average levels of arsenic. They cannot predict whether the arsenic levels in your body will affect your health.

Has the federal government made recommendations to protect human health?

The EPA has set limits on the amount of arsenic that industrial sources can release to the environment and has restricted or cancelled many of the uses of arsenic in pesticides. EPA has set a limit of 0.01 parts per million (ppm) for arsenic in drinking water.

The Occupational Safety and Health Administration (OSHA) has set a permissible exposure limit (PEL) of 10 micrograms of arsenic per cubic meter of workplace air (10 $\mu g/m^3$) for 8 hour shifts and 40 hour work weeks.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Toxicological Profile for Arsenic (Update). Atlanta, GA: U.S. Department of Health and Human Services. Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

Phone: 1-800-232-4636

ToxFAQs™ Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp.

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

CHLORDANE
CAS # 12789-03-6

Agency for Toxic Substances and Disease Registry ToxFAQs **September 1995**

This fact sheet answers the most fr equently asked health questions (FAQs) about chlordane. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. This information is important because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

SUMMARY: Exposure to chlordane occurs mostly from eating contaminated foods, such as root crops, meats, fish, and shellfish, or from touching contaminated soil. High levels of chlordane can cause damage to the nervous system oliver. This chemical has been found in at least 171 of 1,416 National Priorities List sites identified by the Environmental Protection Agency.

What is chlordane?
(Pronounced klôr′dān′)

Chlordane is a manufactured chemical that was used as a pesticide in the United States from 1948 to 1988. Technical chlordane is not a single chemical, but is actually a mixture of pure chlordane mixed with many related chemicals. It doesn't occur naturally in the environment. It is a thick liquid whose color ranges from colorless to amber. Chlordane has a mild, irritating smell.

Some of its trade names are Octachlor and Velsicol 1068. Until 1983, chlordane was used as a pesticide on crops like corn and citrus and on home lawns and gardens.

Because of concern about damage to the environment and harm to human health, the Environmental Protection Agency (EPA) banned all uses of chlordane in 1983 except to control termites. In 1988, EPA banned all uses.

What happens to chlordane when it enters the environment?

- Chlordane entered the environment when it was used as a pesticide on crops, on lawns and gardens, and to control termites.
- Chlordane sticks strongly to soil particles at the surface and is not likely to enter groundwater.
- It can stay in the soil for over 20 years.
- Most chlordane leaves soil by evaporation to the air.
- It breaks down very slowly.
- Chlordane doesn't dissolve easily in water.
- It builds up in the tissues of fish, birds, and mammals.

How might I be exposed to chlordane?

- By eating crops grown in soil that contains chlordane.
- By eating fish or shellfish caught in water that is contaminated by chlordane.
- By breathing air or touching soil near homes treated for termites with chlordane.
- By breathing air or by touching soil near waste sites or landfills.

How can chlordane affect my health?

Chlordane affects the nervous system, the digestive system, and the liver in people and animals. Headaches, irritability, confusion, weakness, vision problems, vomiting, stomach cramps, diarrhea, and jaundice have occurred in people who breathed air containing high concentrations of chlordane or accidentally swallowed small amounts of chlordane. Large amounts of chlordane taken by mouth can cause convulsions and death in people.

A man who had long-term skin contact with soil containing high levels of chlordane had convulsions. Japanese workers who used chlordane over a long period of time had minor changes in liver function.

Animals given high levels of chlordane by mouth for short periods died or had convulsions. Long-term exposure caused harmful effects in the liver of test animals.

We do not know whether chlordane affects the ability of people to have children or whether it causes birth defects. Animals exposed before birth or while nursing developed behavioral effects later.

How likely is chlordane to cause cancer?

The International Agency for Research on Cancer has determined that chlordane is not classifiable as to its carcinogenicity to humans. Studies of workers who made or used chlordane do not show that exposure to chlordane is related to cancer, but the information is not sufficient to know for sure. Mice fed low levels of chlordane in food developed liver cancer.

Is there a medical test to show whether I've been exposed to chlordane?

Laboratory tests can measure chlordane and its breakdown products in blood, fat, urine, feces, and breast milk. The amount of breakdown products measured in body fat or breast milk does not tell how much or how long ago you were exposed to chlordane or if harmful effects will occur.

Has the federal government made recommendations to protect human health?

In 1988, the EPA banned all uses of chlordane. The EPA recommends that a child should not drink water with more than 60 parts of chlordane per billion parts of drinking water (60 ppb) for longer than 1 day. EPA has set a limit in drinking water of 2 ppb.

EPA requires spills or releases of chlordane into the environment of 1 pound or more to be reported to EPA.

The Food and Drug Administration (FDA) limits the amount of chlordane and its breakdown products in most fruits and vegetables to less than 300 ppb and in animal fat and fish to less than 100 ppb.

The Occupational Safety and Health Administration (OSHA), the National Institute for Occupational Health and Safety (NIOSH), and the American Conference of Governmental Industrial Hygienists (ACGIH) set a maximum level of 0.5 milligrams of chlordane per cubic meter (mg/m^3) in workplace air for an 8-hour workday, 40-hour workweek. These agencies have advised that eye and skin contact should be avoided because this may be a significant route of exposure.

Glossary

Carcinogenicity: Ability to cause cancer.

Long-term: Lasting one year or longer.

Milligram (mg): One thousandth of a gram.

Pesticide: A substance that kills pests.

ppb: Parts per billion.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 1994. Toxicological profile for chlordane (update). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq html ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

CHLORINATED DIBENZO-p-DIOXINS (CDDs)

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Division of Toxicology and Environmental Medicine ToxFAQs™ February 1999

This fact sheet answers the most frequently asked health questions (FAQs) about dibenzo-p-dioxins. For more information, call the ATSDR Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because these substances may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to chlorinated dibenzo-p-dioxins (CDDs) (75 chemicals) occurs mainly from eating food that contains the chemicals. One chemical in this group, 2,3,7,8-tetrachlorodibenzo-p-dioxin or 2,3,7,8-TCDD, has been shown to be very toxic in animal studies. It causes effects on the skin and may cause cancer in people. This chemical has been found in at least 91 of the 1,467 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What are CDDs?

CDDs are a family of 75 chemically related compounds commonly known as chlorinated dioxins. One of these compounds is called 2,3,7,8-TCDD. It is one of the most toxic of the CDDs and is the one most studied.

In the pure form, CDDs are crystals or colorless solids. CDDs enter the environment as mixtures containing a number of individual components. 2,3,7,8-TCDD is odorless and the odors of the other CDDs are not known.

CDDs are not intentionally manufactured by industry except for research purposes. They (mainly 2,3,7,8-TCDD) may be formed during the chlorine bleaching process at pulp and paper mills. CDDs are also formed during chlorination by waste and drinking water treatment plants. They can occur as contaminants in the manufacture of certain organic chemicals. CDDs are released into the air in emissions from municipal solid waste and industrial incinerators.

What happens to CDDs when they enter the environment?

❑ When released into the air, some CDDs may be transported long distances, even around the globe.
❑ When released in waste waters, some CDDs are broken down by sunlight, some evaporate to air, but most attach to soil and settle to the bottom sediment in water.
❑ CDD concentrations may build up in the food chain, resulting in measurable levels in animals.

How might I be exposed to CDDs?

❑ Eating food, primarily meat, dairy products, and fish, makes up more than 90% of the intake of CDDs for the general population.
❑ Breathing low levels in air and drinking low levels in water.
❑ Skin contact with certain pesticides and herbicides.
❑ Living near an uncontrolled hazardous waste site containing CDDs or incinerators releasing CDDs.
❑ Working in industries involved in producing certain pesticides containing CDDs as impurities, working at paper and pulp mills, or operating incinerators.

How can CDDs affect my health?

The most noted health effect in people exposed to large amounts of 2,3,7,8-TCDD is chloracne. Chloracne is a severe skin disease with acne-like lesions that occur mainly on the face and upper body. Other skin effects noted in people exposed to high doses of 2,3,7,8-TCDD include skin rashes, discoloration, and excessive body hair. Changes in blood and urine that may indicate liver damage also are seen in people. Exposure to high concentrations of CDDs may induce longterm alterations in glucose metabolism and subtle changes in hormonal levels.

In certain animal species, 2,3,7,8-TCDD is especially harmful and can cause death after a single exposure. Exposure to lower levels can cause a variety of effects in animals, such as weight loss, liver damage, and disruption of the endocrine system. In many species of animals, 2,3,7,8-TCDD weakens the immune system and causes a decrease in the system's ability to fight bacteria and viruses. In other animal studies, exposure to 2,3,7,8-TCDD has caused reproductive damage and birth defects. Some animal species exposed to CDDs during pregnancy had miscarriages and the offspring of animals exposed to 2,3,7,8-TCDD during pregnancy often had severe birth defects including skeletal deformities, kidney defects, and weakened immune responses.

How likely are CDDs to cause cancer?

Several studies suggest that exposure to 2,3,7,8-TCDD increases the risk of several types of cancer in people. Animal studies have also shown an increased risk of cancer from exposure to 2,3,7,8-TCDD.
The World Health Organization (WHO) has determined that 2,3,7,8-TCDD is a human carcinogen.
The Department of Health and Human Services (DHHS) has determined that 2,3,7,8-TCDD may reasonably be anticipated to cause cancer.

How can CDDs affect children?

Very few studies have looked at the effects of CDDs on children. Chloracne has been seen in children exposed to high levels of CDDs. We don't know if CDDs affect the ability of people to have children or if it causes birth defects, but given the effects observed in animal studies, this cannot be ruled out.

How can families reduce the risk of exposure to CDDs?

❑ Children should avoid playing in soils near uncontrolled hazardous waste sites.
❑ Discourage children from eating dirt or putting toys or other objects in their mouths.
❑ Everyone should wash hands frequently if playing or working near uncontrolled hazardous waste sites.
❑ For new mothers and young children, restrict eating foods from the proximity of uncontrolled sites with known CDDs.
❑ Children and adults should eat a balanced diet preferably containing low to moderate amounts of animal fats including meat and dairy products, and fish that contain lower amounts of CDDs and eat larger amounts of fruits, vegetables, and grains.

Is there a medical test to determine whether I've been exposed to CDDs?

Tests are available to measure CDD levels in body fat, blood, and breast milk, but these tests are not routinely available. Most people have low levels of CDDs in their body fat and blood, and levels considerably above these levels indicate past exposure to above-normal levels of 2,3,7,8-TCDD. Although CDDs stay in body fat for a long time, tests cannot be used to determine when exposure occurred.

Has the federal government made recommendations to protect human health?

The EPA has set a limit of 0.00003 micrograms of 2,3,7,8-TCDD per liter of drinking water (0.00003 μg/L). Discharges, spills, or accidental releases of 1 pound or more of 2,3,7,8-TCDD must be reported to EPA. The Food and Drug Administration (FDA) recommends against eating fish and shellfish with levels of 2,3,7,8-TCDD greater than 50 parts per trillion (50 ppt).

References

Agency for Toxic Substances and Disease Registry (ATSDR). 1998. Toxicological Profile for Chlorinated Dibenzo-p-Dioxins. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Environmental Medicine, 1600 Clifton Road NE, Mailstop F-62, Atlanta, GA 30333. Phone: 1-800-232-4636, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

DDT, DDE, and DDD - ToxFAQs™

CAS # 50-29-3, 72-55-9, 72-54-8

This fact sheet answers the most frequently asked health questions (FAQs) about DDT, DDE, and DDD. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to DDT, DDE, and DDD occurs mostly from eating foods containing small amounts of these compounds, particularly meat, fish and poultry. High levels of DDT can affect the nervous system causing excitability, tremors and seizures. In women, DDE can cause a reduction in the duration of lactation and an increased chance of having a premature baby. DDT, DDE, and DDD have been found in at least 442 of the 1,613 National Priorities List (NPL) sites identified by the Environmental Protection Agency (EPA).

What are DDT, DDE, and DDD?

DDT (dichlorodiphenyltrichloroethane) is a pesticide once widely used to control insects in agriculture and insects that carry diseases such as malaria. DDT is a white, crystalline solid with no odor or taste. Its use in the U.S. was banned in 1972 because of damage to wildlife, but is still used in some countries.

DDE (dichlorodiphenyldichloroethylene) and DDD (dichlorodiphenyldichloroethane) are chemicals similar to DDT that contaminate commercial DDT preparations. DDE has no commercial use. DDD was also used to kill pests, but its use has also been banned. One form of DDD has been used medically to treat cancer of the adrenal gland.

What happens to DDT, DDE, and DDD when they enter the environment?

- DDT entered the environment when it was used as a pesticide; it still enters the environment due to current use in other countries.
- DDE enters the environment as contaminant or breakdown product of DDT; DDD also enters the environment as a breakdown product of DDT.
- DDT, DDE, and DDD in air are rapidly broken down by sunlight. Half of what's in air breaks down within 2 days.
- They stick strongly to soil; most DDT in soil is broken down slowly to DDE and DDD by microorganisms; half the DDT in soil will break down in 2–15 years, depending on the type of soil.
- Only a small amount will go through the soil into groundwater; they do not dissolve easily in water.
- DDT, and especially DDE, build up in plants and in fatty tissues of fish, birds, and other animals.

How might I be exposed to DDT, DDE, and DDD?

- Eating contaminated foods, such as root and leafy vegetables, fatty meat, fish, and poultry, but levels are very low.
- Eating contaminated imported foods from countries that still allow the use of DDT to control pests.
- Breathing contaminated air or drinking contaminated water near waste sites and landfills that may contain higher levels of these chemicals.
- Infants fed on breast milk from mothers who have been exposed.
- Breathing or swallowing soil particles near waste sites or landfills that contain these chemicals.

How can DDT, DDE, and DDD affect my health?

DDT affects the nervous system. People who accidentally swallowed large amounts of DDT became excitable and had tremors and seizures. These effects went away after the exposure stopped. No effects were seen in people who took small daily doses of DDT by capsule for 18 months. A study in humans showed that women who had high amounts of a form of DDE in their breast milk were unable to breast feed their babies for as long as women who had little DDE in the breast milk. Another study in humans showed that women who had high amounts of DDE in the blood had an increased chance of having premature babies. In animals, short-term exposure to large amounts of DDT in food affected the nervous system, while long-term exposure to smaller amounts affected the liver. Also in animals, short-term oral exposure to small amounts of DDT or its breakdown products may also have harmful effects on reproduction.

DDT, DDE, and DDD - ToxFAQs™

CAS # 50-29-3, 72-55-9, 72-54-8

How likely are DDT, DDE, and DDD to cause cancer?

Studies in DDT-exposed workers did not show increases in cancer. Studies in animals given DDT with the food have shown that DDT can cause liver cancer.

The Department of Health and Human Services (DHHS) determined that DDT may reasonable be anticipated to be a human carcinogen.

The International Agency for Research on Cancer (IARC) determined that DDT may possibly cause cancer in humans. The EPA determined that DDT, DDE, and DDD are probable human carcinogens.

How can DDT, DDE, and DDD affect children?

There are no studies on the health effects of children exposed to DDT, DDE, or DDD. We can assume that children exposed to large amounts of DDT will have health effects similar to the effects seen in adults. However, we do not know whether children differ from adults in their susceptibility to these substances.

There is no evidence that DDT, DDE, or DDD cause birth defects in people. A study showed that teenage boys whose mothers had higher DDE amounts in the blood when they were pregnant were taller than those whose mothers had lower DDE levels. However, a different study found the opposite in preteen girls. The reason for the discrepancy between these studies is unknown.

Studies in rats have shown that DDT and DDE can mimic the action of natural hormones and in this way affect the development of the reproductive and nervous systems. Puberty was delayed in male rats given high amounts of DDE as juveniles. This could possibly happen in humans.

A study in mice showed that exposure to DDT during the first weeks of life may cause neurobehavioral problems later in life.

How can families reduce the risk of exposure to DDT,DDE, and DDE?

- Most families will be exposed to DDT by eating food or drinking liquids contaminated with small amounts of DDT.
- Cooking will reduce the amount of DDT in fish.
- Washing fruit and vegetables will remove most DDT from their surface.
- Follow health advisories that tell you about consumption of fish and wildlife caught in contaminated areas.

Is there a medical test to show whether I've been exposed to DDT, DDE, and DDD?

Laboratory tests can detect DDT, DDE, and DDD in fat, blood, urine, semen, and breast milk. These tests may show low, moderate, or excessive exposure to these compounds, but cannot tell the exact amount you were exposed to, or whether you will experience adverse effects. These tests are not routinely available at the doctor's office because they require special equipment.

Has the federal government made recommendations to protect human health?

The Occupational Safety and Health Administration (OSHA) sets a limit of 1 milligram of DDT per cubic meter of air (1 mg/m^3) in the workplace for an 8-hour shift, 40-hour workweek.

The Food and Drug Administration (FDA) has set limits for DDT, DDE, and DDD in foodstuff at or above which the agency will take legal action to remove the products from the market.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2002. Toxicological Profile for DDT/DDE/DDD (Update). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

Phone: 1-800-232-4636

ToxFAQs™ Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp.

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Sources of Exposure

General Populations

- The general population may be exposed to aldrin or dieldrin in ambient air, food, water, and soil.
- Contaminated foods include those obtained from plants grown on contaminated lands or from animals living in contaminated areas, as well as commercial food products high in animal fat, such as dairy, fatty fish, and meat products.
- Members of the general population who live in homes that were once treated for termites with aldrin or dieldrin can be exposed by inhalation of contaminated air.

Occupational Populations

- Use of aldrin and dieldrin for pest control on crops was cancelled by the EPA in 1974 and the use for extermination of termites was voluntarily cancelled by the manufacturer in 1987.
- Consequently, potential occupational exposure may be limited to workers cleaning up hazardous waste sites where these substances may have been disposed.

Toxicokinetics and Normal Human Levels

Toxicokinetics

- There are no studies directly showing that aldrin/dieldrin can be absorbed through the lungs. Aldrin and dieldrin can be absorbed through the gastrointestinal tract and the skin, but quantitative data are lacking.
- Aldrin in the body is rapidly converted to dieldrin in liver and lung microsomes.
- Dieldrin distributes preferentially to fat tissue where it can remain for years, depending on the type of exposure. Elimination half-lives of 266 and 369 days have been estimated in humans.
- Dieldrin can be directly oxidized by cytochrome oxidases or the epoxy ring can be opened by epoxide hydratases.
- Limited human data and results from studies in monkeys suggest that unchanged dieldrin and conjugated metabolites are excreted mainly in the feces via the bile.

Normal Human Levels

- In a U.S. national survey (2001–2002), the 95th percentile value for serum dieldrin in subjects 12-year-old and older was 0.146 ppb (whole blood).

Biomarkers/Environmental Levels

Biomarkers

- Blood levels of dieldrin are specific biomarkers for aldrin and dieldrin.
- An elevated level of dieldrin in blood may indicate either recent exposure or past exposure.

Environmental Levels

Air

- No recent data were located.

Sediment and Soil

- Maximum concentrations of dieldrin in soil samples taken in 1995–1996 from Alabama, Ohio, Indiana, and Illinois were 23, 4,250, 69, and 13 ng/g dry weight.

Water

- Dieldrin was detected at a maximum concentration of 0.045 μg/L in 2.4% of 208 well water samples from 9 urban areas across the United States in the early 1990s
- Dieldrin was detected at a maximum concentration of 0.068 μg/L in 1.63% of 2,459 sites from the largest river basins and aquifers in the United States tested between 1992 and 1996.

Reference

Agency for Toxic Substances and Disease Registry (ATSDR). 2002. Toxicological Profile for Aldrin/Dieldrin (Update). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

ToxGuide™ for Aldrin/Dieldrin

CAS# 309-00-2/60-57-1

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U.S. Department of Health and Human Services
Public Health Service
Agency for Toxic Substances and Disease Registry
www.atsdr.cdc.gov

Contact Information:
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1-800-CDC-INFO
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Chemical and Physical Information

Aldrin and Dieldrin are Organochlorine Pesticides

- Aldrin and dieldrin are synthetic organochlorine insecticides. The technical-grade formulations contain no less than 85.5% of either chemical.
- Pure aldrin and dieldrin are white powders with mild chemical odor.
- Aldrin is readily converted to dieldrin in the environment.
- From the 1950s until 1970 aldrin and dieldrin were widely used as pesticides for crops like corn and cotton.
- Aldrin and dieldrin were also used as a prophylactic and for treatment of timber against termite infestation until 1987, when all uses were banned.

Routes of Exposure

- Inhalation (breathing) – Predominant route of exposure for members of the general population living in homes that were treated with either pesticide.
- Oral (mouth) – Predominant route of exposure for the general population through ingestion of contaminated food.
- Dermal – Minor route of exposure for the general population.

Aldrin and Dieldrin in the Environment

- Aldrin is converted to dieldrin in the environment by sunlight and bacteria.
- Dieldrin binds tightly to soil and evaporates slowly to the air. The half-life of dieldrin in temperate soils is about 5 years.
- Dieldrin can travel long distances in the environment attached to dust particles blown by the wind.
- Aldrin and dieldrin are not very water soluble, but readily bind to sediment and are rarely leached in deeper soil layers and groundwater.
- Dieldrin bioconcentrates and biomagnifies through the terrestrial and aquatic food chains.

Relevance to Public Health (Health Effects)

Health effects are determined by the dose (how much), the duration (how long), and the route of exposure.

Minimal Risk Levels (MRLs)

Inhalation

- No inhalation MRLs were derived for aldrin or dieldrin.

Oral

- An MRL of 0.002 mg/kg/day was derived for acute-duration exposure to aldrin (≤14 days).
- No intermediate-duration oral MRL was derived for aldrin (15–364 days).
- An MRL of 0.00003 mg/kg/day was derived for chronic-duration exposure to aldrin (≥1 year).
- No acute-duration oral MRL was derived for dieldrin (≤14 days).
- An MRL of 0.0001 mg/kg/day was derived for intermediate-duration exposure to dieldrin (15–364 days).
- An MRL of 0.00005 mg/kg/day was derived for chronic-duration exposure to dieldrin (≥1 year).

Health Effects

- Acute exposure to high concentrations of aldrin or dieldrin can cause seizures and convulsions and even death.
- Prolonged exposure to lower levels has induced headaches, dizziness, irritability, vomiting, and muscle spasms.
- Studies in humans have not addressed whether adverse reproductive effects occur as a result of exposure to aldrin or dieldrin.
- There is no conclusive evidence that aldrin or dieldrin cause cancer in humans. The EPA has determined that aldrin and dieldrin are probable human carcinogens. IARC has determined that aldrin and dieldrin are not classifiable as to their carcinogenicity to humans.

Children's Health

- Children who accidentally ingested high doses of aldrin or dieldrin exhibited effects similar to those seen in adults exposed to high amounts of these chemicals.
- It is not known if children are more susceptible to poisoning with aldrin or dieldrin than adults.
- Aldrin and dieldrin can cross the placenta and dieldrin has been found in human breast milk.

Polycyclic Aromatic Hydrocarbons (PAHs) - ToxFAQs™

This fact sheet answers the most frequently asked health questions (FAQs) about polycyclic aromatic hydrocarbons (PAHs). For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. This information is important because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to polycyclic aromatic hydrocarbons usually occurs by breathing air contaminated by wild fires or coal tar, or by eating foods that have been grilled. PAHs have been found in at least 600 of the 1,430 National Priorities List (NPL) sites identified by the Environmental Protection Agency (EPA).

What are polycyclic aromatic hydrocarbons?

(Pronounced pŏl′ĭ-sī′klĭk ăr′ə-măt′ĭk hī′drə-kar′bənz)

Polycyclic aromatic hydrocarbons (PAHs) are a group of over 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances like tobacco or charbroiled meat. PAHs are usually found as a mixture containing two or more of these compounds, such as soot.

Some PAHs are manufactured. These pure PAHs usually exist as colorless, white, or pale yellow-green solids. PAHs are found in coal tar, crude oil, creosote, and roofing tar, but a few are used in medicines or to make dyes, plastics, and pesticides.

What happens to PAHs when they enter the environment?

- PAHs enter the air mostly as releases from volcanoes, forest fires, burning coal, and automobile exhaust.
- PAHs can occur in air attached to dust particles.
- Some PAH particles can readily evaporate into the air from soil or surface waters.
- PAHs can break down by reacting with sunlight and other chemicals in the air, over a period of days to weeks.
- PAHs enter water through discharges from industrial and wastewater treatment plants.
- Most PAHs do not dissolve easily in water. They stick to solid particles and settle to the bottoms of lakes or rivers.
- Microorganisms can break down PAHs in soil or water after a period of weeks to months.
- In soils, PAHs are most likely to stick tightly to particles; certain PAHs move through soil to contaminate underground water.
- PAH contents of plants and animals may be much higher than PAH contents of soil or water in which they live.

How might I be exposed to PAHs?

- Breathing air containing PAHs in the workplace of coking, coal-tar, and asphalt production plants; smokehouses; and municipal trash incineration facilities.
- Breathing air containing PAHs from cigarette smoke, wood smoke, vehicle exhausts, asphalt roads, or agricultural burn smoke.
- Coming in contact with air, water, or soil near hazardous waste sites.
- Eating grilled or charred meats; contaminated cereals, flour, bread, vegetables, fruits, meats; and processed or pickled foods.
- Drinking contaminated water or cow's milk.
- Nursing infants of mothers living near hazardous waste sites may be exposed to PAHs through their mother's milk.

How can PAHs affect my health?

Mice that were fed high levels of one PAH during pregnancy had difficulty reproducing and so did their offspring. These offspring also had higher rates of birth defects and lower body weights. It is not known whether these effects occur in people.

Animal studies have also shown that PAHs can cause harmful effects on the skin, body fluids, and ability to fight disease after both short- and long-term exposure. But these effects have not been seen in people.

How likely are PAHs to cause cancer?

The Department of Health and Human Services (DHHS) has determined that some PAHs may reasonably be expected to be carcinogens.

Some people who have breathed or touched mixtures of PAHs and other chemicals for long periods of time have developed cancer. Some PAHs have caused cancer in laboratory animals when they breathed air containing them (lung cancer), ingested them in food (stomach cancer), or had them applied to their skin (skin cancer).

Is there a medical test to show whether I've been exposed to PAHs?

In the body, PAHs are changed into chemicals that can attach to substances within the body. There are special tests that can detect PAHs attached to these substances in body tissues or blood. However, these tests cannot tell whether any health effects will occur or find out the extent or source of your exposure to the PAHs. The tests aren't usually available in your doctor's office because special equipment is needed to conduct them.

Has the federal government made recommendations to protect human health?

The Occupational Safety and Health Administration (OSHA) has set a limit of 0.2 milligrams of PAHs per cubic meter of air (0.2 mg/m^3). The OSHA Permissible Exposure Limit (PEL) for mineral oil mist that contains PAHs is 5 mg/m^3 averaged over an 8-hour exposure period.

The National Institute for Occupational Safety and Health (NIOSH) recommends that the average workplace air levels for coal tar products not exceed 0.1 mg/m^3 for a 10-hour workday, within a 40-hour workweek. There are other limits for workplace exposure for things that contain PAHs, such as coal, coal tar, and mineral oil.

Glossary

Carcinogen: A substance that can cause cancer.

Ingest: Take food or drink into your body.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. Toxicological profile for polycyclic aromatic hydrocarbons. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

Phone: 1-800-232-4636.

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Polychlorinated Biphenyls - ToxFAQs™

This fact sheet answers the most frequently asked health questions (FAQs) about polychlorinated biphenyls. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Polychlorinated biphenyls (PCBs) are a mixture of individual chemicals which are no longer produced in the United States, but are still found in the environment. Health effects that have been associated with exposure to PCBs include acne-like skin conditions in adults and neurobehavioral and immunological changes in children. PCBs are known to cause cancer in animals. PCBs have been found in at least 500 of the 1,598 National Priorities List (NPL) sites identified by the Environmental Protection Agency (EPA).

What are polychlorinated biphenyls?

Polychlorinated biphenyls are mixtures of up to 209 individual chlorinated compounds (known as congeners). There are no known natural sources of PCBs. PCBs are either oily liquids or solids that are colorless to light yellow. Some PCBs can exist as a vapor in air. PCBs have no known smell or taste. Many commercial PCB mixtures are known in the U.S. by the trade name Aroclor.

PCBs have been used as coolants and lubricants in transformers, capacitors, and other electrical equipment because they don't burn easily and are good insulators. The manufacture of PCBs was stopped in the U.S. in 1977 because of evidence they build up in the environment and can cause harmful health effects. Products made before 1977 that may contain PCBs include old fluorescent lighting fixtures and electrical devices containing PCB capacitors, and old microscope and hydraulic oils.

What happens to PCBs when they enter the environment?

- PCBs entered the air, water, and soil during their manufacture, use, and disposal; from accidental spills and leaks during their transport; and from leaks or fires in products containing PCBs.
- PCBs can still be released to the environment from hazardous waste sites; illegal or improper disposal of industrial wastes and consumer products; leaks from old electrical transformers containing PCBs; and burning of some wastes in incinerators.
- PCBs do not readily break down in the environment and thus may remain there for very long periods of time. PCBs can travel long distances in the air and be deposited in areas far away from where they were released. In water, a small amount of PCBs may remain dissolved, but most stick to organic particles and bottom sediments. PCBs also bind strongly to soil.
- PCBs are taken up by small organisms and fish in water. They are also taken up by other animals that eat these aquatic animals as food. PCBs accumulate in fish and marine mammals, reaching levels that may be many thousands of times higher than in water.

How might I be exposed to PCBs?

- Using old fluorescent lighting fixtures and electrical devices and appliances, such as television sets and refrigerators, that were made 30 or more years ago. These items may leak small amounts of PCBs into the air when they get hot during operation, and could be a source of skin exposure.
- Eating contaminated food. The main dietary sources of PCBs are fish (especially sportfish caught in contaminated lakes or rivers), meat, and dairy products.
- Breathing air near hazardous waste sites and drinking contaminated well water.
- In the workplace during repair and maintenance of PCB transformers; accidents, fires or spills involving transformers, fluorescent lights, and other old electrical devices; and disposal of PCB materials.

How can PCBs affect my health?

The most commonly observed health effects in people exposed to large amounts of PCBs are skin conditions such as acne and rashes. Studies in exposed workers have shown changes in blood and urine that may indicate liver damage. PCB exposures in the general population are not likely to result in skin and liver effects. Most of the studies of health effects of PCBs in the general population examined children of mothers who were exposed to PCBs.

Animals that ate food containing large amounts of PCBs for short periods of time had mild liver damage and some died. Animals that ate smaller amounts of PCBs in food over several weeks or months developed various kinds of health effects, including anemia; acne-like skin conditions; and liver, stomach, and thyroid gland injuries. Other effects of PCBs in animals include changes in the immune system, behavioral alterations, and impaired reproduction. PCBs are not known to cause birth defects.

How likely are PCBs to cause cancer?

Few studies of workers indicate that PCBs were associated with certain kinds of cancer in humans, such as cancer of the liver and biliary tract. Rats that ate food containing high levels of PCBs for two years developed liver cancer. The Department of Health and Human Services (DHHS) has concluded that PCBs may reasonably be anticipated to be carcinogens. PCBs have been classified as probably carcinogenic, and carcinogenic to humans (group 1) by the Environmental Protection Agency (EPA) and International Agency for Research on Cancer (IARC), respectively.

How can PCBs affect children?

Women who were exposed to relatively high levels of PCBs in the workplace or ate large amounts of fish contaminated with PCBs had babies that weighed slightly less than babies from women who did not have these exposures. Babies born to women who ate PCB-contaminated fish also showed abnormal responses in tests of infant behavior. Some of these behaviors, such as problems with motor skills and a decrease in short-term memory, lasted for several years. Other studies suggest that the immune system was affected in children born to and nursed by mothers exposed to increased levels of PCBs. There are no reports of structural birth defects caused by exposure to PCBs or of health effects of PCBs in older children. The most likely way infants will be exposed to PCBs is from breast milk. Transplacental transfers of PCBs were also reported In most cases, the benefits of breast-feeding outweigh any risks from exposure to PCBs in mother's milk.

How can families reduce the risks of exposure to PCBs?

- You and your children may be exposed to PCBs by eating fish or wildlife caught from contaminated locations. Certain states, Native American tribes, and U S. territories have issued advisories to warn people about PCB-contaminated fish and fish-eating wildlife. You can reduce your family's exposure to PCBs by obeying these advisories.
- Children should be told not play with old appliances, electrical equipment, or transformers, since they may contain PCBs.
- Children should be discouraged from playing in the dirt near hazardous waste sites and in areas where there was a transformer fire. Children should also be discouraged from eating dirt and putting dirty hands, toys or other objects in their mouths, and should wash hands frequently.
- If you are exposed to PCBs in the workplace it is possible to carry them home on your clothes, body, or tools. If this is the case, you should shower and change clothing before leaving work, and your work clothes should be kept separate from other clothes and laundered separately.

Is there a medical test to show whether I've been exposed to PCBs?

Tests exist to measure levels of PCBs in your blood, body fat, and breast milk, but these are not routinely conducted. Most people normally have low levels of PCBs in their body because nearly everyone has been environmentally exposed to PCBs. The tests can show if your PCB levels are elevated, which would indicate past exposure to above-normal levels of PCBs, but cannot determine when or how long you were exposed or whether you will develop health effects.

Has the federal government made recommendations to protect human health?

The EPA has set a limit of 0.0005 milligrams of PCBs per liter of drinking water (0.0005 mg/L). Discharges, spills or accidental releases of 1 pound or more of PCBs into the environment must be reported to the EPA. The Food and Drug Administration (FDA) requires that infant foods, eggs, milk and other dairy products, fish and shellfish, poultry and red meat contain no more than 0 2-3 parts of PCBs per million parts (0.2-3 ppm) of food. Many states have established fish and wildlife consumption advisories for PCBs.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2000. Toxicological profile for polychlorinated biphenyls (PCBs). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

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