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NSTC GREAT LAKES
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# FINAL FINAL RECORD OF DECISION SITE 5 TRANSFORMER STORAGE BONEYARD, SITE 9 CAMP MOFFETT RAVINE FILL AREA AND SITE 21 BUILDINGS 1517/1506 AREA NSTC GREAT LAKES IL

10/01/2014

TETRA TECH INC

# RECORD OF DECISION

## Site 5 - Transformer Storage Boneyard, Site 9 - Camp Moffett Ravine Fill Area, and Site 21 - Buildings 1517/1506 Area

## Naval Station Great Lakes, Illinois

October 2014

SITE 5 - TRANSFORMER STORAGE BONEYARD,
SITE 9 - CAMP MOFFETT RAVINE FILL AREA,
AND SITE 21 - BUILDINGS 1517/1506 AREA
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

# 1.0 DECLARATION

## 1.1 SITE NAME AND LOCATION

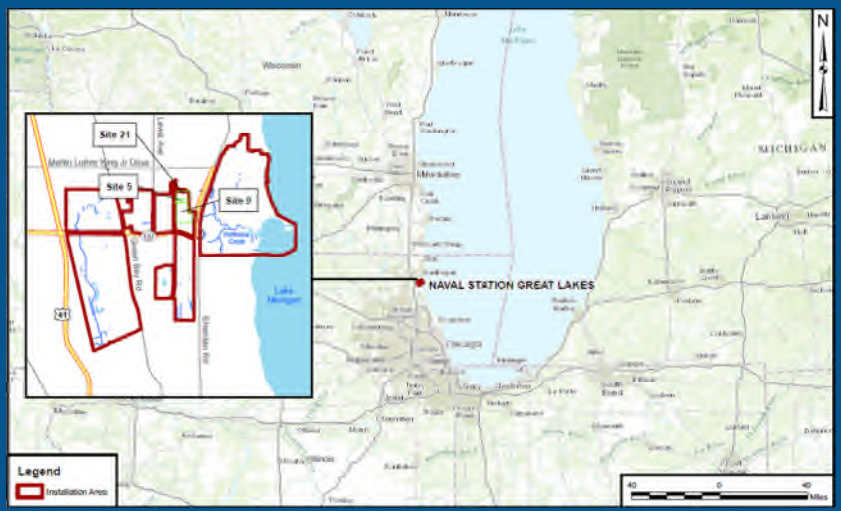
Naval Station Great Lakes (NSGL)
United States Environmental Protection Agency (USEPA) ID No. IL7170024577
Site 5 - Transformer Storage Boneyard
Site 9 - Camp Moffett Ravine Fill Area
Site 21 - Buildings 1517/1506 Area
Great Lakes, Illinois

## 1.2 STATEMENT OF BASIS AND PURPOSE

This Record of Decision (ROD) presents the Selected Remedies for Site 5 - Transformer Storage Boneyard, Site 9 - Camp Moffett Ravine Fill Area, and Site 21 - Buildings 1517/1506 Area (Figure 1-1), which was chosen by the Department of the Navy, the lead agency, and Illinois Environmental Protection Agency (Illinois EPA), the support agency, in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 United States Code §9601 et seq., as amended by the Superfund Amendments and Reauthorization Act, and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) Part 300 et seq., as amended. This decision is based on information contained in the Administrative Record file for these sites. NSGL is an active facility, and environmental investigations at the facility are funded under the Environmental Restoration, Navy program.

Sites 5, 9, and 21 are addressed together in this ROD because of their proximity to each other and their similar geology, hydrogeology, and contaminated media.

**FIGURE 1-1. SITE LOCATION MAP**




## 1.3 ASSESSMENT OF SITE

The response actions selected in this ROD are necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment. CERCLA actions are required to minimize the exposure to site contaminants that may pose unacceptable risk to hypothetical future human residents, including low concentrations of

polynuclear aromatic hydrocarbons (PAHs) and metals in soil and contaminants in groundwater, including carbon tetrachloride and barium at Site 5, arsenic and lead at Site 9, and pentachlorophenol at Site 21.

## 1.4 DESCRIPTION OF SELECTED REMEDIES

The Selected Remedies for Sites 5, 9, and 21 are similar and consist of the following major components:

- Implementation of land use controls (LUCs) to prevent residential land use or non-residential special use (such as for child-care facilities, pre-schools, elementary schools, secondary schools, playgrounds, convalescent, or nursing care facilities) of these sites, provide for long-term inspection of LUCs, and provide requirements for dealing with changes in land use or site features.
- Inspection of the barrier (surface soil, pavement, and/or building) to limit exposure to contaminated soil.
- Implementation of LUCs to prevent groundwater use.
- Implementation of LUCs to restrict unauthorized construction, require notification of the presence of contaminants to construction workers, require review of construction activities and intrusive work in the area to protect workers through personal protective equipment (PPE) and alternative methods to reduce exposure, and require proper management of excavated material.

The Selected Remedies eliminate potential unacceptable human exposure to soil and groundwater by implementing LUCs to limit future site uses to non-residential activities, inspection the existing barriers for their presence, controlling construction activities, and preventing groundwater use. The Selected Remedies for the sites will not adversely impact the current and reasonably anticipated future land use of the sites for industrial/commercial (I/C) purposes. The Selected Remedies are expected to achieve substantial long-term risk reduction and allow the property to be used for the reasonably anticipated future land use, which is I/C. This ROD documents the final remedial actions for Sites 5, 9, and 21 and does not include or affect any other sites at the facility. Implementation of these remedies will allow I/C reuse of the sites, which is consistent with current use and the overall cleanup strategy for NSGL of restoring sites to support base operations.

## 1.5 STATUTORY DETERMINATIONS

The Selected Remedies are protective of human health and the environment, comply with federal and state requirements that are applicable or relevant and appropriate to the remedial actions, are cost-effective, and utilize permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable. The Selected Remedies do not satisfy the statutory preference for remedies that use treatment as a principal element to reduce the toxicity, mobility, or volume of hazardous substances, pollutants, and contaminants. The types and locations of contamination at Sites 5, 9, and 21 (PAHs and metals in soil) and the relatively low concentrations make treatment impracticable. USEPA generally expects the use of containment rather than treatment to address contamination such as that at Sites 5, 9, and 21, which pose a relatively low long-term threat to human health and the environment.

Because these remedies will result in hazardous substances, pollutants, or contaminants remaining on site in excess of levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within 5 years of initiation of the remedial actions and every 5 years thereafter to ensure that the remedies are, or will be, protective of human health and the environment.

## 1.6 ROD DATA CERTIFICATION CHECKLIST

The locations in Section 2.0, Decision Summary, of the information required to be included in the ROD are summarized in Table 1-1. Additional information can be found in the Administrative Record file for NSGL.

**TABLE 1-1. ROD DATA CERTIFICATION CHECKLIST**

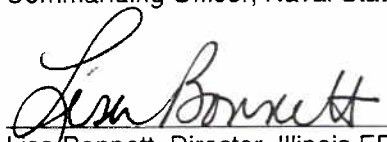
| DATA | LOCATION IN ROD |
|---|---|
| Contaminants of Concern (COCs) and their respective concentrations | Sections 2.2.2, 2.3.2, 2.4.2 |
| Baseline risk represented by the COCs | Sections 2.2.2, 2.3.2, 2.4.2 |
| Cleanup objectives established for COCs and the basis for these levels | Sections 2.2.3, 2.3.3, 2.4.3 |
| How source materials constituting principal threats are addressed | Section 2.2.6, 2.3.6, 2.4.6 |
| Current and reasonably anticipated future land use assumptions used in the risk assessment | Section 2.1.6 |
| Potential land and groundwater uses that will be available at the site as a result of the Selected Remedies | Sections 2.2.6, 2.3.6, 2.4.6 |
| Estimated capital and net present worth (NPW) costs; discount rate; and number of years over which the remedy costs are projected | Sections 2.2.4, 2.3.4, 2.4.4 |
| Key factors that led to the selection of the remedies | Sections 2.2.6, 2.3.6, 2.4.6 |

## 1.7 AUTHORIZING SIGNATURES

5 FEB 2015

W. A. Bulis, Captain, United States Navy
Commanding Officer, Naval Station Great Lakes

Date



7/2/15

Lisa Bonnett, Director, Illinois EPA

Date

# 2.0 DECISION SUMMARY

Section 2.1 includes general information on NSGL as a whole and information applicable to each site. Site-specific information for Sites 5, 9, and 21 is summarized in Sections 2.2 through 2.4, respectively.

## 2.1 NAVAL STATION GREAT LAKES

### 2.1.1 Site Name, Location, and Brief Description

NSGL, USEPA ID number IL7170024577, covers 1,202 acres of Lake County, which is located in northeastern Illinois, north of the City of Chicago, and encompasses 1.5 miles of Lake Michigan shoreline. NSGL is used to support naval training and consists of the Recruit Training Command, Training Support Center, and Naval Facilities Engineering Command Midwest.

Sites 5, 9, and 21 are part of a comprehensive environmental investigation and cleanup program currently being performed at NSGL for 22 areas of potential hazardous material releases. The sites are being evaluated with respect to contamination characteristics, migration pathways, and pollutant receptors. Several of these sites warranted further investigation to assess potential long-term impacts, including Site 5, Site 9, and Site 21, because historical activities at these sites may have resulted in soil and/or groundwater contamination.

### 2.1.2 Site History and Enforcement Activities

Table 2-1 summarizes the previous investigations at Sites 5, 9, and 21. Additional details are provided in Sections 2.2 through 2.4 for Sites 5, 9, 21, respectively.

**TABLE 2-1. PREVIOUS INVESTIGATIONS AND SITE DOCUMENTATION**

| INVESTIGATION | DATE | ACTIVITIES |
|---|---|---|
| **SITE 5 AND SITE 9** | | |
| **Initial Assessment Study** (IAS) | 1986 | Included review of historical records and aerial photographs, field inspections, and personnel interviews to evaluate the potential for environmental impacts at numerous sites across the base. Site 5 and 9 were identified as areas where further investigation was recommended to confirm or refute the presence of suspected contamination. |
| **SITE 5** | | |
| **Verification Study** | 1991 | Indicated the presence of oil and grease, Aroclor-1260, and elevated concentrations of lead in soil at Site 5. |
| **Remedial Investigation (RI)/Risk Assessment** | 2013a | Field investigations conducted in 2010 and 2012 at Site 5. Analysis of soil and groundwater samples indicated PAHs and metals in soil and volatile organic compounds (VOCs) and metals in groundwater at concentrations exceeding **Illinois EPA Tiered Approach to Corrective Action Objectives (TACO) criteria**. A risk assessment was performed using data from the Site 5 RI, and the results are discussed in Section 2.2.2. |
| **SITE 9** | | |
| **RI** | 2013b | Field investigation conducted in 2009 at Site 9 to determine the nature and extent of fill materials in former ravines. PAHs, lead, and mercury in subsurface soil and chloroform, iron, lead, and manganese in groundwater were at concentrations exceeding Illinois EPA TACO criteria. A risk assessment was performed using data from the Site 9 RI and the results are discussed in Section 2.3.2. |

| TABLE 2-1. PREVIOUS INVESTIGATIONS AND SITE DOCUMENTATION | | |
|---|---|---|
| **INVESTIGATION** | **DATE** | **ACTIVITIES** |
| **SITE 21** | | |
| **RI** | 2012 | Soil borings drilled prior to building construction indicated the presence of thin zones of fill; therefore, a field investigation was conducted in 2009 to determine the nature and extent of fill materials. Concentrations of PAHs, lead, and manganese in soil and pentachlorophenol (PCP), iron, and manganese in groundwater exceeded Illinois EPA TACO criteria. A risk assessment was performed using data from the Site 21 RI, and the results are discussed in Section 2.4.2. |

### 2.1.3 Community Participation

The **Proposed Plan** for Site 5 - Transformer Storage Boneyard, Site 9 – Camp Moffett Ravine Fill Area, and Site 21 – Buildings 1517/1506 Area (Tetra Tech, 2014) presented the proposed remedial actions and was released for public review and comment by the Navy and Illinois EPA. In accordance with Sections 113 and 117 of CERCLA, a **public notice** was published informing the community that the Proposed Plan was available for review at the Environmental Department at NSGL. The public notice was published in the newspapers (Lake County Suburban Life/Great Lakes Bulletin and Lake County News-Sun) on February 28, 2014 and on the Public Notice Illinois/Illinois Press Association web site (http://publicnoticeillinois.com/Details.aspx?SID=lfxbd4yvsdo121fmer5bwgyb&ID=781906). With the public notice, the Navy solicited comments on the Proposed Plan and provided the opportunity for interested parties to request a public meeting within a 30-day period beginning March 14 and ending April 14, 2014. No meeting requests or public comments were received.

The NSGL Administrative Record for Sites 5, 9, and 21 can be accessed online at: http://go.usa.gov/DyNB. At that web site, click on the "Administrative Records" link in the left-hand column and then click the “Administrative Record File” link in the center of the next webpage to access to the “Admin Record” search page. On the “Admin Record” Search webpage, enter “SITE 5”, “SITE 9”, or “SITE 21” in the Basic Search box. Documents and other relevant information, including investigation activities, results, and associated remedial decisions relied on in the remedy selection process, are included in the Administrative Record. This ROD will become part of the Administrative Record File per 40 CFR 300.810(a)(4). For additional information about the Installation Restoration Program at NSGL, contact John Sheppard, NAVFAC Public Affairs Office at (847) 688-2430, Extension 359 or by e-mail at john.l.sheppard@navy.mil.

### 2.1.4 Scope and Role of Operable Unit

Sites 5, 9, and 21 are part of a comprehensive environmental investigation and cleanup program currently being performed. As part of the IAS, the Navy identified 14 potential areas at the base where hazardous materials may have been released to the environment at NSGL (Rogers, Golden, & Halpern, 1986). Of these 14 areas of potential hazardous material releases, seven were recommended for further investigation, and one was recommended for a cleanup action. Following the IAS, an additional eight sites were identified, for a total of 22 areas of potential hazardous material releases.

Sites 5, 9, and 21 are three of the 22 sites identified. This ROD selects the final actions for Sites 5, 9, and 21.

### 2.1.5 Site Characteristics

#### Physical Characteristics

Sites 5, 9, and 21 are located adjacent to each other at the northern end of NSGL and together cover approximately 30 acres of the facility (Figure 2-1). These sites are located on relatively flat terrain that creates poorly defined drainage patterns. Groundwater flow is generally in a southeastern direction; therefore, groundwater contamination from Site 21 (northernmost site) has the potential to impact both Site 5 and Site 9. Site 5 has the potential to impact groundwater at Site 9 (downgradient) but is unlikely to affect groundwater at Site 21 (upgradient). There are no drinking water wells located on or immediately downgradient of the sites that could be impacted by the sites. The silt and pebbly clay in the surficial aquifer underlying the facility is not productive enough to allow free groundwater movement at the sites, and therefore is not considered to be a viable source of groundwater for drinking water. Because of existing groundwater use restrictions at NSGL and the City of North Chicago (Ordinance 11-7-2), groundwater cannot used for drinking water. The facility and the area surrounding the facility are supplied by a public water system.

The gently rolling topography of Lake County, Illinois, is the result of glaciation. The most prominent topographic features in the area are glacial moraines and other unconsolidated glacial deposits that cover most of NSGL. Most of NSGL is located on a plateau with elevations of 640 to 660 feet above mean sea level. Intensive development has replaced most of the oak, hickory, maple, and other hardwood forests that originally covered the area. Native woodlands occur primarily on the vertical sloped ravine of Pettibone Creek and on the bluffs facing Lake Michigan.

NSGL is located within both the North Branch Chicago River Drainage Basin and Lake Michigan North Drainage Basin. The divide between the basins is along Green Bay Road, which runs north to south through the center of the base. The areas east of Green Bay Road that includes Sites 5, 9, and 21 drain into Lake Michigan through Pettibone Creek, and areas west of Green Bay Road drain into the Skokie River, which discharges to the Chicago River. Overland flow from precipitation that does not infiltrate into the ground flows into the Skokie River (located south of NSGL) or Pettibone Creek.

The silt and pebbly clay in the surficial aquifer has insufficient permeability to allow free groundwater movement. Water-bearing sand stringers do exist in this aquifer, but these deposits, which would characteristically be capable of transporting groundwater are neither abundant nor extensive enough to be considered favorable sources of groundwater (Illinois State Geological Survey, 1950). At NSGL, potable water is supplied from Lake Michigan (NSGL, 2010).

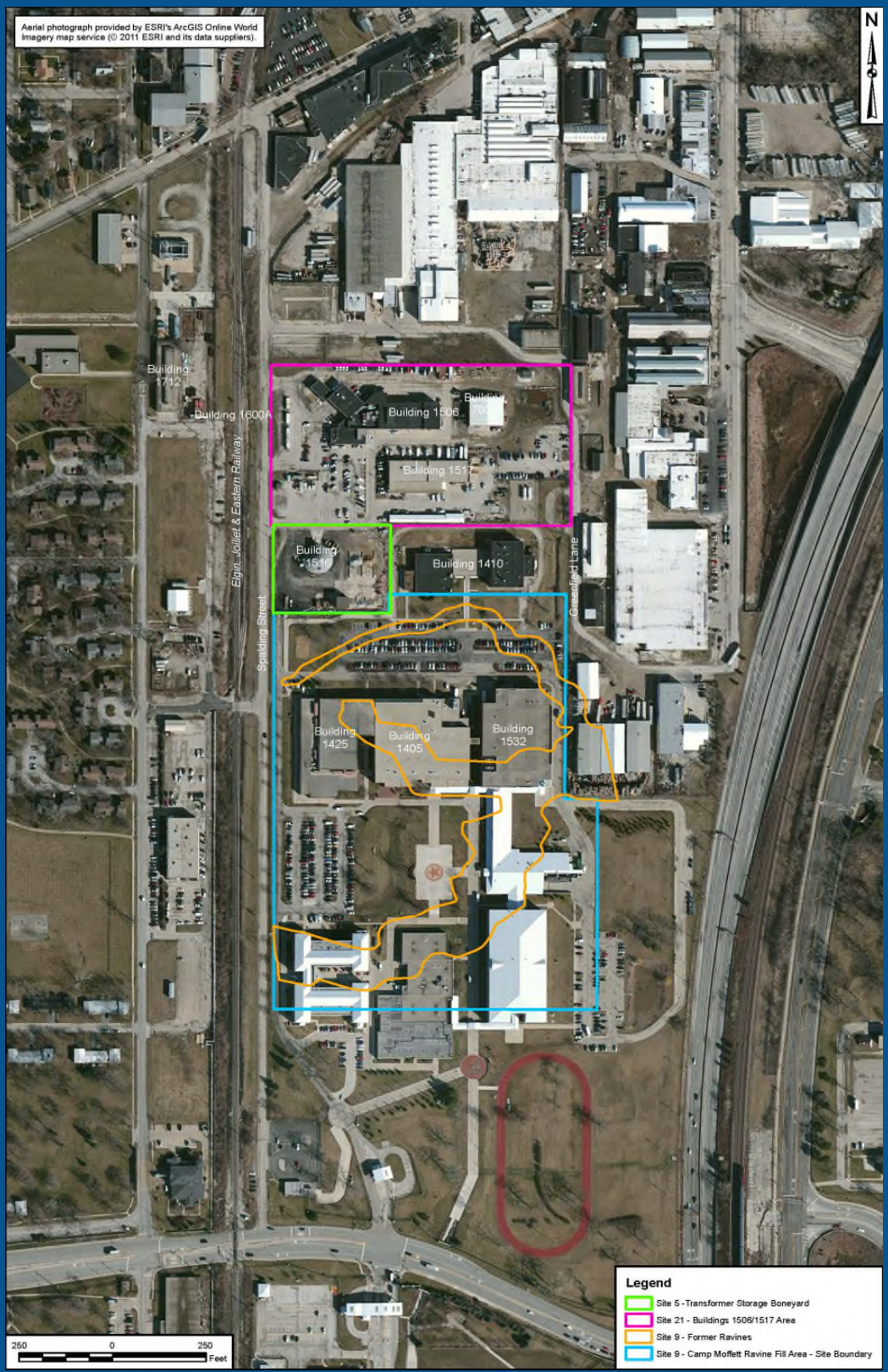
The water table is typically within 10 feet of the ground surface in most parts of NSGL and may intersect the surface in low-lying areas. The shallow water table intersects Pettibone Creek and may intersect the Skokie River after periods of heavy rainfall. Groundwater movement is primarily horizontal through the till, and rates of movement are slow due to low hydraulic conductivities. With depth, pore spaces are filled with calcareous cement that isolates the overlying till from the deeper aquifers (NSGL, 2010). The groundwater is not used at NSGL or the surrounding area.

Site characteristics for Sites 5, 9, and 21 are discussed in the site-specific sections (Sections 2.2.1, 2.3.1, and 2.4.1).

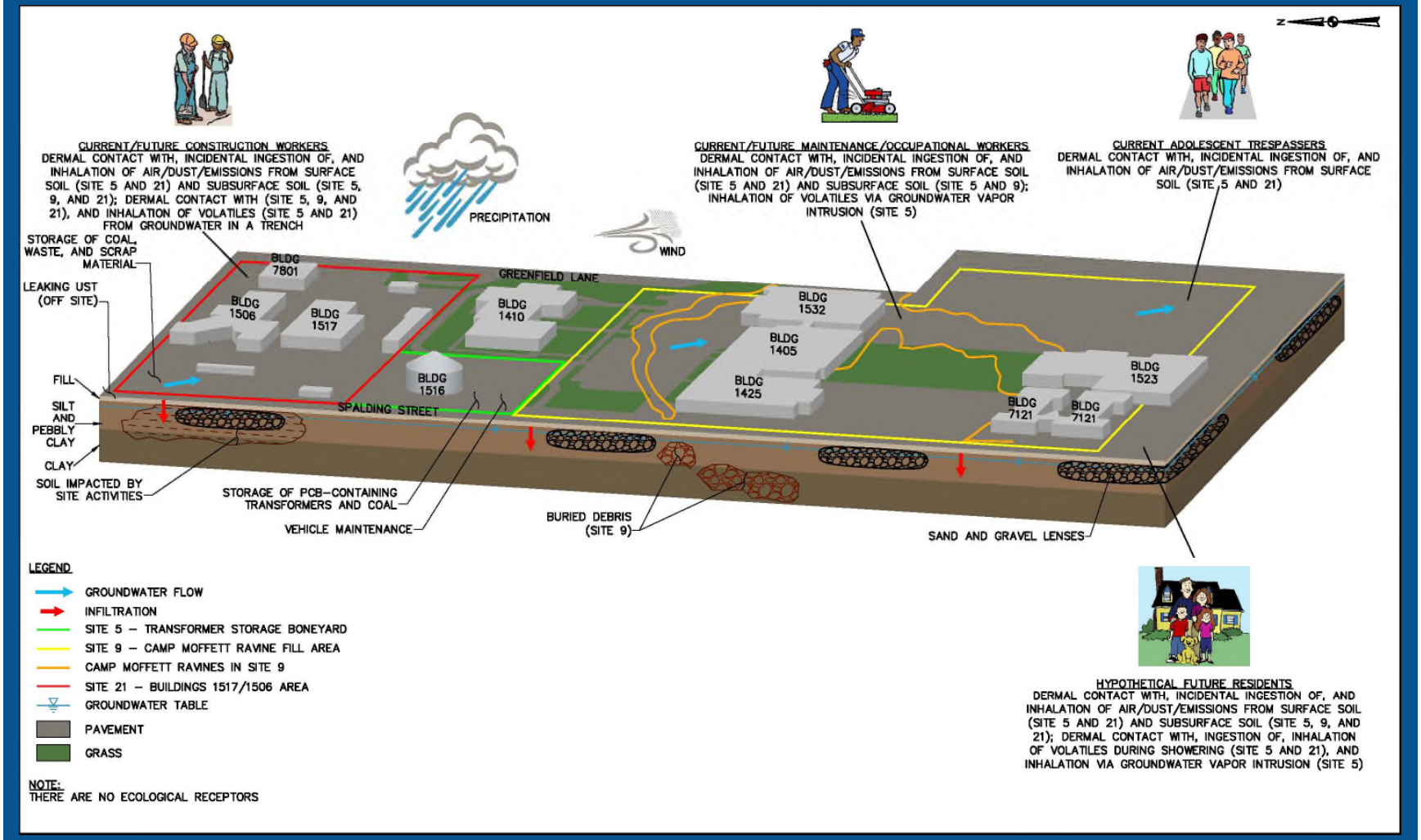
#### Conceptual Site Model

Figure 2-2 presents the conceptual site model (CSM) for Sites 5, 9 and 21, which identifies contaminant sources, contaminant release mechanisms, transport routes, and receptors under current and future land use scenarios. The sources of contamination to soil and groundwater at the sites were: (1) storage of materials (i.e., coal, transformers, equipment, waste/scrap material), (2) fueling activities, (3) disposal of galley-type wastes, and/or (4) leaks associated with underground storage tanks (USTs). Additional details are provided in Sections 2.2 through 2.4 for Sites 5, 9, and 21, respectively.

## FIGURE 2-1. SITE VICINITY MAP



## FIGURE 2-2. CONCEPTUAL SITE MODEL



Under current land use, access to and use of the sites is primarily limited to maintenance and occupational workers, such as military personnel and civilian employees. In addition, adolescent trespassers may be exposed to surface soil at the sites. The evaluation of future use scenarios included these populations and also included site residents under the unlikely premise that the site would be developed in the future for residential use.

The maintenance/occupational workers, adolescent trespassers, construction workers, and hypothetical future residents may have direct contact exposure to soil. Hypothetical future residents may also be exposed to groundwater by dermal contact, ingestion, and inhalation (during showering). Occupational/maintenance workers and hypothetical future residents may also be exposed to chemicals that have migrated from groundwater by vapor intrusion. Construction workers might come into contact with groundwater during excavation activities and may be exposed to chemicals that have migrated from groundwater in a trench.

PAHs and metals may have been released from the sites by a variety of mechanisms including stormwater runoff and associated erosion of surface soil. Because most of the study area currently consists of buildings or is paved, surface soil erosion is expected to be minimal. PAHs and metals are much more likely to remain bound to particulate matter and be transported by erosion than go into solution. PAHs are only slightly volatile and have very low aqueous solubilities and are not likely to migrate to groundwater. PAHs are subject to degradation via aerobic bacteria but may be relatively persistent in the environment in the absence of microbial populations. Metals are generally not very mobile in the environment, but the physical or chemical properties of a particular metal and the pH, redox potential, and cation exchange capacity of soil can affect the mobility of metals. Metals are highly persistent in the environment and do not degrade.

NSGL and the communities surrounding the base use a public water supply that obtains water from Lake Michigan. The silt and pebbly clay in the surficial aquifer has insufficient permeability to allow free groundwater movement, and is not considered to be a usable source of groundwater. Therefore, direct exposure by consumption or use of groundwater is not expected to occur at any of the three sites under current and/or future land uses.

Exposure of ecological receptors to site contaminants is expected to be minimal based on the industrial nature of the sites and lack of suitable habitat due to limited vegetation at the site. Therefore, it was not necessary to evaluate potential risks to ecological receptors at the sites.

## Nature and Extent of Contamination

This section summarizes general information applicable to Sites 5, 9, and 21 at NSGL. Nature and extent information that is specific to each site is summarized in Sections 2.2.1, 2.3.1, and 2.4.1. PAHs and metals were identified as COCs in soil for these sites. Carbon tetrachloride and barium (Site 5), arsenic and lead (Site 9), and pentachlorophenol (Site 21) were identified as COCs in groundwater.

The presence of PAHs in soil might be due to asphalt pavement or former coal storage at Site 5 and Site 21 and the backfill materials used to fill the ravines at Site 9. Concentrations of metals at the sites may be the result of past site activities or representative of background conditions because metals are naturally occurring substances. PAHs and metals may have been released from the sites by a variety of mechanisms including stormwater runoff and associated erosion of surface soil. Because most of the study area is currently paved at Site 5 and Site 21 and paved and landscaped at Site 9, surface soil erosion is expected to be minimal.

The presence of VOCs in groundwater might be due to past site activities at Site 5 and Site 21 and the presence of metals in groundwater might be due to leaching of the metals from the backfill in the ravines at Site 9. The concentrations of these VOCs and metals slightly exceed the USEPA Maximum Contaminant Levels (MCLs) in one well at each site.

### 2.1.6 Current and Potential Future Site and Resources Use

NSGL is an active Navy facility and is expected to remain active for the foreseeable future. Sites 5, 9, and 21, located in the northern portion of NSGL, are overlain by parking areas and buildings used for storage and offices. NSGL is the only Navy recruit training facility in the country; therefore, land use is unlikely to change.

There are a variety of land uses that currently surround NSGL. Along the northern boundary of the base are the most highly urbanized and industrial areas. Much of the land beyond the northwestern site boundary comprises unincorporated lands of Lake County and is vacant except for scattered retail and residential properties. Adjacent to the western boundary are primarily industrial properties, and along the southern boundary is a mixture of public open space and residential land.

In accordance with **NSGL Instruction 11130.1** dated September 29, 2003, use of groundwater and surface water runoff within all geographical areas of the base, for any purpose, is strictly prohibited without prior written approval. Groundwater underlying NSGL is not used for drinking water and is not expected to be used as a water supply in the future. Drinking water for the base and residents of the surrounding communities is supplied from municipal systems drawing water from Lake Michigan. Additionally, the shallow aquifer below the sites would not be an adequate water supply source because it is not sufficiently productive to provide a consistent long-term source of water. If actual future land uses at the sites differ from what is anticipated, the Navy will reassess the associated risks.

### 2.1.7 Summary of Site Risks

A baseline human health risk assessment (HHRA) estimates what risks a site poses if no action was taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. The HHRAs completed for Sites 5, 9, and 21 indicated unacceptable human health risks from exposure to surface soil, subsurface soil, and/or groundwater. A brief discussion of the findings of each HHRA is presented in each site-specific section with details provided in the RI Report for Site 5 (Tetra Tech, 2013a), RI Report for Site 9 (Tetra Tech, 2013b), and RI Report for Site 21 (Tetra Tech, 2012).

The major components of a HHRA include data evaluation, exposure assessment, toxicity assessment, risk characterization, and uncertainty analysis. Data evaluation is a task that uses a variety of information to determine which of the chemicals detected in site media are most likely to present a risk to potential receptors. The end result of the evaluation is a list of chemicals of potential concern (COPCs) and representative exposure point concentrations (EPCs) for each medium. Chemicals were identified as COPCs if they exceeded conservative screening levels. During the exposure assessment, potential human exposure pathways are identified at the areas under consideration. Chemical-specific toxicity criteria for the identified COPCs are identified during the toxicity assessment and are used in the quantification of potential human health risks. Risk characterization involves quantifying the risks associated with exposure to the COPCs using algorithms established by USEPA. Risks from chemicals are calculated for both carcinogenic and non-carcinogenic effects. The uncertainty analysis identifies limitations in the HHRA that might affect the final risk results. The final result of the HHRA if unacceptable risks are identified is the identification of medium-specific COCs and exposure pathways that need to be addressed by a remedial action. COPCs that pose unacceptable risks to receptors based on cancer and non-cancer risk estimates are identified as COCs. Tables summarizing data used in the HHRAs and associated HHRA results are presented in Appendix A.

#### Identification of COPCs

Validated data collected during the RIs were used to identify COPCs for each site. USEPA Regional Screening Levels, Illinois EPA Tier 1 Soil Remediation Objectives (SROs) for Residential Properties for the soil ingestion and inhalation exposure routes, and SROs for non-TACO chemicals were used to select

COPCs in soil. Although site groundwater is not a current source of drinking water, Illinois EPA and USEPA drinking water criteria were used to select COPCs in groundwater.

Appendix A includes EPCs for the COPCs identified at each site in soil and groundwater. EPCs are the concentrations used in the HHRA to estimate exposure and risk from each COPC. Maximum detected concentrations or 95-percent upper confidence limits on the mean (calculated using various statistical methods) were used as the EPCs.

## Exposure Assessment

The pathways through which humans might come into contact with chemicals identified as COPCs are evaluated in the exposure assessment step of the HHRA. These receptors were identified by analyzing current land use practices, potential future land use, and the identified areas of contamination to focus the HHRA on potential site-related exposures. Potential receptors under current land use were maintenance/occupational workers and trespassers, and potential receptors under future land use were construction workers and hypothetical adult and child residents. Future residential land use is not anticipated; however, it was evaluated in the HHRA for decision-making purposes. Maintenance/occupational workers, construction workers, and trespassers were evaluated for exposure to direct contact with surface and/or subsurface soil. Hypothetical residents were evaluated for exposure to groundwater by dermal contact and ingestion. Occupational/maintenance workers and hypothetical residents were evaluated for exposure to chemicals that have migrated from groundwater via vapor intrusion; however, pathways were incomplete for Sites 9 and 21 because VOCs were not COPCs. Hypothetical residents were evaluated for inhalation of volatiles from groundwater during showering; however, the pathway was incomplete for Site 9 because VOCs were not COPCs. Direct contact exposure to groundwater was evaluated for construction workers who might encounter groundwater during excavation activities. Current and future exposure pathways at Sites 5, 9, and 21 are summarized in Table 2-2.

**TABLE 2-2. RECEPTORS AND EXPOSURE ROUTES**

| RECEPTOR | EXPOSURE ROUTE |
|---|---|
| Construction Worker – current/future land use[1] | Soil dermal contact (surface and subsurface)<br>Incidental soil ingestion (surface and subsurface)<br>Inhalation of air/dust/emissions (surface and subsurface soil)<br>Groundwater (dermal contact)<br>Groundwater (inhalation in a trench)(Sites 5 and 21) |
| Maintenance/Occupational Worker – current and future land use[1, 2] | Soil dermal contact (surface and subsurface)<br>Incidental soil ingestion (surface and subsurface)<br>Inhalation of air/dust/emissions (surface soil and subsurface soil)<br>Vapor intrusion (volatilization from groundwater) (Site 5) |
| Adolescent Trespasser – current land use[3] | Soil dermal contact (surface)<br>Incidental soil ingestion (surface)<br>Inhalation of air/dust/emissions (surface soil) |
| Child and Adult Resident - hypothetical future land use[1] | Soil dermal contact (surface and subsurface)<br>Incidental soil ingestion (surface and subsurface)<br>Inhalation of air/dust/emissions (surface and subsurface soil)<br>Groundwater dermal contact<br>Groundwater ingestion<br>Groundwater inhalation of volatiles during showering (Sites 5 and 21)<br>Vapor intrusion (volatilization from groundwater)(Site 5) |

1 – Only subsurface soil and groundwater evaluated at Site 9.
2 – Subsurface soil and groundwater not evaluated for this receptor at Site 21.
3 – This receptor was not evaluated for Site 9 because contamination is only present in subsurface soil.

## Toxicity Assessment

Toxicity assessment involves identifying the types of adverse health effects caused by exposure to site COPCs and determining the relationship between the magnitude of exposure and the severity of adverse effects (i.e., dose-response relationship) for each COPC. Quantitative toxicity values [oral cancer slope factors (CSFs)], oral reference doses (reference doses [RfDs], cancer inhalation unit risks, and non-cancer inhalation reference concentrations) determined during this component of the risk assessment were integrated with outputs of the exposure assessment to characterize the potential for adverse health effects for each receptor group.

Appendix A includes tables of non-carcinogenic hazard and carcinogenic risk information relevant to the COPCs identified at each site for oral/dermal and inhalation routes of exposure.

## Risk Characterization

During the risk characterization, the outputs of the exposure and toxicity assessments are combined to characterize the baseline risk (cancer risks and non-cancer hazards) at each site if no action was taken to address the contamination. Potential cancer risks and non-cancer hazards were calculated based on reasonable maximum exposure (RME) and central tendency exposure (CTE) assumptions. The RME scenario assumes the maximum level of human exposure that could reasonably be expected to occur, and the CTE scenario assumes a median or average level of human exposure.

For carcinogens, risks are generally expressed as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the carcinogen. Excess lifetime cancer risk is calculated from the following equation:

$$\text{Risk} = \text{chronic daily intake (CDI)} \times \text{CSF}$$

where:
Risk = a unitless probability (e.g., $2 \times 10^{-5}$) of an individual developing cancer
CDI = chronic daily intake averaged over exposure duration (in milligram per kilogram-day [mg/kg-day])
CSF = slope factor (in $[\text{mg/kg-day}]^{-1}$)

Cancer risks estimates for the human receptors and routes of exposure evaluated for each site are presented in each of the site-specific summary of risks sections. For known or suspected carcinogens, USEPA acceptable additional cancer risk falls within a range between 1 person in 10,000 ($1 \times 10^{-4}$) and 1 person in 1 million ($1 \times 10^{-6}$), known as the risk management range. Risks less than 1 in 1 million (that is, less than $1 \times 10^{-6}$) are considered to be acceptable. Risks greater than 1 in 10,000 (that is, greater than $1 \times 10^{-4}$) are typically considered unacceptable and require remedial action. The Illinois EPA goal for carcinogenic risks, as specified in TACO Tier 1 and 2, is $1 \times 10^{-6}$. However, under a TACO Tier 3 Evaluation [35 Illinois Administrative Code (IAC) 742.900(d)], a formal HHRA can be used to support a less restrictive target risk range of $1 \times 10^{-4}$ to $1 \times 10^{-6}$.

The potential for non-carcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., a lifetime) to an RfD derived for a similar exposure period. An RfD represents a level to which an individual may be exposed that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is called a hazard quotient (HQ). An HQ of 1 or less indicates that the dose of a single contaminant is unlikely to result in toxic non-carcinogenic effects from that chemical. The hazard index (HI) is generated by adding the HQs for the chemicals that affect the same target organ (e.g., liver) or that act through the same mechanism of action within a medium or across the media to which a given individual may be reasonably exposed. An HI less than 1 indicates that, based on the sum of the HQs from different contaminants and exposure routes, toxic non-carcinogenic effects from the contaminants are unlikely. An HI greater than 1 indicates that site-related exposures may present a risk to human health. The HQ is calculated as follows:

Non-cancer HQ = CDI / RfD

where: HQ = hazard quotient
CDI = chronic daily intake (mg/kg-day)
RfD = reference dose (mg/kg-day)

Non-cancer HQs for each receptor and route of exposure evaluated and total HIs for the routes of exposure at each site are presented in each of the site-specific summary of risks sections. The USEPA and Illinois EPA acceptable non-cancer risk level is an HI less than or equal to 1.

No major sources of uncertainty, other than those typically associated with HHRA estimates, were identified for the HHRAs.

### Remedial Action Objective and Cleanup Level Development

Remedial Action Objectives (RAOs) are medium-specific goals that define the objective of conducting remedial actions to protect human health and the environment. RAOs specify the COCs, potential exposure routes and receptors, and acceptable concentrations (i.e., cleanup levels) for a site and provide a general description of what the cleanup will accomplish. The RAOs and remedial alternatives for each site are described in the site-specific sections below. The RAOs considered both current and future land use at NSGL.

Because groundwater is not used due to existing use restrictions and based on discussion with Illinois EPA, cleanup levels were only developed for COCs in groundwater that were detected at concentrations that exceed **USEPA Maximum Contaminant Levels (MCLs)**. In addition to the COCs determined from the HHRA, chemicals that exceeded TACO criteria for I/C and construction worker exposure were also considered when evaluating RAOs in addition to the COCs determined from the HHRA.

### General Response Actions

To address potential unacceptable human health risks associated with soil and groundwater at Sites 5, 9, and 21, a preliminary technology screening evaluation for all three sites was conducted in the **Focused Feasibility Study** (FFS) (Tetra Tech, 2013c). The general response actions for soil and groundwater are presented in site-specific tables below.

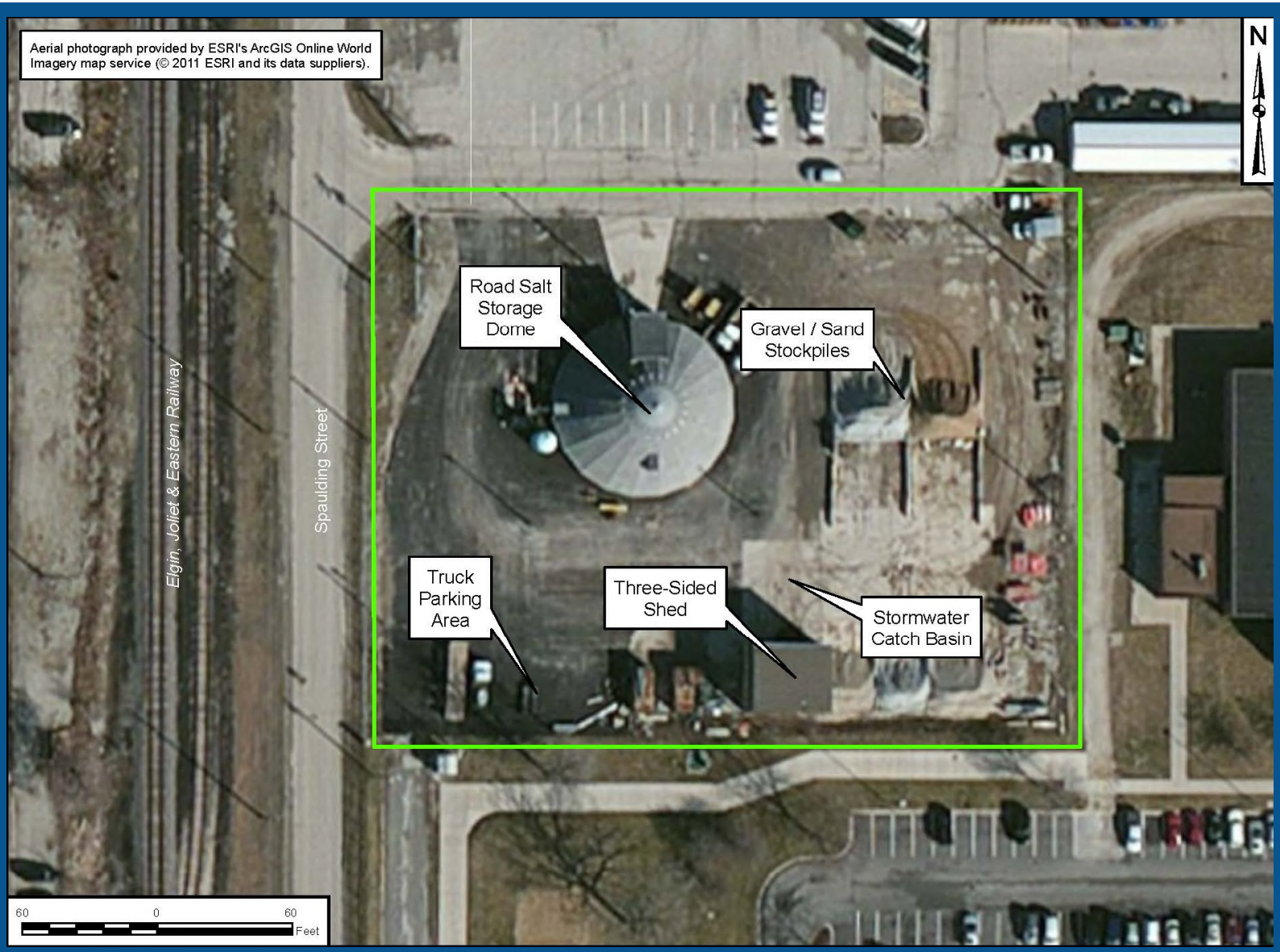
The technologies and process options retained after detailed screening were assembled into alternatives that are described in the site-specific sections. Consistent with the NCP, the no action alternative was evaluated as a baseline for comparison with other alternatives during the comparative analysis for each site for which alternatives were developed. The site-specific sections describe the major components and provide estimated costs for each remedial alternative identified for Sites 5, 9, and 21.

## 2.2 SITE 5

### 2.2.1 Site 5 Site Characteristics

Site 5 is located in an industrial area of the base that consists largely of buildings and parking lots and has very little vegetation. The approximately 2-acre site is a flat area that is partially paved and graveled. From 1945 to 1985, Site 5 was used primarily as a storage area for out-of-service transformers, including some that contained polychlorinated biphenyl (PCB) oils. Lead-insulated cable, heavy equipment, and other miscellaneous scrap metal and materials were also stored at the site. Currently, the site contains a road salt storage dome, shed, catch basin, sand and gravel stockpiles, and equipment and vehicles for road maintenance (Figure 2-3).

## FIGURE 2-3. SITE 5 LAYOUT



Pettibone Creek is located approximately 1,000 feet east of Site 5. Stormwater runoff from the area may discharge contaminated soil into Pettibone Creek; however, possible impacts to Pettibone Creek were evaluated as part of the Remedial Investigation for Pettibone Creek (Site 17).

The site is almost entirely covered by pavement and a storage structure; therefore, current occupational/maintenance workers are not regularly exposed to soil at the site.

The IAS documented that waste materials at Site 5 included transformer oils, PCB transformer oils, and lead insulation from high-voltage cables. A Verification Study, completed in 1991, indicated the presence of oil and grease, the PCB Aroclor-1260, and elevated concentrations of lead in soil. The presence of oil and grease was presumably due to leaks from stored vehicles, vehicle maintenance activities, and transformer storage. Aroclor-1260 detections in soil may have been from storage of PCB oil-laden transformers. Lead was detected at concentrations exceeding regional background concentrations, and the source of lead at the site is likely from the storage of lead-insulated cable.

Coal was stored near this area before its use as the former transformer boneyard. When the site was used as a transformer storage area, surface soil was most likely impacted from maintenance of the transformers or from leaking transformers. The oil and grease and lead contamination in surface soil could have resulted from fueling activities, spills, or from the storage of equipment and materials at the site. It was also reported that dumpsters from NSGL have been cleaned and painted in the area in the past which could have contributed contaminants to the surface soil. PAH concentrations may be linked to asphalt paving or historical storage of coal near the area before site use for transformer storage.

Potential receptors and exposure pathways are discussed in Section 2.1.7.

### Nature and Extent of Contamination

The Navy conducted a RI at Site 5 in 2010 and 2012 that included the collection of surface soil (i.e., the first 6 inches of soil below the asphalt and gravel base of the parking lot), subsurface soil, and groundwater samples. Samples were analyzed for VOCs, semivolatile organic compounds (SVOCs), PCBs, and metals during the 2010 field investigation. The **results of the chemical analyses** were used to identify the type and extent of chemicals in soil and groundwater at Site 5. The 2012 field investigation was conducted to complete delineation of VOCs in soil and groundwater at Site 5.

Concentrations of PAHs, iron, and manganese in surface soil and benzene, PAHs, manganese, and mercury in subsurface soil exceeded Illinois EPA TACO criteria. Concentrations of arsenic in subsurface soil exceeded an **Illinois EPA background value**. Concentrations of chloroform, carbon tetrachloride, barium, iron, and manganese in groundwater exceeded Illinois EPA TACO criteria; however, only carbon tetrachloride and barium exceeded their respective MCLs. Concentrations of other parameters, such as Aroclor-1260 and lead noted for elevated concentrations in the Verification Study, were less than Illinois EPA TACO criteria. Based on consideration of Illinois EPA criteria exceedances as well as unacceptable human health risks, PAHs, arsenic, iron (surface soil only), and manganese in soil and carbon tetrachloride and barium in groundwater were selected as COCs, as described further below.

The majority of PAH concentrations in soil exceeding criteria were beneath pavement or immediately adjacent to paved areas. Most metals detected may be background constituents, but some metals concentrations are likely from storage of materials at the site. Metals concentrations in soil were generally greatest at the northwestern and southwestern corners of the site. VOCs in groundwater were detected at the northeastern corner of the site near maintenance shops. Barium was detected in groundwater near Building 1516, which stores road salt. Sodium from the road salt may affect groundwater pH and cause dissolution of certain soil metals (e.g., barium iron, and manganese) into groundwater.

### 2.2.2 Summary of Site 5 Risks

The investigation at Site 5 included evaluating the potential **human health risks** from detected chemical concentrations in surface soil, subsurface soil, and groundwater.

#### Summary of Human Health Risks

Tables summarizing data used in the Site 5 HHRA and associated results are presented in Appendix A. Tables 1 to 3 in Appendix A.1 present EPCs for the COPCs identified at Site 5 in surface soil, subsurface soil, and groundwater. Tables 4 and 5 in Appendix A.1 provide assumptions about the frequency and duration of exposure for each receptor. Tables 6 and 7 in Appendix A.1 provide non-carcinogenic hazard information relevant to the Site 5 COPCs for oral/dermal and inhalation routes of exposure, respectively. Tables 8 and 9 in Appendix A.1 provide carcinogenic risk information relevant to the Site 5 COPCs for oral/dermal and inhalation exposure.

Tables 10 to 12 in Appendix A.1 provide RME and CTE cancer risk estimates for the significant receptors and routes of exposure developed by taking into account various conservative assumptions about the frequency and duration of exposure for each receptor and also about the toxicity of the COPCs. RME cancer risk estimates are presented in this section. Cancer risks were compared to the USEPA and Illinois EPA Tier 3 target risk range of $1 \times 10^{-4}$ to $1 \times 10^{-6}$. The risks from exposure to surface soil and/or subsurface soil for construction workers, maintenance/occupational workers, and trespassers were within the risk range. However, several soil samples had concentrations of PAHs that were greater than the I/C and construction worker TACO criteria. The risks from exposure to groundwater for construction workers and maintenance/occupational workers were within the risk range. There were unacceptable cancer risks from exposure to surface soil, subsurface soil, and groundwater for hypothetical future child, adult, and lifelong residents.

Carcinogenic PAHs and arsenic in soil and groundwater are the major contributors to cancer risk at Site 5, with carbon tetrachloride in groundwater also contributing to cancer risk. Carbon tetrachloride in groundwater contributes to risk only if groundwater (with the carbon tetrachloride result from the single detection in a single well) was used for 30 years of residential use.

Tables 10 to 12 in Appendix A.1 also provide RME and CTE non-cancer HQs for each receptor and route of exposure and total HIs for the routes of exposure. RME non-cancer HIs are presented in this section. Non-cancer risks were compared to the USEPA and Illinois EPA HI target risk level of 1. There were no unacceptable risks from exposure to surface soil and/or subsurface soil for construction workers (based on re-evaluation of the soil inhalation pathway as discussed below), maintenance/occupational workers, and trespassers. There were no unacceptable risks from exposure to groundwater for construction workers (based on further evaluation of exposure assumptions as discussed below) and maintenance/occupational workers. There were unacceptable non-cancer risks from exposure to surface soil, subsurface soil, and groundwater for hypothetical future child, adult, and lifelong residents.

Carbon tetrachloride, barium, cobalt, iron, and manganese, but predominantly manganese, were identified as the chemicals in groundwater resulting in an HQ greater than 1 for hypothetical future residents (ingestion).

The Navy, Illinois EPA, and Tetra Tech collectively determined that the USEPA Particulate Emissions Factor (PEF) used to calculate the HI for the inhalation pathway was overly conservative for the site and not a realistic representation of Site 5. Therefore, a site-specific determination was made to use the Illinois EPA TACO PEF to calculate HIs for the construction worker inhalation pathway. The Illinois EPA TACO PEF is less conservative than the USEPA PEF; however, it is still considered protective. This recalculation conducted as part of the FFS (Tetra Tech, 2013c) resulted in soil RME HIs (including the inhalation pathway) of less than 1 for construction workers (Tables 13 to 18 in Appendix A.1). Therefore, non-cancer risks from soil exposure are acceptable for the construction worker receptor at Site 5.

Manganese was identified as the COC in groundwater resulting in an HQ greater than 1 for construction workers (dermal contact). However, the HHRA assumptions are unrealistically conservative for the dermal pathway with groundwater for the construction worker. Realistically, contact with shallow groundwater in a construction scenario would be of short duration and limited since it is likely that waterproof boots would be worn in an inundated excavation. Therefore, actual non-cancer risks are likely much lower for a construction worker's potential contact with groundwater and non-cancer risks for groundwater exposure are acceptable for the construction worker receptor at Site 5.

The following constituents were identified as Site 5 COCs for exceeding a cancer risk of $1x10^{-4}$ and/or an HQ of 1:

- Carcinogenic PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, and indeno(123-cd)pyrene) , arsenic, and iron for hypothetical future residential exposure to surface soil.
- Carcinogenic PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(123-cd)pyrene), arsenic, and manganese for hypothetical future residential exposure to subsurface soil.
- Carbon tetrachloride, barium, cobalt, iron, manganese for hypothetical future residential exposure to groundwater.

### Basis for Action

Unacceptable risks from exposure to carcinogenic PAHs, arsenic, iron, and manganese in soil and carbon tetrachloride, barium, cobalt, iron, manganese in groundwater were estimated for hypothetical future residents at Site 5. In addition several soil samples had concentrations of PAHs that were greater than the I/C and construction worker TACO criteria.

Because unacceptable risks were identified under a future land use scenario for human receptors and concentrations of PAHs exceeded TACO criteria for the current and future I/C and construction worker, a response action is necessary to protect human health or the environment from actual or threatened releases of hazardous substances into the environment that may present an imminent and substantial endangerment.

## 2.2.3 Site 5 Remedial Action Objectives

RAOs are medium-specific goals that define the objective of conducting remedial actions to protect human health and the environment. RAOs generally specify the COCs, potential exposure routes and receptors, and acceptable concentrations (i.e., cleanup levels) for a site, and provide a general description of what the cleanup will accomplish. The following RAOs were developed for Site 5:

**RAO 1:** Prevent residential exposure through ingestion, dust inhalation, and dermal contact to contaminated surface soil and subsurface soil with COC concentrations exceeding cleanup levels.

**RAO 2:** Prevent I/C and construction worker exposure through ingestion, dust inhalation, and dermal contact to contaminated surface soil with COC concentrations exceeding TACO criteria.

**RAO 3:** Return the groundwater resource to beneficial use, if practicable, and address human health risks associated with groundwater consumption.

For soil, the most conservative of the Illinois EPA TACO Tier 1 SROs for residential exposure via incidental ingestion and inhalation were used to identify target concentrations for evaluation of unrestricted use of the property. In addition, risk-based criteria based on residential exposure associated with an HI of 1 and a cancer risk of $1 \times 10^{-5}$ were also considered as possible cleanup levels. For a given COC, the SROs and risk-based values are generally comparable. In those cases, the greater of the two

values is selected so that the cleanup levels are not overly conservative. However, for a COC for which the difference is an order of magnitude or more, suggesting that significantly different assumptions were made in the risk calculation method(s), the lesser value was used to provide better certainty of protectiveness. Selection of cleanup levels for concentrations of PAHs and inorganics in surface soil also took background concentrations into consideration, with background concentrations as defined in the TACO Appendix A Table G for inorganics and Appendix A Table H for PAHs. Because several soil samples exceeded the TACO criteria for occupational/maintenance workers and construction worker, the corresponding I/C and construction worker TACO values for the COCs identified in surface and subsurface soil were retained as cleanup levels. Table 2-3 summarizes the cleanup levels for Site 5 soil. Residential levels are used where residential use is required or assumed. I/C and construction levels are used where non-residential use is required or assumed.

**TABLE 2-3. SOIL CLEANUP LEVELS**

| COC | RESIDENTIAL SURFACE SOIL | BASIS | RESIDENTIAL SUB-SURFACE SOIL | BASIS | TACO I/C | TACO CONST |
|---|---|---|---|---|---|---|
| Arsenic (mg/kg) | 13 | BG | 13 | BG | 13 | 61 |
| Iron (mg/kg) | 55,000 | HHRA | NA | - | - | - |
| Manganese (mg/kg) | 1,600 | TACO | 1,600 | TACO | 41,000 | 4,100 |
| Benzo(a)anthracene [micrograms per kilogram (µg/kg)] | 1,800 | BG | 1,500 | HHRA | 8,000 | 170,000 |
| Benzo(a)pyrene (µg/kg) | 2,100 | BG | 150 | HHRA | 800 | 17,000 |
| Benzo(b)fluoranthene (µg/kg) | 2,100 | BG | 1,500 | HHRA | 8,000 | 170,000 |
| Benzo(k)fluoranthene (µg/kg) | 9,000 | TACO | 15,000 | HHRA | 78,000 | 1,700,000 |
| Dibenzo(a,h)anthracene (µg/kg) | 420 | BG | 150 | HHRA | 800 | 17,000 |
| Indeno(123-cd)pyrene (µg/kg) | 1,600 | BG | 1,500 | HHRA | 8,000 | 170,000 |

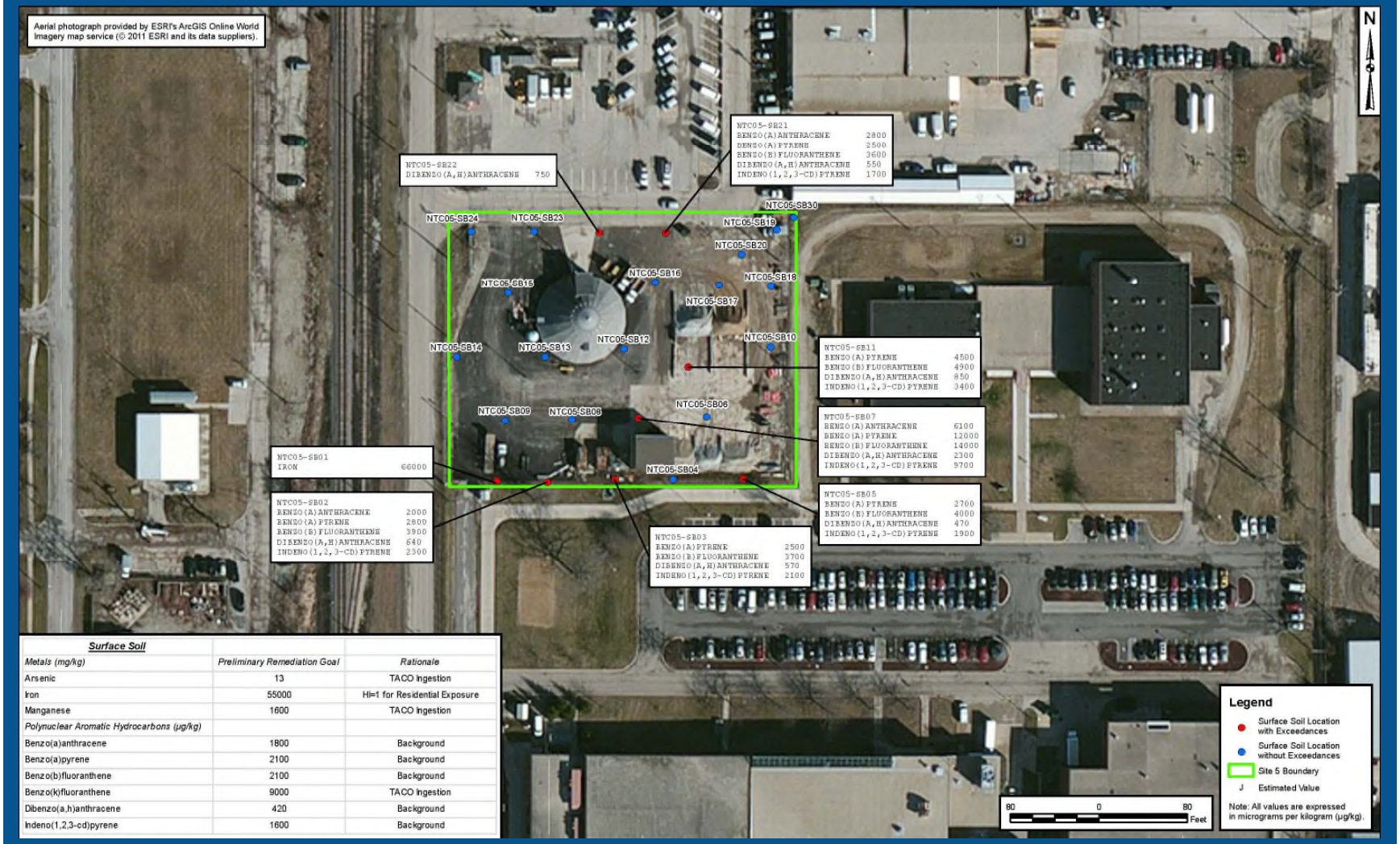
BG – Background.
Const – Construction worker.

Groundwater cleanup levels were developed using Class I groundwater standards in 35 IAC 620, federal MCLs, and Illinois EPA TACO values. Based on current site information, groundwater at Site 5 is assumed to be classified as Class I under 35 IAC 620. Existing administrative restrictions on groundwater use and low yield prevent the effective use of groundwater as a drinking water source, so although MCLs and TACO values have been considered, exposure routes are not complete, and MCLs and TACO values were not used to select cleanup levels. At Site 5, only carbon tetrachloride and barium concentrations in groundwater exceed their MCLs and, per Illinois EPA, require identification of cleanup levels. The cleanup levels based on Class I standards are 5 micrograms per liter (µg/L) and 2,000 µg/L, respectively.

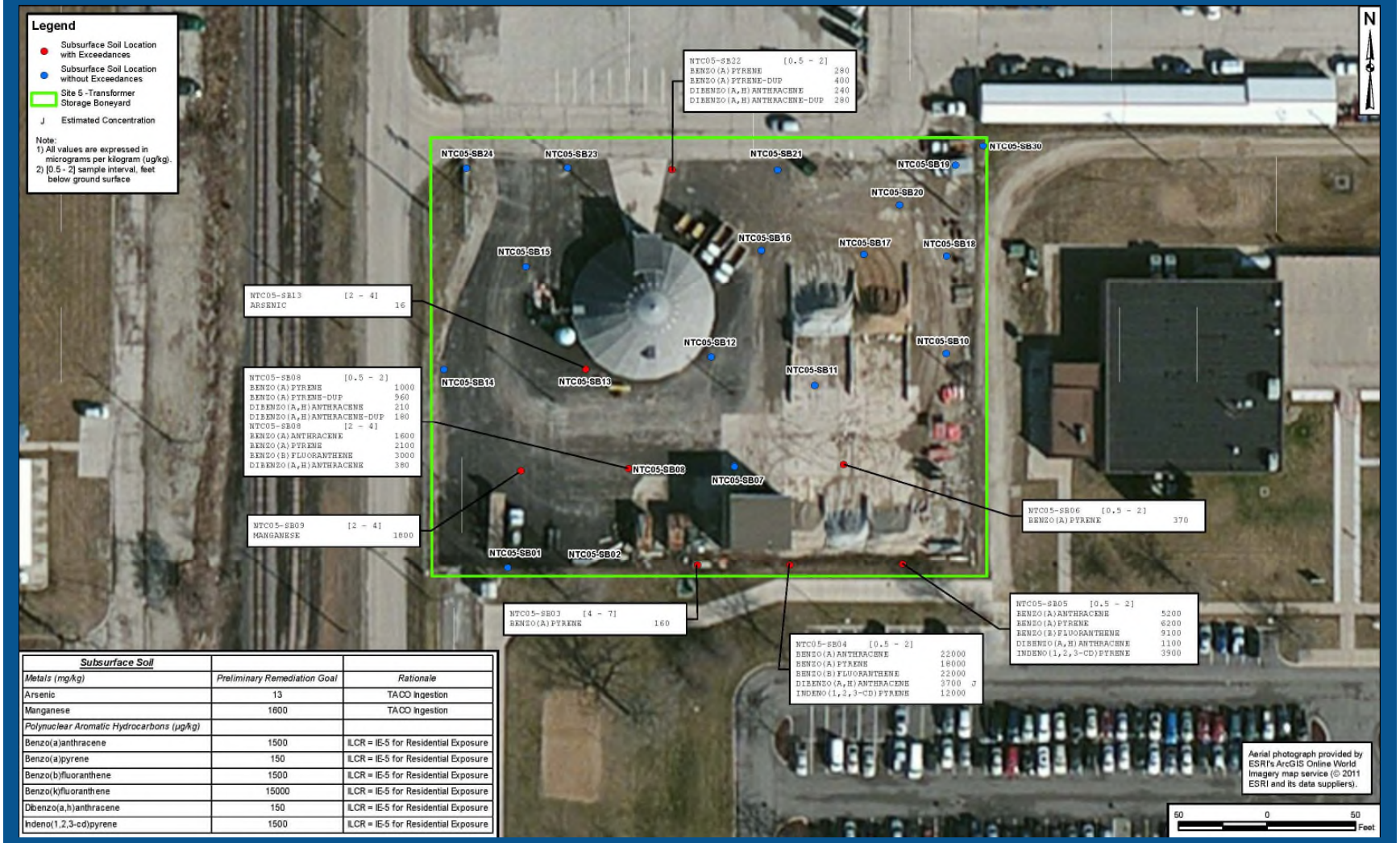
For Site 5, exceedances of residential cleanup levels in surface soil are shown on Figure 2-4, and exceedances of residential cleanup levels in subsurface soil are shown on Figure 2-5. Exceedances of groundwater cleanup levels are shown on Figure 2-6.

Approximately 4,000 cubic yard (cy) of contaminated soil is present at Site 5. The contamination is present to an approximate depth of 1 to 4 feet below ground surface (bgs). The groundwater plume is limited to the area around one well where contaminant concentrations were greater than cleanup levels. Therefore, the volume of contaminated groundwater was not calculated.

## FIGURE 2-4. SITE 5 EXCEEDANCES OF RESIDENTIAL CRITERIA IN SURFACE SOIL

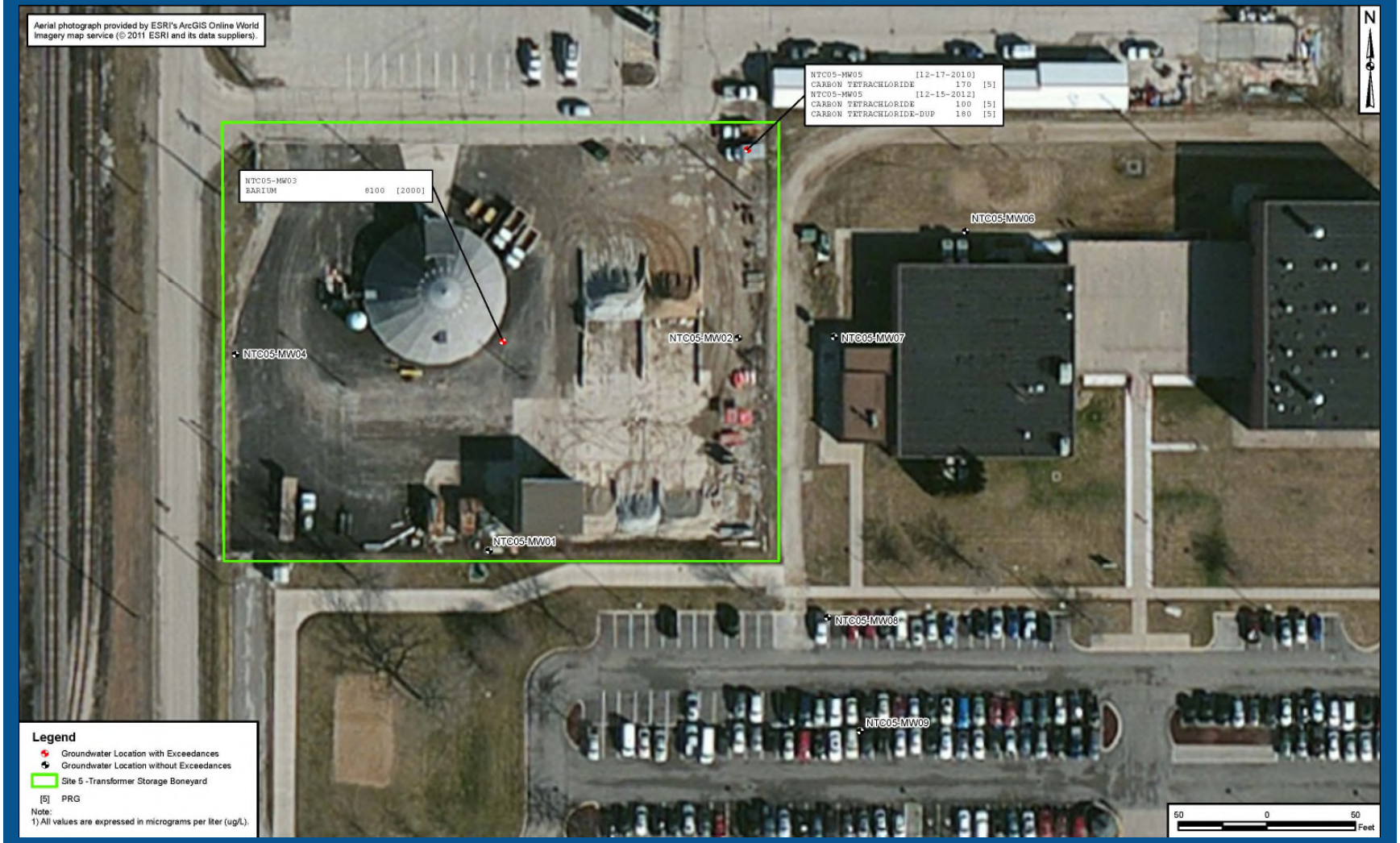


## FIGURE 2-5. SITE 5 EXCEEDANCES OF RESIDENTIAL CRITERIA IN SUBSURFACE SOIL




| Subsurface Soil | | |
|---|---|---|
| *Metals (mg/kg)* | *Preliminary Remediation Goal* | *Rationale* |
| Arsenic | 13 | TACO Ingestion |
| Manganese | 1600 | TACO Ingestion |
| *Polynuclear Aromatic Hydrocarbons (µg/kg)* | | |
| Benzo(a)anthracene | 1500 | ILCR = IE-5 for Residential Exposure |
| Benzo(a)pyrene | 150 | ILCR = IE-5 for Residential Exposure |
| Benzo(b)fluoranthene | 1500 | ILCR = IE-5 for Residential Exposure |
| Benzo(k)fluoranthene | 15000 | ILCR = IE-5 for Residential Exposure |
| Dibenzo(a,h)anthracene | 150 | ILCR = IE-5 for Residential Exposure |
| Indeno(1,2,3-cd)pyrene | 1500 | ILCR = IE-5 for Residential Exposure |

## FIGURE 2-6. SITE 5 EXCEEDANCES OF GROUNDWATER CRITIERA



### 2.2.4 Description of Alternatives for Site 5

**General response actions** are broadly defined remedial approaches that may be used (by themselves or in combination with others) to attain the RAOs. Because the HHRA identified potential non-carcinogenic risks at a concentration in excess of the HI of 1 and carcinogenic risks in excess of 1 x $10^{-4}$, general response actions for Site 5 were developed as presented in Table 2-4.

**TABLE 2-4. GENERAL RESPONSE ACTIONS FOR SITE 5**

| GENERAL RESPONSE ACTION | TECHNOLOGY | PROCESS OPTIONS |
|---|---|---|
| **Soil** | | |
| No Action | None | Not Applicable |
| Limited Action | Institutional Controls | LUCs |
| Containment | Barrier | Asphalt, Soil, or Building |
| Removal | Excavation/Disposal | Off-Base Landfill Disposal |
| **Groundwater** | | |
| No Action | None | Not Applicable |
| Limited Action | Institutional Controls | LUCs |
| | Monitoring | Sampling and Analysis |
| In-Situ Treatment | Chemical | Chemical Oxidation |

Table 2-5 describes the major components of the Site 5 alternatives evaluated and provides associated costs.

**TABLE 2-5. SUMMARY OF REMEDIAL ALTERNATIVES EVALUATED FOR SITE 5**

| ALTERNATIVE | COMPONENTS | DETAILS | COST |
|---|---|---|---|
| **Alternative 5-1:**<br>**No Action**<br>*No action to address contamination and no use restrictions* | No action would be conducted | Five-year reviews would not be included under the no action alternative. | **Cost**: $0 |
| **Alternative 5-2:**<br>**LUCs and Barrier**<br>*Current and future land use restrictions, maintenance of existing pavement and building foundation* | LUCs | LUCs would be implemented to prevent residential land use, restrict unauthorized construction, require notification of the presence of contaminants to construction workers, require review of construction activities and intrusive work in the area to protect workers through PPE and alternative methods to reduce exposure, require proper management of excavated material, provide for long-term inspection of LUCs, and provide requirements for dealing with changes in land use or site features. LUCs would be maintained in perpetuity. | **Capital**: $21,000<br>**Operation and Maintenance (O&M)**: $9,000<br>**Five-Year Reviews**: $26,000<br>**30-Year NPW**: $366,000 |
| | | LUCs would require routine inspection of the pavement and building foundation and repairs to the pavement and foundation to prevent exposure to contaminated soil. | |
| | | LUCs would be implemented over the entire site to restrict groundwater use. | |

**TABLE 2-5. SUMMARY OF REMEDIAL ALTERNATIVES EVALUATED FOR SITE 5**

| ALTERNATIVE | COMPONENTS | DETAILS | COST |
|---|---|---|---|
| **Alternative 5-2:** (continued) | Barrier | The existing pavement and building would be used as a barrier to prevent exposure of I/C workers to soil contaminants exceeding I/C TACO cleanup levels. Barriers would be required to remain, either a building, pavement, or soil. | (See previous page) |
| **Alternative 5-2A: LUCs, Barrier, and In-Situ Chemical Oxidation (ISCO)** *Current and future land use restrictions, maintenance of existing pavement and building foundation, ISCO treatment of groundwater* | LUCs | Implementation of LUC requirements as described in Alternative 5-2. Soil LUCs would be maintained in perpetuity. Groundwater LUCs would only continue until the ISCO is completed and the groundwater cleanup level is met. | **Capital**: $378,000 **O&M**: $9,000 **Five-Year Reviews**: $26,000 **30-Year NPW**: $723,000 |
| | Barrier | The existing pavement and building would be used as a barrier as described in Alternative 5-2. | |
| | ISCO | Oxidant would be injected into the groundwater at the location where the groundwater cleanup level for carbon tetrachloride is exceeded. Groundwater samples would be collected and analyzed to monitor the progress of treatment. | |
| **Alternative 5-3 Excavation (Unrestricted Reuse), Off-Site Disposal, and LUCs** *Excavation and off-site disposal of unsaturated soil, LUCs for groundwater* | Excavation and Disposal | Excavation and off-site disposal of 4,000 cy of soil to meet cleanup levels for residential exposure. It is assumed that this alternative would only be implemented if the base was closed and there was a change in land use. Excavated material would be transported off site to a non-hazardous landfill for disposal. Excavated areas would be backfilled with clean soil, and the surface would be reseeded with grass. | **Capital**: $1,301,000 **O&M**: $3,000 **Five-Year Reviews**: $26,000 **30-Year NPW**: $1,492,000 |
| | LUCs | LUCs would be implemented over the entire site to restrict groundwater use. | |
| **Alternative 5-3A Excavation (Unrestricted Reuse), Off-Site Disposal, LUCs, and ISCO** *Excavation and off-site disposal of unsaturated soil, ISCO treatment of groundwater, LUCs for groundwater* | Excavation and Disposal | Contaminated soil would be excavated and disposed of off-site as described in Alternative 5-3A. | **Capital**: $1,637,000 **O&M**: $3,000 **Five-Year Reviews**: $26,000 **30-Year NPW**: $1,829,000 |
| | ISCO | ISCO would be applied as described in Alternative 5-2A. | |
| | LUCs | Implementation of LUC requirements as described in Alternative 5-3. Groundwater LUCs would only continue until the ISCO is completed and the groundwater cleanup level is met. | |

### 2.2.5 Comparative Analysis of Alternatives for Site 5

Table 2-6 and subsequent text in this section summarize the comparison of the remedial alternatives for Site 5 with respect to the **nine CERCLA evaluation criteria** outlined in the NCP at 40 CFR 300.430(e)(9)(iii) and categorized as threshold, primary balancing, and modifying criteria. Further information on the detailed comparison of remedial alternatives is presented in the Sites 5, 9, and 21 FFS (Tetra Tech, 2013c).

**TABLE 2-6: SUMMARY OF COMPARATIVE ANALYSIS OF SITE 5 REMEDIAL ALTERNATIVES**

| ALTERNATIVE | 5-1 | 5-2 | 5-2A | 5-3 | 5-3A |
|---|---|---|---|---|---|
| **Estimated Time Frame** | | | | | |
| Designing and Constructing the Alternative (months) | N/A | 3 | 24 | 2 | 24 |
| Achieving the Cleanup Objectives (months) | N/A | 3 | 3 | 2 | 2 |
| **Criteria Analysis** | | | | | |
| **Threshold Criteria** | | | | | |
| Protects human health and the environment<br>Will it protect you and plant and animal life on and near the site? | No | Yes | Yes | Yes | Yes |
| Meets federal and state regulations<br>Does the alternative meet federal and state environmental statutes, regulations, and requirements? | N/A | ● | ● | ● | ● |
| **Primary Balancing Criteria** | | | | | |
| Provides long-term effectiveness and is permanent<br>Will the effects of the cleanup last? | ○ | ◘ | ◘ | ● | ● |
| Reduces mobility, toxicity, and volume of contaminants through treatment<br>Are the harmful effects of the contaminants, their ability to spread, and the amount of contaminated material present reduced? | ○ | ○ | ◘ | ○ | ◘ |
| Provides short-term protection<br>How soon will the site risks be reduced?<br>Are there hazards to workers, residents, or the environment that could occur during cleanup? | N/A | ● | ● | ◘ | ◘ |
| Can it be implemented<br>Is the alternative technically feasible?<br>Are the goods and services necessary to implement the alternative readily available? | N/A | ● | ● | ● | ● |
| Cost (K = 1,000s)<br>Upfront costs to design and construct the alternative (capital costs)<br>Total cost in today's dollars (30-year NPW cost) | <br>$0<br>$0 | <br>$21K<br>$366K | <br>$378K<br>$723K | <br>$1,301K<br>$1,492K | <br>$1,637K<br>$1,829K |
| **Modifying Criteria** | | | | | |
| State agency acceptance<br>Does Illinois EPA agree with the Navy's recommendation? | Illinois EPA concurs with Alternative 5-2. | | | | |
| Community acceptance<br>What objections, suggestions, or modifications does the public offer during the comment period? | No written questions, comments, or requests for a public meeting were received during the formal public comment period for the Proposed Plan. | | | | |
| Relative comparison of the nine balancing criteria and each alternative:<br>● – Good , ◘ – Average, ○ – Poor; N/A –Not applicable. | | | | | |

## Threshold Criteria

***Overall Protection of Human Health and the Environment***. The no action alternative would not achieve the RAOs and therefore does not protect human health and the environment. It will therefore not be considered further in this ROD. The other four alternatives meet this criterion. Alternative 5-3A would

be the most protective because contaminants would be removed from the site by excavation, and concentrations in groundwater that exceed MCLs would be treated. Alternative 5-3 would be the next most protective because contaminants would be removed from the site by excavation and, LUCs would prevent exposure to contaminated groundwater. Alternatives 5-2 and 5-2A are similar in protectiveness because both would rely on LUCs and the barriers to prevent exposure to contaminants in soil and groundwater. Alternative 5-2A is slightly more protective because concentrations in groundwater that exceed MCLs would be treated.

***Compliance with ARARs***. Applicable or Relevant and Appropriate Requirements (ARARs) include any federal or state standards, requirements, criteria, or limitations determined to be legally applicable or relevant and appropriate to the site or remedial action. The four alternatives would comply with ARARs.

## Primary Balancing Criteria

***Long-Term Effectiveness and Permanence***. Alternative 5-3A would provide the most long-term effectiveness and permanence because contaminated soil would be disposed of off-site, and some of the groundwater COCs would be removed by in-situ treatment. Alternative 5-3 would provide the next-most long-term effectiveness and permanence because contaminated soil would be disposed of off-site, but exposure to groundwater COCs would be prevented by LUCs. The effectiveness of LUCs would rely on enforcement of the provisions of the LUCs. Alternatives 5-2 and 5-2A would provide similar effectiveness and permanence through LUCs and barriers that would prevent exposure to COCs in soil and groundwater. As noted, the effectiveness of LUCs would rely on enforcement of the provisions of the LUCs. Alternative 5-2A would provide slightly more permanence compared to Alternative 5-2 because some of the groundwater COCs would be removed by in-situ treatment.

***Reduction in Toxicity, Mobility, or Volume Through Treatment***. Alternatives 5-2A and 5-3A would provide treatment of some of the COCs in groundwater. Alternatives 5-2 and 5-3 do not include groundwater treatment, and none of the alternatives include soil treatment. Contaminant concentrations in soil are too low to justify the cost of treatment.

***Short-Term Effectiveness***. The four alternatives would require the maintenance of groundwater LUCs. Alternatives 5-2A and 5-3A would include groundwater treatment so some LUCs could be discontinued after ISCO is applied and cleanup levels are met. Alternative 5-2 could be completed in the shortest time because only LUCs would need to be implemented. Alternative 5-3 would take a longer time to complete because of implementation LUCs and soil excavation. Alternatives 5-2A and 5-3A would require the longest time to complete (over 1 year) to implement ISCO treatment and groundwater performance monitoring.

Alternative 5-2 would have no short-term risk to the local community or the environment. Alternative 5-2A would have a slight risk to the community during the transport of oxidant to the site. Potential risks to workers conducting the ISCO injection and groundwater monitoring would be managed by proper safety procedures and PPE. Alternative 5-3 would have a slightly greater risk to the community associated with transport of contaminated soil from the site and clean soil to the site. Potential risks to workers conducting the excavation would be managed by proper safety procedures and PPE. Alternative 5-3A would have the greatest potential risk to the community associated with transport of contaminated soil from the site and clean soil and oxidant to the site. Potential risks to workers conducting the excavation, ISCO injection, and groundwater monitoring would be managed by proper safety procedures and PPE.

***Implementability***. The alternatives could be readily implemented. Alternative 5-2 would be the easiest to implement because it would involve administrative activities associated with documenting and maintaining use restrictions. Alternative 5-2A would be slightly more difficult to implement because of the tasks associated with ISCO drilling and injection and groundwater monitoring. However, there are numerous contractors that perform this work. Alternative 5-3 would be the next most difficult to perform due to the excavation. However, the excavation is shallow, and no special expertise would be required. Alternative 5-3A would be the most difficult, but only when compared to the other alternatives. The shallow excavation and ISCO tasks could be performed by many contractors.

***Cost***. Alternative 5-2 has the lowest estimated NPW of $366,000. The estimated NPW for Alternatives 5-2A and 5-3 are $723,000 and $1,492,000, respectively. Alternative 5-3A has the highest estimated NPW of $1,829,000. There is uncertainty in the excavation costs because the extent of contamination is not completely delineated. In addition, the ISCO treatment in Alternative 5-2A and 5-3A provides little risk reduction relative to the treatment costs. Detailed cost estimates for each alternative are presented in the FFS (Tetra Tech, 2013c).

### Modifying Criteria

***State Acceptance***. State involvement has been solicited throughout the CERCLA process. Illinois EPA, as the designated state support agency in Illinois, concurs with the Site 5 Selected Remedy.

***Community Acceptance***. No written questions, comments, or requests for a public meeting were received during the formal public comment period for the Proposed Plan.

## 2.2.6 Principal Threat Waste

The NCP at 40 CFR 300.430(a)(1)(iii)(A) establishes an expectation that treatment will be used to address the principal threats posed by a site wherever practicable. **Principal threat wastes** are hazardous or highly toxic source materials that result in ongoing contamination to surrounding media and that generally cannot be reliably contained or that present a significant risk to human health or the environment should exposure occur. A source material includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to groundwater, surface water, or air, or acts as a source for direct exposure.

A current source of contamination is not present at Site 5. Contaminant concentrations are not at levels that are characteristic of a source. In addition, contaminant concentrations are not highly toxic nor highly mobile. Therefore, principal threat wastes are not present at Site 5.

## 2.2.7 Selected Remedy for Site 5

### 2.2.7.1 Rationale for Selected Remedy

The Selected Remedy for Site 5 is Alternative 5-2, LUCs and Barrier, which was selected because it provides the best balance of tradeoffs with respect to the nine evaluation criteria and will allow for continued non-residential use of the property. This alternative was selected based on consideration of the requirements of CERCLA, the NCP, and input received from Illinois EPA. The remedy will meet the RAOs by implementing LUCs to prevent residential uses, to limit intrusive activities, to maintain the existing pavement and building to prevent exposure to contaminated soil, and to prevent groundwater use as a potable source. A Base Instruction is already in place to restrict groundwater use at NSGL.

The principal factors in the selection of this remedy included the following:

- The remedy is consistent with the current and future non-residential use of the site. The remedy will reduce risk by continuing restrictions on residential uses of property.
- Use of groundwater is already prohibited via a Base Instruction and local ordinance, so groundwater treatment is not necessary to address existing or future exposure risks. The remedy will reduce risk by continuing restrictions on groundwater use.
- The remedy can be implemented in a relatively short time frame, will be protective of human health, is cost-effective, and will result in a permanent solution to the maximum extent practicable.

### 2.2.7.2 Description of Selected Remedy

The Selected Remedy includes two major components: (1) LUCs to prevent residential use of the site, limit exposure to contaminated soil, and prevent groundwater use, and (2) a barrier to prevent exposure to contaminated soil. The LUCs will be implemented and maintained by the Navy in perpetuity or until concentrations of hazardous substances in site media are at levels that allow for unrestricted use and unlimited exposure. Five-Year Reviews will be required because contaminants will remain in soil and groundwater at concentrations greater than levels acceptable for unrestricted use of the site.

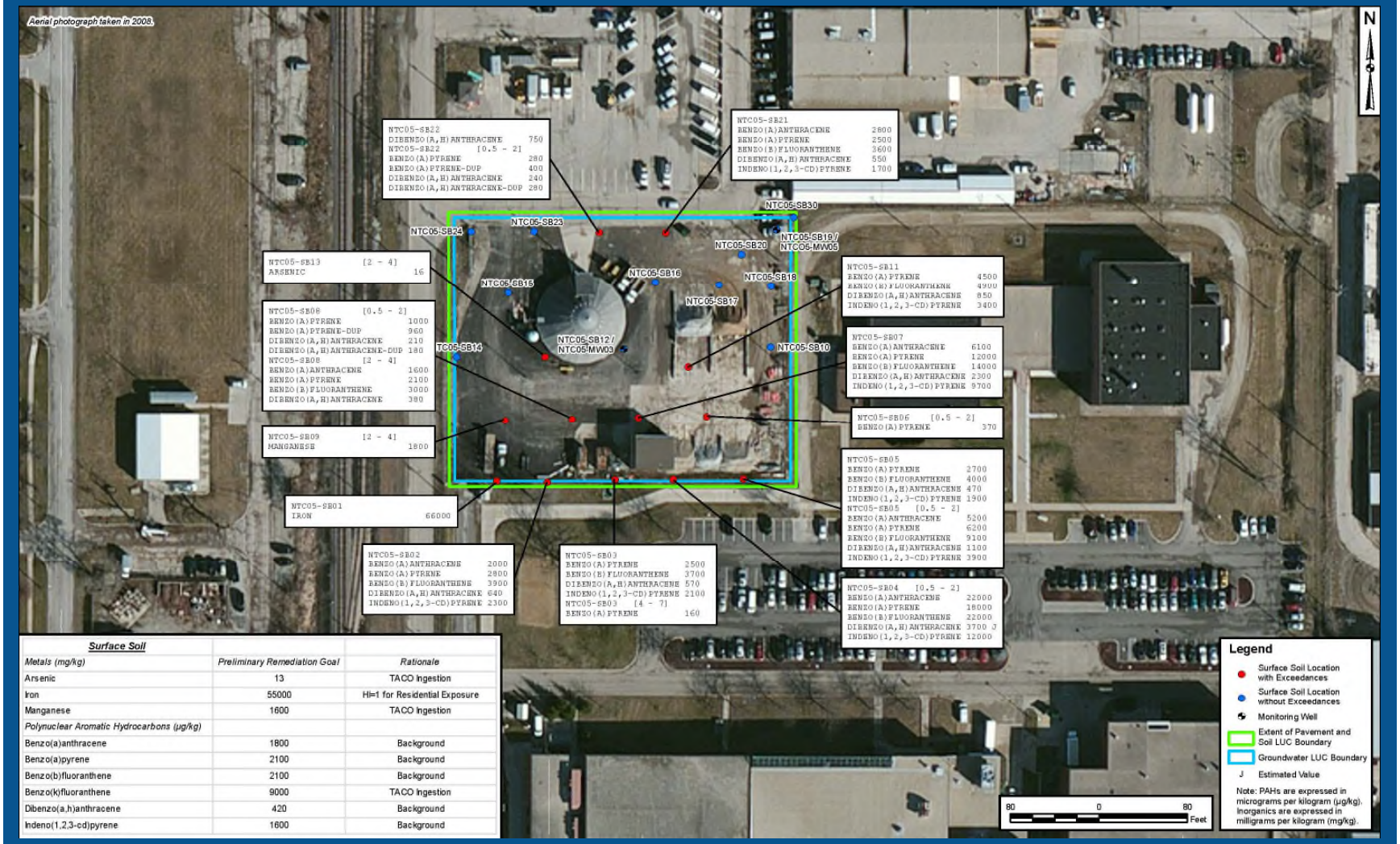
The existing pavement and building will serve as a barrier to prevent exposure to contaminated soil at Site 5. Buildings and pavement will be routinely inspected to prevent exposure to the soil. At locations where a building or pavement prevents exposure to soil, the level of effort of the inspection will be limited to confirming the presence or absence of a building, pavement, or Illinois EPA-approved clean soil cover. The limited areas that currently have no barrier will remain that way to allow for some infiltration of storm water. LUCs will be implemented within the Site 5 boundaries to limit use of the property, limit exposure to contaminated soil, and prohibit groundwater use. The LUC boundary encompasses most of the site, as shown on Figure 2-7. The groundwater LUC applies to the entire site to be consistent with the existing Base Instruction. Consistent with the RAOs developed for the site, the specific performance objectives for the LUCs to be implemented at Site 5 are as follows:

- To prohibit residential use or non-residential special use (such as for child-care facilities, pre-schools, elementary schools, secondary schools, playgrounds, convalescent, or nursing care facilities) by a population that requires special protections.
- To prevent the use of groundwater throughout the site as a potable water source.
- To require routine inspection of the building, pavement, and clean soil cover to prevent exposure to contaminated soil. During this inspection, the presence of the building, pavement or clean soil cover, which prevents exposure to contaminated soil, will be confirmed.
- To restrict unauthorized construction.
- To require notification of the presence of contaminants to construction workers.
- To require review of construction activities and intrusive work in the area to protect workers through PPE and alternative methods to reduce exposure.
- To require proper management of excavated material.
- To provide for long-term inspection of LUCs.
- To provide requirements for dealing with changes in land use or site features.

The following generally describes LUCs that will be implemented at the site to achieve the LUC performance objectives:

- Preparation of a site plat describing the LUCs within the boundaries of the site and filing of the plat with NAVFAC Midwest's real estate division.
- Incorporation of these restrictions, in the form of a deed notice or lease notice, into any real estate property documents associated with future sale or lease of the site. The real estate property documents will also include a discussion of the status of the site and a description of the COCs in site media.
- Notification of Illinois EPA at least 6 months prior to any transfer, sale, or lease of any property subject to LUCs required by a decision document. This will enable Illinois EPA to be involved in discussions to make sure that appropriate provisions, such as the Illinois EPA's Uniform Environmental Covenants Act 765 Illinois Compiled Statutes 122 (an environmental covenant), are included in the conveyance documents to maintain effective LUCs.

## FIGURE 2-7. SITE 5 SELECTED REMEDY




| Surface Soil | | |
|---|---|---|
| *Metals (mg/kg)* | *Preliminary Remediation Goal* | *Rationale* |
| Arsenic | 13 | TACO Ingestion |
| Iron | 55000 | HI=1 for Residential Exposure |
| Manganese | 1600 | TACO Ingestion |
| *Polynuclear Aromatic Hydrocarbons (µg/kg)* | | |
| Benzo(a)anthracene | 1800 | Background |
| Benzo(a)pyrene | 2100 | Background |
| Benzo(b)fluoranthene | 2100 | Background |
| Benzo(k)fluoranthene | 9000 | TACO Ingestion |
| Dibenzo(a,h)anthracene | 420 | Background |
| Indeno(1,2,3-cd)pyrene | 1600 | Background |

- Annual inspections to make sure that there are no violations of these restrictions. The Installation Commander will provide annual certification to Illinois EPA that there have been no violations of these restrictions.
- If a violation of a restriction occurs, a description of the violation and the corrective actions to be taken to restore protectiveness will be reported immediately to Illinois EPA and USEPA.

LUCs will be implemented and maintained by the Navy in perpetuity or until concentrations of hazardous substances in site media are at levels that allow for unrestricted use and unlimited exposure. The Navy or any subsequent owners shall not modify, delete, or terminate any LUC without Illinois EPA concurrence. The Navy is responsible for implementing, maintaining, reporting on, and enforcing the LUCs described in this ROD. Although the Navy may later transfer these procedural responsibilities to another party by contract, property transfer agreement, or through other means, the Navy shall retain ultimate responsibility for the remedy integrity. If the Navy transfers, sells, or leases the property, the Navy will be required to meet the requirements of Illinois EPA's Uniform Environmental Covenants Act 765 Illinois Compiled Statutes 122 (an environmental covenant).

Should any LUC remedy fail, the Navy will make sure that appropriate actions are taken to re-establish the remedy's protectiveness and may initiate legal action to either compel action by a third party(ies) and/or to recover the Navy's costs for remedying any discovered LUC violation(s). The Navy will maintain, monitor, and enforce the LUCs according to the LUC Memorandum of Agreement (MOA). LUCs will be developed in accordance with the **Principles and Procedures for Specifying, Monitoring, and Enforcement of Land Use Controls and Other Post-ROD Actions**, per letter dated October 2, 2003, from Raymond F. DuBois, Deputy Under Secretary of Defense (Installations and Environment), to Hon. Marianne Lamont Horinko, Acting Administrator, USEPA. Implementation of this remedy will require a survey of the site, annual visual inspections, and a Five-Year Review with report preparation.

By separate MOA with Illinois EPA and Commander, Navy Region Midwest, on behalf of the Department of the Navy, the Navy agreed to implement base wide, certain periodic site inspection, condition certification, and agency notification procedures designed to ensure the maintenance by Commander, Navy Region Midwest personnel of any site-specific LUCs deemed necessary for present and future protection of human health and the environment. A fundamental premise underlying execution of this agreement was through the Navy's substantial good-faith compliance with the procedures called for therein, reasonable assurances would be provided to Illinois EPA as to the permanency of those remedies that included the use of specific LUCs.

It is understood that the terms and conditions of the MOA are not specifically incorporated or made enforceable herein by reference. Should compliance with the MOA not occur or should the MOA be terminated, it is understood that the protectiveness of the remedy concurred with may be reconsidered, and additional measures may need to be taken to adequately ensure necessary future protection of human health and the environment.

The sequence of actions for implementing the Selected Remedy is:

1. Institute LUCs and input the site into the LUC Tracker System.
2. Perform annual inspection and certification of the site.
3. Perform Five-Year Reviews.

### 2.2.7.3 Cost of Selected Remedy for Site 5

A detailed cost estimate for the Selected Remedy, Alternative 5-2, for capital cost, annual cost, and present worth analysis is provided in Appendix C. The information in this cost estimate is based on the best available information regarding the anticipated scope of the Selected Remedy and implementation of

the Selected Remedy at this site independent of the other two sites. Implementation of the Selected Remedy at the three sites is expected to be performed as part of a single project, so the actual cost for this site may be lower due to economies of scale. Changes in the cost elements may occur because of new information or data collected during the design and implementation of the Selected Remedy. This is an order-of-magnitude cost estimate that is expected to be within -30 to +50 percent of the actual project cost. This estimate will be refined as the remedy is designed and implemented. Even after the Selected Remedy is implemented, the total project cost is still reported as an estimate because of the uncertainty associated with annual O&M expenditures.

#### 2.2.7.4 Expected Outcomes of Selected Remedy for Site 5

The current use of Site 5 as a non-residential area is expected to remain the same for the foreseeable future. Groundwater at the site is not used and is not expected to be used in the future because an existing Base Instruction and local ordinance preventing groundwater use. There are no socio-economic, community revitalization, or economic impacts or benefits associated with implementation of the Selected Remedy at Site 5. It is estimated that the RAOs for Site 5 will be achieved upon implementation of the remedy. Table 2-7 describes how the Selected Remedy mitigates risks and achieves the RAOs for the site.

Site use is not expected to change; therefore, modification or removal of the LUCs will not be required. However, if proposed land use changes in the future and other uses are expected, other remedial approaches may be required. Any modifications to LUCs will be conducted in accordance with provisions in the base's LUC MOA.

**TABLE 2-7. HOW SELECTED REMEDY FOR SITE 5 MITIGATES RISK AND ACHIEVES RAOS**

| RISK | RAO | COMMENTS |
|---|---|---|
| Potential unacceptable risks to human health from exposure to contaminated soil | Prevent residential exposure through ingestion, dust inhalation, and dermal contact to contaminated surface soil and subsurface soil with COC concentrations exceeding cleanup levels | Pavement and the building foundation act as a barrier that prevents exposure to reduce risk to acceptable levels for current industrial workers. LUCs will restrict potential future residential use of the site and will limit risks to contaminated soil by controlling exposure during construction. |
| Potential unacceptable risks to I/C workers and construction workers from exposure to contaminated soil | Prevent I/C and construction worker exposure through ingestion, dust inhalation, and dermal contact to contaminated surface soil with COC concentrations exceeding TACO criteria | Implementation of LUCs to restrict unauthorized construction, require notification of the presence of contaminants, and to protect workers through PPE and alternative methods to reduce exposure. |
| Potential unacceptable risks to human health from exposure to contaminated groundwater | Return the groundwater resource to beneficial use, if practicable, and address human health risks associated with groundwater consumption | Implementation of LUCs to prevent potable use of groundwater, which prevents exposure. Base Instruction and local ordinance already restrict the use of groundwater, which has marginal beneficial use. |

### 2.2.8 Site 5 Statutory Determinations

In accordance with the NCP, the Selected Remedy for Site 5 meets the following statutory determinations:

- **Protection of Human Health and the Environment** – The Selected Remedy is needed to prevent risks associated with hypothetical future residential exposure and groundwater use, to minimize

exposure to construction workers and I/C workers to soil that has concentrations of PAHs greater than TACO criteria. LUCs and barriers will be implemented and maintained to ensure protectiveness.

- **Compliance with ARARs** – The Selected Remedy will attain the identified federal and state ARARs, as presented in Appendix B.
- **Cost-Effectiveness** – The Selected Remedy is the most cost-effective alternative that allows for continued non-residential use of the property and represents the most reasonable value for the money. The costs are proportional to overall effectiveness by achieving an adequate amount of long-term effectiveness and permanence within a reasonable time frame. Detailed costs for the Selected Remedy are presented in Appendix C.
- **Utilization of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable** – The Selected Remedy represents the maximum extent to which permanent solutions and alternative treatment technologies can be used in a practical manner at Site 5. Based on the type and volume of soil contamination and the current and reasonably anticipated future use of the site, no soil treatment alternatives were evaluated for Site 5 in the FFS (Tetra Tech, 2013c). LUCs and barriers provide the best balance of tradeoffs for long-term effectiveness and permanence with ease of implementation for reasonable cost. Groundwater treatment was considered in two alternatives; however, the extent of groundwater contamination is limited, and LUCs provide the best balance of tradeoffs for long-term effectiveness and permanence with ease of implementation for reasonable cost.
- **Preference for Treatment as a Principal Element** – Treatment is not a principal element of the Selected Remedy for soil or groundwater at Site 5 because there are no principal threat wastes at the site, and LUCs and barriers provide the best balance of tradeoffs with respect to long-term effectiveness and permanence at a reasonable cost.
- **Five-Year Review Requirement** – Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on site in excess of levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within 5 years after initiation of remedial action and every 5 years thereafter to ensure that the remedy is, or will be, protective of human health and the environment.

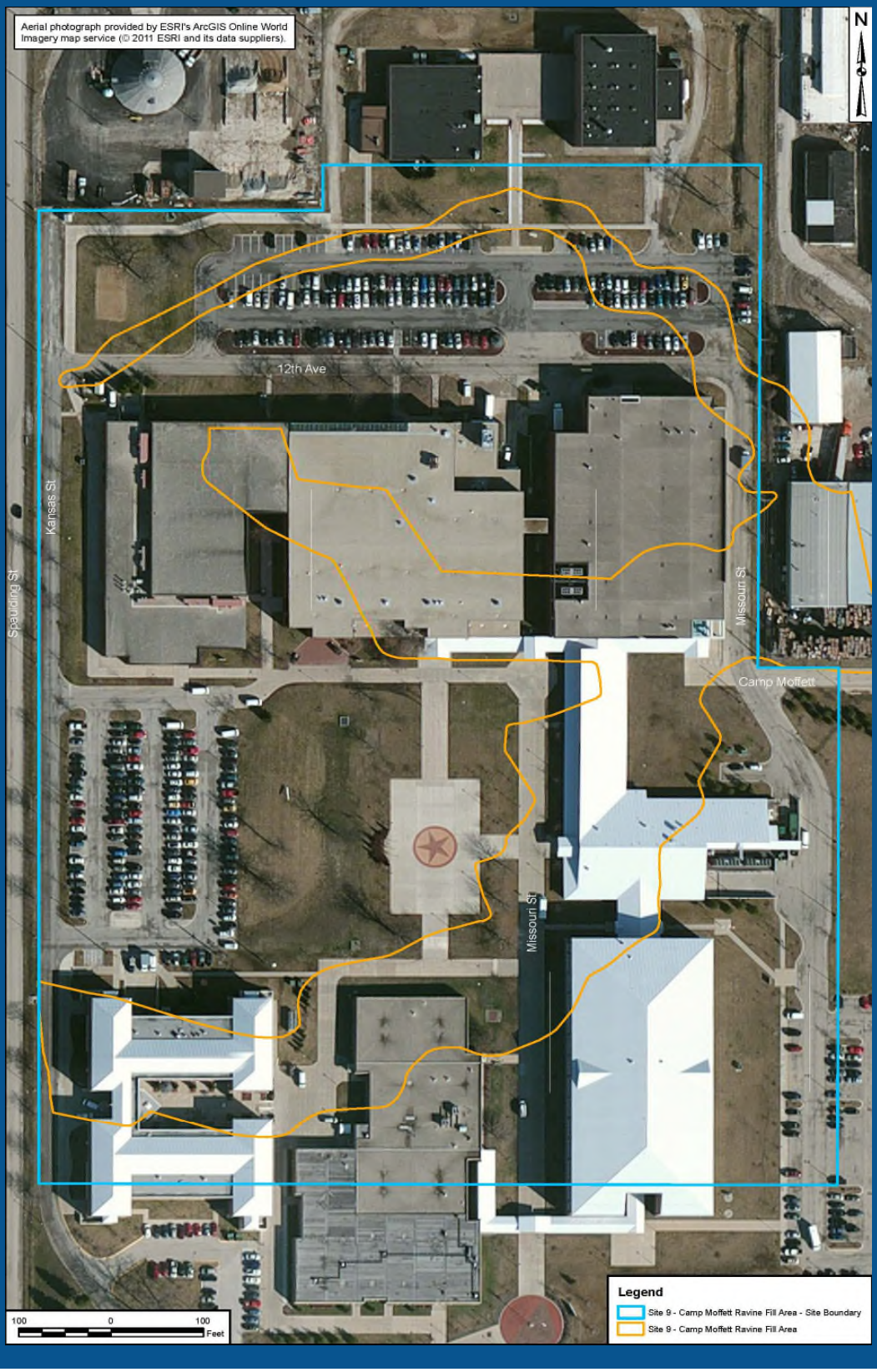
## 2.3 SITE 9

### 2.3.1 Site 9 Site Characteristics

Site 9 which covers approximately 21 acres is located in the area of three former ravines that were filled and are currently overlain by buildings and parking lots (Figure 2-8). The area of the former ravines was approximately 1.5 acres. The ravines were likely filled to create usable property during the construction and development of Camp Moffett during World War II. The site was identified as a disposal area based on the IAS. Although various materials and wastes may potentially have been used as fill, the fill material is predominantly soil, and there is no information to suggest that hazardous waste disposal occurred at Site 9. During excavation activities in 2003 associated with Building 1425 construction, galley-type wastes (e.g., stainless steel serving trays and food wastes) and non-hazardous material/debris (including stained soil, slag, brick, and ash) were encountered. Also, during 2005/2006 construction of the new Recruit Processing Facility and Uniform Issue Building, non-hazardous material/debris was excavated while digging the foundation for the building. Geotechnical soil boring logs collected for the design of the foundation of the new Recruit Processing Facility and Uniform Issue Building, which is located in area of the middle ravine, describe fill material including cinders, cobbles, concrete, glass, and brick.

Groundwater flow direction at the site is in an easterly direction towards Pettibone Creek and Lake Michigan. Groundwater from the site may be collected in the stormwater piping that discharges into the unnamed tributary to Pettibone Creek east of Sheridan Road. If groundwater at the site is contaminated, it could contribute to surface water contamination in the tributary. However, investigations of Site 17,

## FIGURE 2-8. SITE 9 LAYOUT



Pettibone Creek, and the unnamed tributary of Pettibone Creek did not identify surface water contamination or identify Site 9 groundwater as a potential contamination source.

No effort was made to determine the lateral extent of the fill; however, examination of older aerial photographs and topographic maps of the area suggests that the area was once a narrow V-shaped ravine, a former tributary of Pettibone Creek.

Potential receptors and exposure pathways for Site 9 are discussed in Section 2.1.7.

### Nature and Extent of Contamination

The Navy conducted a RI at Site 9 in 2009 to determine the **nature and extent of subsurface fill materials** that were placed in the former ravines and to identify potential risks associated with Site 9. The investigation included the collection of subsurface soil and groundwater samples, which were analyzed for VOCs, SVOCs, PCBs, pesticides, dioxins/furans, and metals.

The first 8 feet of soil encountered in borings were generally considered fill materials comprising sand with silt and clay and coal, fly ash, brick, gravel, cinders, slag, etc. The general area of contamination at the site appears to be where the three fingers of the ravine merge. The fill material consisting of coal, fly ash, brick, gravel, cinders, slag, etc. could have been placed in the ravine by the surrounding industries (including the former foundry that was located immediately east of the site and pre-dated Navy development), and/or by the Navy, which produced some of these byproducts in the 1940s. No information has been identified to indicate the presence of listed hazardous waste or characteristically hazardous waste at the site.

Contaminants were detected in several soil samples at scattered locations around the site. Concentrations of tetrachloroethene, PAHs, alpha-benzene hexachloride, lead, and mercury in subsurface soil exceeded Illinois EPA TACO criteria. Concentrations of chloroform, iron, lead, and manganese in groundwater exceeded Illinois EPA TACO criteria for unrestricted property use. Concentrations of other parameters were less than the Illinois EPA TACO criteria. Concentrations of arsenic in groundwater exceeded its MCL. Based on consideration of Illinois EPA TACO criteria exceedances as well as unacceptable human health risks, PAHs, arsenic, lead, and manganese in subsurface soil and arsenic and lead in groundwater were selected as COCs.

## 2.3.2 Summary of Site 9 Risks

The investigation at Site 9 included evaluating the potential **human health risks** from detected chemical concentrations in subsurface soil and groundwater. Surface soil samples were not collected because they were not considered to be representative of the buried fill materials and ravine conditions.

### Summary of Human Health Risks

Tables summarizing data used in the Site 9 HHRA and associated results are presented in Appendix A. Tables 1 and 2 in Appendix A.2 present EPCs for the COPCs identified at Site 9 in subsurface soil and groundwater. Tables 3 and 4 in Appendix A.2 provide assumptions about the frequency and duration of exposure for each receptor. Tables 5 and 6 in Appendix A.2 provide non-carcinogenic hazard information relevant to the Site 9 COPCs for oral/dermal and inhalation routes of exposure, respectively. Tables 7 and 8 in Appendix A.2 provide carcinogenic risk information relevant to the Site 9 COPCs for oral/dermal and inhalation exposures.

Tables 9 to 12 in Appendix A.2 provide RME and CTE cancer risk estimates for the significant receptors and routes of exposure developed for Site 9 by taking into account various conservative assumptions about the frequency and duration of exposure for each receptor and also about the toxicity of the COPCs. RME cancer risk estimates are presented in this section. Cancer risks were compared to the USEPA and Illinois EPA Tier 3 target risk range of $1 \times 10^{-4}$ to $1 \times 10^{-6}$. The risks from exposure to subsurface soil for

construction workers and maintenance/occupational workers were within the risk range. However, several soil samples had concentrations of lead and arsenic that were greater than the I/C and construction worker TACO criteria. There were unacceptable cancer risks from exposure to subsurface soil and groundwater for hypothetical future child, adult, and lifelong residents.

Cancer risks for hypothetical future residents were primarily due to carcinogenic PAHs and arsenic with tetrachlorodibenzo-p-dioxin (TCDD) toxicity equivalence (TEQ) also contributing to cancer risks for soil. Cancer risks for hypothetical future residents from groundwater were primarily due to carcinogenic PAHs and arsenic.

Tables 9 to 12 in Appendix A.2 also provide RME and CTE non-cancer HQs for each receptor and route of exposure and total HIs for the routes of exposure. RME non-cancer HIs are presented in this section. Non-cancer risks were compared to the USEPA and Illinois EPA HI target risk level of 1. There were no unacceptable risks from exposure to subsurface soil for construction workers (based on re-evaluation of the soil inhalation pathway as discussed below) and maintenance/occupational workers. There were no unacceptable risks from exposure to groundwater for construction workers and maintenance/occupational workers. There were unacceptable non-cancer risks from exposure to subsurface soil and groundwater for hypothetical future child and adult residents.

The major contributor to the hypothetical future child resident HI was arsenic by ingestion. Non-cancer risk for child and hypothetical future adult residents exposed to groundwater exceeded an HI of 1. For hypothetical future child residents, multiple metals (arsenic, cobalt, manganese, iron, and selenium) contributed to the HI exceeding 1; however, arsenic was the primary risk driver. For hypothetical future adult residents, arsenic was the non-cancer risk driver.

The Navy, Illinois EPA, and Tetra Tech collectively determined that the USEPA PEF used to calculate the HI for the inhalation pathway was overly conservative for the site and not a realistic representation of Site 9. Therefore, a site-specific determination was made to use the Illinois EPA TACO PEF to calculate HIs for the construction worker inhalation pathway. The Illinois EPA TACO PEF is less conservative than the USEPA PEF; however, it is still considered protective. This recalculation conducted as part of the FFS (Tetra Tech, 2013c) resulted in soil RME HIs (including the inhalation pathway) of less than 1 for construction workers (Tables 13 to 15 in Appendix A.2). Therefore, non-cancer risks from soil exposure are acceptable for construction worker receptor at Site 9.

Lead concentrations detected at Site 9 exceeded TACO ingestion residential (400 mg/kg), industrial (800 mg/kg), and construction worker (700 mg/kg) SROs. However, modeling used to evaluate potential health risks from lead to hypothetical future residents, construction workers, and maintenance/occupational workers indicated low risk to workers and acceptable blood-lead levels based on USEPA target values.

Although several chemicals were identified in the HHRA in groundwater had unacceptable risks associated with hypothetical future residential exposure to groundwater, only arsenic in groundwater, which exceeded its MCL, was considered when developing cleanup levels. TCDD TEQ was identified as a soil COC in the HHRA; however, because the maximum TCDD TEQ concentration [7.32 nanograms per kilogram (ng/kg)] was less than the USEPA soil screening PRG of 50 ng/kg, TCDD TEQ was not considered when developing cleanup levels. Lead was not selected as a COC in the HHRA, but lead concentrations in soil did exceed TACO criteria; therefore, lead was considered when determining RAOs.

The following constituents were identified as Site 9 COCs for exceeding a cancer risk of $1x10^{-4}$ and/or an HQ of 1:

- Carcinogenic PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(123-cd)pyrene), arsenic, and manganese for hypothetical future residential exposure to subsurface soil.

- Carcinogenic PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, and dibenzo(a,h)anthracene) and arsenic for hypothetical future residential exposure to groundwater.

### Basis for Action

Unacceptable risks from exposure to arsenic, lead, manganese, and carcinogenic PAHs in subsurface soil and arsenic and lead in groundwater were estimated for hypothetical future residents. In additional several soil samples had concentrations of arsenic and lead that were greater than the I/C and construction worker TACO criteria.

Because unacceptable risks were identified under a future land use scenario for human receptors and concentrations of arsenic and lead exceeded TACO criteria for the current and future I/C and construction worker, a response action is necessary to protect human health or the environment from actual or threatened releases of hazardous substances into the environment that may present an imminent and substantial endangerment.

## 2.3.3 Site 9 Remedial Action Objectives

RAOs are medium-specific goals that define the objective of conducting remedial actions to protect human health and the environment. RAOs generally specify the COCs, potential exposure routes and receptors, and acceptable concentrations (i.e., cleanup levels) for a site, and provide a general description of what the cleanup will accomplish. The following RAOs were developed for Site 9 to address protection of human health:

**RAO 1:** Prevent residential exposure through ingestion, dust inhalation, and dermal contact to contaminated subsurface soil with COC concentrations exceeding cleanup levels.

**RAO 2:** Prevent I/C and construction worker exposure through ingestion, dust inhalation, and dermal contact to contaminated subsurface soil with COC concentrations exceeding TACO criteria.

**RAO 3:** Return the groundwater resource to beneficial use, if practicable, and address human health risks associated with groundwater consumption.

For soil, the most conservative of the Illinois EPA TACO Tier 1 SROs for residential exposure via incidental ingestion and inhalation were used to identify target concentrations for evaluation of unrestricted use of the property. In addition, risk-based criteria based on residential exposure associated with an HI of 1 and a cancer risk of $1 \times 10^{-5}$ were also considered as possible cleanup levels. For a given COC, the SROs and risk-based values are generally comparable. In those cases, the greater of the two values is selected so that the cleanup levels are not overly conservative. However, for a COC for which the difference is an order of magnitude or more, suggesting that significantly different assumptions were made in the risk calculation method(s), the lesser value was used to provide better certainty of protectiveness. Because several soil samples exceeded the TACO criteria for I/C and construction worker, the corresponding I/C and construction worker TACO values for the COCs identified in the subsurface soil were retained as cleanup levels. Residential levels are used where residential use is required or assumed. Table 2-8 summarizes the cleanup levels for Site 9 soil. I/C and construction levels are used where non-residential use is required or assumed.

**TABLE 2-8. SOIL CLEANUP LEVELS**

| COC | RESIDENTIAL SUB-SURFACE SOIL | BASIS | TACO I/C | TACO CONST |
|---|---|---|---|---|
| Arsenic (mg/kg) | 13 | BG | 13 | 61 |
| Manganese (mg/kg) | 1,600 | TACO | 41,000 | 4,100 |
| Lead (mg/kg) | 400 | TACO | 800 | 700 |
| Benzo(a)anthracene (µg/kg) | 1,500 | HHRA | 8,000 | 170,000 |
| Benzo(a)pyrene (µg/kg) | 150 | HHRA | 800 | 17,000 |
| Benzo(b)fluoranthene (µg/kg) | 1,500 | HHRA | 8,000 | 170,000 |
| Benzo(k)fluoranthene (µg/kg) | NA | - | 78,000 | 1,700,000 |
| Dibenzo(a,h)anthracene (µg/kg) | 150 | HHRA | 800 | 17000 |
| Indeno(123-cd)pyrene (µg/kg) | 1,500 | HHRA | 8,000 | 170,000 |

NA - No cleanup levels were identified for COCs that had acceptable concentrations for the identified receptor.
Const – Construction Worker

Groundwater cleanup levels were developed based on Class I groundwater standards in 35 IAC 620, federal MCLs, and Illinois EPA TACO values. Based on current site information, groundwater at Site 9 is assumed to be classified as Class I under 35 IAC 620. Existing administrative restrictions on groundwater use and low yield prevent the effective use of groundwater as a drinking water source, so although MCLs and TACO values have been considered, exposure routes are not complete, and MCLs and TACO values were not used to select cleanup levels. At Site 9, arsenic concentrations in groundwater exceed its MCL, per Illinois EPA, and require identification of a cleanup level, and the cleanup level based on Class I standards is 10 µg/L. Lead concentrations in groundwater exceed its Class I groundwater standard, and per Illinois EPA, require identification of a cleanup level, and the cleanup level based on Class I standards is 7.5 µg/L.

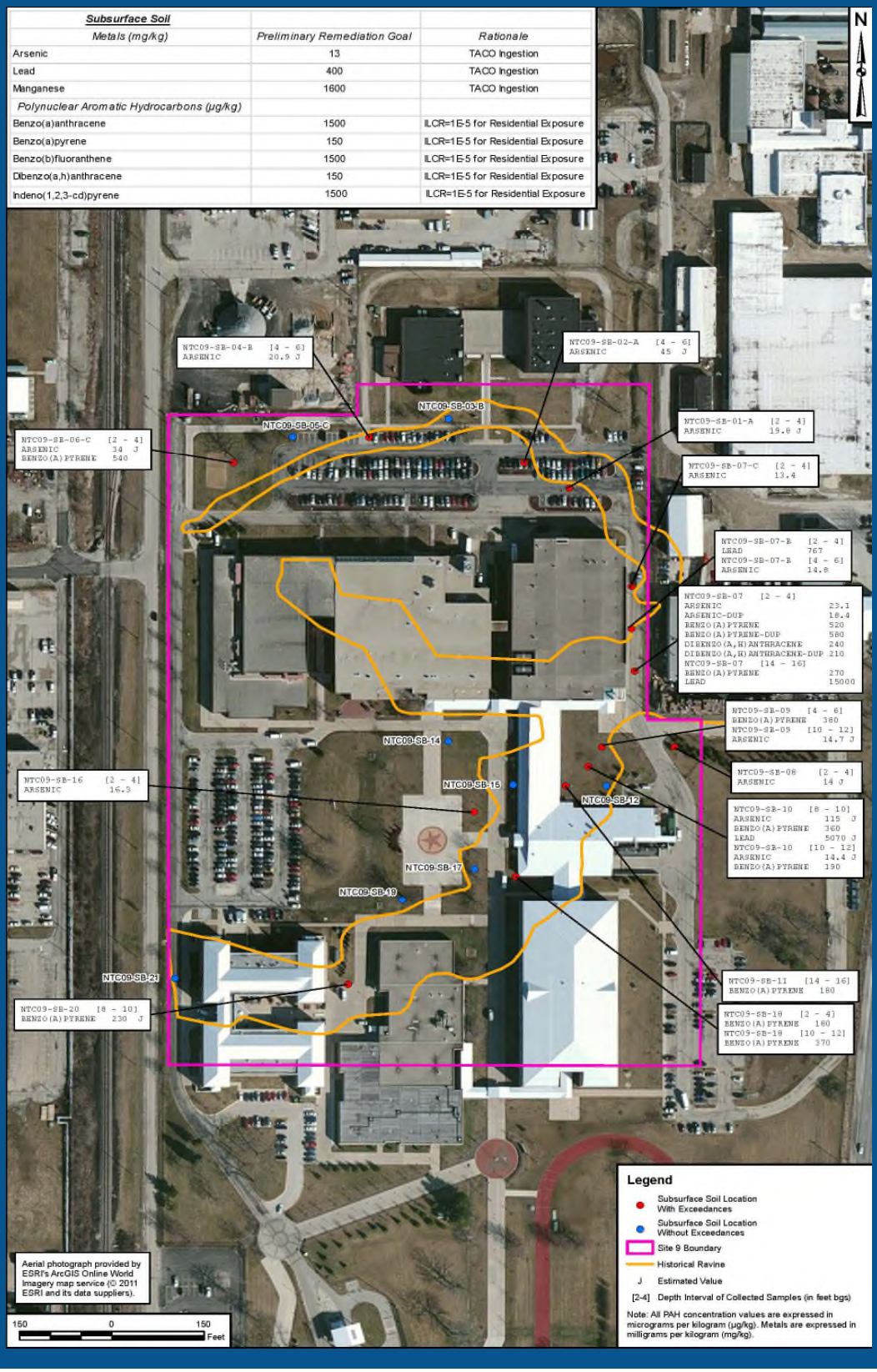
For Site 9, exceedances of residential cleanup levels in subsurface soil are shown on Figure 2-9, and exceedances of groundwater cleanup levels are shown on Figure 2-10.

Approximately 10,000 cy of contaminated subsurface soil is present at Site 9. The contamination is present to an approximate depth of 16 feet bgs. The groundwater plume is limited to the area around one well where contaminant concentrations were greater than cleanup levels. Therefore, the volume of contaminated groundwater was not calculated

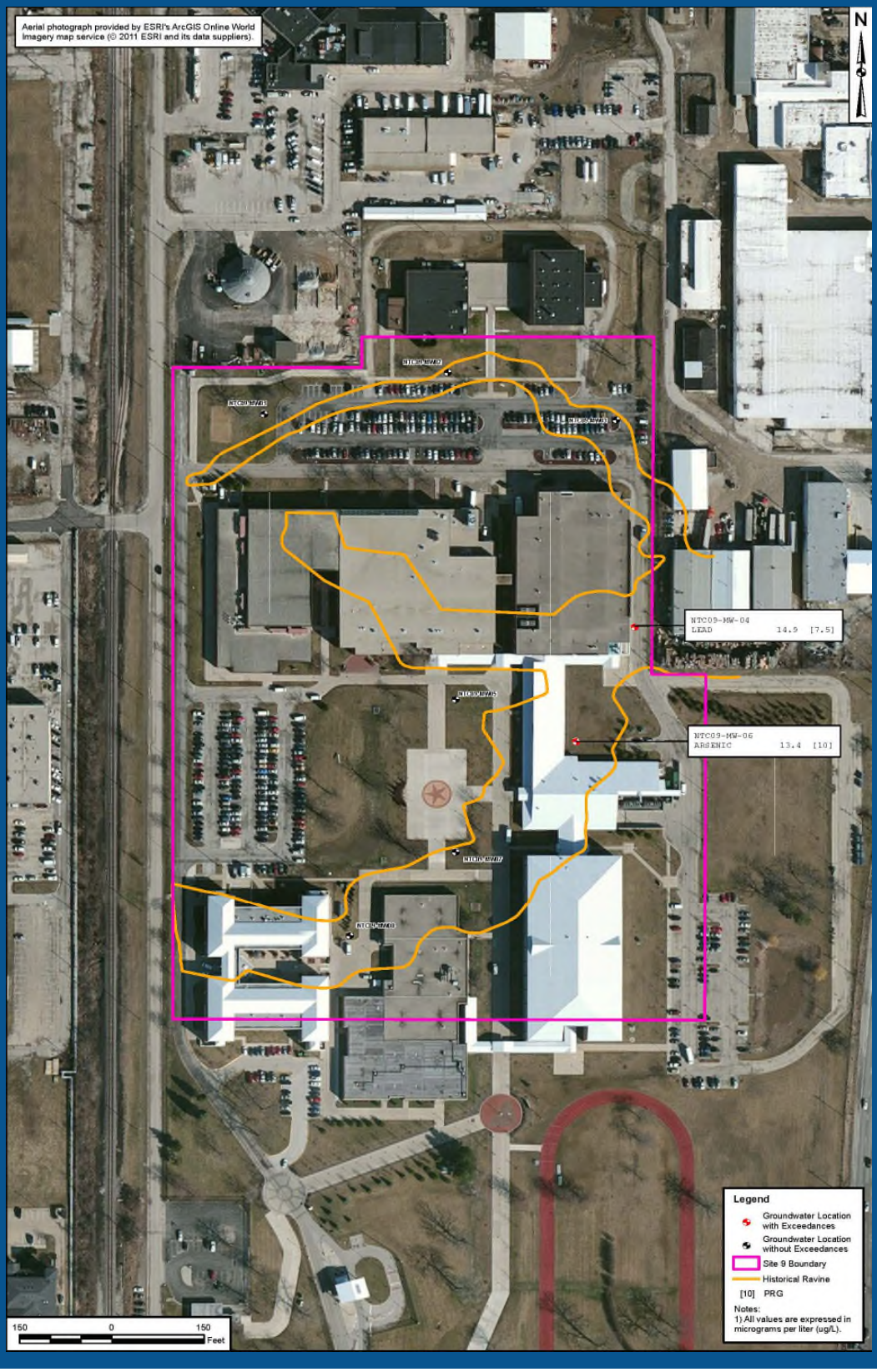
### 2.3.4 Description of Alternatives for Site 9

General response actions are broadly defined remedial approaches that may be used (by themselves or in combination with others) to attain the RAOs. Because the HHRA identified potential non-carcinogenic risks in excess of a HI of 1 and carcinogenic risks in excess of $1 \times 10^{-4}$, general response actions for Site 9 were developed as presented on Table 2-9.

## FIGURE 2-9. SITE 9 EXCEEDANCES OF RESIDENTIAL CRITERIA IN SUBSURFACE SOIL



## FIGURE 2-10. SITE 9 EXCEEDANCES OF GROUNDWATER CRITERIA



| TABLE 2-9. GENERAL RESPONSE ACTIONS FOR SITE 9 | | |
|---|---|---|
| **GENERAL RESPONSE ACTION** | **TECHNOLOGY** | **PROCESS OPTIONS** |
| **Soil** | | |
| No Action | None | Not Applicable |
| Limited Action | Institutional Controls | LUCs |
| Containment | Barrier | Asphalt, Soil, or Building |
| Removal | Excavation/Disposal | Off-Base Landfill Disposal |
| **Groundwater** | | |
| No Action | None | Not Applicable |
| Limited Action | Institutional Controls | LUCs |
| | Monitoring | Sampling and Analysis |
| In-Situ Treatment | Chemical | Chemical Oxidation |

Table 2-10 describes the major components of the Site 9 alternatives evaluated and provides associated costs.

| TABLE 2-10. SUMMARY OF REMEDIAL ALTERNATIVES EVALUATED FOR SITE 9 | | | |
|---|---|---|---|
| **ALTERNATIVE** | **COMPONENTS** | **DETAILS** | **COST** |
| **Alternative 9-1:**<br>**No Action**<br>*No action to address contamination and no use restrictions* | No action would be conducted | Five-year reviews would not be included under the no action alternative. | **Cost**: $0 |
| **Alternative 9-2:**<br>**LUCs and Barrier**<br>*Current and future land use restrictions, maintenance of existing surface soil, pavement, and foundations* | LUCs | LUCs would be implemented to prevent residential land use, restrict unauthorized construction, require notification of the presence of contaminants to construction workers, require review of construction activities and intrusive work in the area to protect workers through PPE and alternative methods to reduce exposure, require proper management of excavated material, provide for long-term inspection of LUCs, and provide requirements for dealing with changes in land use or site features. LUCs would be maintained in perpetuity. | **Capital**: $21,000<br>**O&M**: $9,000<br>**Five-Year Reviews**: $26,000<br>**30-Year NPW**: $366,000 |
| | | LUCs would require routine inspection of the surface soil, pavement, and foundations used as barriers and repairs to the surface soil, pavement, and foundations to prevent exposure to contaminated soil. | |
| | | LUCs would be implemented over the entire site to restrict groundwater use. | |
| | Barrier | The existing soil, pavement, and buildings will be used as a barrier to prevent exposure by I/C workers to soil contaminants exceeding I/C TACO criteria. Barriers would be required to remain, either a building, pavement, or soil. | |

**TABLE 2-10. SUMMARY OF REMEDIAL ALTERNATIVES EVALUATED FOR SITE 9**

| ALTERNATIVE | COMPONENTS | DETAILS | COST |
|---|---|---|---|
| **Alternative 9-2A: LUCs, Barrier, and ISCO** *Current and future land use restrictions, maintenance of existing surface soil, pavement, and foundations, ISCO treatment of groundwater* | LUCs | Implementation of LUC requirements as described in Alternative 9-2. Soil LUCs would be maintained in perpetuity. Groundwater LUCs would only continue until ISCO is completed and the groundwater cleanup level is met. | **Capital**: $488,000 **O&M**: $9,000 **Five-Year Reviews**: $26,000 **30-Year NPW**: $834,000 |
| | Barrier | The existing soil, pavement, and buildings would be used as a barrier as described in Alternative 9-2. | |
| | ISCO | Oxidant would be injected into the groundwater at the location where groundwater cleanup levels are exceeded (arsenic and lead). Groundwater samples would be collected and analyzed to monitor the progress of treatment. | |
| **Alternative 9-3 Excavation (Unrestricted Reuse), Off-Site Disposal, and LUCs** *Excavation and off-site disposal of unsaturated soil, LUCs for groundwater* | Excavation and Disposal | Excavation and off-site disposal of 10,000 cy of soil to meet cleanup levels for residential exposure. It is assumed that this alternative would only be implemented if the base was closed, there was a change in land use, and the buildings over ravine areas were removed. Excavated material would be transported off-site to a non-hazardous landfill for disposal. Excavated areas would be backfilled with clean soil, and the surface would be reseeded with grass. | **Capital**: $3,220,000 **O&M**: $3,000 **Five-Year Reviews**: $26,000 **30-Year NPW**: $3,411,000 |
| | LUCs | LUCs would be implemented over the entire site to restrict groundwater use. | |
| **Alternative 9-3A Excavation (Unrestricted Reuse), Off-Site Disposal, LUCs, and ISCO** *Excavation and off-site disposal of unsaturated soil, ISCO treatment of groundwater, LUCs for groundwater* | Excavation and Disposal | Contaminated soil would be excavated and disposed of off-site as described in Alternative 9-3A. | **Capital**: $3,668,000 **O&M**: $3,000 **Five-Year Reviews**: $26,000 **30-Year NPW**: $3,860,000 |
| | ISCO | ISCO would be applied as described in Alternative 9-2A | |
| | LUCs | Groundwater LUCs would only continue until ISCO is completed and the groundwater cleanup level is met. | |

### 2.3.5 Comparative Analysis of Alternatives for Site 9

Table 2-11 and subsequent text in this section summarize the comparison of the Site 9 remedial alternatives with respect to the nine CERCLA evaluation criteria outlined in the NCP at 40 CFR 300.430(e)(9)(iii) and categorized as threshold, primary balancing, and modifying criteria. Further information on the detailed comparison of remedial alternatives is presented in the Sites 5, 9, and 21 FFS (Tetra Tech, 2013c).

**TABLE 2-11: SUMMARY OF COMPARATIVE ANALYSIS OF SITE 9 REMEDIAL ALTERNATIVES**

| ALTERNATIVE | 9-1 | 9-2 | 9-2A | 9-3 | 9-3A |
|---|---|---|---|---|---|
| **Estimated Time Frame** | | | | | |
| Designing and Constructing the Alternative (months) | N/A | 3 | 24 | 4 | 24 |
| Achieving the Cleanup Objectives (months) | N/A | 3 | 3 | 4 | 4 |
| **Criteria Analysis** | | | | | |
| **Threshold Criteria** | | | | | |
| Protects human health and the environment<br>Will it protect you and plant and animal life on and near the site? | No | Yes | Yes | Yes | Yes |
| Meets federal and state regulations<br>Does the alternative meet federal and state environmental statutes, regulations, and requirements? | N/A | ● | ● | ● | ● |
| Primary Balancing Criteria | | | | | |
| Provides long-term effectiveness and is permanent<br>Will the effects of the cleanup last? | ○ | ◘ | ◘ | ● | ● |
| Reduces mobility, toxicity, and volume of contaminants through treatment<br>Are the harmful effects of the contaminants, their ability to spread, and the amount of contaminated material present reduced? | ○ | ○ | ◘ | ○ | ◘ |
| Provides short-term protection<br>How soon will the site risks be reduced?<br>Are there hazards to workers, residents, or the environment that could occur during cleanup? | N/A | ● | ● | ◘ | ◘ |
| Can it be implemented<br>Is the alternative technically feasible?<br>Are the goods and services necessary to implement the alternative readily available? | N/A | ● | ● | ● | ● |
| Cost (K = 1,000s)<br>Upfront costs to design and construct the alternative (capital costs)<br>Total cost in today's dollars (30-year NPW cost) | <br>$0<br>$0 | <br>$21K<br>$366K | <br>$488<br>$834K | <br>$3,220K<br>$3,411K | <br>$3,668K<br>$3,860K |
| **Modifying Criteria** | | | | | |
| State agency acceptance<br>Does Illinois EPA agree with the Navy's recommendation? | Illinois EPA concurs with Alternative 9-2. | | | | |
| Community acceptance<br>What objections, suggestions, or modifications does the public offer during the comment period? | No written questions, comments, or requests for a public meeting were received during the formal public comment period for the Proposed Plan. | | | | |
| Relative comparison of the nine balancing criteria and each alternative:<br>● – Good , ◘ – Average, ○ – Poor; N/A – Not applicable . | | | | | |

## Threshold Criteria

***Overall Protection of Human Health and the Environment***. The no action alternative would not achieve the RAOs and therefore does not protect human health and the environment. It will therefore not be considered further in this ROD. The other four alternatives meet this criterion. Alternative 9-3A would

be the most protective because contaminants would be removed from the site by excavation, and concentrations in groundwater that exceed MCLs would be treated. Alternative 9-3 would be the next most protective because contaminants would be removed from the site by excavation and LUCs would prevent exposure to contaminated groundwater. Alternatives 9-2 and 9-2A would be similar in protectiveness because both would rely on LUCs and the barriers to prevent exposure to contaminants in soil and groundwater. Alternative 9-2A would be slightly more protective because concentrations of COCs in groundwater that exceed MCLs would be treated.

***Compliance with ARARs***. ARARs include any federal or state standards, requirements, criteria, or limitations determined to be legally applicable or relevant and appropriate to the site or remedial action. The four alternatives would comply with ARARs.

## Primary Balancing Criteria

***Long-Term Effectiveness and Permanence***. Alternative 9-3A would provide the most long-term effectiveness and permanence because contaminated soil would be disposed of off-site and some of the groundwater COCs would be removed by in-situ treatment. Alternative 9-3 would provide the next most long-term effectiveness and permanence because contaminated soil would be disposed of off-site, but exposure to groundwater COCs would prevent by LUCs. The effectiveness of LUCs relies on enforcement of the provisions of the LUCs. Alternatives 9-2 and 9-2A would provide similar effectiveness and permanence through LUCs and barriers that would prevent exposure to COCs in soil and groundwater. As noted, the effectiveness of LUCs relies on enforcement of the provisions of the LUCs. Alternative 9-2A would provide slightly more permanence compared to Alternative 9-2 because some of the groundwater COCs would be removed by in-situ treatment.

***Reduction in Toxicity, Mobility, or Volume Through Treatment***. Alternatives 9-2A and 9-3A would provide treatment of some of the COCs in groundwater. Alternatives 9-2 and 9-3 do not include groundwater treatment, and none of the alternatives include soil treatment. The contaminant concentrations in soil are too low to justify the cost of treatment.

***Short-Term Effectiveness***. The four alternatives would require the maintenance of groundwater LUCs. Alternatives 9-2A and 9-3A would include groundwater treatment so some LUCs could be discontinued after ISCO is applied and cleanup levels are met. Alternative 9-2 could be completed in the shortest time because only LUCs would need to be implemented. Alternative 9-3 would take a longer time to complete because of implementation LUCs and soil excavation. Alternatives 9-2A and 9-3A would require the longest time to complete (over 1 year) to implement the ISCO treatment and groundwater performance monitoring.

Alternative 9-2 would have no short-term risk to the local community or the environment. Alternative 9-2A would have a slight risk to the community during the transport of oxidant to the site. Potential risks to workers conducting the ISCO injection and groundwater monitoring would be managed by proper safety procedures and PPE. Alternative 9-3 would have a slightly greater risk to the community associated with transport of contaminated soil from the site and clean soil to the site. Potential risks to workers conducting the excavation would be managed by proper safety procedures and PPE. Alternative 9-3A would have the highest potential risk to the community associated with transport of contaminated soil from the site and clean soil and oxidant to the site. Potential risks to workers conducting the excavation, ISCO injection, and groundwater monitoring would be managed by proper safety procedures and PPE.

***Implementability***. The alternatives could be readily implemented. Alternative 9-2 would be the easiest to implement because it would involve administrative activities associated with documenting and maintaining use restrictions. Alternative 9-2A would be slightly more difficult to implement because of the tasks associated with ISCO drilling and injection and groundwater monitoring. However, there are numerous contractors that perform this work. Alternative 9-3 would be the next most difficult to perform due to the excavation. The excavations are deep, and special expertise may be required to support the foundations of adjacent buildings. Alternative 9-3A would be the most difficult, but only when compared to the other alternatives. The excavation and ISCO tasks could be performed by many contractors.

***Cost***. Alternative 9-2 has the lowest estimated NPW of $366,000. The estimated NPW for Alternatives 9-2A and 9-3 are $834,000 and $3,411,000, respectively. Alternative 9-3A has the highest estimated NPW of $3,860,000. There is uncertainty in the excavation costs because the extent of contamination is not completely delineated. In addition, the ISCO treatment in Alternative 9-2A and 9-3A provides little risk reduction relative to the treatment costs. Detailed cost estimates for each alternative are presented in the FFS (Tetra Tech, 2013c).

### Modifying Criteria

***State Acceptance***. State involvement has been solicited throughout the CERCLA process. Illinois EPA, as the designated state support agency in Illinois, concurs with the Site 9 Selected Remedy.

***Community Acceptance***. No written questions, comments, or requests for a public meeting were received during the formal public comment period for the Proposed Plan.

## 2.3.6 Principal Threat Waste

The NCP at 40 CFR 300.430(a)(1)(iii)(A) establishes an expectation that treatment will be used to address the principal threats posed by a site wherever practicable. Principal threat wastes are hazardous or highly toxic source materials that result in ongoing contamination to surrounding media and that generally cannot be reliably contained or that present a significant risk to human health or the environment should exposure occur. A source material includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to groundwater, surface water, or air, or acts as a source for direct exposure.

A current source of contamination is not present at Site 9. Contaminant concentrations are not at levels that are characteristic of a source. In addition, contaminant concentrations are not highly toxic or highly mobile. Therefore, principal threat wastes are not present.

## 2.3.7 Selected Remedy for Site 9

### 2.3.7.1 Rationale for Selected Remedy

The Selected Remedy for Site 9 is Alternative 9-2, LUCs and Barrier, which was selected because it provides the best balance of tradeoffs with respect to the nine evaluation criteria and will allow for continued non-residential use of the property. This alternative was selected based on consideration of the requirements of CERCLA, the NCP, and input received from Illinois EPA. The remedy will meet the RAOs by implementing LUCs to prevent residential uses, to limit intrusive activities, to maintain the existing surface soil, pavement, and foundations to prevent exposure to contaminated soil, and to prevent groundwater use. A Base Instruction is already in place to restrict groundwater use at NSGL.

The principal factors in the selection of this remedy included the following:

- The remedy is consistent with the current and future non-residential use of the site. The remedy will reduce risk by continuing restrictions on residential uses of property.
- Use of groundwater is already prohibited via a Base Instruction and local ordinance, so groundwater treatment is not necessary to address existing or future exposure risks. The remedy will reduce risk by continuing restrictions on groundwater use.
- The remedy can be implemented in a relatively short time frame, will be protective of human health, is cost-effective, and will result in a permanent solution to the maximum extent practicable.

### 2.3.7.2 Description of Selected Remedy

The Selected Remedy includes two major components: (1) LUCs to prevent residential use of the site, limit exposure to contaminated soil, and prevent groundwater use, and (2) a barrier to limit exposure to contaminated soil. The LUCs will be implemented and maintained by the Navy in perpetuity or until concentrations of hazardous substances in soil are at levels that allow for unrestricted use and unlimited exposure. Five-Year Reviews will be required because contaminants will remain in soil and groundwater at concentrations greater than levels acceptable for unrestricted use of the site.

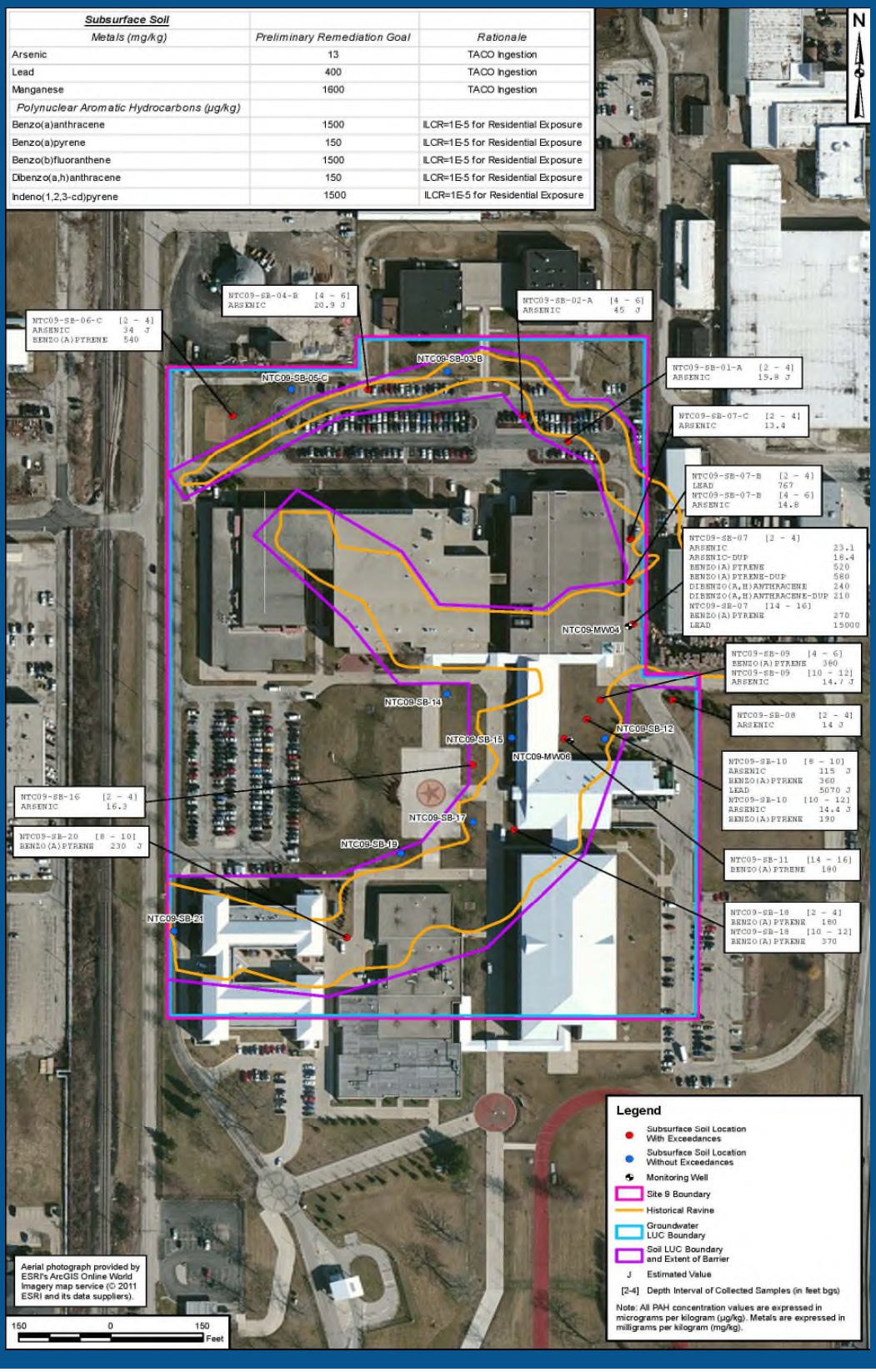
The existing pavement, shallow soil, buildings, and building foundations will serve as a barrier to prevent exposure to contaminated soil. Buildings and pavement will be routinely inspected to prevent exposure to the subsurface soil. At locations where a building or pavement prevents exposure to soil, the level of effort of the inspection will be limited to confirming the presence or absence of a building, pavement, or Illinois EPA-approved clean soil cover. The limited areas that currently have no barrier will remain that way to allow for some infiltration of storm water. LUCs will be implemented within the Site 9 boundaries to limit use of the property, limit exposure to contaminated soil, and prohibit groundwater use. The LUC boundary encompasses most of the site, as shown on Figure 2-11. The groundwater LUC applies to the entire site to be consistent with the existing Base Instruction. Consistent with the RAOs developed for the site, the specific performance objectives for the LUCs to be implemented at Site 9 are as follows:

- To prohibit residential use or non-residential special use (such as for child-care facilities, pre-schools, elementary schools, secondary schools, playgrounds, convalescent, or nursing care facilities) by a population that requires special protections.
- To prevent the use of groundwater throughout the site as a potable water source.
- To require routine inspection of the surface soil buildings, pavement, and clean soil cover to prevent exposure to contaminated subsurface soil. During this inspection, the presence of the clean soil cover, buildings, and pavement, which prevents exposure to contaminated soil, will be confirmed.
- To restrict unauthorized construction.
- To require notification of the presence of contaminants to construction workers.
- To require review of construction activities and intrusive work in the area to protect workers through PPE and alternative methods to reduce exposure.
- To require proper management of excavated material.
- To provide for long-term inspection of LUCs.
- To provide requirements for dealing with changes in land use or site features.

The following generally describes LUCs that will be implemented at the site to achieve the LUC performance objectives:

- Preparation of a site plat describing the LUCs within the boundaries of the site and filing of the plat with NAVFAC Midwest's real estate division.
- Incorporation of these restrictions, in the form of a deed notice or lease notice, into any real estate property documents associated with future sale or lease of the site. The real estate property documents will also include a discussion of the status of the site and a description of the COCs in site media.
- Notification of Illinois EPA at least 6 months prior to any transfer, sale, or lease of any property subject to LUCs required by a decision document. This will enable Illinois EPA to be involved in discussions to make sure that appropriate provisions, such as the Illinois EPA's Uniform Environmental Covenants Act 765 Illinois Compiled Statutes 122 (an environmental covenant), are included in the conveyance documents to maintain effective LUCs.

## FIGURE 2-11. SITE 9 SELECTED REMEDY



- Annual inspections to make sure that there are no violations of these restrictions. The Installation Commander will provide annual certification to Illinois EPA that there have been no violations of these restrictions.
- If a violation of a restriction occurs, a description of the violation and the corrective actions to be taken to restore protectiveness will be reported immediately to Illinois EPA and USEPA.

LUCs will be implemented and maintained by the Navy in perpetuity or until concentrations of hazardous substances in site media are at levels that allow for unrestricted use and unlimited exposure. The Navy or any subsequent owners shall not modify, delete, or terminate any LUC without Illinois EPA concurrence. The Navy is responsible for implementing, maintaining, reporting on, and enforcing the LUCs described in this ROD. Although the Navy may later transfer these procedural responsibilities to another party by contract, property transfer agreement, or through other means, the Navy shall retain ultimate responsibility for the remedy integrity. If the Navy transfers, sells, or leases the property, the Navy will be required to meet the requirements of Illinois EPA's Uniform Environmental Covenants Act 765 Illinois Compiled Statutes 122 (an environmental covenant).

Should any LUC remedy fail, the Navy will make sure that appropriate actions are taken to re-establish the remedy's protectiveness and may initiate legal action to either compel action by a third party(ies) and/or to recover the Navy's costs for remedying any discovered LUC violation(s). The Navy will maintain, monitor, and enforce the LUCs according to the LUC MOA. LUCs will be developed in accordance with the Principles and Procedures for Specifying, Monitoring, and Enforcement of Land Use Controls and Other Post-ROD Actions, per letter dated October 2, 2003, from Raymond F. DuBois, Deputy Under Secretary of Defense (Installations and Environment), to Hon. Marianne Lamont Horinko, Acting Administrator, USEPA. Implementation of this remedy will require a survey of the site, annual visual inspections, and a Five-Year Review with report preparation.

By separate MOA with Illinois EPA and Commander, Navy Region Midwest, on behalf of the Department of the Navy, the Navy agreed to implement base wide, certain periodic site inspection, condition certification, and agency notification procedures designed to ensure the maintenance by Commander, Navy Region Midwest personnel of any site-specific LUCs deemed necessary for present and future protection of human health and the environment. A fundamental premise underlying execution of this agreement was through the Navy's substantial good-faith compliance with the procedures called for therein, reasonable assurances would be provided to Illinois EPA as to the permanency of those remedies that included the use of specific LUCs.

It is understood that the terms and conditions of the MOA are not specifically incorporated or made enforceable herein by reference. Should compliance with the MOA not occur or should the MOA be terminated, it is understood that the protectiveness of the remedy concurred with may be reconsidered, and additional measures may need to be taken to adequately ensure necessary future protection of human health and the environment.

The sequence of actions for implementing the Selected Remedy is:

1. Institute LUCs and input the site into the LUC Tracker System.
2. Perform annual inspection and certification of the site.
3. Perform Five-Year Reviews.

#### 2.3.7.3 Cost of Selected Remedy for Site 9

A detailed cost estimate for the Selected Remedy, Alternative 9-2, for capital cost, annual cost, and present worth analysis is provided in Appendix C. The information in this cost estimate is based on the best available information regarding the anticipated scope of the Selected Remedy and implementation of the Selected Remedy at this site independent of the other two sites. Implementation of the Selected

Remedy at the three sites is expected to be performed as part of a single project, so the actual cost for this site may be lower due to economies of scale. Changes in the cost elements may occur because of new information or data collected during the design and implementation of the Selected Remedy. This is an order-of-magnitude cost estimate that is expected to be within -30 to +50 percent of the actual project cost. This estimate will be refined as the remedy is designed and implemented. Even after the Selected Remedy is implemented, the total project cost is still reported as an estimate because of the uncertainty associated with annual O&M expenditures.

#### 2.3.7.4 Expected Outcomes of Selected Remedy for Site 9

The current use of Site 9 as a non-residential area is expected to remain the same for the foreseeable future. Groundwater at the site is not used and is not expected to be used in the future because an existing Base Instruction and local ordinance prevent groundwater use. There are no socio-economic, community revitalization, or economic impacts or benefits associated with implementation of the Selected Remedy at Site 9. It is estimated that the RAOs for Site 9 will be achieved upon implementation of the remedy. Table 2-12 describes how the Selected Remedy mitigates risks and achieves the RAOs for the site.

Site use is not expected to change; therefore, modification or removal of the LUCs will not be required. However, if proposed land use changes in the future and other uses are expected, other remedial approaches may be required. Any modifications to LUCs will be conducted in accordance with provisions in the base's LUC MOA.

**TABLE 2-12. HOW SELECTED REMEDY FOR SITE 9 MITIGATES RISK AND ACHIEVES RAOS**

| RISK | RAO | COMMENTS |
|---|---|---|
| Potential unacceptable risks to human health from exposure to contaminated soil | Prevent residential exposure through ingestion, dust inhalation, and dermal contact to contaminated subsurface soil with COC concentrations exceeding cleanup levels | Surface soil, pavement, and building act as a barrier that prevents exposure to reduce risk to acceptable levels for current industrial workers. LUCs will restrict potential future residential use of the site and will limit risks to contaminated soil by controlling exposure during construction. |
| Potential unacceptable risks to I/C workers and construction workers from exposure to contaminated soil | Prevent I/C and construction worker exposure through ingestion, dust inhalation, and dermal contact to contaminated subsurface soil with COC concentrations exceeding TACO criteria | Implementation of LUCs to restrict unauthorized construction, require notification of the presence of contaminants, and to protect workers through PPE and alternative methods to reduce exposure. |
| Potential unacceptable risks to human health from exposure to contaminated groundwater | Return the groundwater resource to beneficial use, if practicable, and address human health risks associated with groundwater consumption | Implementation of LUCs to prevent potable use of groundwater, which prevents exposure. Base Instruction and local ordinance already restrict the use of groundwater, which has marginal beneficial use. |

### 2.3.8 Site 9 Statutory Determinations

In accordance with the NCP, the Selected Remedy for Site 9 meets the following statutory determinations:

- **Protection of Human Health and the Environment** – The Selected Remedy is needed to prevent hypothetical future risks associated with residential exposure and groundwater, to minimize exposure

to construction workers and I/C workers to soil that has concentrations of lead and arsenic greater than TACO criteria. LUCs and barriers will be implemented to ensure protectiveness.

- **Compliance with ARARs** – The Selected Remedy will attain the identified federal and state ARARs, as presented in Appendix B.
- **Cost-Effectiveness** – The Selected Remedy is the most cost-effective alternative that allows for continued non-residential use of the property and represents the most reasonable value for the money. The costs are proportional to overall effectiveness by achieving an adequate amount of long-term effectiveness and permanence within a reasonable time frame. Detailed costs for the Selected Remedy are presented in Appendix C.
- **Utilization of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable** – The Selected Remedy represents the maximum extent to which permanent solutions and alternative treatment technologies can be used in a practical manner at Site 9. Based on the type and volume of soil contamination and the current and reasonably anticipated future use of the site, no treatment alternatives were evaluated for soil at Site 9 in the FFS (Tetra Tech, 2013c). LUCs and barriers provide the best balance of tradeoffs for long-term effectiveness and permanence with ease of implementation for reasonable cost. Groundwater treatment was considered in two alternatives; however, the extent of groundwater contamination is limited, and LUCs provide the best balance of tradeoffs for long-term effectiveness and permanence with ease of implementation for reasonable cost.
- **Preference for Treatment as a Principal Element** – Treatment is not a principal element of the Selected Remedy for soil or groundwater at Site 9 because there are no principal threat wastes at the site, and LUCs and barriers provide the best balance of tradeoffs with respect to long-term effectiveness and permanence at a reasonable cost.
- **Five-Year Review Requirement** – Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on site in excess of levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within 5 years after initiation of remedial action and every 5 years thereafter to ensure that the remedy is, or will be, protective of human health and the environment.

## 2.4 SITE 21

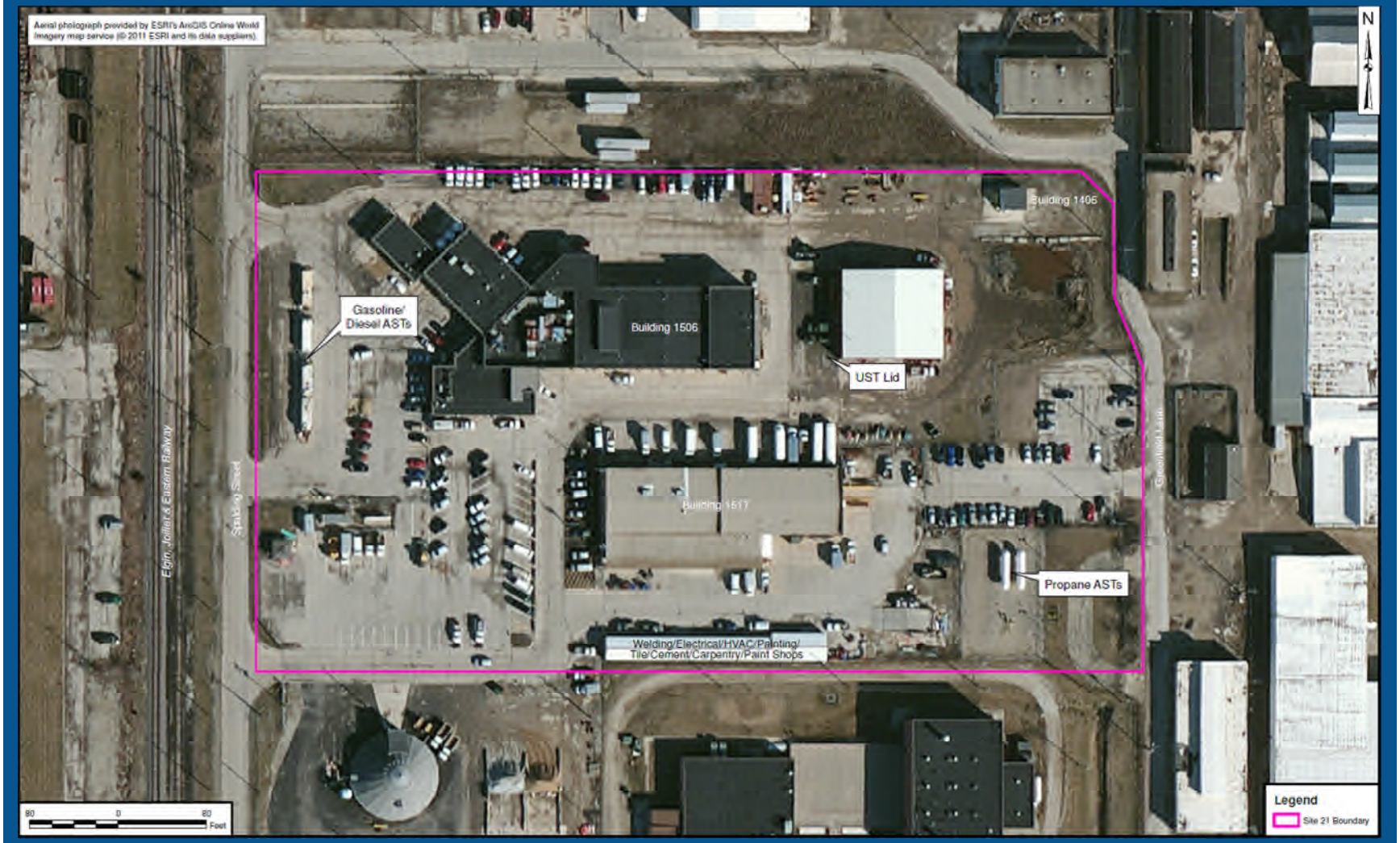
### 2.4.1 Site 21 Site Characteristics

Site 21 contains several buildings and parking lots and covers an area of approximately 7 acres (Figure 2-12). The site includes Building 1517, used for equipment storage, and Building 1506 which houses offices along with a garage and fueling station for base support and government vehicles. In addition, a storage building used by paint, plumbing, and electrical shops and a temporary hazardous waste storage area are located at the site. Historical practices at NSGL may have resulted in soil and groundwater contamination at the site.

The site is almost entirely covered by pavement and buildings; therefore, current occupational/ maintenance workers are not regularly exposed to soil at the site.

Building 1517 was historically associated with salvage operations at NSGL. The area north of Building 1517 may have been used during the 1930s and 1940s to store waste or scrap material on concrete pads next to rail spurs. These materials may have been hauled away by railcar, or the waste materials may have been sent to an incinerator that was located in the northwestern portion of the site until 1964. Prior to 1950 until the 1960s or 1970s, the site was used as a coal stockpile area, which covered most of Site 21 north of Building 1517. Two nearby sites may also have affected Site 21. One of these sites is Building 1600A, which is located northwest of Site 21. Several leaks associated with USTs, which were likely used for oil or fuel storage, were identified at this site. A plume of contaminated groundwater was documented to extend from Building 1600A to the northwestern corner of Site 21. The groundwater

## FIGURE 2-12. SITE 21 LAYOUT



plume was remediated to meet regulatory standards using biosparging techniques, and the site was closed in 2010. However, impacted soil from the Building 1600A release is considered to remain on Site 21. The other site, Site 5, is located south of Site 21. Site 5 is discussed in Section 2.2 of this document.

Potential receptors and exposure pathways for Site 21 are discussed in Section 2.1.7.

### Nature and Extent of Contamination

Soil borings drilled prior to the construction of Building 1506 over a large portion of the northern and western sections of Site 21 indicated the presence of thin zones of fill. The Navy conducted a RI at Site 21 in 2009 to determine the **nature and extent of fill materials** at the site and to identify potential risks associated with Site 21. The investigation included the collection of surface soil (i.e., the first 6 inches of soil below the asphalt and gravel base of the parking lot), subsurface soil, and groundwater samples, which were analyzed for VOCs, SVOCs, PCBs, pesticides, dioxins/furans, and metals.

With the exception of the southwestern portion of the site, most of the site has a layer of fill material below the asphalt/grassy top to a depth of 1 to 5 feet below ground surface. Typically, this fill is a sand, gravelly sand, and/or silty sand with areas of coal, ash, slag, brick fragments, etc. There was no evidence of waste disposal at the site. No information has been identified to indicate the presence of listed hazardous waste or characteristically hazardous waste at the site.
Concentrations of PAHs, three pesticides, and several metals in surface soil and PAHs, two pesticides, and manganese in subsurface soil exceeded Illinois EPA TACO criteria. High concentrations of PAHs and mercury in surface soil were detected in a sample near shops used for welding, electrical, heating, ventilation and air conditioning, pipefitting, tiling, cement, carpentry, and painting and a Resource Conservation and Recovery Act (RCRA) hazardous material storage facility. High concentrations of PAHs in subsurface soil were detected in a sample near a vehicle maintenance facility and fuel station and a leaking UST. Concentrations of pentachlorophenol (PCP), iron, and manganese in groundwater exceeded Illinois EPA TACO criteria; however, only PCP exceeded its MCL. Concentrations of other parameters were less than the Illinois EPA TACO criteria. Based on consideration of Illinois EPA criteria exceedances as well as unacceptable human health risks, PAHs, arsenic, cobalt (subsurface soil only), iron, and lead (surface soil only) in soil and PCP in groundwater were selected as COCs, as described further below. PCP was detected in one groundwater sample located in the northwestern corner of the site, which is the former location of the incinerator. PAH concentrations may be linked to asphalt paving or historical storage of coal at the site. Material storage and vehicle maintenance may have contributed to the presence of other COCs at the site.

## 2.4.2 Summary of Site 21 Risks

The investigation at Site 21 included evaluating the potential **human health risks** from detected chemical concentrations in surface soil, subsurface soil, and groundwater.

### Summary of Human Health Risks

Tables summarizing data used in the Site 21 HHRA and associated results are presented in Appendix A. Tables 1 to 3 in Appendix A.3 present EPCs for the COPCs identified at Site 21 in surface soil, subsurface soil, and groundwater. Tables 4 and 5 in Appendix A.3 provide assumptions about the frequency and duration of exposure for each receptor. Tables 6 and 7 in Appendix A.3 provide non-carcinogenic hazard information relevant to the Site 21 COPCs for oral/dermal and inhalation routes of exposure, respectively. Tables 8 and 9 in Appendix A.3 provide carcinogenic risk information relevant to the Site 21 COPCs for oral/dermal and inhalation exposures.

Tables 10 and 11 in Appendix A.3 provide RME and CTE cancer risk estimates for the significant receptors and routes of exposure developed by taking into account various conservative assumptions about the frequency and duration of exposure for each receptor and also about the toxicities of the COPCs. RME cancer risk estimates are presented in this section. Cancer risks were compared to the

USEPA and Illinois EPA Tier 3 target risk range of 1 x $10^{-4}$ to 1 x $10^{-6}$. The risks from exposure to surface soil and/or subsurface soil for construction workers, maintenance/occupational workers, and trespassers were within the risk range. However, several soil samples had concentrations of PAHs and arsenic that were greater than the I/C and construction worker TACO criteria. There were no unacceptable risks from exposure to groundwater for construction workers. There were unacceptable cancer risks from exposure to surface soil, subsurface soil, and groundwater for hypothetical future child, adult, and lifelong residents.

Carcinogenic PAHs and arsenic in soil (surface and subsurface) are the major contributors to cancer risk at Site 21. PCP and arsenic in groundwater are identified as primary contributors to cancer risk at Site 21.

Tables 10 and 11 in Appendix A.3 also provide RME and CTE non-cancer HQs for each receptor and route of exposure and total HIs for the routes of exposure. RME non-cancer HIs are presented in this section. Non-cancer risks were compared to the USEPA and Illinois EPA HI target risk level of 1. There were no unacceptable risks from exposure to surface soil and/or subsurface soil for construction workers (based on re-evaluation of the soil inhalation pathway as discussed below), maintenance/occupational workers, and trespassers. There were no unacceptable risks from exposure to groundwater for construction workers and maintenance/occupational workers. There were unacceptable non-cancer risks from exposure to surface soil and subsurface soil for hypothetical future child residents and from exposure to groundwater for hypothetical future child and adult residents.

Arsenic, cobalt (subsurface only), and iron concentrations in soil resulted in an HQ greater than 1 for hypothetical future child residents. Cobalt, iron, and manganese concentrations in groundwater resulted in HQs greater than 1 for hypothetical future child residents and adult residents.

The Navy, Illinois EPA, and Tetra Tech collectively determined that the USEPA PEF used to calculate the HI for the inhalation pathway was overly conservative for the site and not a realistic representation of Site 21. Therefore, a site-specific determination was made to use the Illinois EPA TACO PEF to calculate the HIs for the construction worker inhalation pathway. The Illinois EPA TACO PEF is less conservative than the USEPA PEF; however, it is still considered protective. This recalculation conducted as part of the FFS (Tetra Tech, 2013c) resulted in soil RME HIs (including the inhalation pathway) of less than 1 for construction workers (Tables 12 to 17 in Appendix A.3). Therefore, non-cancer risks from soil exposure are acceptable for the construction worker receptor at Site 21.

The following constituents were identified as Site 21 COCs for exceeding a cancer risk of 1x$10^{-4}$ and/or an HQ of 1:

- Carcinogenic PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene chrysene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene), arsenic, and iron for hypothetical future residential exposure to surface soil.
- Carcinogenic PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene chrysene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene), arsenic, cobalt, and iron for hypothetical future residential exposure to subsurface soil.
- Arsenic, cobalt, iron, manganese, and PCP for hypothetical future residential exposure to groundwater.

## Basis for Action

Unacceptable risks from exposure to carcinogenic PAHs, arsenic, cobalt, iron, and lead in soil and PCP in groundwater were estimated for hypothetical future residents. In addition several soil samples had concentrations of PAHs and arsenic that were greater than the I/C and construction worker TACO criteria.

Because unacceptable risks were identified under a future land use scenario for human receptors and concentrations of PAHs and arsenic exceeded TACO criteria for the current and future I/C and

construction worker, a response action is necessary to protect human health or the environment from actual or threatened releases of hazardous substances into the environment that may present an imminent and substantial endangerment.

### 2.4.3 Site 21 Remedial Action Objectives

RAOs are medium-specific goals that define the objective of conducting remedial actions to protect human health and the environment. RAOs generally specify the COCs, potential exposure routes and receptors, and acceptable concentrations (i.e., cleanup levels) for a site, and provide a general description of what the cleanup will accomplish. The following RAOs were developed for Site 21 to address protection of human health:

**RAO 1:** Prevent residential exposure through ingestion, dust inhalation, and dermal contact to contaminated surface soil and subsurface soil with COC concentrations exceeding cleanup levels.

**RAO 2:** Prevent I/C and construction worker exposure through ingestion, dust inhalation, and dermal contact to contaminated surface soil and subsurface soil with COC concentrations exceeding TACO criteria.

**RAO 3:** Return the groundwater resource to beneficial use, if practicable, and address human health risks associated with groundwater consumption.

For soil, the most conservative of the Illinois EPA TACO Tier 1 SROs for residential exposure via incidental ingestion and inhalation were used to identify target concentrations for evaluation of unrestricted use of the property. In addition, risk-based criteria based on residential exposure associated with an HI of 1 and a cancer risk of $1 \times 10^{-5}$ were also considered as possible cleanup levels. For a given COC, the SROs and risk-based values are generally comparable. In those cases, the greater of the two values is selected so that the cleanup levels are not overly conservative. However, for a COC for which the difference is an order of magnitude or more, suggesting that significantly different assumptions were made in the risk calculation method(s), the lesser value was used to provide better certainty of protectiveness. Selection of cleanup levels for concentrations of PAHs and inorganics in surface soil also took background concentrations into consideration, with background concentrations as defined in the TACO Appendix A Table G for inorganics and Appendix A Table H for PAHs. Because several soil samples exceeded the TACO criteria for occupational/maintenance workers and construction worker, the corresponding I/C TACO values for the COCs identified in surface and subsurface soil were retained as cleanup levels. Table 2-13 summarizes the cleanup levels. I/C and construction levels are used where non-residential use is required or assumed.

**TABLE 2-13. SOIL CLEANUP LEVELS**

| COC | RESIDENTIAL SURFACE SOIL | BASIS | RESIDENTIAL SUB-SURFACE SOIL | BASIS | TACO I/C | TACO CONST |
|---|---|---|---|---|---|---|
| Arsenic (mg/kg) | 13 | BG | 13 | BG | 1,200 | 61 |
| Cobalt (mg/kg) | NA | - | 24 | HHRA | 120,000 | 12,000 |
| Iron (mg/kg) | 55,000 | HHRA | 55,000 | HHRA | - | - |
| Lead (mg/kg) | 400 | TACO | NA | - | 800 | 700 |
| Benzo(a)anthracene (µg/kg) | 1,800 | BG | 1,500 | HHRA | 8,000 | 170,000 |
| Benzo(a)pyrene (µg/kg) | 2,100 | BG | 150 | HHRA | 800 | 17,000 |
| Benzo(b)fluoranthene (µg/kg) | 2,100 | BG | 1,500 | HHRA | 8,000 | 170,000 |

| TABLE 2-13. SOIL CLEANUP LEVELS | | | | | | |
|---|---|---|---|---|---|---|
| COC | RESIDENTIAL SURFACE SOIL | BASIS | RESIDENTIAL SUB-SURFACE SOIL | BASIS | TACO I/C | TACO CONST |
| Benzo(k)fluoranthene (µg/kg) | 9,000 | TACO | 15,000 | HHRA | 78,000 | 1,700,000 |
| Chrysene (µg/kg) | 88,000 | TACO | 150,000 | HHRA | 780,000 | 17,000,000 |
| Dibenzo(a,h)anthracene (µg/kg) | 420 | BG | 150 | HHRA | 800 | 17,000 |
| Indeno(123-cd)pyrene (µg/kg) | 1,600 | BG | 1,500 | HHRA | 8,000 | 170,000 |

NA – No cleanup levels were identified for COCs that had acceptable concentrations for the identified receptor.
BG – Background.
Const – Construction worker.

Groundwater cleanup levels were developed based on Class I groundwater standards in 35 IAC 620, federal MCLs, and Illinois EPA TACO values. Based on current site information, groundwater at Site 21 is assumed to be classified as Class I under 35 IAC 620. Existing administrative restrictions on groundwater use and low yield prevent the effective use of groundwater as a drinking water source, so although MCLs and TACO values have been considered, exposure routes are not complete, and MCLs and TACO values were not used to select cleanup levels. At Site 21, only PCP exceeds its MCL, per Illinois EPA, and requires identification of a cleanup level, and the cleanup level based on Class I standards is 1 µg/L.

For Site 21, exceedances of residential cleanup levels in surface soil are shown on Figure 2-13, and exceedances of residential cleanup levels in subsurface soil are shown on Figure 2-14. Exceedances of groundwater cleanup levels are shown on Figure 2-15.

Approximately 3,000 cy of contaminated soil is present at Site 21. The contamination is present to an approximate depth of 1 to 4 feet bgs. The groundwater plume is limited to the area around one well where contaminant concentrations were greater than cleanup levels. Therefore, the volume of contaminated groundwater was not calculated.

### 2.4.4 Description of Alternatives for Site 21

General response actions are broadly defined remedial approaches that may be used (by themselves or in combination with others) to attain the RAOs. Because the HHRA identified potential non-carcinogenic risks at a concentration in excess of the HI of 1 and carcinogenic risks in excess of 1 x $10^{-4}$, general response actions for Site 21 were developed as presented on Table 2-14:

| TABLE 2-14. GENERAL RESPONSE ACTIONS FOR SITE 21 | | |
|---|---|---|
| GENERAL RESPONSE ACTION | TECHNOLOGY | PROCESS OPTIONS |
| **Soil** | | |
| No Action | None | Not Applicable |
| Limited Action | Institutional Controls | LUCs |
| Containment | Barrier | Asphalt, Soil, or Building |
| Removal | Excavation/Disposal | Off-Base Landfill Disposal |

| TABLE 2-14. GENERAL RESPONSE ACTIONS FOR SITE 21 | | |
|---|---|---|
| **GENERAL RESPONSE ACTION** | **TECHNOLOGY** | **PROCESS OPTIONS** |
| **Groundwater** | | |
| No Action | None | Not Applicable |
| Limited Action | Institutional Controls | LUCs |
| | Monitoring | Sampling and Analysis |
| In-Situ Treatment | Chemical | Chemical Oxidation |

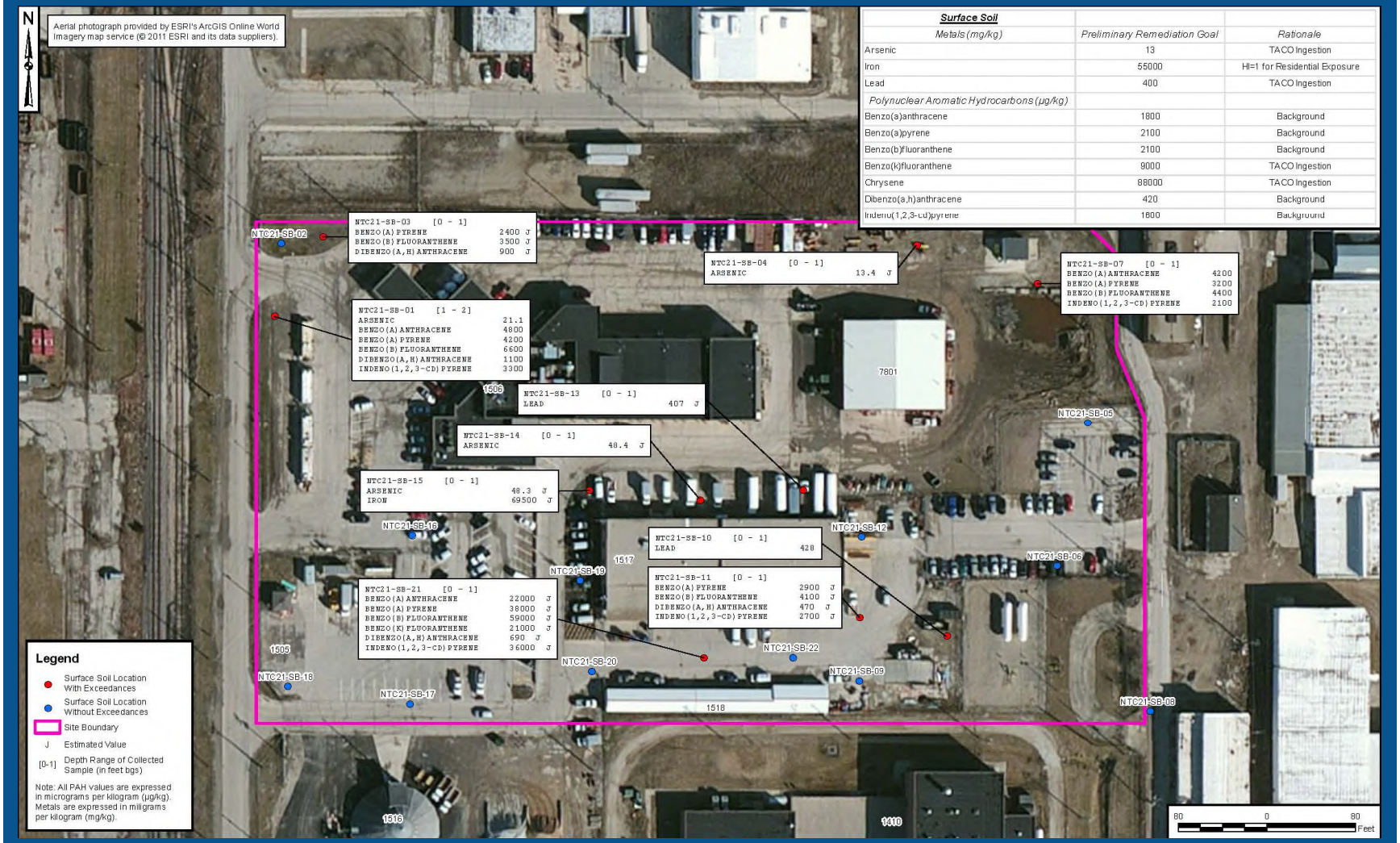
Table 2-15 describes the major components of the Site 21 alternatives evaluated and provides associated costs.

| TABLE 2-15. SUMMARY OF REMEDIAL ALTERNATIVES EVALUATED FOR SITE 21 | | | |
|---|---|---|---|
| **ALTERNATIVE** | **COMPONENTS** | **DETAILS** | **COST** |
| **Alternative 21-1:**<br>**No Action**<br>*No action to address contamination and no use restrictions* | No action would be conducted | Five-year reviews would not be included under the no action alternative. | **Cost**: $0 |
| **Alternative 21-2:**<br>**LUC and Barrier**<br>*Current and future land use restrictions, maintenance of existing pavement and buildings* | LUCs | LUCs would be implemented to prevent residential land use, restrict unauthorized construction, require notification of the presence of contaminants to construction workers, require review of construction activities and intrusive work in the area to protect workers through PPE and alternative methods to reduce exposure, require proper management of excavated material, provide for long-term inspection of LUCs, and provide requirements for dealing with changes in land use or site features. LUCs would be maintained in perpetuity. | **Capital**: $21,000<br>**O&M**: $9,000<br>**Five-Year Reviews**: $26,000<br>**30-Year NPW**: $366,000 |
| | | LUCs would require routine inspection of the pavement and building foundations and repairs to the pavement and foundations to prevent exposure to contaminated soil. | |
| | | LUCs would be implemented over the entire site to restrict groundwater use. | |
| | Barrier | The existing pavement and buildings will be used as a barrier to prevent exposure of I/C workers to soil contaminants exceeding I/C TACO criteria. In addition, approximately 2,000 square feet in the northwestern corner of the site will need to be further evaluated to determine the appropriate remedial action, such as a barrier (soil, asphalt, etc.) or excavation over this limited area. This area had a surface soil sample with PAH concentrations greater than soil cleanup levels based on background values. The specific remedial action will be identified in the remedial action work plan. Barriers would be required to remain, either a building, pavement, or soil. | |

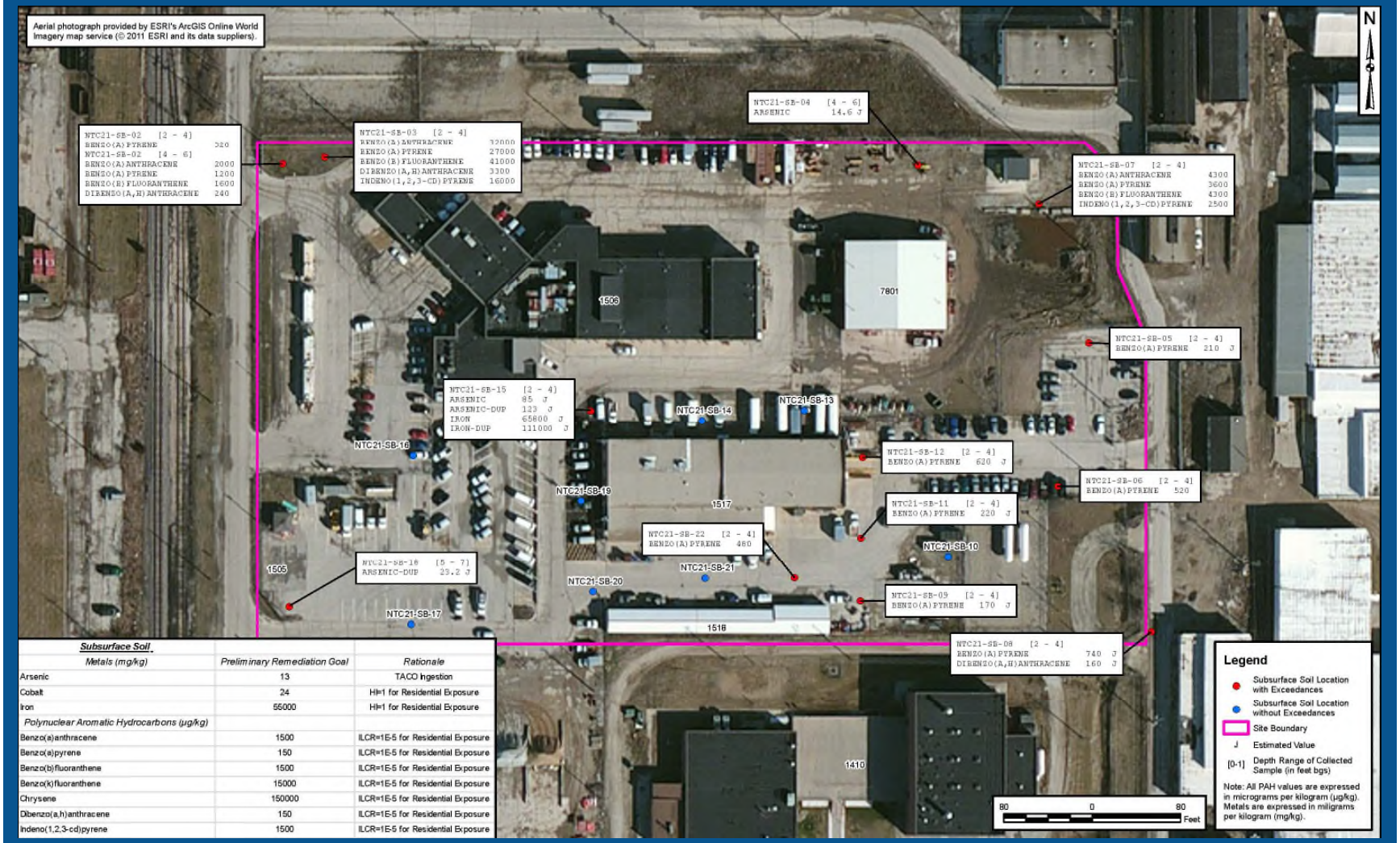
**TABLE 2-15. SUMMARY OF REMEDIAL ALTERNATIVES EVALUATED FOR SITE 21**

| ALTERNATIVE | COMPONENTS | DETAILS | COST |
|---|---|---|---|
| **Alternative 21-2A: LUCs, Barrier, and ISCO** *Current and future land use restrictions, maintenance of existing pavement and buildings, ISCO treatment of groundwater* | LUCs | Implementation of LUC requirements as described in Alternative 21-2. Soil LUCs would be maintained in perpetuity. Groundwater LUCs would only continue until ISCO is completed and the groundwater cleanup level is met. | **Capital**: $554,000 **O&M**: $9,000 **Five-Year Reviews**: $26,000 **30-Year NPW**: $900,000 |
| | Barrier | The existing pavement and building foundations would be used as a barrier as described in Alternative 21-2. | |
| | ISCO | Oxidant would be injected into the groundwater at the location where groundwater cleanup levels are exceeded (PCP). Groundwater samples would be collected and analyzed to monitor the progress of treatment. | |
| **Alternative 21-3 Excavation (Unrestricted Reuse), Off-Site Disposal, and LUCs** *Excavation and off-site disposal of unsaturated soil, LUCs for groundwater* | Excavation and Disposal | Excavation and off-site disposal of 3,000 cy of soil to meet cleanup levels for residential exposure. It is assumed that this alternative would only be implemented if the base was closed and there was a change in land use. Excavated material would be transported off-site to a non-hazardous landfill for disposal. Excavated areas would be backfilled with clean soil, and the surface would be reseeded with grass. | **Capital**: $1,244,000 **O&M**: $3,000 **Five-Year Reviews**: $26,000 **30-Year NPW**: $1,436,000 |
| | LUCs | LUCs would be implemented over the entire site to restrict groundwater use. | |
| **Alternative 21-3A Excavation (Unrestricted Reuse), Off-Site Disposal, LUCs, and ISCO** *Excavation and off-site disposal of unsaturated soil, ISCO treatment of groundwater, LUCs for groundwater* | Excavation and Disposal | Contaminated soil would be excavated and disposed of off-site as described in Alternative 21-3A. | **Capital**: $1,686,000 **O&M**: $3,000 **Five-Year Reviews**: $26,000 **30-Year NPW**: $1,878,000 |
| | ISCO | ISCO would be applied as described in Alternative 21-2A. | |
| | LUCs | Implementation of LUC requirements as described in Alternative 21-3. Groundwater LUCs would only continue until ISCO is completed and the groundwater cleanup level is met. | |

## FIGURE 2-13. SITE 21 EXCEEDANCES OF RESIDENTIAL CRITERIA IN SURFACE SOIL

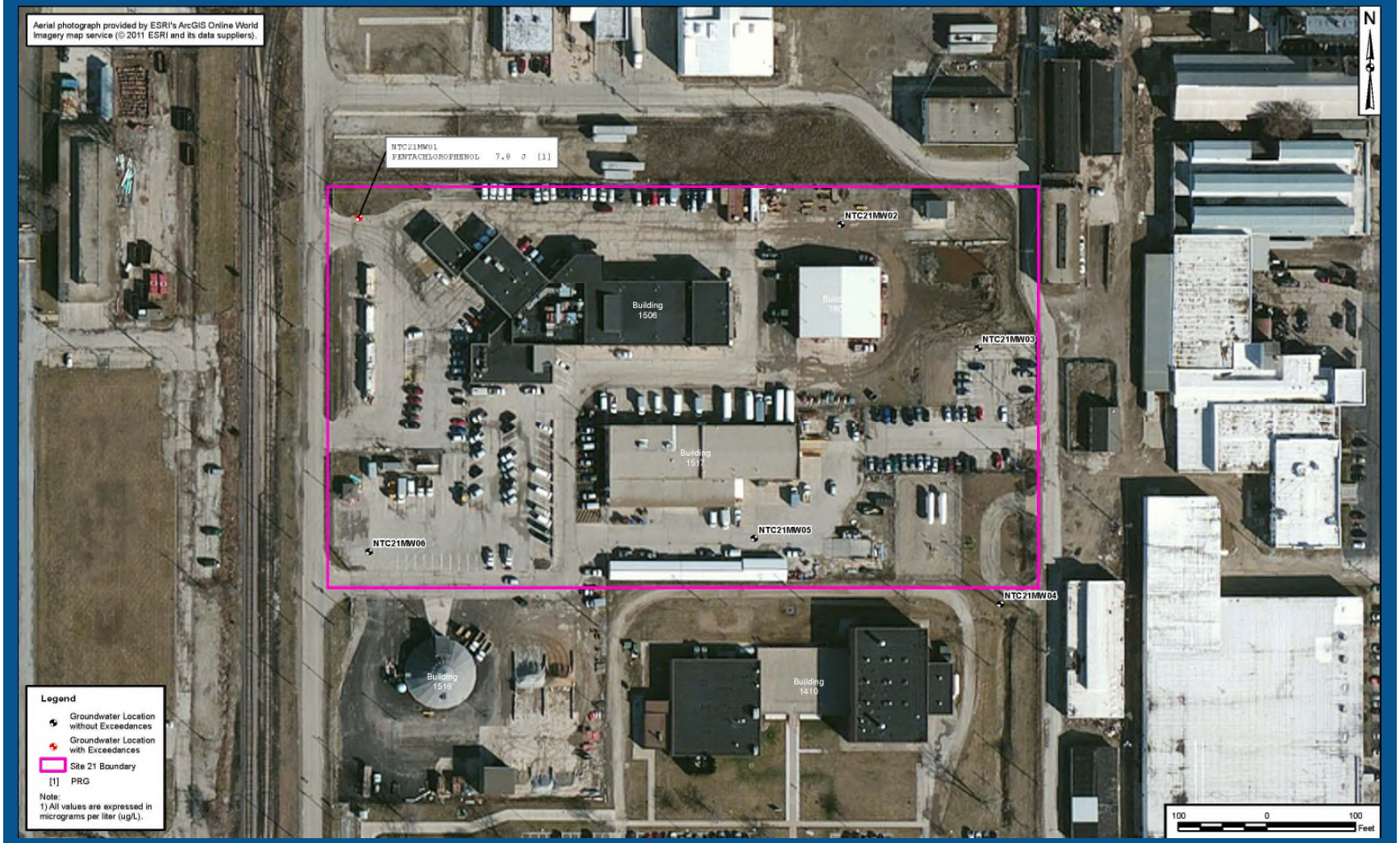


## FIGURE 2-14. SITE 21 EXCEEDANCES OF RESIDENTIAL CRITERIA IN SUBSURFACE SOIL




| Subsurface Soil | | |
|---|---|---|
| *Metals (mg/kg)* | *Preliminary Remediation Goal* | *Rationale* |
| Arsenic | 13 | TACO Ingestion |
| Cobalt | 24 | HI=1 for Residential Exposure |
| Iron | 55000 | HI=1 for Residential Exposure |
| *Polynuclear Aromatic Hydrocarbons (µg/kg)* | | |
| Benzo(a)anthracene | 1500 | ILCR=1E-5 for Residential Exposure |
| Benzo(a)pyrene | 150 | ILCR=1E-5 for Residential Exposure |
| Benzo(b)fluoranthene | 1500 | ILCR=1E-5 for Residential Exposure |
| Benzo(k)fluoranthene | 15000 | ILCR=1E-5 for Residential Exposure |
| Chrysene | 150000 | ILCR=1E-5 for Residential Exposure |
| Dibenzo(a,h)anthracene | 150 | ILCR=1E-5 for Residential Exposure |
| Indeno(1,2,3-cd)pyrene | 1500 | ILCR=1E-5 for Residential Exposure |

## FIGURE 2-15. SITE 21 EXCEEDANCES OF GROUNDWATER CRITERIA



### 2.4.5 Comparative Analysis of Alternatives for Site 21

Table 2-16 and subsequent text in this section summarize the comparison of the Site 21 remedial alternatives with respect to the nine CERCLA evaluation criteria outlined in the NCP at 40 CFR 300.430(e)(9)(iii) and categorized as threshold, primary balancing, and modifying criteria. Further information on the detailed comparison of remedial alternatives is presented in the Sites 5, 9, and 21 FFS (Tetra Tech, 2013c).

**TABLE 2-16: SUMMARY OF COMPARATIVE ANALYSIS OF SITE 21 REMEDIAL ALTERNATIVES**

| ALTERNATIVE | 21-1 | 21-2 | 21-2A | 21-3 | 21-3A |
|---|---|---|---|---|---|
| **Estimated Time Frame** | | | | | |
| Designing and Constructing the Alternative (months) | N/A | 3 | 24 | 2 | 24 |
| Achieving the Cleanup Objectives (months) | N/A | 3 | 3 | 3 | 2 |
| **Criteria Analysis** | | | | | |
| **Threshold Criteria** | | | | | |
| Protects human health and the environment<br>Will it protect you and plant and animal life on and near the site? | No | Yes | Yes | Yes | Yes |
| Meets federal and state regulations<br>Does the alternative meet federal and state environmental statutes, regulations, and requirements? | N/A | ● | ● | ● | ● |
| Primary Balancing Criteria | | | | | |
| Provides long-term effectiveness and is permanent<br>Will the effects of the cleanup last? | ○ | ◐ | ◐ | ● | ● |
| Reduces mobility, toxicity, and volume of contaminants through treatment<br>Are the harmful effects of the contaminants, their ability to spread, and the amount of contaminated material present reduced? | ○ | ○ | ◐ | ○ | ◐ |
| Provides short-term protection<br>How soon will the site risks be reduced?<br>Are there hazards to workers, residents, or the environment that could occur during cleanup? | N/A | ● | ● | ◐ | ◐ |
| Can it be implemented<br>Is the alternative technically feasible?<br>Are the goods and services necessary to implement the alternative readily available? | N/A | ● | ● | ● | ● |
| Cost (K = 1,000s) | | | | | |
| Upfront costs to design and construct the alternative (capital costs) | $0 | $21K | $554K | $1,244K | $1,686K |
| Total cost in today's dollars (30-year NPW cost) | $0 | $366K | $900K | $1,436K | $1,878K |
| **Modifying Criteria** | | | | | |
| State agency acceptance<br>Does Illinois EPA agree with the Navy's recommendation? | Illinois EPA concurs with Alternative 21-2. | | | | |
| Community acceptance<br>What objections, suggestions, or modifications does the public offer during the comment period? | No written questions, comments, or requests for a public meeting were received during the formal public comment period for the Proposed Plan. | | | | |
| Relative comparison of the nine balancing criteria and each alternative:<br>● – Good , ◐ – Average, ○ – Poor; N/A – Not applicable. | | | | | |

## Threshold Criteria

***Overall Protection of Human Health and the Environment***. The no action alternative would not achieve the RAOs and therefore does not protect human health and the environment. It will therefore not be considered further in this ROD. The other four alternatives meet this criterion. Alternative 21-3A would be the most protective because contaminants would be removed from the site by excavation, and concentrations in groundwater that exceed MCLs would be treated. Alternative 21-3 would be the next most protective because contaminants would be removed from the site by excavation, and LUCs would prevent exposure to contaminated groundwater. Alternatives 21-2 and 21-2A would be similar in protectiveness because both would rely on LUCs and the barriers to prevent exposure to contaminants in soil and groundwater. Alternative 21-2A would be slightly more protective because concentrations in groundwater that exceed MCLs would be treated.

***Compliance with ARARs***. ARARs include any federal or state standards, requirements, criteria, or limitations determined to be legally applicable or relevant and appropriate to the site or remedial action. The four alternatives would comply with ARARs.

## Primary Balancing Criteria

***Long-Term Effectiveness and Permanence***. Alternative 21-3A would provide the most long-term effectiveness and permanence because contaminated soil would be disposed of off site and some groundwater COCs would be removed by in-situ treatment. Alternative 21-3 would provide the next most long-term effectiveness and permanence because contaminated soil would be disposed of off-site, but exposure to groundwater COCs would be prevented by LUCs. The effectiveness of LUCs would rely on enforcement of the provisions of the LUCs. Alternatives 21-2 and 21-2A would provide similar effectiveness and permanence through LUCs and barriers that would prevent exposure to COCs in soil and groundwater. As noted, effectiveness of LUCs would rely on enforcement of the provisions of the LUCs. Alternative 21-2A would provide slightly more permanence compared to Alternative 21-2 because some of the groundwater COCs would be removed by in-situ treatment.

***Reduction in Toxicity, Mobility, or Volume Through Treatment***. Alternatives 21-2A and 21-3A would provide treatment of some of the COCs in groundwater. Alternatives 21-2 and 21-3 do not include groundwater treatment, and none of the alternatives include soil treatment. Contaminant concentrations in soil are too low to justify the cost of treatment.

***Short-Term Effectiveness***. The four alternatives would require the maintenance of groundwater LUCs. Alternatives 21-2A and 21-3A would include groundwater treatment so some LUCs could be discontinued after ISCO is applied and cleanup levels are met. Alternative 21-2 could be completed in the shortest time because only LUCs would need to be implemented. Alternative 21-3 would take a longer time to complete because of implementation LUCs and soil excavation. Alternatives 21-2A and 21-3A would require the longest time to complete (over 1 year) to implement the ISCO treatment and groundwater performance monitoring.

Alternative 21-2 would have no short-term risk to the local community or the environment. Alternative 21-2A would have a slight risk to the community during the transport of oxidant to the site. Potential risks to workers conducting the ISCO injection and groundwater monitoring would be managed by proper safety procedures and PPE. Alternative 21-3 would have a slightly greater risk to the community associated with transport of contaminated soil from the site and clean soil to the site. Potential risks to workers conducting the excavation will be managed by proper safety procedures and PPE. Alternative 21-3A would have the highest potential risk to the community associated with transport of contaminated soil from the site and clean soil and oxidant to the site. Potential risks to workers conducting the excavation, ISCO injection, and groundwater monitoring would be managed by proper safety procedures and PPE.

***Implementability***. The alternatives could be readily implemented. Alternative 21-2 would be the easiest to implement because it would involve administrative activities associated with documenting and maintaining use restrictions. Alternative 21-2A would be slightly more difficult to implement because of the tasks associated with ISCO drilling and injection and groundwater monitoring. However, there are numerous contractors that perform this work. Alternative 21-3 would be the next most difficult to perform due to the excavation. However, the excavation is shallow, and no special expertise is required. Alternative 21-3A would be the most difficult, but only when compared to the other alternatives. The shallow excavation and ISCO tasks could be performed by many contractors.

***Cost***. Alternative 21-2 has the lowest estimated NPW of $366,000. The estimated NPW for Alternatives 21-2A and 21-3 are $900,000 and $1,436,000, respectively. Alternative 21-3A has the highest estimated NPW of $1,878,000. There is uncertainty in the excavation costs because the extent of PAH contamination is not completely delineated. In addition, the ISCO treatment in Alternative 21-2A and 21-3A provides little risk reduction relative to the treatment costs. Detailed cost estimates for each alternative are presented in the FFS (Tetra Tech, 2013c).

### Modifying Criteria

***State Acceptance***. State involvement has been solicited throughout the CERCLA process. Illinois EPA, as the designated state support agency in Illinois, concurs with the Site 21 Selected Remedy.

***Community Acceptance***. No written questions, comments, or requests for a public meeting were received during the formal public comment period for the Proposed Plan.

## 2.4.6 Principal Threat Waste

The NCP at 40 CFR 300.430(a)(1)(iii)(A) establishes an expectation that treatment will be used to address the principal threats posed by a site wherever practicable. Principal threat wastes are hazardous or highly toxic source materials that result in ongoing contamination to surrounding media and that generally cannot be reliably contained or that present a significant risk to human health or the environment should exposure occur. A source material includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to groundwater, surface water, or air, or acts as a source for direct exposure.

A current source of contamination is not present at Site 21. Contaminant concentrations are not at levels that are characteristic of a source. In addition, contaminant concentrations are not highly toxic or highly mobile. Therefore, principal threat wastes are not present at Site 21.

## 2.4.7 Selected Remedy for Site 21

### 2.4.7.1 Rationale for Selected Remedy

The Selected Remedy for Site 21 is Alternative 21-2, LUCs and Barrier, which was selected because it provides the best balance of tradeoffs with respect to the nine evaluation criteria and will allow for continued non-residential use of the property. This alternative was selected based on consideration of the requirements of CERCLA, the NCP, and input received from Illinois EPA. The remedy will meet the RAOs by implementing LUCs to prevent residential uses, to limit intrusive activities, to maintain the existing pavement and building foundations to prevent exposure to contaminated soil, and to prevent groundwater use. A Base Instruction is already in place to prevent groundwater use at NSGL.

The principal factors in the selection of this remedy included the following:

- The remedy is consistent with the current and future non-residential use of the site. The remedy will reduce risk by continuing restrictions on residential uses of property.

- Use of groundwater is already prohibited via a Base Instruction and local ordinance, so groundwater treatment is not necessary to address existing or future exposure risks. The remedy will reduce risk by continuing restrictions on groundwater use.
- The remedy can be implemented in a relatively short time frame, will be protective of human health, is cost-effective, and will result in a permanent solution to the maximum extent practicable.

#### 2.4.7.2 Description of Selected Remedy

The Selected Remedy includes two major components: (1) LUCs to prevent residential use of the site, limit exposure to contaminated soil, and prevent groundwater use, and (2) a barrier to prevent exposure to contaminated soil. The LUCs will be implemented and maintained by the Navy in perpetuity or until concentrations of hazardous substances in soil are at levels that allow for unrestricted use and unlimited exposure. Five-Year Reviews will be required since contaminants will remain in soil and groundwater at concentrations greater than levels acceptable for unrestricted use of the site.

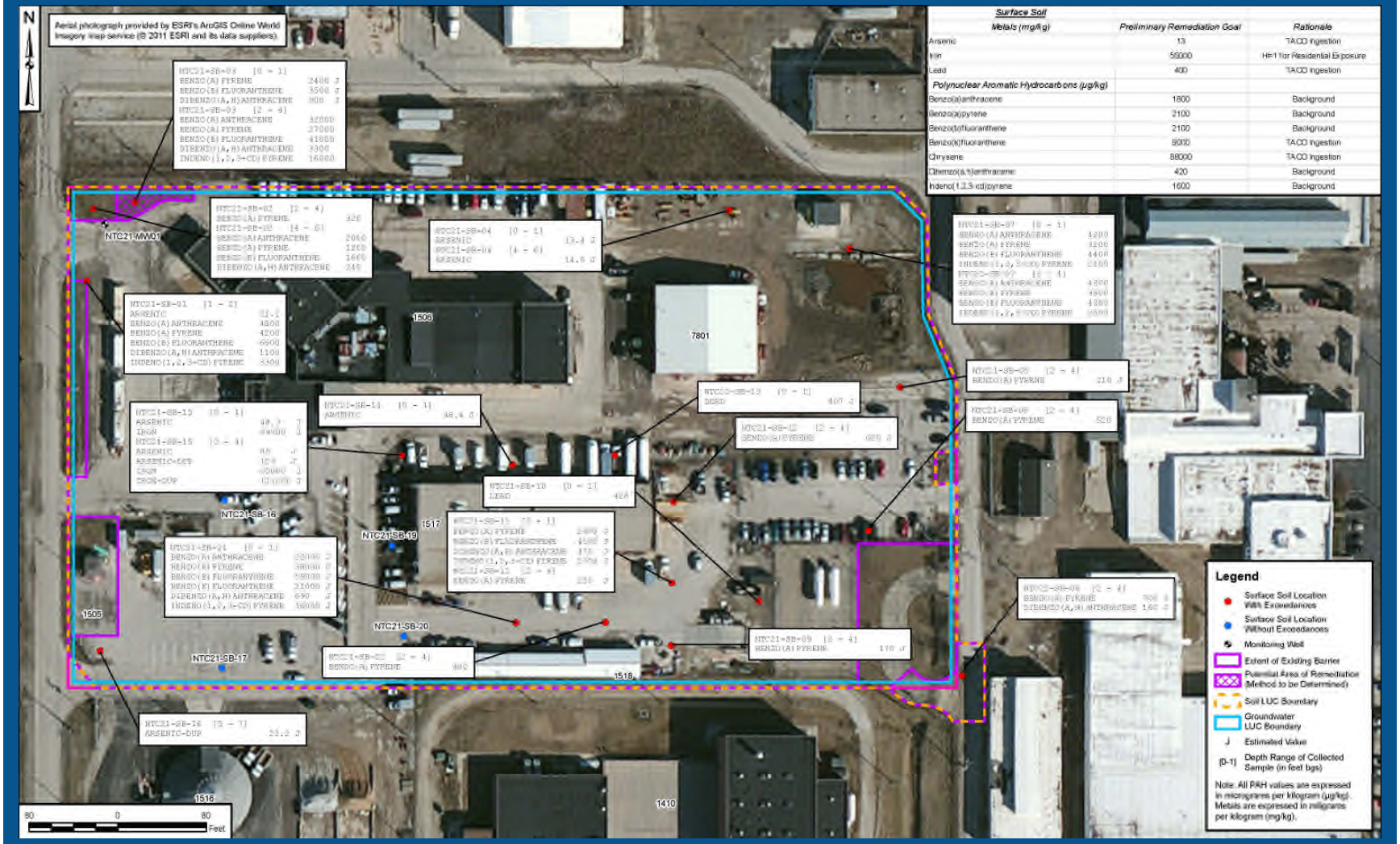
The existing pavement and buildings will serve as a barrier to prevent exposure to contaminated soil. Buildings and pavement will be routinely inspected to prevent exposure to the soil. At locations where a building or pavement prevents exposure to soil, the level of effort of the inspection will be limited to confirming the presence or absence of a building, pavement, or Illinois EPA-approved clean soil cover. The limited areas that currently have no barrier will remain that way to allow for some infiltration of storm water. In addition, approximately 2,000 square feet in the northwestern corner of the site will need to be further evaluated to determine the appropriate remedial action, such as a barrier (soil, asphalt, etc.) or excavation. This area had a surface soil sample with PAH concentrations greater than soil cleanup levels based on background values. The specific remedial action will be identified in the remedial action work plan. LUCs will be implemented within the Site 21 boundaries to limit use of the property, limit exposure to contaminated soil, and prohibit groundwater use. The LUC boundary encompasses most of the site, as shown on Figure 2-16. The groundwater LUC applies to the entire site to be consistent with the existing Base Instruction. Consistent with the RAOs developed for the site, the specific performance objectives for the LUCs to be implemented at Site 21 are as follows:

- To prohibit residential use or non-residential special use (such as for child-care facilities, pre-schools, elementary schools, secondary schools, playgrounds, convalescent, or nursing care facilities) by a population that requires special protections.
- To restrict the use of groundwater throughout the site as a potable water source.
- To require routine inspection of the building, pavement, and clean soil cover to prevent exposure to contaminated soil. During this inspection, the presence of the buildings, pavement, or clean soil cover, which prevents exposure to contaminated soil, will be confirmed.
- To restrict unauthorized construction.
- To require notification of the presence of contaminants to construction workers.
- To require review of construction activities and intrusive work in the area to protect workers through PPE and alternative methods to reduce exposure.
- To require proper management of excavated material.
- To provide for long-term inspection of LUCs.
- To provide requirements for dealing with changes in land use or site features.

The following generally describes LUCs that will be implemented at the site to achieve the LUC performance objectives:

- Preparation of a site plat describing the LUCs within the boundaries of the site and filing of the plat with NAVFAC Midwest's real estate division.

## FIGURE 2-16. SITE 21 SELECTED REMEDY



- Incorporation of these restrictions, in the form of a deed notice or lease notice, into any real estate property documents associated with future sale or lease of the site. The real estate property documents will also include a discussion of the status of the site and a description of the COCs in site media.
- Notification of Illinois EPA at least 6 months prior to any transfer, sale, or lease of any property subject to LUCs required by a decision document. This will enable Illinois EPA to be involved in discussions to make sure that appropriate provisions, such as the Illinois EPA's Uniform Environmental Covenants Act 765 Illinois Compiled Statutes 122 (an environmental covenant), are included in the conveyance documents to maintain effective LUCs.
- Annual inspections to make sure that there are no violations of these restrictions. The Installation Commander will provide annual certification to Illinois EPA that there have been no violations of these restrictions.
- If a violation of a restriction occurs, a description of the violation and the corrective actions to be taken to restore protectiveness will be reported immediately to Illinois EPA and USEPA.

LUCs will be implemented and maintained by the Navy in perpetuity or until concentrations of hazardous substances in site media are at levels that allow for unrestricted use and unlimited exposure. The Navy or any subsequent owners shall not modify, delete, or terminate any LUC without Illinois EPA concurrence. The Navy is responsible for implementing, maintaining, reporting on, and enforcing the LUCs described in this ROD. Although the Navy may later transfer these procedural responsibilities to another party by contract, property transfer agreement, or through other means, the Navy shall retain ultimate responsibility for the remedy integrity. If the Navy transfers, sells, or leases the property, the Navy will be required to meet the requirements of Illinois EPA's Uniform Environmental Covenants Act 765 Illinois Compiled Statutes 122 (an environmental covenant).

Should any LUC remedy fail, the Navy will make sure that appropriate actions are taken to re-establish the remedy's protectiveness and may initiate legal action to either compel action by a third party(ies) and/or to recover the Navy's costs for remedying any discovered LUC violation(s). The Navy will maintain, monitor, and enforce the LUCs according to the LUC MOA. LUCs will be developed in accordance with the Principles and Procedures for Specifying, Monitoring, and Enforcement of Land Use Controls and Other Post-ROD Actions, per letter dated October 2, 2003, from Raymond F. DuBois, Deputy Under Secretary of Defense (Installations and Environment), to Hon. Marianne Lamont Horinko, Acting Administrator, USEPA. Implementation of this remedy will require a survey of the site, annual visual inspections, and a Five-Year Review with report preparation.

By separate MOA with Illinois EPA and Commander, Navy Region Midwest, on behalf of the Department of the Navy, the Navy agreed to implement base wide, certain periodic site inspection, condition certification, and agency notification procedures designed to ensure the maintenance by Commander, Navy Region Midwest personnel of any site-specific LUCs deemed necessary for present and future protection of human health and the environment. A fundamental premise underlying execution of this agreement was through the Navy's substantial good-faith compliance with the procedures called for therein, reasonable assurances would be provided to Illinois EPA as to the permanency of those remedies that included the use of specific LUCs.

It is understood that the terms and conditions of the MOA are not specifically incorporated or made enforceable herein by reference. Should compliance with the MOA not occur or should the MOA be terminated, it is understood that the protectiveness of the remedy concurred with may be reconsidered, and additional measures may need to be taken to adequately ensure necessary future protection of human health and the environment.

The sequence of actions for implementing the Selected Remedy is:

1. Institute LUCs and input the site into the LUC Tracker System.
2. Perform annual inspection and certification of the site.

3. Perform Five-Year Reviews.

### 2.4.7.3 Cost of Selected Remedy for Site 21

A detailed cost estimate for the Selected Remedy, Alternative 21-2, for capital cost, annual cost, and present worth analysis is provided in Appendix C. The information in this cost estimate is based on the best available information regarding the anticipated scope of the Selected Remedy and implementation of the Selected Remedy at this site independent of the other two sites. Implementation of the Selected Remedy at the three sites is expected to be performed as part of a single project, so the actual cost for this site may be lower due to economies of scale. Changes in the cost elements may occur because of new information or data collected during the design and implementation of the Selected Remedy. This is an order-of-magnitude cost estimate that is expected to be within -30 to +50 percent of the actual project cost. This estimate will be refined as the remedy is designed and implemented. Even after the Selected Remedy is implemented, the total project cost is still reported as an estimate because of the uncertainty associated with annual O&M expenditures.

### 2.4.7.4 Expected Outcomes of Selected Remedy for Site 21

The current use of Site 21 as a non-residential area is expected to remain the same for the foreseeable future. Groundwater at the site is not used and is not expected to be used in the future, as an existing Base Instruction and local ordinance prevent groundwater use. There are no socio-economic, community revitalization, or economic impacts or benefits associated with implementation of the Selected Remedy at Site 21. It is estimated that the RAOs for Site 21 will be achieved upon implementation of the remedy. Table 2-17 describes how the Selected Remedy mitigates risks and achieves the RAOs for the site.

Site use is not expected to change; therefore, modification or removal of the LUCs will not be required. However, if proposed land use changes in the future and other uses are expected, other remedial approaches may be required. Any modifications to LUCs will be conducted in accordance with provisions in the base's LUC MOA.

**TABLE 2-17. HOW SELECTED REMEDY FOR SITE 21 MITIGATES RISK AND ACHIEVES RAOS**

| RISK | RAO | COMMENTS |
|---|---|---|
| Potential unacceptable risks to human health from exposure to contaminated soil. | Prevent residential exposure through ingestion, dust inhalation, and dermal contact to contaminated surface soil and subsurface soil with COC concentrations exceeding cleanup levels | Pavement and buildings act as a barrier that will prevent exposure to reduce risk to acceptable levels for current industrial workers. LUCs will restrict potential future residential use of the site and will limit risks to contaminated soil by controlling exposure during construction. |
| Potential unacceptable risks to I/C workers and construction workers from exposure to contaminated soil. | Prevent I/C and construction worker exposure through ingestion, dust inhalation, and dermal contact to contaminated surface soil and subsurface soil with COC concentrations exceeding TACO criteria | Implementation of LUCs to restrict unauthorized construction, require notification of the presence of contaminants, and to protect workers through PPE and alternative methods to reduce exposure. |
| Potential unacceptable risks to human health from exposure to contaminated groundwater. | Return the groundwater resource to beneficial use, if practicable, and address human health risks associated with groundwater consumption | Implementation of LUCs to prevent potable use of groundwater, which prevents exposure. Base Instruction and local ordinance already restrict the use of groundwater, which has marginal beneficial use. |

### 2.4.8 Site 21 Statutory Determinations

In accordance with the NCP, the Selected Remedy for Site 21 meets the following statutory determinations:

- **Protection of Human Health and the Environment** – The Selected Remedy is needed to prevent hypothetical future risks associated with residential exposure and groundwater use, to minimize exposure to construction workers and I/C workers to soil that has concentrations of PAHs and arsenic greater than TACO criteria. LUCs and barriers will be implemented to ensure protectiveness.
- **Compliance with ARARs** – The Selected Remedy will attain the identified federal and state ARARs, as presented in Appendix B.
- **Cost-Effectiveness** – The Selected Remedy is the most cost-effective alternative that allows for continued non-residential use of the property and represents the most reasonable value for the money. The costs are proportional to overall effectiveness by achieving an adequate amount of long-term effectiveness and permanence within a reasonable time frame. Detailed costs for the Selected Remedy are presented in Appendix C.
- **Utilization of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable** – The Selected Remedy represents the maximum extent to which permanent solutions and alternative treatment technologies can be used in a practical manner at Site 21. Based on the type and volume of soil contamination and the current and reasonably anticipated future use of the site, no treatment alternatives were evaluated for soil at Site 21 in the FFS (Tetra Tech, 2013c). LUCs and barriers provide the best balance of tradeoffs for long-term effectiveness and permanence with ease of implementation for reasonable cost. Groundwater treatment was considered in two alternatives; however, the extent of groundwater contamination is limited, and LUCs provide the best balance of tradeoffs for long-term effectiveness and permanence with ease of implementation for reasonable cost.
- **Preference for Treatment as a Principal Element** – Treatment is not a principal element of the Selected Remedy for soil or groundwater at Site 21 because there are no principal threat wastes at the site, and LUCs and barriers provide the best balance of tradeoffs with respect to long-term effectiveness and permanence at a reasonable cost.
- **Five-Year Review Requirement** – Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on site in excess of levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within 5 years after initiation of remedial action and every 5 years thereafter to ensure that the remedy is, or will be, protective of human health and the environment.

## 2.5 DOCUMENTATION OF SIGNIFICANT CHANGES

CERCLA Section 117(b) requires an explanation of significant changes from the Selected Remedies presented in the Proposed Plan published for public comment. Although the opportunity for a public meeting was provided as stated in the Navy's public notice, none was requested, and no written comments, concerns, or questions were received by the Navy or Illinois EPA during the public comment period.

# 3.0 RESPONSIVENESS SUMMARY

The Navy released the Proposed Plan for Sites 5, 9, and 21 for public comment and encouraged public participation in the remedy selection process. There was no request for a public meeting nor were comments or questions received during the public comment period.

No technical or legal issues associated with the Sites 5, 9, and 21 ROD were identified.

# ACRONYMS

| | |
|---|---|
| ARAR | Applicable or Relevant and Appropriate Requirement |
| BaP | Benzo(a)pyrene |
| bgs | below ground surface |
| CDI | Chronic Daily Intake |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CFR | Code of Federal Regulations |
| COC | Contaminant of Concern |
| COPC | Chemical of Potential Concern |
| CSF | Cancer Slope Factor |
| CSM | Conceptual Site Model |
| CTE | Central Tendency Exposure |
| cy | Cubic Yard |
| EPC | Exposure Point Concentration |
| FFS | Focused Feasibility Study |
| HHRA | Human Health Risk Assessment |
| HI | Hazard Index |
| HQ | Hazard Quotient |
| IAC | Illinois Administrative Code |
| IAS | Initial Assessment Study |
| I/C | Industrial/Commercial |
| Illinois EPA | Illinois Environmental Protection Agency |
| ILCR | Incremental Lifetime Cancer Risk |
| ISCO | In-situ Chemical Oxidation |
| LUC | Land Use Control |
| MCL | Maximum Contaminant Level |
| mg/kg | Milligram per Kilogram |
| MOA | Memorandum of Agreement |
| NCP | National Oil and Hazardous Substance Pollution Contingency Plan |
| ng/kg | Nanogram per Kilogram |
| NPW | Net Present Worth |
| NSGL | Naval Station Great Lakes |
| O&M | Operation and Maintenance |
| PAH | Polynuclear Aromatic Hydrocarbon |
| PCB | Polychlorinated Biphenyl |
| PCP | Pentachlorophenol |

| | |
|---|---|
| PEF | Particulate Emissions Factor |
| PPE | Personal Protective Equipment |
| PRG | Preliminary Remediation Goal |
| RAO | Remedial Action Objective |
| RCRA | Resource Conservation and Recovery Act |
| RfD | Reference Dose |
| RI | Remedial Investigation |
| RME | Reasonable Maximum Exposure |
| ROD | Record of Decision |
| SRO | Soil Remediation Objective |
| SVOC | Semivolatile Organic Compound |
| TACO | Tiered Approach to Corrective Action Objectives |
| TCDD | Tetrachlorodibenzo-p-dioxin |
| TEQ | Toxicity Equivalence |
| USEPA | United States Environmental Protection Agency |
| UST | Underground Storage Tank |
| VOC | Volatile Organic Compound |
| µg/kg | Microgram per Kilogram |
| µg/L | Microgram per Liter |

# REFERENCES

Illinois Environmental Protection Agency, 2009. Uniform Environmental Covenants Act, http://www.ilga.gov/legislation/ilcs/ilcs3.asp?ActID=2995&ChapterID=62. 765 Illinois Compiled Statutes 122. January.

Illinois Environmental Protection Agency, 2007. Tiered Approach to Corrective Action Objectives. http://www.ipcb.state.il.us/SLR/IPCBandIEPAEnvironmentalRegulations-Title35.asp. 35 Illinois Administrative Code 742. August

Illinois State Geological Survey, 1950. Waukegan Quadrangle – Surface Geology (online at http://www.isgs.illinois.edu/maps-data-pub/isgs-quads/w/waukegan.shtml).

Naval Energy and Environmental Support Activity, 1991. Technical Memorandum on the Remedial Investigation Verification Step for the Naval Training Center Great Lakes, Illinois

Naval Station Great Lakes, 2003b. Memorandum of Agreement between the Illinois Environmental Protection Agency, the United States Environmental Protection Agency, Region 5, and the United States Department of the Navy, September 30..

Naval Station Great Lakes, 2010. Integrated Natural Resources Management Plan Naval Station Great Lakes, Revised November.

Department of Defense, 2004. Principles and Procedures for Specifying, Monitoring, and Enforcement of Land Use Controls and Other Post-ROD Actions. Raymond F. DuBois, Deputy Under Secretary of Defense (Installations and Environment), to Hon. Marianne Lamont Horinko, Acting Administrator, USEPA. October 2, 2003 and Alex A Beecher, Assistant Deputy Under Secretary of Defense (Environment, Safety and Occupational Health), to the Navy, Air Force, and Army staff. January.

Rogers, Golden, & Halpern and BCM Eastern Inc., March 1996. Initial Assessment Study, Naval Complex, Great Lakes, Illinois.

Tetra Tech, Inc., (Tetra Tech) 2014. Proposed Plan, Site 5 – Transformer Storage Boneyard, Site 9 - Camp Moffett Ravine Fill Area, and Site 21 - Buildings 1517/1506 Area, Naval Station Great Lakes, Great Lakes, Illinois, February.

Tetra Tech, 2013a. Remedial Investigation/Risk Assessment Report for Site 5 – Transformer Storage Boneyard, Naval Station Great Lakes, Great Lakes Illinois. May.

Tetra Tech, 2013b. Remedial Investigation/Risk Assessment Report for Site 9 – Camp Moffett Ravine Fill Area, Naval Station Great Lakes, Great Lakes Illinois. March.

Tetra Tech, 2013c. Focused Feasibility Study, Site 5 – Transformer Storage Boneyard, Site 9 - Camp Moffett Ravine Fill Area, and Site 21 - Buildings 1517/1506 Area, Naval Station Great Lakes, Great Lakes, Illinois, October.

Tetra Tech, 2012. Remedial Investigation Report for Site 21 – Buildings 1517/1506 Area, Naval Station Great Lakes, Great Lakes Illinois. July.

Tetra Tech, 2003. Remedial Investigation and Risk Assessment Report - Site 17 – Pettibone Creek and Boat Basin, Naval Training Center Great Lakes, Great Lakes Illinois. September.

USEPA, 1993. Provisional Guidance for Quantitative Risk Assessment for Polycyclic Aromatic Hydrocarbons.

# Administrative Record Reference Table

SITE 5 - TRANSFORMER STORAGE BONEYARD,
SITE 9 - CAMP MOFFETT RAVINE FILL AREA,
AND SITE 21 - BUILDINGS 1517/1506 AREA
NAVAL STATION GREAT LAKES, ILLINOIS

# DETAILED ADMINISTRATIVE RECORD REFERENCE TABLE

| ITEM | REFERENCE PHRASE IN ROD | LOCATION IN ROD | LOCATION OF INFORMATION IN ADMINISTRATIVE RECORD |
|---|---|---|---|
| 1 | Initial Assessment Study | Table 2-1 | Rogers, Golden & Halpern, 1986. Initial Assessment Study, Naval Complex Great Lakes, Illinois (link to Cover Page) |
| 2 | Verification Study | Table 2-1 | Naval Energy and Environmental Support Activity, 1991. Technical Memorandum on the Remedial Investigation Verification Step (link to Cover Page) |
| 3 | Remedial Investigation (RI) [for Site 5] | Table 2-1 | Tetra Tech, 2013a. Remedial Investigation/Risk Assessment Report for Site 5 – Transformer Storage Boneyard (link to Cover Page) |
| 4 | Illinois EPA Tiered Approach to Corrective Action Objectives (TACO) criteria | Table 2-1 | Illinois EPA, 2007. Tiered Approach to Corrective Action Objectives. http://www.ipcb.state.il.us/documents/dsweb/Get/Document-38408 (link to page 147) |
| 5 | RI [for Site 9] | Table 2-1 | Tetra Tech, 2013b. Remedial Investigation/Risk Assessment Report for Site 9 – Camp Moffett Ravine Fill Area (link to Cover Page) |
| 6 | RI [for Site 21] | Table 2-1 | Tetra Tech, 2012. Remedial Investigation Report for Site 21 – Buildings 1517/1506 Area (link to Cover Page) |
| 7 | Proposed Plan | Section 2.1.3 Page 5 | Tetra Tech, 2014. Proposed Plan, Site 5 – Transformer Storage Boneyard, Site 9 - Camp Moffett Ravine Fill Area, and Site 21 - Buildings 1517/1506 Area (link to page 1) |
| 8 | public notice | Section 2.1.3 Page 5 | Lake County Suburban Life (Great Lakes Bulletin), Lake County News-Sun, and the Public Notice Illinois/ Illinois Press Association web site, February 28, 2014 (link to page 1) |
| 9 | NSGL Instruction 11130.1 | Section 2.1.6 Page 10 | Navy, 2003. Ground Water Use Restrictions. NAVSTAGLAKESINST 11130.1. September 30. (link to page 1) |
| 10 | USEPA Maximum Contaminant Levels (MCLs) | Section 2.1.7 Page 13 | USEPA, 2009. National Recommended Water Quality Criteria (link to page 1) |

# DETAILED ADMINISTRATIVE RECORD REFERENCE TABLE

| ITEM | REFERENCE PHRASE IN ROD | LOCATION IN ROD | LOCATION OF INFORMATION IN ADMINISTRATIVE RECORD |
|---|---|---|---|
| 11 | Focused Feasibility Study | Section 2.1.7 Page 13 | Tetra Tech, 2013c. Focused Feasibility Study, Site 5 – Transformer Storage Boneyard, Site 9 - Camp Moffett Ravine Fill Area, and Site 21 - Buildings 1517/1506 Area (link to Cover Page) |
| 12 | results of chemical analyses | Section 2.2.1 Page 15 | Tetra Tech, 2013a. Remedial Investigation/Risk Assessment Report for Site 5 – Transformer Storage Boneyard (link to Section 4) |
| 13 | Illinois EPA background value | Section 2.2.1 Page 15 | Illinois EPA, 2007. Tiered Approach to Corrective Action Objectives. http://www.ipcb.state.il.us/documents/dsweb/Get/Document-38408 (link to page 120) |
| 14 | human health risks | Section 2.2.2 Page 16 | Tetra Tech, 2013a. Remedial Investigation/Risk Assessment Report for Site 5 – Transformer Storage Boneyard (link to Section 6) |
| 15 | General response actions | Section 2.2.4 Page 22 | Tetra Tech, 2013c. Focused Feasibility Study, Site 5 – Transformer Storage Boneyard, Site 9 - Camp Moffett Ravine Fill Area, and Site 21 - Buildings 1517/1506 Area (link to Section 2.3) |
| 16 | nine CERCLA evaluation criteria | Section 2.2.5 Page 23 | Tetra Tech, 2013c. Focused Feasibility Study, Site 5 – Transformer Storage Boneyard, Site 9 - Camp Moffett Ravine Fill Area, and Site 21 - Buildings 1517/1506 Area (link to Section 4.1.1) |
| 17 | Principal threat wastes | Section 2.2.6 Page 26 | USEPA, 1991. A Guide to Principal Threat and Low Level Threat Wastes. OSWER Directive 9380.3-06FS.6 03 (link to Cover Page) |
| 18 | Principles and Procedures for Specifying, Monitoring, and Enforcement of Land Use Controls and Other Post-ROD Actions | Section 2.2.7.2 Page 29 | Navy, 2003. Principles and Procedures for Specifying, Monitoring, and Enforcement of Land Use Controls and Other Post-ROD Actions (link to page 1) |
| 19 | nature and extent of subsurface fill materials | Section 2.3.1 Page 33 | Tetra Tech, 2013b. Remedial Investigation/Risk Assessment Report for Site 9 – Camp Moffett Ravine Fill Area (link to Section 4) |

# DETAILED ADMINISTRATIVE RECORD REFERENCE TABLE

| ITEM | REFERENCE PHRASE IN ROD | LOCATION IN ROD | LOCATION OF INFORMATION IN ADMINISTRATIVE RECORD |
|---|---|---|---|
| 20 | human health risks | Section 2.3.2 Page 33 | Tetra Tech, 2013b. Remedial Investigation/Risk Assessment Report for Site 9 – Camp Moffett Ravine Fill Area (link to Section 6) |
| 21 | nature and extent of fill materials | Section 2.4.1 Page 50 | Tetra Tech, 2012. Remedial Investigation Report for Site 21 – Buildings 1517/1506 Area (link to Section 4) |
| 22 | human health risks | Section 2.4.2 Page 50 | Tetra Tech, 2012. Remedial Investigation Report for Site 21 – Buildings 1517/1506 Area (link to Section 5) |

# Appendix A
# Human Health Risk Tables

# Appendix A.1
# Site 5 Human Health Risk Tables

**TABLE 1**

**EXPOSURE POINT CONCENTRATION SUMMARY - SURFACE SOIL**
**SITE 5 - TRANSFORMER STORAGE BONEYARD**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Surface Soil
Exposure Point: Entire Site

| Chemical of Potential Concern | Units | # Detects/ # Samples | Arithmetic Mean | Maximum Detection | Dataset Distribution | 95% UCL of the Mean Statistic | RME[1] EPC 95% UCL | CTE[2] EPC Mean |
|---|---|---|---|---|---|---|---|---|
| **Volatile Organics** | | | | | | | | |
| Xylenes*# | mg/kg | 15/24 | 0.061 (3) | 0.760 | LN or gamma | 95% KM (BCA) UCL | 0.128 | 0.061 |
| **PAHs/Semivolatile Organic Compounds** | | | | | | | | |
| BAP EQUIVALENT(4) | mg/kg | 23/24 | 2.47 (3) | 17.3 | LN or gamma | 95% KM (Chebyshev) UCL | 5.68 | 2.47 |
| **PCBs** | | | | | | | | |
| TOTAL AROCLORS (FULL NDs) | mg/kg | 14/24 | 0.110 (3) | 0.292 | nonparametric | 95% KM (t) UCL | 0.126 | 0.110 |
| **Inorganics** | | | | | | | | |
| ALUMINUM | mg/kg | 24/24 | 7,400 | 14,000 | normal | 95% Student's-t (UCL) | 8,594 | 7,400 |
| ANTIMONY | mg/kg | 18/24 | 0.83 (3) | 4.7 | LN or gamma | 95% KM (percentile bootstrap) UCL | 1.2 | 0.83 |
| ARSENIC | mg/kg | 24/24 | 5.6 | 12 | LN or gamma | 95% Approx. Gamma UCL | 6.61 | 5.6 |
| CHROMIUM | mg/kg | 24/24 | 13.3 | 25 | normal | 95% Student's-t (UCL) | 15.1 | 13 |
| COBALT | mg/kg | 24/24 | 5.90 | 11 | normal | 95% Student's-t (UCL) | 6.67 | 5.90 |
| IRON | mg/kg | 24/24 | 20,400 | 66,000 | LN or gamma | 95% Approx. Gamma UCL | 25,080 | 20,400 |
| MANGANESE | mg/kg | 24/24 | 441 | 940 | LN or gamma | 95% Approx. Gamma UCL | 501 | 441 |
| MERCURY*# | mg/kg | 19/24 | 0.084 (3) | 0.530 | LN or gamma | 95% KM (BCA) UCL | 0.129 | 0.084 |
| THALLIUM | mg/kg | 24/24 | 0.373 | 1.2 | LN or gamma | 95% Approx. Gamma UCL | 0.486 | 0.373 |
| VANADIUM | mg/kg | 24/24 | 18.5 | 34 | normal | 95% Student's-t (UCL) | 20.6 | 18.5 |

**Footnotes:**

1. 95% UCL for RME scenario except for construction workers and residential scenario; EPCs for soil for these receptors are the maximum detections of COPCs.
2. Mean is the EPC for each soil COPC in the CTE scenarios.
3. Kaplan-Meier statistical mean (with NDs included)
4. Toxicity equivalent factor approach used to convert individual carcinogenic PAHs into a single concentration of benzo(a)pyrene.

* COPC for inhalation pathway only.

# COPC for construction worker scenario only.

BaP = Benzo(a)pyrene
PCB = Polychlorinated Biphenyl
EPC = Exposure Point Concentration
ND = Non-Detected
UCL = Upper Confidence Limit
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
PAH = Polynuclear Aromatic Hydrocarbon
LN = Log-Normal Distribution
KM = Kaplan-Meier
mg/kg = milligram per kilogram
BCA = Biased-corrected accelerated
COPC = Chemical of Potential Concern

**TABLE 2**

**EXPOSURE POINT CONCENTRATION SUMMARY - SUBSURFACE SOIL**
**SITE 5 - TRANSFORMER STORAGE BONEYARD**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Subsurface Soil
Exposure Point: Construction excavation or post-construction excavation

| Chemical of Potential Concern | Units | # Detects/ # Samples | Arithmetic mean | Maximum Detected Concentration | Dataset Distribution | 95% UCL of the Mean Statistic | 95% UCL | RME EPC Maximum | CTE EPC Mean |
|---|---|---|---|---|---|---|---|---|---|
| **PAHs/Semivolatile Organic Compounds** | | | | | | | | | |
| BAP EQUIVALENT[(1)] | mg/kg | 37/47 | 0.942 [(1)] | 27.4 | nonparametric | 99% KM (Chebyshev) UCL | 7.04 | 27.40 | 0.942 |
| **Inorganics** | | | | | | | | | |
| ALUMINUM | mg/kg | 47/47 | 10,900 | 19,000 | normal | 95% Student's-t UCL | 12,000 | 19,000 | 10,900 |
| ARSENIC | mg/kg | 47/47 | 7.2 | 16 | normal | 95% Student's-t UCL | 7.86 | 16 | 7.2 |
| CHROMIUM | mg/kg | 47/47 | 18 | 39 | normal | 95% Student's-t UCL | 20 | 39 | 18 |
| COBALT | mg/kg | 47/47 | 8.8 | 14 | normal | 95% Student's-t UCL | 9.5 | 14 | 8.8 |
| IRON | mg/kg | 47/47 | 23,600 | 39,000 | normal | 95% Student's-t UCL | 25,600 | 39,000 | 23,600 |
| MANGANESE | mg/kg | 47/47 | 743 | 1,800 | LN or gamma | 95% Approx. Gamma UCL | 833 | 1,800 | 743 |
| MERCURY*# | mg/kg | 38/47 | 0.041 [(2)] | 0.12 | LN or gamma | 95% KM (BCA) UCL | 0.048 | 0.12 | 0.041 |
| THALLIUM | mg/kg | 47/47 | 0.35 | 1.9 | nonparametric | 95% Chebyshev UCL | 0.507 | 1.9 | 0.35 |
| VANADIUM | mg/kg | 47/47 | 23.7 | 40 | normal | 95% Student's-t UCL | 25.4 | 40 | 23.7 |

**Footnotes:**

1. Toxicity equivalent factor approach used to convert individual carcinogenic PAHs into a single concentration of benzo(a)pyrene.

2 - Kaplan-Meier statistical mean (with NDs included)

* COPC for inhalation pathway only.

# COPC for construction worker scenario only.

For fewer than 10 samples, the maximum detected concentration is recommended to be used as the RME EPC.

PAH = Polynuclear Aromatic Hydrocarbon
BaP = Benzo(a)pyrene
mg/kg = miligram per kilogram
LN =Log-Normal

UCL = Upper Confidence Level
BCA = Biased-corrected accelerated
RME =Reasonable Maximum Exposure
EPC = Exposure Point Concentration

CTE = Central Tendency Exposure
COPC = Chemical of Potential Concern

**TABLE 3**

**EXPOSURE POINT CONCENTRATION SUMMARY - GROUNDWATER**
**SITE 5 - TRANSFORMER STORAGE BONEYARD**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Construction Excavation; Hypothetical Residential Potable Water

| Chemical of Potential Concern | Units | # Detects/ # Samples | Maximum Detected Concentration | Maximum Qualifier |
|---|---|---|---|---|
| **Volatile Organics** | | | | |
| CARBON TETRACHLORIDE | mg/L | 1/5 | 0.170 | |
| CHLOROFORM | mg/L | 1/5 | 0.018 | |
| **PAHs/Semivolatile Organic Compounds** | | | | |
| BAP EQUIVALENT[(1)] | mg/L | 2/5 | 0.000078 | |
| **Inorganics** | | | | |
| ANTIMONY | mg/L | 2/6 | 0.0019 | J |
| ARSENIC | mg/L | 3/6 | 0.0013 | J |
| BARIUM | mg/L | 6/6 | 8.1 | |
| COBALT | mg/L | 6/6 | 0.031 | |
| IRON | mg/L | 6/6 | 120 | |
| MANGANESE | mg/L | 6/6 | 19 | |
| NICKEL | mg/L | 6/6 | 0.1 | |

**Footnotes:**

1. Toxicity equivalent factor approach used to convert individual carcinogenic PAHs into a single concentration of benzo(a)pyrene.

mg/L = milligrams per liter

PAH = polynuclear aromatic hydrocarbon

BaP = Benzo(a)pyrene

J = estimated

**TABLE 4**

**SUMMARY OF EXPOSURE INPUT PARAMETERS**
**REASONABLE MAXIMUM EXPOSURES**
**SITE 5 - TRANSFORMER STORAGE BONEYARD**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**


| Exposure Parameter | Occupational/ Maintenance Worker | Adolescent Trespasser | Construction Worker | On-Site Adult Resident | On-Site Child Resident |
|---|---|---|---|---|---|
| **All Exposures** | | | | | |
| $C_{soil}$ (mg/kg) | Maximum or 95% UCL[1] | Maximum or 95% UCL[1] | Maximum or 95% UCL[1] | Maximum or 95% UCL[1] | Maximum or 95% UCL[1] |
| $C_{gw}$ (µg/L) | NA | NA | Maximum | Maximum | Maximum |
| EF (days/year) | 250[3] | 26[5] | 30[2] | 350[5] | 350[5] |
| ED (years) | 25[3] | 10[5] | 1[4] | 24[5] | 6[5] |
| BW (kg) | 70[5] | 42[5] | 70[5] | 70[5] | 15[5] |
| $AT_n$ (days) | 9,125[9] | 3650[9] | 42[8] | 8,760[9] | 2,190[9] |
| $AT_c$ (days) | 25,550[9] | 25,550[9] | 25,550[9] | 25,550[9] | 25,550[9] |
| **Incidental Ingestion/Dermal Contact with Soil** | | | | | |
| IR (mg/day) | 100[5] | 100[5] | 330[10] | 100[5] | 200[5] |
| FI (unitless) | 1[5] | 1[5] | 1[5] | 1[5] | 1[5] |
| SA ($cm^2$/day) | 3,280[11] | 3,280[11] | 3,280[11] | 5,700[11] | 2,800[11] |
| AF ($mg/cm^2$) | 0.2[11] | 0.2[11] | 0.3[11] | 0.07[11] | 0.2[11] |
| ABS (unitless) | chemical-specific[11] | chemical-specific[11] | chemical-specific[11] | chemical-specific[11] | chemical-specific[11] |
| CF (kg/mg) | $1x10^{-6}$ | $1x10^{-6}$ | $1x10^{-6}$ | $1x10^{-6}$ | $1x10^{-6}$ |
| **Inhalation Fugitive Dust/Volatile Emissions from Soil** | | | | | |
| $C_{air}$ ($mg/m^3$) | calculated[10] | calculated[10] | calculated[10] | calculated[10] | calculated[10] |
| ET (hours/day) | 8[10] | 2[10] | 8[12] | 24[10] | 24[7] |
| PEF ($m^3$/kg) | $1.36x10^{9}$[10] | $1.36x10^{9}$[10] | $1.27 \times 10^{6}$[10] | $1.36x10^{9}$[10] | $1.36Ex10^{9}$[10] |
| VF ($m^3$/kg) | chemical-specific[10] | chemical-specific[10] | chemical-specific[10] | chemical-specific[10] | chemical-specific[10] |

**TABLE 4**

**SUMMARY OF EXPOSURE INPUT PARAMETERS**
**REASONABLE MAXIMUM EXPOSURES**
**SITE 5 - TRANSFORMER STORAGE BONEYARD**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**


| Exposure Parameter | Occupational/ Maintenance Worker | Adolescent Trespasser | Construction Worker | On-Site Adult Resident | On-Site Child Resident |
|---|---|---|---|---|---|
| **Ingestion/Dermal Contact with Groundwater** | | | | | |
| $IR_{gw}$ (L/day) | NA | NA | NA | 2[5] | 1.5[7] |
| ET (hours/day) and $t_{event}$ (hours/event) | NA | NA | 4[4] | 0.33[4] | 0.33[4] |
| EV (events/day) | NA | NA | 1[4] | 1[4] | 1[4] |
| A ($cm^2$/day) | NA | NA | 3,300[11] | 18,000[11] | 6,600[11] |
| $K_p$ (cm/hour) | NA | NA | chemical-specific[11] | chemical-specific[11] | chemical-specific[11] |
| t* (hours), $\tau$ (hour), and B (unitless) | NA | NA | chemical-specific[11] | chemical-specific[11] | chemical-specific[11] |

A Skin surface area available for contact
ABS Absorption factor
AF Soil-to-skin adherence factor
$AT_c$ Averaging time for carcinogenic effects
$AT_n$ Averaging time for non-carcinogenic effects
B Bunge Model partitioning coefficient
BW Body weight
CF Conversion factor
IR Ingestion rate
$C_{soil}$ Exposure concentration for soil
$C_{gw}$ Exposure concentration for groundwater
$C_{air}$ Exposure concentration for air
ED Exposure duration
EF Exposure frequency
ET Exposure time
EV Event frequency
FI Fraction ingested from contaminated source
InhR Inhalation rate
IR Ingestion rate (soil or groundwater)
$K_p$ Permeability coefficient from water through skin
SA Skin surface area available for contact
PEF Particulate emission factor
t Lag time
t* Time it takes to reach steady-state conditions
$t_{event}$ Duration of event

1 - USEPA, 2002.
2 - Illinois EPA, 2004.
3 - USEPA, 1991
4- Professional judgment.
5 - USEPA, 1993
6 - Adolescents (7-16 years).
7 - USEPA, 1997
8 - Illinois EPA, 2003.
9 - USEPA, 1989
10 - USEPA, 2002
11 - USEPA, 2004
12 - Assume an 8-hour work shift.

Note: The exposure factors for future civilian and military residents are the same, except for exposure duration (ED) for adult military residents. Exposure duration for adult military residents was assumed to be the typical enlistment times of 6 years for the RME and CTE.

**TABLE 5**

**SUMMARY OF EXPOSURE INPUT PARAMETERS**
**CENTRAL TENDENCY EXPOSURES**
**SITE 5 - TRANSFORMER STORAGE BONEYARD**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**


| Exposure Parameter | Occupational/ Maintenance Worker | Adolescent Trespasser | Construction Worker | On-Site Adult Resident | On-Site Child Resident |
|---|---|---|---|---|---|
| All Exposures | | | | | |
| $C_{soil}$ (mg/kg) | Mean | Mean | Mean | Mean | Mean |
| $C_{gw}$ (µg/L) | NA | NA | Maximum | Maximum | Maximum |
| EF (days/year) | 219[3] | 13[4] | 30[2] | 234[3] | 234[3] |
| ED (years) | 9[3] | 10[5] | 1[4] | 7[3] | 2[3] |
| BW (kg) | 70[3] | 42[6] | 70[3] | 70[3] | 15[3] |
| $AT_n$ (days) | 3,285[8] | 3,650[8] | 42[7] | 2,555[8] | 730[8] |
| $AT_c$ (days) | 25,550[8] | 25,550[8] | 25,550[8] | 25,550[8] | 25,550[8] |
| Incidental Ingestion/Dermal Contact with Soil | | | | | |
| IR (mg/day) | 50[9] | 50[9] | 165[9] | 50[9] | 100[9] |
| FI (unitless) | 1[3] | 1[3] | 1[3] | 1[3] | 1[3] |
| SA ($cm^2$/day) | 3,300[10] | 3,100[6] | 3,300[10] | 5,700[10] | 2,800[10] |
| AF ($mg/cm^2$) | 0.02[10] | 0.04[10] | 0.1[10] | 0.01[10] | 0.04[10] |
| ABS (unitless) | chemical-specific[10] | chemical-specific[10] | chemical-specific[10] | chemical-specific[10] | chemical-specific[10] |
| CF (kg/mg) | 1E-06 | 1E-06 | 1E-06 | 1E-06 | 1E-06 |
| Inhalation Fugitive Dust/Volatile Emissions from Soil | | | | | |
| $C_{air}$ ($mg/m^3$) | calculated[11] | calculated[11] | calculated[11] | calculated[11] | calculated[11] |
| ET (hours/day) | 4[9] | 1[9] | 4[9] | 24[11] | 24[6] |
| PEF ($m^3$/kg) | 1.36E+9[11] | 1.36E+9[11] | 1.27 x 10[6][11] | 1.36E+9[11] | 1.36E+9[11] |
| VF ($m^3$/kg) | chemical-specific[11] | chemical-specific[11] | chemical-specific[11] | chemical-specific[11] | chemical-specific[11] |

**TABLE 5**

**SUMMARY OF EXPOSURE INPUT PARAMETERS**
**CENTRAL TENDENCY EXPOSURES**
**SITE 5 - TRANSFORMER STORAGE BONEYARD**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**


| Exposure Parameter | Occupational/ Maintenance Worker | Adolescent Trespasser | Construction Worker | On-Site Adult Resident | On-Site Child Resident |
|---|---|---|---|---|---|
| Ingestion/Dermal Contact with Groundwater | | | | | |
| $IR_{gw}$ (L/day) | NA | NA | NA | 1.4[3] | 0.66[6] |
| ET (hours/day) and $t_{event}$ (hours/event) | NA | NA | 2[8] | 0.25[4] | 0.25[4] |
| EV (events/day) | NA | NA | 1[4] | 1[4] | 1[4] |
| A ($cm^2$/day) | NA | NA | 3,300[10] | 18,000[10] | 6,600[10] |
| $K_p$ (cm/hour) | NA | NA | chemical-specific[10] | chemical-specific[10] | chemical-specific[10] |
| t* (hours), $\tau$ (hour), and B (unitless) | NA | NA | chemical-specific[10] | chemical-specific[10] | chemical-specific[10] |

Notes:

A Skin surface area available for contact
ABS Absorption factor
AF Soil-to-skin adherence factor
$AT_c$ Averaging time for carcinogenic effects
$AT_n$ Averaging time for non-carcinogenic effects
B Bunge Model partitioning coefficient
BW Body weight
CF Conversion factor
IR Ingestion rate
$C_{soil}$ Exposure concentration for soil
$C_{gw}$ Exposure concentration for groundwater
$C_{air}$ Exposure concentration for air
ED Exposure duration
EF Exposure frequency
ET Exposure time
EV Event frequency
FI Fraction ingested from contaminated source
InhR Inhalation rate
IR Ingestion rate (soil or groundwater)
$K_p$ Permeability coefficient from water through skin
SA Skin surface area available for contact
PEF Particulate emission factor
t Lag time
t* Time it takes to reach steady-state conditions
$t_{event}$ Duration of event

1 - USEPA, 2002
2 - Illinois EPA, 2004.
3 - USEPA, 1993
4 - Professional judgment.
5 - Adolescents (7-16 years).
6 - USEPA, 1997
7 - Illinois EPA, 2003.
8 - USEPA, 1989
9 - CTE is assumed to be 1/2 the RME value.
10 - USEPA, 2004
11 - USEPA, 2002

Note: The exposure factors for future civilian and military residents are the same, except for exposure duration (ED) for adult military residents. Exposure duration for adult military residents was assumed to be the typical enlistment times of 6 years for the RME and CTE.

## TABLE 6

## NON-CANCER TOXICITY DATA - ORAL/DERMAL
## SITE 5 - TRANSFORMER STORAGE BONEYARD
## NAVAL STATION GREAT LAKES
## GREAT LAKES, ILLINOIS

| Chemical of Potential Concern | Chronic/ Subchronic | Oral RfD | | Oral Absorption Efficiency for Dermal[1] | Absorbed RfD for Dermal[2] | | Primary Target Organ(s) | Combined Uncertainty/Modifying Factors | RfD:Target Organ(s) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Value | Units | | Value | Units | | | Source | Date |
| **Semivolatile Organic Compounds** | | | | | | | | | | |
| BENZO(A)ANTHRACENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| BENZO(A)PYRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| BENZO(B)FLUORANTHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| CHRYSENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| DIBENZO(A,H)ANTHRACENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| INDENO(1,2,3-CD)PYRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **Volatile Organic Compound** | | | | | | | | | | |
| CARBON TETRACHLORIDE | Chronic | 4.00E-03 | mg/kg/day | 1 | 4.00E-03 | mg/kg/day | Liver | 1000 | IRIS | 3/2010 |
| CHLOROFORM | Chronic | 1.00E-02 | mg/kg/day | 1 | 1.00E-02 | mg/kg/day | Liver | 1 | IRIS | 10/2001 |
| XYLENES | Chronic | 2.00E-01 | mg/kg/day | 1 | 2.00E-01 | mg/kg/day | CNS | 1 | IRIS | 2/2003 |
| **PCBs** | | | | | | | | | | |
| TOTAL AROCLORS [3] | Chronic | 2.00E-05 | mg/kg/day | 1 | 2.00E-05 | mg/kg/day | eye, immunolog. | 300/1 | IRIS | 11/1996 |
| **Inorganics** | | | | | | | | | | |
| ALUMINUM | Chronic | 1 | mg/kg/day | 1 | 1.0E+00 | mg/kg/day | CNS | 100 | PPRTV | 10/23/2006 |
| ANTIMONY | Chronic | 0.0004 | mg/kg/day | 0.15 | 6.0E-05 | mg/kg/day | longevity | 1000 | IRIS | 2/1991 |
| ARSENIC | Chronic | 0.0003 | mg/kg/day | 1 | 3.0E-04 | mg/kg/day | Skin, CVS | 3/1 | IRIS | 4/2009 |
| BARIUM | Chronic | 0.2 | mg/kg/day | 0.07 | 1.4E-02 | mg/kg/day | Kidney (nephrtox.) | 300 | IRIS | 7/2005 |
| CHROMIUM VI | Chronic | 0.003 | mg/kg/day | 0.025 | 7.5E-05 | mg/kg/day | Fetotoxicity, GS, Bone | 300/3 | IRIS | 2/2/2009 |
| COBALT | Chronic | 0.0003 | mg/kg/day | 1 | 3.0E-04 | mg/kg/day | Thyroid | 3000 | PPRTV | 8/2008 |
| IRON | Chronic | 0.7 | mg/kg/day | 1 | 7.0E-01 | mg/kg/day | GS | 1.5 | PPRTV | 9/11/2006 |
| MANGANESE | Chronic | 0.02 | mg/kg/day | 0.04 | 8.0E-04 | mg/kg/day | CNS | 1/3 | IRIS | 4/2009 |
| MERCURY[4] | Chronic | 0.0003 | mg/kg/day | 0.07 | 2.1E-05 | mg/kg/day | Autoimmune | 1000/1 | IRIS | 2/2/2009 |
| NICKEL | Chronic | 0.02 | mg/kg/day | 0.04 | 8.0E-04 | mg/kg/day | decreased BW | 300 | IRIS | 12/1996 |
| THALLIUM | Chronic | NA | | NA | NA | | No Effect | | IRIS | 9/2009 |
| VANADIUM | Chronic | 0.005 | mg/kg/day | 1[5] | 5.0E-03 | mg/kg/day | Decr. cysteine in hair | NA | ORNL | 5/2011 |
| ALUMINUM | Subchronic | 1 | mg/kg/day | 1 | 1.0E+00 | mg/kg/day | CNS | 30 | ATSDR | 9/2008 |
| ANTIMONY | Subchronic | 0.0004 | mg/kg/day | 0.15 | 6.0E-05 | mg/kg/day | longevity | 1000 | PPRTV | 7/2008 |
| BARIUM | Subchronic | 0.2 | mg/kg/day | 0.07 | 1.4E-02 | mg/kg/day | Kidney (nephrtox.) | 100 | ATSDR | 8/2007 |
| CARBON TETRACHLORIDE | Subchronic | 0.007 | mg/kg/day | 1 | 7.0E-03 | mg/kg/day | Liver | NA | ATSDR | 9/2005 |
| CHLOROFORM | Subchronic | 0.1 | mg/kg/day | 1 | 1.0E-01 | mg/kg/day | Liver | 100 | ATSDR | 9/1997 |
| Chromium VI | Subchronic | 0.02 | mg/kg/day | 0.025 | 5.0E-04 | mg/kg/day | NOAEL | 100 | HEAST | 7/1997 |
| COBALT | Subchronic | 0.003 | mg/kg/day | 1 | 3.0E-03 | mg/kg/day | Thyroid | 300 | PPRTV | 8/2008 |
| MERCURY[4] | Subchronic | 0.003 | mg/kg/day | 0.07 | 2.1E-04 | mg/kg/day | Autoimmune | 100 | HEAST | 7/1997 |
| XYLENES | Subchronic | 0.4 | mg/kg/day | 1 | 4.0E-01 | mg/kg/day | 10% decrease BW | 1000 | PPRTV | 9/2009 |

**Notes:**

1 - USEPA, July 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.

2 - Adjusted dermal RfD = Oral RfD x Oral Absorption Efficiency for Dermal.

3 - No RfD; used surrogate Aroclor 1254 for total Aroclors

4 - Values are for mercuric chloride.

5 - no oral absorption efficiency information on vanadium and compounds other than vanadium pentoxide

**Definitions:**

CNS = Central nervous system

CVS = Cardiovascular system

GS = Gastrointestinal System

HEAST= Health Effects Assessment Summary Tables

IRIS = Integrated Risk Information System

NA = Not available

ORNL = Oak Ridge National Laboratory Regional Screening Level tables, May 2011

ATSDR = Agency for Toxic Substances and Disease Registry

PPRTV = Provisional Peer Reviewed Toxicity Value

**TABLE 7**

**NON-CANCER TOXICITY DATA - INHALATION**
**SITE 5 - TRANSFORMER STORAGE BONEYARD**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**

| Chemical of Potential Concern | Chronic/ Subchronic | Inhalation RfC | | Primary Target Organ(s) | Combined Uncertainty/Modifying Factors | RfC : Target Organ(s) | |
|---|---|---|---|---|---|---|---|
| | | Value | Units | | | Source(s) | Date(s) |
| **Semivolatile Organic Compounds** | | | | | | | |
| BENZO(A)ANTHRACENE | NA | NA | NA | NA | NA | NA | NA |
| BENZO(A)PYRENE | NA | NA | NA | NA | NA | NA | NA |
| BENZO(B)FLUORANTHENE | NA | NA | NA | NA | NA | NA | NA |
| CHRYSENE | NA | NA | NA | NA | NA | NA | NA |
| DIBENZO(A,H)ANTHRACENE | NA | NA | NA | NA | NA | NA | NA |
| INDENO(1,2,3-CD)PYRENE | NA | NA | NA | NA | NA | NA | NA |
| **Volatile Organic Compound** | | | | | | | |
| CARBON TETRACHLORIDE | Chronic | 1.0E-01 | $mg/m^3$ | Liver | 100 | IRIS | 3/2010 |
| CHLOROFORM | Chronic | 9.8E-02 | $mg/m^3$ | Liver | 100 | ATSDR | 9/1997 |
| XYLENES | Chronic | 1.0E-01 | $mg/m^3$ | Neurological | 300 | IRIS | 2/2003 |
| **PCBs** | | | | | | | |
| TOTAL AROCLORS | NA | NA | NA | NA | NA | NA | NA |
| **Inorganics** | | | | | | | |
| ALUMINUM | Chronic | 5.0E-03 | $mg/m^3$ | CNS | 300 | PPRTV | 10/23/2006 |
| ARSENIC | Chronic | 1.50E-05 | $mg/m^3$ | CNS, GI, heart | not available | CA EPA | 9/2009 |
| BARIUM | Chronic | 5.00E-04 | $mg/m^3$ | Reproductive | 1000 | HEAST | 7/1997 |
| CHROMIUM VI | Chronic | 1.0E-04 | $mg/m^3$ | Respiratory | 300/1 | IRIS | 4/2009 |
| COBALT | Chronic | 6.0E-06 | $mg/m^3$ | Respiratory | 300 | PPRTV | 8/2008 |
| MANGANESE | Chronic | 5.00E-05 | $mg/m^3$ | CNS | 1000/1 | IRIS | 4/2009 |
| MERCURY | Chronic | 0.00003 | $mg/m^3$ | CNS | not available | CA EPA | 12/2008 |
| BARIUM | Subchronic | 0.005 | $mg/m^3$ | Reproductive | 100 | HEAST | 7/1997 |
| CARBON TETRACHLORIDE | Subchronic | 0.189 | $mg/m^3$ | Liver | not available | ATSDR | 9/2005 |
| CHLOROFORM | Subchronic | 0.241 | $mg/m^3$ | Liver | 300 | ATSDR | 9/1997 |
| COBALT | Subchronic | 2.00E-05 | $mg/m^3$ | Respiratory | 100 | PPRTV | 8/2008 |
| XYLENES | Subchronic | 4.00E-01 | $mg/m^3$ | CNS | 100 | PPRTV | 9/2009 |

**Definitions:**

IRIS = Integrated Risk Information System

CNS = Central Nervous System

HEAST= Health Effects Assessment Summary Tables

NA = Not available

ATSDR = Agency for Toxic Substances and Disease Registry

CA EPA = California Envirnomental Protection Agency

ORNL = Oak Ridge National Laboratory Regional Screening Level tables, May 2011

PPRTV = Provisional Peer Reviewed Toxicity Value

**TABLE 8**

**CANCER TOXICITY DATA - ORAL/DERMAL**
**SITE 5 - TRANSFORMER STORAGE BONEYARD**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**

| Chemical of Potential Concern | Oral Cancer Slope Factor | | Oral Absorption Efficiency for Dermal[1] | Absorbed Cancer Slope Factor for Dermal[2] | | Weight of Evidence/ Cancer Guideline | Oral CSF | |
|---|---|---|---|---|---|---|---|---|
| | Value | Units | | Value | Units | Description | Source | Date |
| **Semivolatile Organic Compounds** | | | | | | | | |
| BENZO(A)ANTHRACENE | 7.3E-01 | $(mg/kg/day)^{-1}$ | 1 | 7.3E-01 | $(mg/kg/day)^{-1}$ | B2 | USEPA(1) | 7/1993 |
| BENZO(A)PYRENE | 7.3E+00 | $(mg/kg/day)^{-1}$ | 1 | 7.3E+00 | $(mg/kg/day)^{-1}$ | B2 | IRIS | 4/2009 |
| BENZO(B)FLUORANTHENE | 7.3E-01 | $(mg/kg/day)^{-1}$ | 1 | 7.3E-01 | $(mg/kg/day)^{-1}$ | B2 | USEPA(1) | 7/1993 |
| CHRYSENE | 7.3E-03 | $(mg/kg/day)^{-1}$ | 1 | 7.3E-03 | $(mg/kg/day)^{-1}$ | B2 | USEPA(1) | 7/1993 |
| DIBENZO(A,H)ANTHRACENE | 7.3E+00 | $(mg/kg/day)^{-1}$ | 1 | 7.3E+00 | $(mg/kg/day)^{-1}$ | B2 | USEPA(1) | 7/1993 |
| INDENO(1,2,3-CD)PYRENE | 7.3E-01 | $(mg/kg/day)^{-1}$ | 1 | 7.3E-01 | $(mg/kg/day)^{-1}$ | B2 | USEPA(1) | 7/1993 |
| **Volatile Organic Compound** | | | | | | | | |
| CARBON TETRACHLORIDE | 7.0E-02 | $(mg/kg/day)^{-1}$ | 1 | 7.0E-02 | $(mg/kg/day)^{-1}$ | Likely to be carcinogenic to humans. | IRIS | 3/2010 |
| CHLOROFORM | RfD protective | $(mg/kg/day)^{-1}$ | | | | B2 (but threshold MOA - cytotoxicity nec.) | IRIS | 10/2001 |
| XYLENES | NA | | NA | NA | | Data inadequate for assessing carc. | IRIS | 2/2003 |
| **PCBs** | | | | | | | | |
| TOTAL AROCLORS (highly chlorinated) | 2.0E+00 | $(mg/kg/day)^{-1}$ | 1 | 2.0E+00 | $(mg/kg/day)^{-1}$ | B2 | IRIS | 6/1997 |
| **Inorganics** | | | | | | | | |
| ALUMINUM | NA | | NA | NA | | NA | NA | NA |
| ANTIMONY | NA | | NA | NA | | NA | IRIS | 2/1991 |
| ARSENIC | 1.5E+00 | $(mg/kg/day)^{-1}$ | 1 | 1.5E+00 | $(mg/kg/day)^{-1}$ | A | IRIS | 4/2009 |
| BARIUM | NA | | NA | NA | | D | IRIS | 4/2009 |
| CHROMIUM VI* | NA | | NA | NA | | D/Not classifiable as to human carcinogenicity | IRIS | 2/2/2009 |
| COBALT | NA | | NA | NA | | NA | NA | NA |
| IRON | NA | | NA | NA | | NA | NA | NA |
| MANGANESE | NA | | NA | NA | | D | IRIS | 4/2009 |
| MERCURY | NA | | NA | NA | | C/Possible Human Carcinogen | IRIS | 4/2009 |
| NICKEL | NA | | NA | NA | | NA (nickel soluble salts) | IRIS | |
| THALLIUM | NA | | NA | NA | | Inadequate information to assess. | IRIS | 9/2009 |
| VANADIUM | NA | | NA | NA | | NA | IRIS | 6/1988 |

**Notes:**

1 - USEPA, 2004

2 - Adjusted dermal cancer slope factor = oral cancer slope factor/oral absorption efficiency

NA = Not available

* Note that total chromium results are likely to be predominantly Cr III.

**Definitions:**

IRIS = Integrated Risk Information System.

NA = Not available.

USEPA(1) = USEPA, 1993d

CSF = Cancer Slope Factor

PCB = Polychlorinated biphenyl

mg/kg = milligram per kilogram

MOA = Mode of action

**EPA Group:**

A - Human carcinogen.

B1 - Probable human carcinogen - indicates that limited human data are available.

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans.

C - Possible human carcinogen.

D - Not classifiable as a human carcinogen.

E - Evidence of non-carcinogenicity.

## TABLE 9

## CANCER TOXICITY DATA - INHALATION
## SITE 5 - TRANSFORMER STORAGE BONEYARD
## NAVAL STATION GREAT LAKES
## GREAT LAKES, ILLINOIS

| Chemical of Potential Concern | Unit Risk | | Weight of Evidence/ Cancer Guideline Description | Unit Risk | |
|---|---|---|---|---|---|
| | Value | Units | | Source | Date |
| **Semivolatile Organic Compounds** | | | | | |
| BENZO(A)ANTHRACENE | 1.1E-04 | $(ug/m^3)^{-1}$ | B2 | CAEPA | 4/2009 |
| BENZO(A)PYRENE | 1.1E-03 | $(ug/m^3)^{-1}$ | B2 | CAEPA | 4/2009 |
| BENZO(B)FLUORANTHENE | 1.1E-04 | $(ug/m^3)^{-1}$ | B2 | CAEPA | 4/2009 |
| CHRYSENE | 1.1E-05 | $(ug/m^3)^{-1}$ | NA | CAEPA | 4/2009 |
| DIBENZO(A,H)ANTHRACENE | 1.2E-03 | $(ug/m^3)^{-1}$ | B2 | CAEPA | 4/2009 |
| INDENO(1,2,3-CD)PYRENE | 1.1E-04 | $(ug/m^3)^{-1}$ | B2 | CAEPA | 4/2009 |
| **Volatile Organic Compound** | | | | | |
| CARBON TETRACHLORIDE | 6.0E-06 | $(ug/m3)^{-1}$ | Likely to be carcinogenic to humans. | IRIS | 3/2010 |
| CHLOROFORM | 2.3E-05 | $(ug/m^3)^{-1}$ | B2 (but threshold MOA - cytotoxicity nec.) | IRIS | 10/2001 |
| XYLENES | NA | NA | Data inadequate for assessing carc. | IRIS | 2/2003 |
| **PCBs** | | | | | |
| TOTAL AROCLORS | 5.7E-04 | $(ug/m^3)^{-1}$ | B2 | IRIS | 6/1997 |
| **Inorganics** | | | | | |
| ALUMINUM | NA | NA | NA | NA | NA |
| ARSENIC | 4.3E-03 | $(ug/m^3)^{-1}$ | A | IRIS | 4/2009 |
| CHROMIUM VI* | 1.2E-02 | $(ug/m^3)^{-1}$ | A/Known human carcinogen | IRIS | 4/2009 |
| COBALT | 9.0E-03 | $(ug/m^3)^{-1}$ | Likely to be carcinogenic to humans. | PPRTV | 9/12/2008 |
| MANGANESE | NA | NA | NA | NA | NA |
| MERCURY | NA | NA | C/Possible Human Carcinogen | IRIS | 4/2009 |

* Note that total chromium results are likely to be predominantly Cr III.

**Definitions:**

IRIS = Integrated Risk Information System.

PPRTV = Provisional Peer Reviewed Toxicity Value

CA EPA = California Envirnomental Protection Agency

MOA = mode of action

NA = Not available

ORNL = Oak Ridge National Laboratory Regional Screening Level tables, May 2011

PCB = Polychlorinated biphenyl

ug/m3 = microgram per cubic meter

**EPA Group:**

A - Human carcinogen.

B1 - Probable human carcinogen - indicates that limited human data are available.

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans .

C - Possible human carcinogen.

D - Not classifiable as a human carcinogen.

E - Evidence of non-carcinogenicity.

**TABLE 10**

**SUMMARY OF CANCER RISKS AND HAZARD INDICES - REASONABLE MAXIMUM EXPOSURE (RME)**
**SITE 5 - TRANSFORMER STORAGE BONEYARD**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**
**PAGE 1 OF 3**

| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Construction/Excavation Worker | Surface Soil | Ingestion | 8.E-07 | - - | - - | - - | 0.8 | - - |
| | | Dermal Contact | 3.E-07 | - - | - - | - - | 0.03 | - - |
| | | Inhalation | 5.E-08 | - - | - - | - - | 4 | Manganese |
| | | Total | 1.E-06 | - - | - - | - - | 5 | Manganese |
| | Subsurface Soil | Ingestion | 1.E-06 | - - | - - | - - | 0.7 | - - |
| | | Dermal Contact | 4.E-07 | - - | - - | - - | 0.016 | - - |
| | | Inhalation | 6.E-08 | - - | - - | - - | 8 | Manganese |
| | | Total | 2.E-06 | - - | - - | - - | 9 | Manganese |
| | Average Soil[1] | Total | 1.E-06 | | | | 7 | Manganese |
| | Groundwater | Ingestion | NA | - - | - - | - - | NA | - - |
| | | Dermal Contact | 6.E-08 | - - | - - | - - | 3 | Manganese |
| | | Vapor into Trench | 9.E-09 | | | | 0.003 | |
| | | Total | 6.E-08 | - - | - - | - - | 3 | - - |
| | | **Total Surface Soil** | 1.E-06 | - - | - - | - - | 5 | Manganese |
| | | **Total Subsurface Soil** | 2.E-06 | - - | - - | - - | 9 | Manganese |
| | | **Total Groundwater** | 6.E-08 | - - | - - | - - | 3 | Manganese |
| | | **Total Across the Entire Site[2]** | **1.E-06** | - - | - - | - - | **10** | Manganese |

| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Occupational/Maintenance Worker | Surface Soil | Ingestion | 2.E-05 | - - | c-PAH | Arsenic | 0.4 | - - |
| | | Dermal Contact | 1.E-05 | - - | - - | c-PAH | 0.010 | - - |
| | | Total | 3.E-05 | - - | c-PAH | Arsenic | 0.4 | - - |
| | Subsurface Soil | Ingestion | 2.E-05 | - - | c-PAH | Arsenic | 0.49 | - - |
| | | Dermal Contact | 2.E-05 | - - | - - | c-PAH | 0.01 | - - |
| | | Total | 4.E-05 | - - | c-PAH | Arsenic | 0.5 | - - |
| | Average Soil[1] | Total | 3.E-05 | | c-PAH | Arsenic | 0.5 | - - |
| | Groundwater | Vapor Intrusion | 3.E-06 | - - | - - | $CCl_4$ | 0.01 | - - |
| | | **Total Surface Soil** | 3.E-05 | - - | c-PAH | Arsenic | 0.4 | - - |
| | | **Total Subsurface Soil** | 4.E-05 | - - | c-PAH | Arsenic | 0.5 | - - |
| | | **Vapor Intrusion** | 3.E-06 | - - | - - | - - | 0.01 | - - |
| | | **Total Across the Entire Site[2]** | **4.E-05** | - - | c-PAH | Arsenic, $CCl_4$ | **0.5** | - - |

**TABLE 10**

**SUMMARY OF CANCER RISKS AND HAZARD INDICES - REASONABLE MAXIMUM EXPOSURE (RME)**
**SITE 5 - TRANSFORMER STORAGE BONEYARD**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**


| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Adolescent Trespasser | Surface Soil | Ingestion | 3.E-06 | - - | - - | cPAH | 0.07 | - - |
| | | Dermal Contact | 3.E-06 | - - | - - | cPAH | 0.002 | - - |
| | | Total | 6.E-06 | - - | - - | - - | 0.07 | - - |
| | | **Total Surface Soil** | 6.E-06 | - - | - - | cPAH | 0.07 | - - |
| | | **Total Across the Entire Site** | **6.E-06** | - - | - - | cPAH | **0.07** | - - |

| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Future Child Resident | Surface Soil | Ingestion | 1.E-03 | cPAHs | Arsenic | - - | 3 | Iron |
| | | Dermal Contact | 3.E-04 | cPAHs | - - | Arsenic | 0.12 | - - |
| | | Total | 1.E-03 | cPAHs | Arsenic | - - | 4 | Iron |
| | Subsurface Soil | Ingestion | 2.E-03 | cPAHs | Arsenic | - - | 3 | Manganese |
| | | Dermal Contact | 5.E-04 | cPAHs | - - | Arsenic | 0.06 | - - |
| | | Total | 2.E-03 | cPAHs | Arsenic | - - | 3 | Iron, Manganese |
| | Average Soil[1] | Total | 2.E-03 | cPAHs | Arsenic | - - | 4 | Iron, Manganese |
| | Groundwater | Ingestion | 1.E-04 | - - | cPAHs, $CCl_4$, Arsenic | - - | 127 | Many COPCs |
| | | Dermal Contact | 1.E-05 | - - | - - | $CCl_4$ | 0.4 | -- |
| | | Inhalation - Showering | 4.E-09 | - - | - - | - - | 0.00007 | -- |
| | | Vapor Intrusion | 3.E-06 | - - | - - | $CCl_4$ | 0.05 | -- |
| | | Total | 2.E-04 | - - | cPAHs, $CCl_4$, Arsenic | - - | 127 | Many COPCs |
| | | **Total Surface Soil** | 1.E-03 | cPAHs | Arsenic | - - | 4 | Iron |
| | | **Total Subsurface Soil** | 2.E-03 | cPAHs | Arsenic | | 3 | Manganese |
| | | **Total Groundwater** | 2.E-04 | - - | cPAHs, $CCl_4$, Arsenic | - - | 127 | Many COPCs |
| | | **Total Across the Entire Site[2]** | **2.E-03** | cPAHs, Arsenic | $CCl_4$ | - - | **131** | Many COPCs |

**TABLE 10**

**SUMMARY OF CANCER RISKS AND HAZARD INDICES - REASONABLE MAXIMUM EXPOSURE (RME)**
**SITE 5 - TRANSFORMER STORAGE BONEYARD**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**


| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Future Adult Resident | Surface Soil | Ingestion | 2.E-04 | cPAHs | - - | Arsenic | 1.0 | - - |
| | | Dermal Contact | 8.E-05 | - - | cPAHs | -- | 0.018 | - - |
| | | Total | 2.E-04 | cPAHs | -- | Arsenic | 1.0 | - - |
| | Subsurface Soil | Ingestion | 3.E-04 | cPAHs | Arsenic | -- | 1.1 | - - |
| | | Dermal Contact | 1.E-04 | cPAHs | -- | Arsenic | 0.009 | - - |
| | | Total | 4.E-04 | cPAHs | Arsenic | -- | 1.1 | - - |
| | Average Soil[1] | Total | 3.E-04 | cPAHs | Arsenic | -- | 1.1 | - - |
| | Groundwater | Ingestion | 1.E-04 | $CCl_4$ | cPAHs, Arsenic | -- | 36.3 | Many COPCs |
| | | Dermal Contact | 2.E-05 | - - | $CCl_4$ | -- | 0.2 | - - |
| | | Inhalation - Showering | 2.E-08 | - - | - - | - - | 0.00007 | - - |
| | | Vapor Intrusion | 1.E-05 | - - | - - | $CCl_4$ | 0.05 | - - |
| | | Total | 2.E-04 | $CCl_4$ | cPAHs, Arsenic | | 37 | Many COPCs |
| | | **Total Surface Soil** | 2.E-04 | cPAHs | -- | Arsenic | 1.0 | - - |
| | | **Total Subsurface Soil** | 4.E-04 | cPAHs | Arsenic | -- | 1.1 | |
| | | **Total Groundwater** | 2.E-04 | $CCl_4$ | cPAHs, Arsenic | - - | 37 | Many COPCs |
| | | **Total Across the Entire Site[2]** | **5.E-04** | cPAHs, $CCl_4$ | Arsenic | - - | **38** | Many COPCs |

| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Total Residential Risks | Surface Soil | Ingestion | 1.E-03 | cPAHs | Arsenic | - - | NA | - - |
| | | Dermal Contact | 4.E-04 | cPAHs | - - | Arsenic | NA | - - |
| | | Total | 2.E-03 | cPAHs | Arsenic | - - | NA | - - |
| | Subsurface Soil | Ingestion | 2.E-03 | cPAHs | Arsenic | -- | NA | - - |
| | | Dermal Contact | 7.E-04 | cPAHs | - - | Arsenic | NA | - - |
| | | Total | 2.E-03 | cPAHs | Arsenic | -- | NA | - - |
| | Average Soil[1] | Total | 2.E-03 | cPAHs | Arsenic | -- | NA | |
| | Groundwater | Ingestion | 3.E-04 | $CCl_4$ | cPAHs, Arsenic | - - | NA | - - |
| | | Dermal Contact | 2.E-05 | - - | $CCl_4$ | - - | NA | - - |
| | | Inhalation - Showering | 2.E-08 | - - | - - | - - | NA | - - |
| | | Vapor Intrusion | 1.E-05 | - - | - - | - - | NA | - - |
| | | Total | 3.E-04 | $CCl_4$ | cPAHs, Arsenic | - - | NA | - - |
| | | **Total Surface Soil** | 2.E-03 | cPAHs | -- | - - | NA | - - |
| | | **Total Subsurface Soil** | 2.E-03 | cPAHs | Arsenic | - - | NA | - - |
| | | **Total Groundwater** | 3.E-04 | $CCl_4$ | cPAHs, Arsenic | - - | NA | - - |
| | | **Total Across the Entire Site[2]** | **2.E-03** | cPAHs, $CCl_4$ | Arsenic | - - | NA | - - |

cPAHs = Carcinogenic PAHs
NA = Not applicable
[1] The risks and HIs between surface and subsurface soil are averaged because exposure factors in risk assessment apply 100% of soil contact to each soil medium.
[2] Averaged surface and subsurface soil ILCRs and HIs, then added to the total risk calculated for groundwater to achieve the overall risk summaries.
COPC = Chemical of Potential Concern

**TABLE 11**

**SUMMARY OF CANCER RISKS AND HAZARD INDICES - CENTRAL TENDENCY EXPOSURE (CTE)**
**SITE 5 - TRANSFORMER STORAGE BONEYARD**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**


| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Construction/Excavation Worker | Surface Soil | Ingestion | 7.E-08 | - - | - - | - - | 0.2 | - - |
| | | Dermal Contact | 1.E-08 | - - | - - | - - | 0.004 | - - |
| | | Inhalation | 1.E-08 | - - | - - | - - | 1.0 | - - |
| | | Total | 1.E-07 | - - | - - | - - | 1.2 | - - |
| | Subsurface Soil | Ingestion | 5.E-08 | - - | - - | - - | 0.2 | - - |
| | | Dermal Contact | 7.E-09 | - - | - - | - - | 0.0024 | - - |
| | | Inhalation | 2.E-08 | - - | - - | - - | 1.7 | Manganese |
| | | Total | 7.E-08 | - - | - - | - - | 1.9 | Manganese |
| | Average Soil[1] | Total | 9.E-08 | - - | - - | - - | 1.5 | Manganese |
| | Groundwater | Ingestion | NA | - - | - - | - - | NA | - - |
| | | Dermal Contact | 4.E-08 | - - | - - | - - | 1.7 | Manganese |
| | | Vapor into Trench | 4.E-09 | - - | - - | - - | 0.002 | - - |
| | | Total | 4.E-08 | - - | - - | - - | 1.7 | Manganese |
| | | **Total Surface Soil** | 1.E-07 | - - | - - | - - | 1.2 | Manganese |
| | | **Total Subsurface Soil** | 7.E-08 | - - | - - | - - | 1.9 | Manganese |
| | | **Total Groundwater** | 4.E-08 | - - | - - | - - | 1.7 | Manganese |
| | | **Total Across the Entire Site[2]** | **1.E-07** | - - | - - | - - | **3** | Manganese |

| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Occupational/Maintenance Worker | Surface Soil | Ingestion | 1.E-06 | - - | - - | - - | 0.2 | - - |
| | | Dermal Contact | 2.E-07 | - - | - - | - - | 0.0008 | - - |
| | | Total | 2.E-06 | - - | - - | - - | 0.2 | - - |
| | Subsurface Soil | Ingestion | 1.E-06 | - - | - - | - - | 0.20 | - - |
| | | Dermal Contact | 9.E-08 | - - | - - | - - | 0.0004 | - - |
| | | Total | 1.E-06 | - - | - - | - - | 0.2 | - - |
| | Average Soil[1] | Total | 1.E-06 | - - | - - | - - | 0.2 | - - |
| | Groundwater | Vapor Intrusion | 4.E-07 | - - | - - | - - | 0.005 | - - |
| | | **Total Surface Soil** | 2.E-06 | - - | - - | - - | 0.2 | - - |
| | | **Total Subsurface Soil** | 1.E-06 | - - | - - | - - | 0.2 | - - |
| | | **Vapor Intrusion** | 4.E-07 | - - | - - | - - | 0.005 | - - |
| | | **Total Across the Entire Site[2]** | **3.E-06** | - - | - - | - - | **0.3** | - - |

| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Adolescent Trespasser | Surface Soil | Ingestion | 5.E-07 | - - | - - | - - | 0.02 | - - |
| | | Dermal Contact | 1.E-07 | - - | - - | - - | 0.0001 | - - |
| | | Total | 6.E-07 | - - | - - | - - | 0.02 | - - |
| | | **Total Surface Soil** | 6.E-07 | - - | - - | - - | 0.02 | - - |
| | | **Total Across the Entire Site** | **6.E-07** | - - | - - | - - | **0.02** | - - |

**TABLE 11**

**SUMMARY OF CANCER RISKS AND HAZARD INDICES - CENTRAL TENDENCY EXPOSURE (CTE)**
**SITE 5 - TRANSFORMER STORAGE BONEYARD**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**


| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Future Child Resident | Surface Soil | Ingestion | 3.E-05 | - - | cPAHs | Arsenic | 0.5 | - - |
| | | Dermal Contact | 5.E-06 | - - | - - | cPAHs | 0.006 | - - |
| | | Total | 4.E-05 | - - | cPAHs | Arsenic | 0.5 | - - |
| | Subsurface Soil | Ingestion | 1.E-05 | - - | cPAHs | Arsenic | 0.6 | - - |
| | | Dermal Contact | 2.E-06 | - - | - - | cPAHs | 0.003 | - - |
| | | Total | 2.E-05 | - - | cPAHs | Arsenic | 0.6 | - - |
| | Average Soil[1] | Total | 3.E-05 | - - | cPAHs | Arsenic | 0.5 | - - |
| | Groundwater | Ingestion | 2.E-05 | - - | - - | cPAHs, $CCl_4$, Arsenic | 37 | Many COPCs |
| | | Dermal Contact | 2.E-06 | - - | - - | - - | 0.27 | -- |
| | | Inhalation - Showering[3] | 4.E-09 | - - | - - | - - | 0.00007 | -- |
| | | Vapor Intrusion | 6.E-07 | - - | - - | - - | 0.03 | -- |
| | | Total | 2.E-05 | - - | - - | cPAHs, $CCl_4$, Arsenic | 38 | Many COPCs |
| | | **Total Surface Soil** | 4.E-05 | - - | cPAHs | Arsenic | 0.49 | - - |
| | | **Total Subsurface Soil** | 2.E-05 | - - | cPAHs | Arsenic | 0.6 | - - |
| | | **Total Groundwater** | 2.E-05 | - - | - - | cPAHs, $CCl_4$, Arsenic | 38 | Many COPCs |
| | | **Total Across the Entire Site[2]** | **7.E-05** | - - | cPAHs, Arsenic | $CCl_4$ | **38** | Many COPCs |

| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Future Adult Resident | Surface Soil | Ingestion | 4.E-06 | - - | - - | cPAHs | 0.2 | - - |
| | | Dermal Contact | 6.E-07 | - - | - - | - - | 0.0007 | - - |
| | | Total | 5.E-06 | - - | - - | cPAHs | 0.2 | - - |
| | Subsurface Soil | Ingestion | 2.E-06 | - - | - - | cPAHs | 0.2 | - - |
| | | Dermal Contact | 2.E-07 | - - | - - | - - | 0.0004 | - - |
| | | Total | 2.E-06 | - - | - - | cPAHs | 0.2 | - - |
| | Average Soil[1] | Total | 4.E-06 | - - | - - | cPAHs | 0.2 | - - |
| | Groundwater | Ingestion | 2.E-05 | - - | $CCl_4$ | cPAHs, Arsenic | 17 | Cobalt, Iron, Manganese |
| | | Dermal Contact | 4.E-06 | - - | - - | $CCl_4$ | 0.2 | - - |
| | | Inhalation - Showering[3] | 2.E-08 | - - | - - | - - | 0.00007 | - - |
| | | Vapor Intrusion | 2.E-06 | - - | - - | $CCl_4$ | 0.03 | - - |
| | | Total | 3.E-05 | - - | $CCl_4$ | cPAHs, Arsenic | 17 | Cobalt, Iron, Manganese |
| | | **Total Surface Soil** | 5.E-06 | - - | - - | cPAHs | 0.2 | - - |
| | | **Total Subsurface Soil** | 2.E-06 | - - | - - | cPAHs | 0.2 | - - |
| | | **Total Groundwater** | 3.E-05 | - - | $CCl_4$ | cPAHs, Arsenic | 17 | Cobalt, Iron, Manganese |
| | | **Total Across the Entire Site[2]** | **3.E-05** | - - | $CCl_4$ | cPAHs, Arsenic | **17** | Cobalt, Iron, Manganese |

**TABLE 11**

**SUMMARY OF CANCER RISKS AND HAZARD INDICES - CENTRAL TENDENCY EXPOSURE (CTE)**
**SITE 5 - TRANSFORMER STORAGE BONEYARD**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**


| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Total Residential Risks | Surface Soil | Ingestion | 4.E-05 | - - | cPAHs | Arsenic | NA | - - |
| | | Dermal Contact | 5.E-06 | - - | - - | cPAHs | NA | - - |
| | | Total | 4.E-05 | - - | cPAHs | Arsenic | NA | - - |
| | Subsurface Soil | Ingestion | 2.E-05 | - - | cPAHs | Arsenic | NA | - - |
| | | Dermal Contact | 2.E-06 | - - | - - | cPAHs | NA | - - |
| | | Total | 2.E-05 | - - | cPAHs | Arsenic | NA | - - |
| | Average Soil[1] | Total | 3.E-05 | - - | cPAHs | Arsenic | NA | - - |
| | Groundwater | Ingestion | 4.E-05 | - - | $CCl_4$ | cPAHs, Arsenic | NA | - - |
| | | Dermal Contact | 4.E-06 | - - | - - | $CCl_4$ | NA | - - |
| | | Inhalation - Showering[3] | 2.E-08 | - - | - - | - - | NA | - - |
| | | Vapor Intrusion | 3.E-06 | - - | - - | $CCl_4$ | NA | - - |
| | | Total | 5.E-05 | - - | $CCl_4$ | cPAHs, Arsenic | NA | - - |
| | | **Total Surface Soil** | 4.E-05 | - - | cPAHs | Arsenic | NA | - - |
| | | **Total Subsurface Soil** | 2.E-05 | - - | cPAHs | Arsenic | NA | - - |
| | | **Total Groundwater** | 5.E-05 | - - | $CCl_4$ | cPAHs, Arsenic | NA | - - |
| | | **Total Across the Entire Site[2]** | **9.8E-05** | - - | cPAHs, $CCl_4$ | Arsenic | NA | - - |

cPAHs = Carcinogenic PAHs
NA = Not applicable
[1] The risks and HIs between surface and subsurface soil are averaged because exposure factors in risk assessment apply 100% of soil contact to each soil medium.
[2] Averaged surface and subsurface soil ILCRs and HIs, then added to the total risk calculated for groundwater to achieve the overall risk summaries.
[3] RME values for inhalation of volatiles from groundwater during showering.
COPC = Chemicals of Potential Concern

**TABLE 12**

**SUMMARY OF ESTIMATED POTENTIAL UNACCEPTABLE HUMAH HEALTH RISKS**
**SITE 5 - TRANSFORMER STORAGE BONEYARD**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**

| Receptor | Medium | Exposure Route | RME Cancer Risk | RME COC (carcinogenic) (indiv. risks >$10^{-6}$) | RME (HI) | RME COC (noncarcinogenic) (indiv. HQ>1) | CTE Cancer Risk | CTE COC (carcinogenic) (indiv. risks >$10^{-6}$) | CTE (HI) | CTE COC (noncarcinogenic) (indiv. HQ>1) |
|---|---|---|---|---|---|---|---|---|---|---|
| Construction/Excavation Worker | Surface/Subsurface Soil | Inhalation | - - | - - | 6 | Manganese | **- -** | **- -** | 1.7 | Manganese |
| | Groundwater | Dermal Contact | - - | - - | 3 | Manganese | **- -** | **- -** | 1.7 | Manganese |
| **Total Risk (for all Media, all Pathways, and all COCs)** | | | **- -** | | **10** | | **- -** | | **3** | |
| Occupational/Maintenance Worker | Surface Soil | Ingestion | 1.8E-05 | c-PAH<br>Arsenic | - - | - - | 1.5E-06 | - - | - - | - - |
| | | Dermal Contact | 1.3E-05 | c-PAH | - - | - - | - - | - - | - - | - - |
| | Subsurface Soil | Ingestion | 2.2E-05 | c-PAH<br>Arsenic | - - | - - | - - | - - | - - | - - |
| | | Dermal Contact | 1.6E-05 | c-PAH | - - | - - | - - | - - | - - | - - |
| | Groundwater | Vapor Intrusion | 2.5E-06 | $CCl_4$ | - - | - - | - - | - - | - - | - - |
| **Total Risk (for all Media[1], all Pathways, and all COCs)** | | | **4.E-05** | | **- -** | | **3.E-06** | | **- -** | |
| Adolescent Trespasser | Surface Soil | Ingestion | 3.3E-06 | cPAH | - - | - - | **- -** | **- -** | **- -** | **- -** |
| | | Dermal Contact | 2.6E-06 | cPAH | - - | - - | **- -** | **- -** | **- -** | **- -** |
| **Total Risk (for all Media, all Pathways, and all COCs)** | | | **6.E-06** | | **- -** | | **- -** | | **- -** | |
| Future Child Resident | Surface Soil | Ingestion | 9.5E-04 | c-PAH<br>Arsenic | 3 | Iron | 3.3E-05 | c-PAH<br>Arsenic | -- | -- |
| | | Dermal Contact | 3.4E-04 | c-PAH<br>Arsenic | - - | - - | 4.8E-06 | c-PAH<br>Arsenic | -- | -- |
| | Subsurface Soil | Ingestion | 1.5E-03 | c-PAH<br>Arsenic | 3 | Manganese | 1.4E-05 | c-PAH<br>Arsenic | -- | -- |
| | | Dermal Contact | 5.4E-04 | c-PAH<br>Arsenic | | - - | 1.6E-06 | c-PAH<br>Arsenic | --<br>-- | --<br>-- |
| | Groundwater | Ingestion | 1.5E-04 | c-PAH<br>Arsenic<br>$CCl_4$ | 127 | Many COPCs[2] | 1.8E-05 | c-PAH<br>Arsenic<br>$CCl_4$ | 38 | Many COPCs[2] |
| | | Dermal Contact | 9.7E-06 | $CCl_4$ | -- | -- | 2.2E-06 | $CCl_4$ | -- | -- |
| | | Vapor Intrusion | 2.6E-06 | $CCl_4$ | 0.05 | -- | -- | -- | -- | -- |
| **Total Risk (for all Media[1], all Pathways, and all COCs)** | | | **2.E-03** | | **131** | | **7.E-05** | | **38** | |
| Future Adult Resident | Surface Soil | Ingestion | 1.6E-04 | c-PAH<br>Arsenic | 1.0 | -- | 4.4E-06 | - - | - - | - - |
| | | Dermal Contact | 8.0E-05 | c-PAH<br>Arsenic | | --<br>-- | 6.1E-07 | - - | - - | - - |
| | Subsurface Soil | Ingestion | 2.6E-04 | c-PAH<br>Arsenic | 1.1 | --<br>-- | 2.0E-06 | - - | - - | - - |
| | | Dermal Contact | 1.3E-04 | c-PAH<br>Arsenic | | --<br>-- | 2.4E-07 | - - | - - | - - |
| | Groundwater | Ingestion | 1.4E-04 | c-PAH<br>Arsenic<br>$CCl_4$ | 36.3 | Many COPCs[2] | 2.1E-05 | c-PAH<br>Arsenic<br>$CCl_4$ | 17 | Cobalt<br>Iron<br>Manganese |
| | | Dermal Contact | 2.3E-05 | $CCl_4$ | 0.2 | - - | 4.4E-06 | -- | -- | -- |
| | | Vapor Intrusion | 1.0E-05 | $CCl_4$ | 0.05 | - - | 2.0E-06 | $CCl_4$ | -- | -- |
| **Total Risk (for all Media[1], all Pathways, and all COCs)** | | | **5.E-04** | | **38** | | **3.E-05** | | **17** | |

- - Indicates cancer risk less than 1 x $10^{-6}$ or HI less than 1.0.

cPAHs = Carcinogenic PAHs

NA = Not applicable

[1] Averaged surface and subsurface soil ILCRs and HIs, then added to the total risk calculated for groundwater to achieve the overall risk summaries.

[2] Carbon tetrachloride ($CCl_4$), barium, cobalt, iron, manganese, but predominantly manganese).

**TABLE 13**

**VALUES USED FOR DAILY INTAKE CALCULATIONS**
**EXPOSURE OF CONSTRUCTION WORKERS BY INHALATION FROM SURFACE SOIL**
**SITE 5 - TRANSFORMER STORAGE BONEYARD**
**NAVAL STATION GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Air
Exposure Point: Entire Site
Receptor Population: Construction Worker
Receptor Age: Adult

| Exposure Route | Parameter Code | Parameter Definition | Units | RME Value | RME Rationale/ Reference | CT Value | CT Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|
| Inhalation | CS | Chemical concentration in soil | mg/kg | 95% UCL or Max | USEPA, May 1993 | 95% UCL or Max | USEPA, May 1993 | Intake (mg/kg/day) = $\frac{CS \times \left[\frac{1}{VF} + \frac{1}{PEF}\right] \times ET \times EF \times ED}{AT \times 24}$ |
| | VF | Volatilization factor - Chemical Specific | $m^3/kg$ | (1) | USEPA, December 2002 | (1) | USEPA, December 2002 | |
| | PEF | Particulate emission factor | $m^3/kg$ | 1.24E+08 | IEPA, 2007. TACO | 1.24E+08 | IEPA, 2007. TACO | |
| | ET | Exposure Time | hours/day | 8 | USEPA, December 2002 | 4 | USEPA, December 2002 | |
| | EF | Exposure Frequency | days/year | 30 | IEPA, April 2004 | 30 | IEPA, April 2004 | |
| | ED | Exposure Duration | years | 1 | Professional Judgement | 1 | Professional Judgement | |
| | AT-C | Averaging Time (Cancer) | days | 25550 | USEPA, December 1989 | 25550 | USEPA, December 1989 | |
| | AT-N | Averaging Time (Non-Cancer) | days | 42 | IEPA, Janaury 2003 | 42 | IEPA, Janaury 2003 | |

Notes:
(1) - Calculated according to USEPA Soil Screening Guidance, December 2002.

**Daily Intake Calculations**
Inhalation Intake = (ET x EF x ED x (1/PEF)+(1/VF)) / (AT x 24)

Cancer Inhalation Intake(RME) = 3.91E-04
Noncancer Inhalation Intake(RME) = 2.38E-01
Cancer Inhalation Intake(CTE) = 1.96E-04
Noncancer Inhalation Intake(CTE) = 1.19E-01

Cancer risk from inhalation = Air concentration x Cancer Inhalation Intake x Cancer Inhalation Unit Risk (IUR)
Hazard Index from inhalation = Air concentration x Noncancer Inhalation Intake / Reference Concentration (RfCi)

**TABLE 14 REASONABLE MAXIMUM EXPOSURE (RME)**
**CALCULATION OF NON-CANCER HAZARDS**
**EXPOSURE OF CONSTRUCTION WORKERS BY INHALATION FROM SURFACE SOIL**
**SITE 5 - TRANSFORMER STORAGE BONEYARD**
**NAVAL STATION GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Air
Exposure Point: Entire Site
Receptor Population: Construction Worker
Receptor Age: Adult

| Exposure Route | Chemical of Potential Concern | Medium EPC Max. | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Hazard Calculation [1] | Intake (Non-Cancer) | Intake (Non-Cancer) Units | Reference Concentration (Subchronic [2] if available) | Reference Concentration Units | Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Inhalation | XYLENES (PARTICULATE) | 7.60E-01 | mg/kg | 6.1E-09 | $mg/m^3$ | R | 1.5E-09 | $mg/m^3$ | 1.0E-01 | $mg/m^3$ | 1.5E-08 |
| | ALUMINUM | 1.40E+04 | mg/kg | 1.1E-04 | $mg/m^3$ | R | 2.7E-05 | $mg/m^3$ | 5.0E-03 | $mg/m^3$ | 5.4E-03 |
| | ARSENIC | 1.20E+01 | mg/kg | 9.7E-08 | $mg/m^3$ | R | 2.3E-08 | $mg/m^3$ | 1.5E-05 | $mg/m^3$ | 1.5E-03 |
| | COBALT | 1.10E+01 | mg/kg | 8.9E-08 | $mg/m^3$ | R | 2.1E-08 | $mg/m^3$ | *2.0E-05* | $mg/m^3$ | 1.1E-03 |
| | MANGANESE | 9.40E+02 | mg/kg | 7.6E-06 | $mg/m^3$ | R | 1.8E-06 | $mg/m^3$ | 5.0E-05 | $mg/m^3$ | 3.6E-02 |
| | MERCURY | 5.30E-01 | mg/kg | 4.3E-09 | $mg/m^3$ | R | 1.0E-09 | $mg/m^3$ | 3.0E-05 | $mg/m^3$ | 3.4E-05 |
| | XYLENES (VOL) | 7.60E-01 | mg/kg | 1.1E-04 | $mg/m^3$ | R | 2.7E-05 | $mg/m^3$ | 1.0E-01 | $mg/m^3$ | 2.7E-04 |
| | (total) | | | | | | | | | | 0.04 |

[1] Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

**Total Hazard Index Across All Exposure Routes/Pathways** **0.04**

[2] Subchronic values in *italics.*

**TABLE 15 REASONABLE MAXIMUM EXPOSURE (RME)**
**CALCULATION OF CANCER RISKS**
**EXPOSURE OF CONSTRUCTION WORKERS BY INHALATION FROM SURFACE SOIL**
**SITE 5 - TRANSFORMER STORAGE BONEYARD**
**NAVAL STATION GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Air
Exposure Point: Entire Site
Receptor Population: Construction Worker
Receptor Age: Adult

| Exposure Route | Chemical of Potential Concern | Medium EPC Max. | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation (1) | Intake (Cancer) | Intake (Cancer) Units | Cancer Unit Risk | Cancer Unit Risk Units | Cancer Risk |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Inhalation | XYLENES (PARTICULATE) | 7.60E-01 | mg/kg | 6.1E-09 | $mg/m^3$ | R | 2.4E-12 | $mg/m^3$ | | $(mg/m^3)^{-1}$ | |
| | ALUMINUM | 1.40E+04 | mg/kg | 1.1E-04 | $mg/m^3$ | R | 4.4E-08 | $mg/m^3$ | | $(mg/m^3)^{-1}$ | |
| | ARSENIC | 1.20E+01 | mg/kg | 9.7E-08 | $mg/m^3$ | R | 3.8E-11 | $mg/m^3$ | 4.3E+00 | $(mg/m^3)^{-1}$ | 1.6E-10 |
| | COBALT | 1.10E+01 | mg/kg | 8.9E-08 | $mg/m^3$ | R | 3.5E-11 | $mg/m^3$ | 9.0E+00 | $(mg/m^3)^{-1}$ | 3.1E-10 |
| | MANGANESE | 9.40E+02 | mg/kg | 7.6E-06 | $mg/m^3$ | R | 3.0E-09 | $mg/m^3$ | | $(mg/m^3)^{-1}$ | |
| | MERCURY | 5.30E-01 | mg/kg | 4.3E-09 | $mg/m^3$ | R | 1.7E-12 | $mg/m^3$ | | $(mg/m^3)^{-1}$ | |
| | XYLENES (VOL) | 7.60E-01 | mg/kg | 6.1E-09 | $mg/m^3$ | R | 2.4E-12 | $mg/m^3$ | | $(mg/m^3)^{-1}$ | |
| | (total) | | | | | | | | | | 4.8E-10 |
| | | | | | | | | | | **Total Risk Across All Exposure Routes/Pathways** | **4.8E-10** |

**TABLE 16**

**VALUES USED FOR DAILY INTAKE CALCULATIONS**
**EXPOSURE OF CONSTRUCTION WORKERS BY INHALATION FROM SUBSURFACE SOIL**
**SITE 5 - TRANSFORMER STORAGE BONEYARD**
**NAVAL STATION GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future
Medium: Subsurfce Soil
Exposure Medium: Air
Exposure Point: Entire Site
Receptor Population: Construction Worker
Receptor Age: Adult

| Exposure Route | Parameter Code | Parameter Definition | Units | RME Value | RME Rationale/ Reference | CT Value | CT Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|
| Inhalation | CS | Chemical concentration in soil | mg/kg | 95% UCL or Max | USEPA, May 1993 | 95% UCL or Max | USEPA, May 1993 | Intake (mg/kg/day) = $\frac{CS \times \left[\frac{1}{VF} + \frac{1}{PEF}\right] \times ET \times EF \times ED}{AT \times 24}$ |
| | VF | Volatilization factor - Chemical Specific | $m^3/kg$ | (1) | USEPA, December 2002 | (1) | USEPA, December 2002 | |
| | PEF | Particulate emission factor | $m^3/kg$ | 1.24E+08 | IEPA, 2007. TACO. | 1.24E+08 | IEPA, 2007. TACO. | |
| | ET | Exposure Time | hours/day | 8 | USEPA, December 2002 | 4 | USEPA, December 2002 | |
| | EF | Exposure Frequency | days/year | 30 | IEPA, April 2004 | 30 | IEPA, April 2004 | |
| | ED | Exposure Duration | years | 1 | Professional Judgement | 1 | Professional Judgement | |
| | AT-C | Averaging Time (Cancer) | days | 25550 | USEPA, December 1989 | 25550 | USEPA, December 1989 | |
| | AT-N | Averaging Time (Non-Cancer) | days | 42 | IEPA, Janaury 2003 | 42 | IEPA, Janaury 2003 | |

Notes:
(1) - Calculated according to USEPA Soil Screening Guidance, December 2002.

**Daily Intake Calculations**
Inhalation Intake = (ET x EF x ED x (1/PEF)+(1/VF)) / (AT x 24)

Cancer Inhalation Intake(RME) = 3.91E-04
Noncancer Inhalation Intake(RME) = 2.38E-01
Cancer Inhalation Intake(CTE) = 1.96E-04
Noncancer Inhalation Intake(CTE) = 1.19E-01

Cancer risk from inhalation = Air concentration x Cancer Inhalation Intake x Cancer Inhalation Unit Risk (IUR)
Hazard Index from inhalation = Air concentration x Noncancer Inhalation Intake / Reference Concentration (RfCi)

**TABLE 17 REASONABLE MAXIMUM EXPOSURE (RME)**
**CALCULATION OF NON-CANCER HAZARDS**
**EXPOSURE OF CONSTRUCTION WORKERS BY INHALATION FROM SUBSURFACE SOIL**
**SITE 5 - TRANSFORMER STORAGE BONEYARD**
**NAVAL STATION GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future
Medium: Subsurfce Soil
Exposure Medium: Air
Exposure Point: Entire Site
Receptor Population: Construction Worker
Receptor Age: Adult

| Exposure Route | Chemical of Potential Concern | Medium EPC Max. | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Hazard Calculation [1] | Intake (Non-Cancer) | Intake (Non-Cancer) Units | Reference Concentration | Reference Concentration Units | Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ALUMINUM | 1.90E+04 | mg/kg | 1.5E-04 | $mg/m^3$ | R | 3.6E-05 | $mg/m^3$ | 5.0E-03 | $mg/m^3$ | 7.3E-03 |
| | ARSENIC | 1.60E+01 | mg/kg | 1.3E-07 | $mg/m^3$ | R | 3.1E-08 | $mg/m^3$ | 1.5E-05 | $mg/m^3$ | 2.0E-03 |
| | COBALT | 1.40E+01 | mg/kg | 1.1E-07 | $mg/m^3$ | R | 2.7E-08 | $mg/m^3$ | *2.0E-05* | $mg/m^3$ | 1.3E-03 |
| | MANGANESE | 1.80E+03 | mg/kg | 1.5E-05 | $mg/m^3$ | R | 3.5E-06 | $mg/m^3$ | 5.0E-05 | $mg/m^3$ | 6.9E-02 |
| | MERCURY | 1.20E-01 | mg/kg | 9.7E-10 | $mg/m^3$ | R | 2.3E-10 | $mg/m^3$ | 3.0E-05 | $mg/m^3$ | 7.7E-06 |
| | (total) | | | | | | | | | | 8.0E-02 |

[1] Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

**Total Hazard Index Across All Exposure Routes/Pathways** **0.08**

[2] Subchronic values in *italics.*

**TABLE 18 REASONABLE MAXIMUM EXPOSURE (RME)**
**CALCULATION OF CANCER RISKS**
**EXPOSURE OF CONSTRUCTION WORKERS BY INHALATION FROM SUBSURFACE SOIL**
**SITE 5 - TRANSFORMER STORAGE BONEYARD**
**NAVAL STATION GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future
Medium: Subsurfce Soil
Exposure Medium: Air
Exposure Point: Entire Site
Receptor Population: Construction Worker
Receptor Age: Adult

| Exposure Route | Chemical of Potential Concern | Medium EPC Max. | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation (1) | Intake (Cancer) | Intake (Cancer) Units | Cancer Unit Risk | Cancer Unit Risk Units | Cancer Risk |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ALUMINUM | 1.90E+04 | mg/kg | 1.5E-04 | $mg/m^3$ | R | 6.0E-08 | $mg/m^3$ | | | |
| | ARSENIC | 1.60E+01 | mg/kg | 1.3E-07 | $mg/m^3$ | R | 5.1E-11 | $mg/m^3$ | 4.3E+00 | $(mg/m^3)^{-1}$ | 2.2E-10 |
| | COBALT | 1.40E+01 | mg/kg | 1.1E-07 | $mg/m^3$ | R | 4.4E-11 | $mg/m^3$ | 9.0E+00 | $(mg/m^3)^{-1}$ | 4.0E-10 |
| | MANGANESE | 1.80E+03 | mg/kg | 1.5E-05 | $mg/m^3$ | R | 5.7E-09 | $mg/m^3$ | | | |
| | MERCURY | 1.20E-01 | mg/kg | 0.0E+00 | $mg/m^3$ | R | 0.0E+00 | $mg/m^3$ | | | |
| | (total) | | | | | | | | | | 6.1E-10 |
| | | | | | | | | | | **Total Risk Across All Exposure Routes/Pathways** | **6.1E-10** |

# Appendix A.2
# Site 9 Human Health Risk Tables

**TABLE 1**

**EXPOSURE POINT CONCENTRATION SUMMARY - SUBSURFACE SOIL**
**SITE 9 - CAMP MOFFETT RAVINE FILL AREA**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**

| Parameter | Units | Number of Samples | Arithmetic Mean | Maximum Detection (mg/kg) | Dataset Distribution | 95% UCL of the Mean Statistic | RME[1] EPC 95% UCL | CTE EPC Mean |
|---|---|---|---|---|---|---|---|---|
| **PAHs/Semivolatile Organic Compounds** | | | | | | | | |
| NAPHTHALENE | mg/kg | 32 | 0.0486 [2] | 0.38 | LN | 99%KM UCL | 0.1837 | 0.0486 [2] |
| BAP EQUIVALENT[7] | mg/kg | 32 | 0.1705 | 0.951 | nonparametric | 95% Chebyshev UCL | 0.3598 | 0.1705 |
| **Volatile Organic Compound (VOC)** | | | | | | | | |
| TETRACHLOROETHYLENE[3] | mg/kg | 34 | -- | 0.93 | -- | -- | 0.93 | 0.93 |
| **Dioxins/Furans** | | | | | | | | |
| 2,3,7,8-TCDD[4] | mg/kg | 7 | -- | 7.32E-06 | -- | -- | 7.32E-06 | -- |
| TCDD TEQs full NDs[5] | mg/kg | 7 | 2.80E-06 | 8.92E-06 | nonparametric | 95% Chebyshev UCL | 7.27E-06 | 2.80E-06 |
| TCDD TEQs detected congeners[5] | mg/kg | 7 | 2.01E-06 | 8.73E-06 | gamma | 95% Approx Gamma UCL | 6.35E-06 | 2.01E-06 |
| **Inorganics** | | | | | | | | |
| ALUMINUM | mg/kg | 36 | 9,091 | 19,700 | normal | 95% Student's-t UCL | 10,132 | 9,091 |
| ANTIMONY | mg/kg | 36 | 2.226 | 11.80 | gamma | 95% KM (t) UCL | 1.457 | 2.226 |
| ARSENIC | mg/kg | 36 | 15.49 | 115.0 | nonparametric | 95% Chebyshev UCL | 29.16 | 15.49 |
| BARIUM | mg/kg | 36 | 126.9 | 1,220 | lognormal | 95% Chebyshev UCL | 191.3 | 126.9 |
| CADMIUM | mg/kg | 36 | 1.194 | 8.040 | nonparametric | 95% KM (BCA) UCL | 1.405 | 1.194 |
| CHROMIUM | mg/kg | 36 | 16.09 | 31.50 | LN or gamma | 95% Approx Gamma UCL | 17.58 | 16.09 |
| COBALT | mg/kg | 36 | 10.15 | 22.10 | normal | 95% Student's-t UCL | 11.33 | 10.15 |
| COPPER | mg/kg | 36 | 92.26 | 1,140 | nonparametric | 95% Chebyshev UCL | 256.7 | 92.26 |
| IRON | mg/kg | 36 | 23,456 | 52,400 | nonparametric | 95% Modified-t UCL | 26,442 | 23,456 |
| LEAD | mg/kg | 36 | 209.8 | 5,070 | NA | NA | 209.8 [6] | 209.8 |
| MANGANESE | mg/kg | 36 | 634.0 | 1,090 | normal | 95% Student's-t UCL | 697.1 | 634.0 |
| MERCURY | mg/kg | 36 | 1.113 [2] | 31.5 | nonparametric | 99% KM (Chebyshev) | 9.698 | 1.113 [2] |
| VANADIUM | mg/kg | 36 | 21.59 | 36.20 | normal | 95% Student's-t UCL | 23.49 | 21.59 |
| ZINC | mg/kg | 36 | 134.9 | 792.0 | nonparametric | 95% Chebyshev UCL | 242.5 | 134.9 |

NA = Not applicable.
mg/kg = Milligram per kilogram.
UCL = Upper confidence limit.
RME = Reasonable maximum exposure.
EPC = Exposure point concentration.
CTE = Central tendency exposure.
LN = Lognormal.

1. RME except for construction workers; EPCs for soil for this receptor are the maximum detections of COPCs.
2. Mean value of detects only. Kaplan-Meier statistical mean (with NDs included) = 0.991 mg/kg.
3. Only one detected result, so summary statistics could not be calculated for this dataset.
4. Only two detected results, so meaningful summary statistics could not be calculated for this dataset.
5. 7 samples is considered to be potentially inadequate for calculating meaningful statistics, although it is close to the recommended 8-10 sample size.
6. The EPC for lead is the mean as recommended in the IEUBK and ALM lead models.
7. Toxicity equivalent factor approach used to convert individual carcinogenic PAHs into a single concentration of benzo(a)pyrene (BaP).

**TABLE 2**

**EXPOSURE POINT CONCENTRATION SUMMARY - GROUNDWATER**
**SITE 9 - CAMP MOFFETT RAVINE FILL AREA**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**

| Chemical of Potential Concern | Units | EPCs for RME and CTE | | |
|---|---|---|---|---|
| | | Number of Samples | Maximum Detected Concentration | Maximum Qualifier |
| **Volatile Organic Compounds** | | | | |
| CHLOROFORM | ug/L | 8 | 0.21 | J |
| **PAHs/Semivolatile Organic Compounds** | | | | |
| BAP EQUIVALENT[1] | ug/L | 8 | 0.139 | -- |
| DICHLORODIFLUOROMETHANE[2] | ug/L | 8 | 28 | J |
| **Inorganics** | | | | |
| ARSENIC | ug/L | 8 | 13.4 | -- |
| BARIUM | ug/L | 8 | 1690 | -- |
| COBALT | ug/L | 8 | 3.3 | -- |
| IRON | ug/L | 8 | 12500 | -- |
| LEAD | ug/L | 8 | 14.9 | -- |
| MANGANESE | ug/L | 8 | 743 | -- |
| SELENIUM | ug/L | 8 | 23 | -- |

EPC = Exposure point concentration.
RME = Reasonable maximum exposure.
CTE = Central tendency exposure.
ug/L = Microgram per liter.
J = Value is estimated.

1. Toxicity equivalent factor approach used to convert individual carcinogenic PAHs into a single concentration of benzo(a)pyrene (BaP).
2. COPC for vapor intrusion pathway only.

**TABLE 3**

**SUMMARY OF EXPOSURE INPUT PARAMETERS**
**REASONABLE MAXIMUM EXPOSURES**
**SITE 9 - CAMP MOFFETT RAVINE FILL AREA**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**


| Exposure Parameter | Occupational/ Maintenance Worker | Construction Worker | On-Site Adult Resident | On-Site Child Resident |
|---|---|---|---|---|
| **All Exposures** | | | | |
| $C_{soil}$ (mg/kg) | Maximum or 95% UCL[1] | Maximum or 95% UCL[1] | Maximum or 95% UCL[1] | Maximum or 95% UCL[1] |
| $C_{gw}$ (µg/L) | NA | Maximum | Maximum | Maximum |
| EF (days/year) | 250[3] | 30[2] | 350[5] | 350[5] |
| ED (years) | 25[3] | 1[4] | 24[5] | 6[5] |
| BW (kg) | 70[5] | 70[5] | 70[5] | 15[5] |
| $AT_n$ (days) | 9,125[9] | 42[8] | 8,760[9] | 2,190[9] |
| $AT_c$ (days) | 25,550[9] | 25,550[9] | 25,550[9] | 25,550[9] |
| **Incidental Ingestion/Dermal Contact with Soil** | | | | |
| IR (mg/day) | 100[5] | 330[10] | 100[5] | 200[5] |
| FI (unitless) | 1[5] | 1[5] | 1[5] | 1[5] |
| SA ($cm^2$/day) | 3,300[11] | 3,300[11] | 5,700[11] | 2,800[11] |
| AF ($mg/cm^2$) | 0.2[11] | 0.3[11] | 0.07[11] | 0.2[11] |
| ABS (unitless) | chemical-specific[11] | chemical-specific[11] | chemical-specific[11] | chemical-specific[11] |
| CF (kg/mg) | 1E-06 | 1E-06 | 1E-06 | 1E-06 |
| **Inhalation Fugitive Dust/Volatile Emissions from Soil** | | | | |
| $C_{air}$ ($mg/m^3$) | calculated[10] | calculated[10] | calculated[10] | calculated[10] |
| InhR ($m^3$/hour) | 2.5[10] | 2.5[7] | 20 $m^3$/day[10] | 10 $m^3$/day[7] |
| ET (hours/day) | 8[10] | 8[12] | 24[10] | 24[7] |
| PEF ($m^3$/kg) | 1.36E+9[10] | 1.27E+6[10] | 1.36E+9[10] | 1.36E+9[10] |
| VF ($m^3$/kg) | chemical-specific[10] | chemical-specific[10] | chemical-specific[10] | chemical-specific[10] |

**TABLE 3**

**SUMMARY OF EXPOSURE INPUT PARAMETERS**
**REASONABLE MAXIMUM EXPOSURES**
**SITE 9 - CAMP MOFFETT RAVINE FILL AREA**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**


| Exposure Parameter | Occupational/ Maintenance Worker | Construction Worker | On-Site Adult Resident | On-Site Child Resident |
|---|---|---|---|---|
| **Ingestion/Dermal Contact with Groundwater** | | | | |
| $IR_{gw}$ (L/day) | NA | NA | 2[5] | 1.5[7] |
| ET (hours/day) and $t_{event}$ (hours/event) | NA | 4[4] | 0.33[4] | 0.33[4] |
| EV (events/day) | NA | 1[4] | 1[4] | 1[4] |
| A ($cm^2$/day) | NA | 3,300[11] | 18,000[11] | 6,600[11] |
| $K_p$ (cm/hour) | NA | chemical-specific[11] | chemical-specific[11] | chemical-specific[11] |
| t* (hours), t (hour), and B (unitless) | NA | chemical-specific[11] | chemical-specific[11] | chemical-specific[11] |

A = Skin surface area available for contact
ABS = Absorption factor
AF = Soil-to-skin adherence factor
$AT_c$ = Averaging time for carcinogenic effects
$At_n$ = Averaging time for non-carcinogenic effects
B = Bunge Model partitioning coefficient
BW = Body weight
CF = Conversion factor
IR = Ingestion rate
$t_{event}$ = Duration of event
$C_{soil}$ = Exposure concentration for soil
$C_{gw}$ = Exposure concentration for groundwater
$C_{air}$ = Exposure concentration for air
ED = Exposure duration
UCL = Upper confidence limit
NA = Not applicable
cm = centimeter
L = Liter
m = Meter
kg = Kilogram

EF = Exposure frequency
ET = Exposure time
EV = Event frequency
FI = Fraction ingested from contaminated source
InhR = Inhalation rate
$K_p$ = Permeability coefficient for water through skin
SA = Skin surface area available for contact
PEF = Particulate emission factor
t = Lag time
t* = Time it takes to reach steady-state conditions
mg = Miligram

1 - USEPA, 2002.
2 - Illinois EPA, 2004.
3 - USEPA, 1991
4- Professional judgment.
5 - USEPA, 1993
6 - Adolescents (7-16 years).
7 - USEPA, 1997
8 - Illinois EPA, 2003.
9 - USEPA, 1989
10 - USEPA, 2002
11 - USEPA, 2004
12 - Assume an 8-hour work shift.

Note: The exposure factors for future civilian and military residents are the same, except for exposure duration (ED) for adult military residents. Exposure duration for adult military residents was assumed to be the typical enlistment times of 6 years for the RME and CTE.

**TABLE 4**

**SUMMARY OF EXPOSURE INPUT PARAMETERS**
**CENTRAL TENDENCY EXPOSURES**
**SITE 9 - CAMP MOFFETT RAVINE FILL AREA**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**


| Exposure Parameter | Occupational/ Maintenance Worker | Construction Worker | On-Site Adult Resident | On-Site Child Resident |
|---|---|---|---|---|
| **All Exposures** | | | | |
| $C_{soil}$ (mg/kg) | Mean | Mean | Mean | Mean |
| $C_{gw}$ (µg/L) | NA | Maximum | Maximum | Maximum |
| EF (days/year) | 219[3] | 30[2] | 234[3] | 234[3] |
| ED (years) | 9[3] | 1[4] | 7[3] | 2[3] |
| BW (kg) | 70[3] | 70[3] | 70[3] | 15[3] |
| $AT_n$ (days) | 3,285[8] | 42[7] | 2,555[8] | 730[8] |
| $AT_c$ (days) | 25,550[8] | 25,550[8] | 25,550[8] | 25,550[8] |
| **Incidental Ingestion/Dermal Contact with Soil** | | | | |
| IR (mg/day) | 50[9] | 165[9] | 50[9] | 100[9] |
| FI (unitless) | 1[3] | 1[3] | 1[3] | 1[3] |
| SA ($cm^2$/day) | 3,300[10] | 3,300[10] | 5,700[10] | 2,800[10] |
| AF (mg/$cm^2$) | 0.02[10] | 0.1[10] | 0.01[10] | 0.04[10] |
| ABS (unitless) | chemical-specific[10] | chemical-specific[10] | chemical-specific[10] | chemical-specific[10] |
| CF (kg/mg) | 1E-06 | 1E-06 | 1E-06 | 1E-06 |
| **Inhalation Fugitive Dust/Volatile Emissions from Soil** | | | | |
| $C_{air}$ (mg/$m^3$) | calculated[11] | calculated[11] | calculated[11] | calculated[11] |
| InhR ($m^3$/hour) | 1.5[6] | 1.5[6] | 20 $m^3$/day[11] | 10 $m^3$/day[6] |
| ET (hours/day) | 4[9] | 4[9] | 24[11] | 24[6] |
| PEF ($m^3$/kg) | 1.36E+9[11] | 1.27E+6[11] | 1.36E+9[11] | 1.36E+9[11] |
| VF ($m^3$/kg) | chemical-specific[11] | chemical-specific[11] | chemical-specific[11] | chemical-specific[11] |

**TABLE 4**

**SUMMARY OF EXPOSURE INPUT PARAMETERS**
**CENTRAL TENDENCY EXPOSURES**
**SITE 9 - CAMP MOFFETT RAVINE FILL AREA**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**


| Exposure Parameter | Occupational/ Maintenance Worker | Construction Worker | On-Site Adult Resident | On-Site Child Resident |
|---|---|---|---|---|
| **Ingestion/Dermal Contact with Groundwater** | | | | |
| $IR_{gw}$ (L/day) | NA | NA | 1.4[3] | 0.66[6] |
| ET (hours/day) and $t_{event}$ (hours/event) | NA | 2[8] | 0.25[4] | 0.25[4] |
| EV (events/day) | NA | 1[4] | 1[4] | 1[4] |
| A ($cm^2$/day) | NA | 3,300[10] | 18,000[10] | 6,600[10] |
| $K_p$ (cm/hour) | NA | chemical-specific[10] | chemical-specific[10] | chemical-specific[10] |
| t* (hours), t (hour), and B (unitless) | NA | chemical-specific[10] | chemical-specific[10] | chemical-specific[10] |

**Notes:**

A = Skin surface area available for contact
ABS = Absorption factor
AF = Soil-to-skin adherence factor
$AT_c$ = Averaging time for carcinogenic effects
$At_n$ = Averaging time for non-carcinogenic effects
B = Bunge Model partitioning coefficient
BW = Body weight
CF = Conversion factor
IR = Ingestion rate
$t_{event}$ = Duration of event
$C_{soil}$ = Exposure concentration for soil
$C_{gw}$ = Exposure concentration for groundwater
$C_{air}$ = Exposure concentration for air
ED = Exposure duration
UCL = Upper confidence limit
NA = Not applicable
cm = centimeter

EF = Exposure frequency
ET = Exposure time
EV = Event frequency
FI = Fraction ingested from contaminated source
InhR = Inhalation rate
$K_p$ = Permeability coefficient for water through skin
SA = Skin surface area available for contact
PEF = Particulate emission factor
t = Lag time
t* = Time it takes to reach steady-state conditions
L = Liter
m = Meter
kg = Kilogram
mg = Miligram

1 - USEPA, 2002
2 - Illinois EPA, 2004.
3 - USEPA, 1993
4 - Professional judgment.
5 - Adolescents (7-16 years).
6 - USEPA, 1997
7 - Illinois EPA, 2003.
8 - USEPA, 1989
9 - CTE is assumed to be 1/2 the RME value.
10 - USEPA, 2004
11 - USEPA, 2002

Note: The exposure factors for future civilian and military residents are the same, except for exposure duration (ED) for adult military residents. Exposure duration for adult military residents was assumed to be the typical enlistment times of 6 years for the RME and CTE.

**TABLE 5**

**NON-CANCER TOXICITY DATA - ORAL/DERMAL**
**SITE 9 - CAMP MOFFETT RAVINE FILL AREA**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**

| Chemical of Potential Concern | Chronic/ Subchronic | Oral RfD | | Oral Absorption Efficiency for Dermal[1] | Absorbed RfD for Dermal[2] | | Primary Target Organ(s) | Combined Uncertainty/Modifying Factors | RfD:Target Organ(s) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Value | Units | | Value | Units | | | Source | Date |
| **Volatile Organic Compound** | | | | | | | | | | |
| TETRACHLOROETHYLENE | Chronic | 1.00E-02 | mg/kg/day | >50% | 1.00E-02 | mg/kg/day | Liver (hepatox.) | 1000 | IRIS | 3/1/1988 |
| **Semivolatile Organic Compounds** | | | | | | | | | | |
| BENZO(A)ANTHRACENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| BENZO(A)PYRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| BENZO(B)FLUORANTHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| DIBENZO(A,H)ANTHRACENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| INDENO(1,2,3-CD)PYRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| NAPHTHALENE | Chronic | 0.02 | mg/kg/day | >50% | 0.02 | mg/kg/day | body weight | 3000/1 | IRIS | Sep-98 |
| TCDD TEQ (use 2,3,7,8-TCDD) | Chronic | 1.00E-09 | mg/kg/day | >50% | 1.00E-09 | mg/kg/day | developmental | NA | ATSDR | 12/1998 |
| **Inorganics** | | | | | | | | | | |
| ALUMINUM | Chronic | 1 | mg/kg/day | not available | 1.0E+00 | mg/kg/day | CNS | 100 | NCEA | 10/23/2006 |
| ANTIMONY | Chronic | 0.0004 | mg/kg/day | 0.15 | 6.0E-05 | mg/kg/day | longevity | 1000 | IRIS | 2/1991 |
| ARSENIC | Chronic | 0.0003 | mg/kg/day | >50% | 3.0E-04 | mg/kg/day | Skin, CVS | 3/1 | USEPA 8 | 8/2002 |
| BARIUM | Chronic | 0.2 | mg/kg/day | 0.07 | 1.4E-02 | mg/kg/day | Kidney (nephrtox. | 300 | IRIS | 7/2005 |
| CADMIUM | Chronic | 0.001 | mg/kg/day | 0.025 | 2.5E-05 | mg/kg/day | Kidney (proteinuria | 10/1 | IRIS | 2/1994 |
| CHROMIUM VI | Chronic | 0.003 | mg/kg/day | 0.025 | 7.5E-05 | mg/kg/day | Fetotoxicity, GS, Bone | 300/3 | IRIS | 2/2/2009 |
| COBALT | Chronic | 0.0003 | mg/kg/day | not available | 3.0E-04 | mg/kg/day | Blood | NA | ORNL | 9/12/2008 |
| COPPER | Chronic | 0.04 | | not available | 4.0E-02 | mg/kg/day | GI | NA | HEAST | 7/1997 |
| IRON | Chronic | 0.7 | mg/kg/day | not available | 7.0E-01 | mg/kg/day | GS | 1.5 | NCEA | 9/11/2006 |
| LEAD | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| MANGANESE | Chronic | 0.047 | mg/kg/day | 0.04 | 1.9E-03 | mg/kg/day | CNS | 1/3 | IRIS | 4/2009 |
| MERCURY[3] | Chronic | 0.0003 | mg/kg/day | 0.07 | 2.1E-05 | mg/kg/day | Autoimmune | 1000/1 | IRIS | 2/2/2009 |
| SELENIUM | Chronic | 0.005 | mg/kg/day | average >50% | 5.0E-03 | mg/kg/day | whole body | 3/1 | IRIS | 9/1991 |
| VANADIUM | Chronic | 0.009 | mg/kg/day | 0.026 | 2.3E-04 | mg/kg/day | Kidney | 100 | IRIS | 12/1/1996 |
| ZINC | Chronic | 0.3 | mg/kg/day | not available | 3.0E-01 | mg/kg/day | Blood | 3 | IRIS | 10/1/1992 |
| ALUMINUM | Subchronic | 2 | mg/kg/day | not available | 2.0E+00 | mg/kg/day | CNS | 30 | ATSDR | 7/1999 |
| ARSENIC | Subchronic | 0.005 | mg/kg/day | >50% | 5.0E-03 | mg/kg/day | skin | 10 | USEPA 8 | 8/2002 |
| Chromium VI | Subchronic | 0.02 | mg/kg/day | 0.025 | 5.0E-04 | mg/kg/day | NOAEL | 100 | HEAST | 7/1997 |
| MERCURY[3] | Subchronic | 0.003 | mg/kg/day | 0.07 | 2.1E-04 | mg/kg/day | Autoimmune | 100 | HEAST | 7/1997 |

Notes:
1 - USEPA, July 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.
2 - Adjusted dermal RfD = Oral RfD x Oral Absorption Efficiency for Dermal.
3 - Values are for mercuric chloride.

ATSDR = Agency for Toxic Substances and Disease Registry
PPRTV = Provisional Peer Reviewed Toxicity Value

Definitions:
CNS = Central nervous system
CVS = Cardiovascular system
GS = Gastrointestinal System
HEAST= Health Effects Assessment Summary Tables
IRIS = Integrated Risk Information System
NA = Not applicable
NCEA = USEPA National Center for Environmental Assessment
ORNL = Oak Ridge National Laboratory Regional Screening Level tables, May 2010
USEPA 8 = USEPA Region 8, August 2002

**TABLE 6**

**NON-CANCER TOXICITY DATA - INHALATION**
**SITE 9 - CAMP MOFFETT RAVINE FILL AREA**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**

| Chemical of Potential Concern | Chronic/ Subchronic | Inhalation RfC | | Extrapolated RfD[(1)] | | Primary Target Organ(s) | Combined Uncertainty/Modifying Factors | RfC : Target Organ(s) | |
|---|---|---|---|---|---|---|---|---|---|
| | | Value | Units | Value | Units | | | Source(s) | Date(s) |
| **Volatile Organic Compound** | | | | | | | | | |
| TETRACHLOROETHYLENE | Chronic | 2.7E-01 | $mg/m^3$ | 7.7E-02 | (mg/kg/day) | CNS | 100 | ATSDR (per ORNL) | 9/1997 |
| **Semivolatile Organic Compounds** | | | | | | | | | |
| BENZO(A)ANTHRACENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| BENZO(A)PYRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| BENZO(B)FLUORANTHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| DIBENZO(A,H)ANTHRACENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| INDENO(1,2,3-CD)PYRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| NAPHTHALENE | Chronic | 0.003 | $mg/m^3$ | 8.6E-04 | (mg/kg/day) | Nasal | 3000/1 | IRIS | 9/1998 |
| TCDD TEQs (use 2,3,7,8-TCDD) | Chronic | 4.00E-08 | $mg/m^3$ | 1.1E-08 | (mg/kg/day) | NA | NA | CA EPA (per ORNL) | NA |
| **Inorganics** | | | | | | | | | |
| ALUMINUM | Chronic | 5.0E-03 | $mg/m^3$ | 1.4E-03 | (mg/kg/day) | CNS | 300 | NCEA | 10/23/2006 |
| ARSENIC | Chronic | 1.50E-05 | $mg/m^3$ | 4.3E-06 | (mg/kg/day) | CNS, GI, heart | not available | CA EPA (per ORNL) | not available |
| BARIUM | Chronic | 5.0E-04 | $mg/m^3$ | 1.4E-04 | (mg/kg/day) | Fetus | 1000/1 | HEAST | 7/1997 |
| CADMIUM | Chronic | 1.0E-05 | mg/m3 | 2.9E-06 | (mg/kg/day) | Kidney | 9 | ATSDR | 9/2008 |
| CHROMIUM VI | Chronic | 1.0E-04 | $mg/m^3$ | NA | (mg/kg/day) | Respiratory | 300/1 | IRIS | 4/2009 |
| COBALT | Chronic | 6.0E-06 | $mg/m^3$ | NA | (mg/kg/day) | Respiratory | NA | ORNL | 9/12/2008 |
| IRON | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| LEAD | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| MANGANESE | Chronic | 5.00E-05 | $mg/m^3$ | 1.4E-05 | (mg/kg/day) | CNS | 1000/1 | IRIS | 4/2009 |
| MERCURY | Chronic | 3.0E-05 | $mg/m^3$ | 8.6E-06 | (mg/kg/day) | CNS | not available | CA EPA (per ORNL) | not available |
| VANADIUM | Chronic | 7.0E-06 | $mg/m^3$ | 2.0E-06 | (mg/kg/day) | NA | not available | PPRTV (per ORNL) | not available |
| BARIUM | Subchronic | 5.0E-03 | $mg/m^3$ | 1.4E-03 | (mg/kg/day) | Fetus | 100 | HEAST | 7/1997 |

Notes:

1 - Extrapolated RfD = RfC *$20m^3$/day / 70 kg

ORNL = Oak Ridge National Laboratory Regional Screening Level tables, May 2010
PPRTV = Provisional Peer Reviewed Toxicity Value

Definitions:

IRIS = Integrated Risk Information System
CNS = Central Nervous System
HEAST= Health Effects Assessment Summary Tables
NA = Not Applicable
NCEA = USEPA National Center for Environmental Assessment
ORNL = Oak Ridge National Laboratory Screening Level Tables, September 2008
ATSDR = Agency for Toxic Substances and Disease Registry
CA EPA = California Envirnomental Protection Agency

**TABLE 7**

**CANCER TOXICITY DATA - ORAL/DERMAL**
**SITE 9 - CAMP MOFFETT RAVINE FILL AREA**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**

| Chemical of Potential | Oral Cancer Slope Factor | | Oral Absorption Efficiency | Absorbed Cancer Slope Factor for Dermal[2] | | Weight of Evidence/ Cancer Guideline | Oral CSF | |
|---|---|---|---|---|---|---|---|---|
| Concern | Value | Units | for Dermal[1] | Value | Units | Description | Source | Date |
| **Volatile Organic Compound** | | | | | | | | |
| TETRACHLOROETHYLENE | 5.4E-01 | $(mg/kg/day)^{-1}$ | >50% | 5.4E-01 | $(mg/kg/day)^{-1}$ | Not Classified | CA EPA (per ORNL) | NA |
| **Semivolatile Organic Compounds** | | | | | | | | |
| BENZO(A)ANTHRACENE | 7.3E-01 | $(mg/kg/day)^{-1}$ | >50% | 7.3E-01 | $(mg/kg/day)^{-1}$ | B2 | USEPA(1) | 7/1993 |
| BENZO(A)PYRENE | 7.3E+00 | $(mg/kg/day)^{-1}$ | >50% | 7.3E+00 | $(mg/kg/day)^{-1}$ | B2 | IRIS | 4/2009 |
| BENZO(B)FLUORANTHENE | 7.3E-01 | $(mg/kg/day)^{-1}$ | >50% | 7.3E-01 | $(mg/kg/day)^{-1}$ | B2 | USEPA(1) | 7/1993 |
| DIBENZO(A,H)ANTHRACENE | 7.3E+00 | $(mg/kg/day)^{-1}$ | >50% | 7.3E+00 | $(mg/kg/day)^{-1}$ | B2 | USEPA(1) | 7/1993 |
| INDENO(1,2,3-CD)PYRENE | 7.3E-01 | $(mg/kg/day)^{-1}$ | >50% | 7.3E-01 | $(mg/kg/day)^{-1}$ | B2 | USEPA(1) | 7/1993 |
| NAPHTHALENE | NA | NA | NA | NA | NA | C | IRIS | 9/1998 |
| TCDD TEQs (use 2,3,7,8-TCDD tox value) | 1.5E+05 | $(mg/kg/day)^{-1}$ | >50% | 1.5E+05 | $(mg/kg/day)^{-1}$ | B2 | HEAST | 7/1997 |
| **Inorganics** | | | | | | | | |
| ALUMINUM | NA | NA | NA | NA | NA | NA | NA | NA |
| ARSENIC | 1.5E+00 | $(mg/kg/day)^{-1}$ | >50% | 1.5E+00 | $(mg/kg/day)^{-1}$ | A | IRIS | 4/2009 |
| BARIUM | NA | NA | NA | NA | NA | D | IRIS | 4/2009 |
| CHROMIUM | NA | NA | NA | NA | NA | D/Not classifiable as to human carcinogenicity | IRIS | 2/2/2009 |
| COBALT | NA | NA | NA | NA | NA | NA | NA | NA |
| COPPER | NA | NA | NA | NA | NA | D | IRIS | 8/1991 |
| IRON | NA | NA | NA | NA | NA | NA | NA | NA |
| LEAD | NA | NA | NA | NA | NA | NA | NA | NA |
| MANGANESE | NA | NA | NA | NA | NA | D | IRIS | 4/2009 |
| MERCURY | NA | NA | NA | NA | NA | C/Possible Human Carcinogen | IRIS | 4/2009 |
| VANADIUM | NA | NA | NA | NA | NA | NA | IRIS | 6/1988 |
| ZINC | NA | NA | NA | NA | NA | Inadequate information to classify | IRIS | 8/2005 |

**Notes:**

1 - USEPA, 2004
2 - Adjusted dermal cancer slope factor = oral cancer slope factor/oral absorption efficiency for dermal

**EPA Group:**

A - Human carcinogen.

B1 - Probable human carcinogen - indicates that limited human data are available.
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans.
C - Possible human carcinogen.
D - Not classifiable as a human carcinogen.
E - Evidence of non-carcinogenicity.

**Definitions:**

IRIS = Integrated Risk Information System.
NA = Not available.
NCEA = National Center for Environmental Assessment, value from ORNL Regional Screening Level tables.
USEPA(1) = USEPA, 1993d
ORNL = Oak Ridge National Laboratory Regional Screening Level tables, May 2010
PPRTV = Provisional Peer Reviewed Toxicity Value
CA EPA = California Envirnomental Protection Agency

**TABLE 8**

**CANCER TOXICITY DATA - INHALATION**
**SITE 9 - CAMP MOFFETT RAVINE FILL AREA**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**

| Chemical of Potential Concern | Unit Risk | | Weight of Evidence/ Cancer Guideline Description | Source | Date |
|---|---|---|---|---|---|
| | Value | Units | | | |
| **Volatile Organic Compound** | | | | | |
| TETRACHLOROETHYLENE | 5.9E-06 | $(ug/m3)^{-1}$ | Not Classified | CA EPA (per ORNL) | NA |
| **Semivolatile Organic Compounds** | | | | | |
| BENZO(A)ANTHRACENE | 1.1E-04 | $(ug/m^3)^{-1}$ | B2 | CAEPA | 4/2009 |
| BENZO(A)PYRENE | 1.1E-03 | $(ug/m^3)^{-1}$ | B2 | CAEPA | 4/2009 |
| BENZO(B)FLUORANTHENE | 1.1E-04 | $(ug/m^3)^{-1}$ | B2 | CAEPA | 4/2009 |
| DIBENZO(A,H)ANTHRACENE | 1.2E-03 | $(ug/m^3)^{-1}$ | B2 | CAEPA | 4/2009 |
| INDENO(1,2,3-CD)PYRENE | 1.1E-04 | $(ug/m^3)^{-1}$ | B2 | CAEPA | 4/2009 |
| NAPHTHALENE | NA | NA | C | IRIS | 9/1998 |
| TCDD TEQs | 3.8E+01 | $(ug/m^3)^{-1}$ | B2 | CA EPA (per ORNL) | NA |
| **Inorganics** | | | | | |
| ALUMINUM | NA | NA | NA | NA | NA |
| ARSENIC | 4.3E-03 | $(ug/m^3)^{-1}$ | A | IRIS | 4/2009 |
| BARIUM | NA | NA | NA | NA | NA |
| CADMIUM | 1.8E-03 | $(ug/m^3)^{-1}$ | B1 | IRIS | 6/1992 |
| CHROMIUM | 1.2E-02 | $(ug/m^3)^{-1}$ | A/Known human carcinogen | IRIS | 4/2009 |
| COBALT | 9.0E-03 | $(ug/m^3)^{-1}$ | NA | PPRTV (per ORNL) | 9/12/2008 |
| IRON | NA | NA | NA | NA | NA |
| LEAD | NA | NA | D | IRIS | 4/2009 |
| MANGANESE | NA | NA | NA | NA | NA |
| MERCURY | NA | NA | C/Possible Human Carcinogen | IRIS | 4/2009 |
| VANADIUM | 8.0E-03 | $(ug/m^3)^{-1}$ | NA | PPRTV (per ORNL) | NA |

Definitions:

IRIS = Integrated Risk Information System.
HEAST= Health Effects Assessment Summary Tables
ORNL = Oak Ridge National Laboratory Regional Screening Level tables, May 2010
PPRTV = Provisional Peer Reviewed Toxicity Value
CA EPA = California Envirnomental Protection Agency

A - Human carcinogen.

B1 - Probable human carcinogen - indicates that limited human data are available.

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans .

C - Possible human carcinogen.

D - Not classifiable as a human carcinogen.

**TABLE 9**

**SUMMARY OF CANCER RISKS AND HAZARD INDICES - REASONABLE MAXIMUM EXPOSURE**
**SITE 9 - CAMP MOFFETT RAVINE FILL AREA**
**NAVAL STATON GREAT LAKES**
**GREAT LAKES, ILLINOIS**

| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and £ 1E-4 | Chemicals with Cancer Risks > 1E-6 and £ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Construction Worker[1] | Subsurface Soil | Ingestion | 1.E-06 | - - | - - | - - | 1.02 | - - |
| | | Dermal Contact | 1.E-07 | - - | - - | - - | 0.0129 | - - |
| | | Inhalation | 4.E-07 | - - | - - | - - | 8 | Manganese, Arsenic |
| | Groundwater | Ingestion | NA | - - | - - | - - | NA | - - |
| | | Dermal Contact | 1.E-07 | - - | - - | - - | 0.1 | - - |
| | | **Total Subsurface Soil** | 1.E-06 | - - | - - | - - | 9 | - - |
| | | **Total Groundwater** | 1.E-07 | - - | - - | - - | 0.1 | - - |
| | | **Total Across the Entire Site** | **2.E-06** | - - | - - | - - | **9** | Manganese, Arsenic |

| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and £ 1E-4 | Chemicals with Cancer Risks > 1E-6 and £ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Occupational/Maintenance Worker | Subsurface Soil | Ingestion | 2.E-05 | - - | Arsenic | - - | 0.3 | - - |
| | | Dermal Contact | 4.E-06 | - - | - - | Arsenic | 0.021 | - - |
| | | Inhalation | 2.E-07 | - - | - - | - - | 0.004 | |
| | Groundwater | Vapor Intrusion | NC | | | | 0.004 | |
| | | **Total Subsurface Soil** | 2.E-05 | - - | - - | - - | 0.3 | - - |
| | | **Total Across the Entire Site** | **2.E-05** | - - | - - | - - | **0.3** | - - |

[1] Exposure point concentrations for construction worker in soil and groundwater are very conservatively assumed to be the maximum detections of COPCs.

**TABLE 10**

**SUMMARY OF HYPOTHETICAL RESIDENTIAL CANCER RISKS AND HAZARD INDICES - REASONABLE MAXIMUM EXPOSURE (RME)**
**SITE 9 - CAMP MOFFETT RAVINE FILL AREA**
**NAVAL STATON GREAT LAKES, ILLINOIS**


**Hypothetical Residential Scenario - No Domestic Use of Groundwater (Groundwater Ordinance in place)**

| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Future Child Resident | Subsurface Soil | Ingestion | 7.E-05 | - - | cPAHs, Arsenic | TCDD TEQs | 3 | Arsenic |
| | | Dermal Contact | 1.E-05 | - - | - - | cPAHs, Arsenic | 0.11 | - - |
| | | Inhalation | 2.E-07 | - - | - - | - - | 0.02 | - - |
| | Groundwater | Vapor Intrusion | NC | | | | 0.01 | |
| | | **Total Subsurface Soil** | 8.E-05 | - - | - - | - - | 3 | - - |
| | | **Total Across the Entire Site** | **8.E-05** | - - | - - | - - | **3** | - - |

| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Future Adult Resident | Subsurface Soil | Ingestion | 2.E-05 | - - | Arsenic | cPAHs | 0.4 | - - |
| | | Dermal Contact | 2.E-06 | - - | - - | cPAHs | 0.017 | - - |
| | | Inhalation | 7.E-07 | - - | - - | - - | 0.02 | |
| | Groundwater | Vapor Intrusion | NC | | | | 0.006 | |
| | | **Total Subsurface Soil** | 3.E-05 | - - | - - | - - | 0.4 | - - |
| | | **Total Across the Entire Site** | **3.E-05** | - - | - - | - - | **0.4** | - - |

| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Total Residential Risks | Subsurface Soil | Ingestion | 9.E-05 | - - | cPAHs, Arsenic | cPAHs, TCDD TEQs | NA | - - |
| | | Dermal Contact | 1.E-05 | - - | -- | cPAHs, Arsenic | NA | - - |
| | | Inhalation | 9.E-07 | | | | NA | |
| | | **Total Subsurface Soil** | 1.E-04 | - - | - - | - - | NA | - - |
| | | **Total Across the Entire Site** | **1.E-04** | - - | cPAHs, Arsenic | cPAHs, Arsenic, TCDD TEQs | NA | - - |
| | | | | | | | | |

**Hypothetical Residential Scenario with Domestic Use of Groundwater Pathways**

| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Future Child Resident | Subsurface Soil | Ingestion | 7.E-05 | - - | cPAHs, Arsenic | TCDD TEQs | 3 | Arsenic |
| | | Dermal Contact | 1.E-05 | - - | - - | cPAHs, Arsenic | 0.11 | - - |
| | | Inhalation | 2.E-07 | - - | - - | - - | 0.02 | - - |
| | | Total | 8.E-05 | - - | cPAHs, Arsenic | cPAHs, Arsenic, TCDD TEQs | 3 | - - |
| | Groundwater | Ingestion | 2.E-04 | - - | | | 10 | - - |
| | | Dermal Contact | 2.E-07 | - - | | | 0.08 | - - |
| | | Vapor Intrusion | NC | | | | 0.01 | - - |
| | | Total | 2.E-04 | - - | | | 10 | - - |
| | | **Total Subsurface Soil** | 8.E-05 | - - | - - | - - | 3 | - - |
| | | **Total Groundwater** | 2.E-04 | - - | - - | - - | 10 | - - |
| | | **Total Across the Entire Site** | **3.E-04** | - - | - - | - - | **13** | - - |

**TABLE 10**

**SUMMARY OF HYPOTHETICAL RESIDENTIAL CANCER RISKS AND HAZARD INDICES - REASONABLE MAXIMUM EXPOSURE (RME)**
**SITE 9 - CAMP MOFFETT RAVINE FILL AREA**
**NAVAL STATON GREAT LAKES, ILLINOIS**


| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Future Adult Resident | Subsurface Soil | Ingestion | 2.E-05 | - - | Arsenic | cPAHs | 0.4 | - - |
| | | Dermal Contact | 2.E-06 | - - | - - | cPAHs | 0.02 | - - |
| | | Inhalation | 7.E-07 | - - | - - | - - | 0.02 | - - |
| | | Vapor Intrusion | NC | | | | 0.006 | - - |
| | | Total | 3.E-05 | - - | Arsenic | cPAHs | 0.4 | - - |
| | Groundwater | Ingestion | 2.E-04 | Arsenic | cPAHs | | 2.8 | - - |
| | | Dermal Contact | 6.E-07 | - - | | | 0.05 | - - |
| | | Total | 2.E-04 | - - | | | 2.9 | - - |
| | | **Total Subsurface Soil** | 3.E-05 | - - | - - | - - | 0.4 | - - |
| | | **Total Groundwater** | 2.E-04 | - - | - - | - - | 2.9 | - - |
| | | **Total Across the Entire Site** | **2.E-04** | - - | - - | - - | **3** | - - |

| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Total Residential Risks | Subsurface Soil | Ingestion | 9.E-05 | - - | cPAHs, Arsenic | cPAHs, TCDD TEQs | NA | - - |
| | | Dermal Contact | 1.E-05 | - - | -- | cPAHs, Arsenic | NA | - - |
| | | Inhalation | 9.E-07 | | | | NA | |
| | | Total | 1.E-04 | - - | cPAHs, Arsenic | cPAHs, Arsenic, TCDD TEQs | NA | - - |
| | Groundwater | Ingestion | 4.E-04 | - - | cPAHs, Arsenic | - - | NA | - - |
| | | Dermal Contact | 8.E-07 | - - | - - | - - | NA | - - |
| | | Vapor Intrusion - GW | NC | | | | NA | |
| | | Total | 4.E-04 | - - | cPAHs, Arsenic | - - | NA | - - |
| | | **Total Subsurface Soil** | 1.E-04 | - - | - - | - - | NA | - - |
| | | **Total Groundwater** | 4.E-04 | - - | - - | - - | NA | - - |
| | | **Total Across the Entire Site** | **5.E-04** | - - | cPAHs, Arsenic | cPAHs, Arsenic, TCDD TEQs | NA | - - |

cPAHs = Carcinogenic PAHs
NA = Not applicable
NC = No carcinogenic COPCs

**TABLE 11**

**SUMMARY OF WORKER CANCER RISKS AND HAZARD INDICES - CENTRAL TENDENCY EXPOSURE**
**SITE 9 - CAMP MOFFETT RAVINE FILL AREA**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**

| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and £ 1E-4 | Chemicals with Cancer Risks > 1E-6 and £ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Construction/Excavation Worker | Subsurface Soil | Ingestion | 7.E-08 | - - | - - | - - | 0.2 | - - |
| | | Dermal Contact | 5.E-09 | - - | - - | - - | 0.001 | - - |
| | | Inhalation | 8.E-08 | - - | - - | - - | 2 | Manganese |
| | | Total | 2.E-07 | - - | - - | - - | 2 | Manganese |
| | Groundwater | Ingestion | NA | - - | - - | - - | NA | - - |
| | | Dermal Contact | 2.E-09 | - - | - - | - - | 0.04 | - - |
| | | Total | 2.E-09 | - - | - - | - - | 0.04 | - - |
| | | **Total Subsurface Soil** | 2.E-07 | - - | - - | - - | 2 | Manganese |
| | | **Total Groundwater** | 2.E-09 | - - | - - | - - | 0.04 | - - |
| | | **Total Across the Entire Site** | **2.E-07** | - - | - - | - - | **2** | Manganese |

| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and £ 1E-4 | Chemicals with Cancer Risks > 1E-6 and £ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Occupational/Maintenance Worker | Subsurface Soil | Ingestion | 8.E-07 | - - | - - | - - | 0.04 | - - |
| | | Dermal Contact | 3.E-08 | - - | - - | - - | 0.0005 | - - |
| | | Inhalation | 1.E-08 | - - | - - | - - | 0.0009 | - - |
| | Groundwater | Vapor Intrusion | NC | | | | 0.004 | |
| | | Total | 8.E-07 | - - | - - | - - | 0.04 | - - |
| | | **Total Subsurface Soil** | 8.E-07 | - - | - - | - - | 0.04 | - - |
| | | **Total Across the Entire Site** | **8.E-07** | - - | - - | - - | **0.04** | - - |

cPAHs = Carcinogenic PAHs
NC = COPCs are not carcinogenic.

**TABLE 12**

**SUMMARY OF RESIDENTIAL CANCER RISKS AND HAZARD INDICES - CENTRAL TENDENCY EXPOSURE (CTE)**
**SITE 9 - CAMP MOFFETT RAVINE FILL AREA**
**NAVAL STATION GREAT LAKES, ILLINOIS**


**Hypothetical Residential Scenario - No Domestic Use of Groundwater (Groundwater Ordinance in place)**

| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Future Child Resident | Subsurface Soil | Ingestion | 3.E-06 | - - | - - | Arsenic | 0.7 | - - |
| | | Dermal Contact | 1.E-07 | - - | - - | - - | 0.008 | - - |
| | | Inhalation | 4.E-08 | - - | - - | - - | 0.011 | - - |
| | | Total | 3.E-06 | - - | - - | Arsenic | 0.7 | |
| | Groundwater | Vapor Intrusion | NC | | | | 0.01 | |
| | | **Total Subsurface Soil** | 3.E-06 | - - | - - | Arsenic | 0.7 | - - |
| | | **Total Across the Entire Site** | **3.E-06** | - - | - - | Arsenic | **0.7** | - - |

| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Future Adult Resident | Subsurface Soil | Ingestion | 1.E-06 | - - | - - | Arsenic | 0.08 | - - |
| | | Dermal Contact | 5.E-08 | - - | - - | - - | 0.0009 | - - |
| | | Inhalation | 1.E-07 | - - | - - | - - | 0.01 | - - |
| | | Total | 1.E-06 | - - | - - | Arsenic | 0.09 | - - |
| | Groundwater | Vapor Intrusion | NC | | | | 0.006 | |
| | | **Total Subsurface Soil** | 1.E-06 | - - | - - | Arsenic | 0.09 | - - |
| | | **Total Across the Entire Site** | **1.E-06** | - - | - - | Arsenic | **0.09** | - - |

| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Total Residential Risks | Surface Soil | Ingestion | 4.E-06 | - - | - - | Arsenic | NA | - - |
| | | Dermal Contact | 2.E-07 | - - | - - | - - | NA | - - |
| | | Inhalation | 2.E-07 | - - | - - | - - | NA | - - |
| | | Total | 4.E-06 | - - | - - | - - | NA | - - |
| | Groundwater | Vapor Intrusion | NC | | | | NA | |
| | | **Total Subsurface Soil** | 4.E-06 | - - | - - | Arsenic | NA | - - |
| | | **Total Across the Entire Site** | **4.E-06** | - - | - - | Arsenic | NA | - - |

**TABLE 12**

**SUMMARY OF RESIDENTIAL CANCER RISKS AND HAZARD INDICES - CENTRAL TENDENCY EXPOSURE (CTE)**
**SITE 9 - CAMP MOFFETT RAVINE FILL AREA**
**NAVAL STATION GREAT LAKES, ILLINOIS**


**Hypothetical Residential Scenario with Domestic Use of Groundwater Pathways**

| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Future Child Resident | Subsurface Soil | Ingestion | 3.E-06 | - - | - - | Arsenic | 0.7 | - - |
| | | Dermal Contact | 1.E-07 | - - | - - | - - | 0.008 | - - |
| | | Inhalation | 4.E-08 | - - | - - | - - | 0.011 | - - |
| | | Total | 3.E-06 | - - | - - | Arsenic | 0.7 | - - |
| | Groundwater | Ingestion | 2.E-05 | - - | Arsenic | | 0.8 | - - |
| | | Dermal Contact | 4.E-08 | - - | - - | - - | 0.01 | - - |
| | | Vapor Intrusion | NC | | | | 0.01 | |
| | | Total | 2.E-05 | - - | - - | | 0.85 | - - |
| | | **Total Subsurface Soil** | 3.E-06 | - - | - - | Arsenic | 0.7 | - - |
| | | **Total Groundwater** | 2.E-05 | - - | Arsenic | | 0.85 | - - |
| | | **Total Across the Entire Site** | **2.E-05** | - - | Arsenic | Arsenic | **2** | - - |

| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Future Adult Resident | Subsurface Soil | Ingestion | 1.E-06 | - - | - - | Arsenic | 0.08 | - - |
| | | Dermal Contact | 5.E-08 | - - | - - | - - | 0.0009 | - - |
| | | Inhalation | 1.E-07 | - - | - - | - - | 0.01 | - - |
| | | Total | 1.E-06 | - - | - - | Arsenic | 0.09 | - - |
| | Groundwater | Ingestion | 3.E-05 | - - | Arsenic | cPAHs | 1.31 | - - |
| | | Dermal Contact | 8.E-08 | - - | - - | - - | 0.0245 | - - |
| | | Vapor Intrusion | NC | | | | 0.006 | |
| | | Total | 3.E-05 | - - | - - | | 1.34 | - - |
| | | **Total Subsurface Soil** | 1.E-06 | - - | - - | Arsenic | 0.09 | - - |
| | | **Total Groundwater** | 3.E-05 | - - | Arsenic | | 1.34 | - - |
| | | **Total Across the Entire Site** | **3.E-05** | - - | Arsenic | Arsenic,cPAHs | **1** | - - |

| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Total Residential Risks | Surface Soil | Ingestion | 4.E-06 | - - | - - | - - | NA | - - |
| | | Dermal Contact | 2.E-07 | - - | - - | - - | NA | - - |
| | | Inhalation | 2.E-07 | - - | - - | - - | NA | - - |
| | | Total | 5.E-06 | - - | - - | - - | NA | - - |
| | Groundwater | Ingestion | 4.E-05 | - - | Arsenic | cPAHs | NA | - - |
| | | Dermal Contact | 1.E-07 | - - | - - | -- | NA | - - |
| | | Vapor Intrusion | NC | | | | NA | - - |
| | | Total | 4.E-05 | - - | Arsenic | cPAHs | NA | - - |
| | | **Total Subsurface Soil** | 4.E-06 | - - | - - | Arsenic | NA | - - |
| | | **Total Groundwater** | 4.E-05 | - - | - - | cPAHs | NA | - - |
| | | **Total Across the Entire Site** | **5.E-05** | - - | Arsenic | Arsenic,cPAHs | NA | - - |

cPAHs = Carcinogenic PAHs
NC = COPCs are not carcinogenic

**TABLE 13**

**VALUES USED FOR DAILY INTAKE CALCULATIONS**
**EXPOSURE OF CONSTRUCTION WORKERS BY INHALATION FROM SUBSURFACE SOIL**
**SITE 9 - CAMP MOFFETT**
**NAVAL STATION GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future
Medium: Subsurfce Soil
Exposure Medium: Air
Exposure Point: Entire Site
Receptor Population: Construction Worker
Receptor Age: Adult

| Exposure Route | Parameter Code | Parameter Definition | Units | RME Value | RME Rationale/ Reference | CT Value | CT Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|
| Inhalation | CS | Chemical concentration in soil | mg/kg | 95% UCL or Max | USEPA, May 1993 | 95% UCL or Max | USEPA, May 1993 | $\frac{CS \times \left[\frac{1}{VF} + \frac{1}{PEF}\right] \times ET \times EF \times ED}{AT \times 24}$ |
| | VF | Volatilization factor - Chemical Specific | $m^3/kg$ | (1) | USEPA, December 2002 | (1) | USEPA, December 2002 | |
| | PEF | Particulate emission factor | $m^3/kg$ | 1.24E+08 | IEPA, 2007. TACO. | 1.24E+08 | IEPA, 2007. TACO. | |
| | ET | Exposure Time | hours/day | 8 | USEPA, December 2002 | 4 | USEPA, December 2002 | |
| | EF | Exposure Frequency | days/year | 30 | IEPA, April 2004 | 30 | IEPA, April 2004 | |
| | ED | Exposure Duration | years | 1 | Professional Judgement | 1 | Professional Judgement | |
| | AT-C | Averaging Time (Cancer) | days | 25550 | USEPA, December 1989 | 25550 | USEPA, December 1989 | |
| | AT-N | Averaging Time (Non-Cancer) | days | 42 | IEPA, Janaury 2003 | 42 | IEPA, Janaury 2003 | |

Notes:
(1) - Calculated according to USEPA Soil Screening Guidance, December 2002.

**Daily Intake Calculations**
Inhalation Intake = (ET x EF x ED x (1/PEF)+(1/VF)) / (AT x 24)

Cancer Inhalation Intake(RME) = 3.91E-04
Noncancer Inhalation Intake(RME) = 2.38E-01
Cancer Inhalation Intake(CTE) = 1.96E-04
Noncancer Inhalation Intake(CTE) = 1.19E-01

Cancer risk from ingestion = Air concentration x Cancer Inhalation Intake x Cancer Inhalation Unit Risk (IUR)
Hazard Index from ingestion = Air concentration x Noncancer Inhalation Intake / Reference Air Concentration (RfCi)

**TABLE 14 REASONABLE MAXIMUM EXPOSURE (RME)**
**CALCULATION OF NON-CANCER HAZARDS**
**EXPOSURE OF CONSTRUCTION WORKERS BY INHALATION FROM SUBSURFACE SOIL**
**SITE 9 - CAMP MOFFETT**
**NAVAL STATION GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future
Medium: Subsurfce Soil
Exposure Medium: Air
Exposure Point: Entire Site
Receptor Population: Construction Worker
Receptor Age: Adult

| Exposure Route | Chemical of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Hazard Calculation [1] | Intake (Non-Cancer) | Intake (Non-Cancer) Units | Reference Concentration (Subchronic [2] if available) | Reference Concentration Units | Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Inhalation | BAP EQUIVALENT (FULL DLs) | 9.51E-01 | mg/kg | 7.7E-09 | $mg/m^3$ | R | 1.8E-09 | $mg/m^3$ | | $mg/m^3$ | |
| | NAPHTHALENE (partic.) | 3.80E-01 | mg/kg | 3.1E-09 | $mg/m^3$ | R | 7.3E-10 | $mg/m^3$ | 3.0E-03 | $mg/m^3$ | 2.4E-07 |
| | TCDD TEQs (FULL DLs) | 8.92E-06 | mg/kg | 7.2E-14 | $mg/m^3$ | R | 1.7E-14 | $mg/m^3$ | 4.00E-08 | $mg/m^3$ | 4.3E-07 |
| | ALUMINUM | 1.97E+04 | mg/kg | 1.6E-04 | $mg/m^3$ | R | 3.8E-05 | $mg/m^3$ | 5.0E-03 | $mg/m^3$ | 7.6E-03 |
| | ANTIMONY | 1.18E+01 | mg/kg | 9.5E-08 | $mg/m^3$ | R | 2.3E-08 | $mg/m^3$ | 2.0E-04 | $mg/m^3$ | 1.1E-04 |
| | ARSENIC | 1.15E+02 | mg/kg | 9.3E-07 | $mg/m^3$ | R | 2.2E-07 | $mg/m^3$ | 1.5E-05 | $mg/m^3$ | 1.5E-02 |
| | BARIUM | 1.22E+03 | mg/kg | 9.8E-06 | $mg/m^3$ | R | 2.3E-06 | $mg/m^3$ | *5.0E-03* | $mg/m^3$ | 4.7E-04 |
| | CADMIUM | 8.04E+00 | mg/kg | 6.5E-08 | $mg/m^3$ | R | 1.5E-08 | $mg/m^3$ | 1.0E-05 | $mg/m^3$ | 1.5E-03 |
| | CHROMIUM | 3.15E+01 | mg/kg | 2.5E-07 | $mg/m^3$ | R | 6.0E-08 | $mg/m^3$ | 1.0E-04 | $mg/m^3$ | 6.0E-04 |
| | COBALT | 2.21E+01 | mg/kg | 1.8E-07 | $mg/m^3$ | R | 4.2E-08 | $mg/m^3$ | 6.0E-06 | $mg/m^3$ | 7.1E-03 |
| | MANGANESE | 1.09E+03 | mg/kg | 8.8E-06 | $mg/m^3$ | R | 2.1E-06 | $mg/m^3$ | 5.0E-05 | $mg/m^3$ | 4.2E-02 |
| | MERCURY | 3.15E+01 | mg/kg | 2.5E-07 | $mg/m^3$ | R | 6.0E-08 | $mg/m^3$ | 3.0E-05 | $mg/m^3$ | 2.0E-03 |
| | VANADIUM | 1.13E+01 | mg/kg | 9.1E-08 | $mg/m^3$ | R | 2.2E-08 | $mg/m^3$ | 7.0E-06 | $mg/m^3$ | 3.1E-03 |
| | NAPHTHALENE (vol.) | 1.84E-01 | mg/kg | 2.6E-06 | $mg/m^3$ | R | 6.2E-07 | $mg/m^3$ | 3.0E-03 | $mg/m^3$ | 2.1E-04 |
| | TETRACHLOROETHYLENE | 9.30E-01 | mg/kg | 2.9E-04 | $mg/m^3$ | R | 6.9E-05 | $mg/m^3$ | 2.7E-01 | $mg/m^3$ | 2.6E-04 |
| | (total) | | | | | | | | | | 8.0E-02 |
| | | | | | | | | | | **Total Hazard Index Across All Exposure Routes/Pathways** | **0.08** |

[1] Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

[2] Subchronic values in *italics.*

**TABLE 15 REASONABLE MAXIMUM EXPOSURE (RME)**
**CALCULATION OF CANCER RISKS**
**EXPOSURE OF CONSTRUCTION WORKERS BY INHALATION FROM SUBSURFACE SOIL**
**SITE 9 - CAMP MOFFETT**
**NAVAL STATION GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future
Medium: Subsurfce Soil
Exposure Medium: Air
Exposure Point: Entire Site
Receptor Population: Construction Worker
Receptor Age: Adult

| Exposure Route | Chemical of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation (1) | Intake (Cancer) | Intake (Cancer) Units | Cancer Unit Risk | Cancer Unit Risk Units | Cancer Risk |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Inhalation | BAP EQUIVALENT (FULL DLs) | 9.51E-01 | mg/kg | 7.7E-09 | $mg/m^3$ | R | 3.0E-12 | $mg/m^3$ | 1.1E+00 | $(mg/m^3)^{-1}$ | 3.3E-12 |
| | TCDD TEQs (FULL DLs) | 8.92E-06 | mg/kg | 7.2E-14 | $mg/m^3$ | R | 2.8E-17 | $mg/m^3$ | 3.8E+04 | $(mg/m^3)^{-1}$ | 1.1E-12 |
| | ARSENIC | 1.15E+02 | mg/kg | 9.3E-07 | $mg/m^3$ | R | 3.6E-10 | $mg/m^3$ | 4.3E+00 | $(mg/m^3)^{-1}$ | 1.6E-09 |
| | CADMIUM | 8.04E+00 | mg/kg | 6.5E-08 | $mg/m^3$ | R | 2.5E-11 | $mg/m^3$ | 1.8E+00 | $(mg/m^3)^{-1}$ | 4.6E-11 |
| | CHROMIUM | 3.15E+01 | mg/kg | 2.5E-07 | $mg/m^3$ | R | 9.9E-11 | $mg/m^3$ | 1.2E+01 | $(mg/m^3)^{-1}$ | 1.2E-09 |
| | COBALT | 2.21E+01 | mg/kg | 1.8E-07 | $mg/m^3$ | R | 7.0E-11 | $mg/m^3$ | 9.0E+00 | $(mg/m^3)^{-1}$ | 6.3E-10 |
| | VANADIUM | 1.13E+01 | mg/kg | 9.1E-08 | $mg/m^3$ | R | 3.6E-11 | $mg/m^3$ | 8.3E+00 | $(mg/m^3)^{-1}$ | 3.0E-10 |
| | TETRACHLOROETHYLENE | 9.30E-01 | mg/kg | 2.9E-04 | $mg/m^3$ | R | 1.1E-07 | $mg/m^3$ | 5.9E-03 | $(mg/m^3)^{-1}$ | 6.7E-10 |
| | (total) | | | | | | | | | | 4.4E-09 |
| | | | | | | | | | | **Total Risk Across All Exposure Routes/Pathways** | **4.4E-09** |

[1] Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

[2] Subchronic values in *italics.*

# Appendix A.3
# Site 21 Human Health Risk Tables

**TABLE 1**

**EXPOSURE POINT CONCENTRATION SUMMARY - SUBSURFACE SOIL**
**SITE 21 - BUILDINGS 1517/1506 AREA**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil
Exposure Point: Construction excavation or post-construction excavation

| Chemical of Potential Concern | Units | # Detects/ # Samples | RME Maximum Detected Concentration | Maximum Qualifier | CTE Mean Concentration |
|---|---|---|---|---|---|
| **PAHs/Semivolatile Organic Compounds** | | | | | |
| BAP EQUIVALENT[1] | mg/kg | 22/22 | 39.4 | | 2.32 |
| NAPHTHALENE | mg/kg | 16/22 | 4.6 | | 0.433 |
| **Pesticides/PCBs** | | | | | |
| AROCLOR-1260 | mg/kg | 8/22 | 0.44 | J | 0.0704 |
| **Dioxins/Furans** | | | | | |
| TCDD TEQ full NDs [2] | mg/kg | 1/1 | 5.62E-06 | | 5.62E-06 |
| **Inorganics** | | | | | |
| ALUMINUM | mg/kg | 22/22 | 24,300 | | 9,340 |
| ARSENIC | mg/kg | 22/22 | 85 | J | 12.06 |
| CADMIUM | mg/kg | 20/22 | 9.62 | | 1.24 |
| CHROMIUM | mg/kg | 22/22 | 34.3 | J | 15.1 |
| COBALT | mg/kg | 22/22 | 23.8 | | 8.90 |
| IRON | mg/kg | 22/22 | 65,800 | J | 26,970 |
| MANGANESE | mg/kg | 22/22 | 1,690 | | 662 |
| MERCURY[*#] | mg/kg | 21/22 | 0.484 | | 0.0999 |
| VANADIUM | mg/kg | 22/22 | 33.5 | | 19.0 |

Footnotes:
[*] COPC for inhalation pathway only.
[#] COPC for construction worker scenario only.
1. Toxicity equivalent factor approach used to convert individual carcinogenic PAHs into a single concentration of benzo(a)pyrene (BaP).
2. No mean calculation for 1 sample dataset. CTE uses detected concentration of TCDD TEQ.

**TABLE 2**

**EXPOSURE POINT CONCENTRATION SUMMARY - SURFACE SOIL**
**SITE 21 - BUILDINGS 1517/1506 AREA**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Surface Soil
Exposure Point: Entire Site

| Chemical of Potential Concern | Units | # Detects/ # Samples | Arithmetic Mean | Maximum Detection | EPC Units | Dataset Distribution | 95% UCL of the Mean Statistic | RME[1] EPC 95% UCL | CTE[2] EPC Mean |
|---|---|---|---|---|---|---|---|---|---|
| **PAHs/Semivolatile Organic Compounds** | | | | | | | | | |
| AROCLOR 1260 | mg/kg | 12/22 | 0.154 [3] | 0.720 | mg/kg | nonparametric | 95% KM(Percentile Bootstrap) UCL | 0.223 | 0.154 |
| BAP EQUIVALENT[6] | mg/kg | 22/22 | 3.566 | 50.6 | mg/kg | lognormal | 95% Chebyshev UCL | 13.47 | 3.566 |
| NAPHTHALENE [4] | mg/kg | 22/22 | 0.24 | 0.52 | mg/kg | -- | -- | 0.52 | 0.24 |
| **Dioxins/Furans** | | | | | | | | | |
| 2,3,7,8-TCDD[5] | mg/kg | 2/2 | -- | 8.16E-07 | mg/kg | -- | -- | 8.16E-07 | 8.16E-07 |
| TCDD TEQs full NDs[5] | mg/kg | 2/2 | -- | 3.35E-05 | mg/kg | -- | -- | 3.35E-05 | 3.35E-05 |
| **Inorganics** | | | | | | | | | |
| ALUMINUM | mg/kg | 22/22 | 7,623 | 29,500 | mg/kg | LN, gamma | 95% Approx Gamma UCL | 9,888 | 7,623 |
| ANTIMONY | mg/kg | 6/22 | 1.06 [3] | 5.22 | mg/kg | nonparametric | 95% KM(Percentile Bootstrap) UCL | 2.03 | 1.06 |
| ARSENIC | mg/kg | 22/22 | 12.46 | 48.4 | mg/kg | nonparametric | 95% Chebyshev UCL | 23.83 | 12.46 |
| BARIUM | mg/kg | 22/22 | 76.4 | 234 | mg/kg | LN, gamma | 95% Approx Gamma UCL | 94.7 | 76.4 |
| CADMIUM | mg/kg | 21/22 | 2.30 | 13 | mg/kg | nonparametric | 97.5% KM(Chebyshev) UCL | 6.44 | 2.3 |
| CHROMIUM | mg/kg | 22/22 | 20.26 | 163 | mg/kg | nonparametric | 95% Chebyshev UCL | 50.47 | 20.3 |
| COBALT | mg/kg | 22/22 | 6.59 | 17.7 | mg/kg | LN, gamma | 95% Approx Gamma UCL | 8.07 | 6.6 |
| COPPER | mg/kg | 22/22 | 93.6 | 835 | mg/kg | nonparametric | 95% Chebyshev UCL | 258.2 | 93.6 |
| IRON | mg/kg | 22/22 | 26,762 | 69,500 | mg/kg | lognormal | 95% H-UCL | 33,612 | 26,762 |
| MANGANESE | mg/kg | 22/22 | 588.6 | 2,420 | mg/kg | LN, gamma | 95% Approx Gamma UCL | 769.2 | 588.6 |
| MERCURY | mg/kg | 22/22 | 0.57 | 8.98 | mg/kg | nonparametric | 95% Chebyshev UCL | 2.33 | 0.57 |
| VANADIUM | mg/kg | 22/22 | 16.68 | 25.7 | mg/kg | normal | 95% Student's-t UCL | 18.55 | 16.7 |

**Footnotes:**

1. 95UCL for RME scenario except for construction workers and residential scenario; EPCs for soil for these receptors are the maximum detections of COPCs.
2. Mean is the EPC for each soil COPC in the CTE scenarios.
3. Kaplan-Meier statistical mean (with NDs included)
4. Naphthalene is a COPC only for subsurface soil and the inhalation pathway. Included in the CW inhalation exposure risk for surface soil (max. for RME; mean for CTE)
5. Only two samples, so meaningful summary statistics could not be calculated for this dataset.
6. Toxicity equivalent factor approach used to convert individual carcinogenic PAHs into a single concentration of benzo(a)pyrene (BaP).

**TABLE 3**

**EXPOSURE POINT CONCENTRATION SUMMARY - GROUNDWATER**
**SITE 21 - BUILDINGS 1517/1506 AREA**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Construction Excavation; Hypothetical Residential Potable Water

| Chemical of Potential Concern | Units | # Detects/ # Samples | Maximum Detected Concentration | Maximum Qualifier |
|---|---|---|---|---|
| **Volatile Organics (ug/L)** | | | | |
| BENZENE | ug/L | 1/6 | 0.960 | J |
| TETRACHLOROETHENE | ug/L | 1/6 | 0.850 | J |
| **PAHs/Semivolatile Organic Compounds** | | | | |
| BAP EQUIVALENT[1] | ug/L | 2/6 | 0.038 | |
| PENTACHLOROPHENOL | ug/L | 1/6 | 7.8 | J |
| **Pesticides/PCBs (ug/L)** | | | | |
| DELTA-BHC (DELTA-HCH) | ug/L | 2/6 | 0.02 | |
| **Inorganics** | | | | |
| ARSENIC | ug/L | 5/6 | 7.26 | J |
| CADMIUM | ug/L | 6/6 | 3.45 | |
| COBALT | ug/L | 3/6 | 15.3 | |
| IRON | ug/L | 6/6 | 34000 | |
| MANGANESE | ug/L | 6/6 | 5400 | |

Footnotes:
1. Toxicity equivalent factor approach used to convert individual carcinogenic PAHs into a single concentration of benzo(a)pyrene (BaP).
ug/L = microgram per liter.
J = Estimated value.
PAH = Polynuclear aromatic hydrocarbon.
PCB = Polychlorinated biphenyl.

**TABLE 4**

**SUMMARY OF EXPOSURE INPUT PARAMETERS**
**REASONABLE MAXIMUM EXPOSURES**
**SITE 21 - BUILDINGS 1517/1506 AREA**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**


| Exposure Parameter | Occupational/ Maintenance Worker | Adolescent Trespasser | Construction Worker | On-Site Adult Resident | On-Site Child Resident |
|---|---|---|---|---|---|
| **All Exposures** | | | | | |
| $C_{soil}$ (mg/kg) | Maximum or 95% UCL[1] | Maximum or 95% UCL[1] | Maximum or 95% UCL[1] | Maximum or 95% UCL[1] | Maximum or 95% UCL[1] |
| $C_{gw}$ (µg/L) | NA | NA | Maximum | Maximum | Maximum |
| EF (days/year) | 250[3] | 26[5] | 30[2] | 350[5] | 350[5] |
| ED (years) | 25[3] | 10[5] | 1[4] | 24[5] | 6[5] |
| BW (kg) | 70[5] | 42[5] | 70[5] | 70[5] | 15[5] |
| $AT_n$ (days) | 9,125[9] | 3650[9] | 42[8] | 8,760[9] | 2,190[9] |
| $AT_c$ (days) | 25,550[9] | 25,550[9] | 25,550[9] | 25,550[9] | 25,550[9] |
| **Incidental Ingestion/Dermal Contact with Soil** | | | | | |
| IR (mg/day) | 100[5] | 100[5] | 330[10] | 100[5] | 200[5] |
| FI (unitless) | 1[5] | 1[5] | 1[5] | 1[5] | 1[5] |
| SA ($cm^2$/day) | 3,280[11] | 3,280[11] | 3,280[11] | 5,700[11] | 2,800[11] |
| AF ($mg/cm^2$) | 0.2[11] | 0.2[11] | 0.3[11] | 0.07[11] | 0.2[11] |
| ABS (unitless) | chemical-specific[11] | chemical-specific[11] | chemical-specific[11] | chemical-specific[11] | chemical-specific[11] |
| CF (kg/mg) | 1E-06 | 1E-06 | 1E-06 | 1E-06 | 1E-06 |
| **Inhalation Fugitive Dust/Volatile Emissions from Soil** | | | | | |
| $C_{air}$ ($mg/m^3$) | calculated[10] | calculated[10] | calculated[10] | calculated[10] | calculated[10] |
| ET (hours/day) | 8[10] | 2[10] | 8[12] | 24[10] | 24[7] |
| PEF ($m^3$/kg) | 1.36E+9[10] | 1.36E+9[10] | 1.27 x $10^6$[10] | 1.36E+9[10] | 1.36E+9[10] |
| VF ($m^3$/kg) | chemical-specific[10] | chemical-specific[10] | chemical-specific[10] | chemical-specific[10] | chemical-specific[10] |

**TABLE 4**

**SUMMARY OF EXPOSURE INPUT PARAMETERS**
**REASONABLE MAXIMUM EXPOSURES**
**SITE 21 - BUILDINGS 1517/1506 AREA**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**


| Exposure Parameter | Occupational/ Maintenance Worker | Adolescent Trespasser | Construction Worker | On-Site Adult Resident | On-Site Child Resident |
|---|---|---|---|---|---|
| **Ingestion/Dermal Contact with Groundwater** | | | | | |
| $IR_{gw}$ (L/day) | NA | NA | NA | 2[5] | 1.5[7] |
| ET (hours/day) and $t_{event}$ (hours/event) | NA | NA | 4[4] | 0.33[4] | 0.33[4] |
| EV (events/day) | NA | NA | 1[4] | 1[4] | 1[4] |
| A ($cm^2$/day) | NA | NA | 3,300[11] | 18,000[11] | 6,600[11] |
| $K_p$ (cm/hour) | NA | NA | chemical-specific[11] | chemical-specific[11] | chemical-specific[11] |
| t* (hours), t (hour), and B (unitless) | NA | NA | chemical-specific[11] | chemical-specific[11] | chemical-specific[11] |

A Skin surface area available for contact
ABS Absorption factor
AF Soil-to-skin adherence factor
$AT_c$ Averaging time for carcinogenic effects
$AT_n$ Averaging time for non-carcinogenic effects
B Bunge Model partitioning coefficient
BW Body weight
CF Conversion factor
IR Ingestion rate
$C_{soil}$ Exposure concentration for soil
$C_{gw}$ Exposure concentration for groundwater
$C_{air}$ Exposure concentration for air
ED Exposure duration
EF Exposure frequency
ET Exposure time
EV Event frequency
FI Fraction ingested from contaminated source
InhR Inhalation rate
IR Ingestion rate (soil or groundwater)
$K_p$ Permeability coefficient from water through skin
SA Skin surface area available for contact
PEF Particulate emission factor
t Lag time
t* Time it takes to reach steady-state conditions
$t_{event}$ Duration of event

1 - USEPA, 2002.
2 - Illinois EPA, 2004.
3 - USEPA, 1991
4- Professional judgment.
5 - USEPA, 1993
6 - Adolescents (7-16 years).
7 - USEPA, 1997
8 - Illinois EPA, 2003.
9 - USEPA, 1989
10 - USEPA, 2002
11 - USEPA, 2004
12 - Assume an 8-hour work shift.

Note: The exposure factors for future civilian and military residents are the same, except for exposure duration (ED) for adult military residents. Exposure duration for adult military residents was assumed to be the typical enlistment times of 6 years for the RME and CTE.

**TABLE 5**

**SUMMARY OF EXPOSURE INPUT PARAMETERS**
**CENTRAL TENDENCY EXPOSURES**
**SITE 21 - BUILDINGS 1517/1506 AREA**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**


| Exposure Parameter | Occupational/ Maintenance Worker | Adolescent Trespasser | Construction Worker | On-Site Adult Resident | On-Site Child Resident |
|---|---|---|---|---|---|
| **All Exposures** | | | | | |
| $C_{soil}$ (mg/kg) | Mean | | Mean | Mean | Mean |
| $C_{gw}$ (µg/L) | NA | NA | Maximum | Maximum | Maximum |
| EF (days/year) | 219[3] | | 30[2] | 234[3] | 234[3] |
| ED (years) | 9[3] | | 1[4] | 7[3] | 2[3] |
| BW (kg) | 70[3] | | 70[3] | 70[3] | 15[3] |
| $AT_n$ (days) | 3,285[8] | | 42[7] | 2,555[8] | 730[8] |
| $AT_c$ (days) | 25,550[8] | | 25,550[8] | 25,550[8] | 25,550[8] |
| **Incidental Ingestion/Dermal Contact with Soil** | | | | | |
| IR (mg/day) | 50[9] | | 165[9] | 50[9] | 100[9] |
| FI (unitless) | 1[3] | | 1[3] | 1[3] | 1[3] |
| SA ($cm^2$/day) | 3,300[10] | | 3,300[10] | 5,700[10] | 2,800[10] |
| AF ($mg/cm^2$) | 0.02[10] | | 0.1[10] | 0.01[10] | 0.04[10] |
| ABS (unitless) | chemical-specific[10] | | chemical-specific[10] | chemical-specific[10] | chemical-specific[10] |
| CF (kg/mg) | 1E-06 | | 1E-06 | 1E-06 | 1E-06 |
| **Inhalation Fugitive Dust/Volatile Emissions from Soil** | | | | | |
| $C_{air}$ ($mg/m^3$) | calculated[11] | | calculated[11] | calculated[11] | calculated[11] |
| ET (hours/day) | 4[9] | | 4[9] | 24[11] | 24[6] |
| PEF ($m^3$/kg) | 1.36E+9[11] | | 1.27 x $10^{6}$[11] | 1.36E+9[11] | 1.36E+9[11] |
| VF ($m^3$/kg) | chemical-specific[11] | | chemical-specific[11] | chemical-specific[11] | chemical-specific[11] |

**TABLE 5**

**SUMMARY OF EXPOSURE INPUT PARAMETERS**
**CENTRAL TENDENCY EXPOSURES**
**SITE 21 - BUILDINGS 1517/1506 AREA**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**


| Exposure Parameter | Occupational/ Maintenance Worker | Adolescent Trespasser | Construction Worker | On-Site Adult Resident | On-Site Child Resident |
|---|---|---|---|---|---|
| **Ingestion/Dermal Contact with Groundwater** | | | | | |
| $IR_{gw}$ (L/day) | NA | NA | NA | 1.4[3] | 0.66[6] |
| ET (hours/day) and $t_{event}$ (hours/event) | NA | NA | 2[8] | 0.25[4] | 0.25[4] |
| EV (events/day) | NA | NA | 1[4] | 1[4] | 1[4] |
| A ($cm^2$/day) | NA | NA | 3,300[10] | 18,000[10] | 6,600[10] |
| $K_p$ (cm/hour) | NA | NA | chemical-specific[10] | chemical-specific[10] | chemical-specific[10] |
| t* (hours), $\tau$ (hour), and B (unitless) | NA | NA | chemical-specific[10] | chemical-specific[10] | chemical-specific[10] |

**Notes:**

A Skin surface area available for contact
ABS Absorption factor
AF Soil-to-skin adherence factor
$AT_c$ Averaging time for carcinogenic effects
$AT_n$ Averaging time for non-carcinogenic effects
B Bunge Model partitioning coefficient
BW Body weight
CF Conversion factor
IR Ingestion rate
$C_{soil}$ Exposure concentration for soil
$C_{gw}$ Exposure concentration for groundwater
$C_{air}$ Exposure concentration for air
ED Exposure duration
EF Exposure frequency
ET Exposure time
EV Event frequency
FI Fraction ingested from contaminated source
InhR Inhalation rate
IR Ingestion rate (soil or groundwater)
$K_p$ Permeability coefficient from water through skin
SA Skin surface area available for contact
PEF Particulate emission factor
t Lag time
t* Time it takes to reach steady-state conditions
$t_{event}$ Duration of event

1 - USEPA, 2002
2 - Illinois EPA, 2004.
3 - USEPA, 1993
4 - Professional judgment.
5 - Adolescents (7-16 years).
6 - USEPA, 1997
7 - Illinois EPA, 2003.
8 - USEPA, 1989
9 - CTE is assumed to be 1/2 the RME value.
10 - USEPA, 2004
11 - USEPA, 2002

Note: The exposure factors for future civilian and military residents are the same, except for exposure duration (ED) for adult military residents. Exposure duration for adult military residents was assumed to be the typical enlistment times of 6 years for the RME and CTE.

**TABLE 6**

**NON-CANCER TOXICITY DATA - ORAL/DERMAL**
**SITE 21 - BUILDINGS 1517/1506 AREA**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**

| Chemical of Potential Concern | Chronic/ Subchronic | Oral RfD | | Oral Absorption Efficiency for Dermal[1] | Absorbed RfD for Dermal[2] | | Primary Target Organ(s) | Combined Uncertainty/Modifying Factors | RfD:Target Organ(s) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Value | Units | | Value | Units | | | Source | Date |
| **CHRONIC** | | | | | | | | | | |
| **Semivolatile Organic Compounds** | | | | | | | | | | |
| BENZO(A)ANTHRACENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| BENZO(A)PYRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| BENZO(B)FLUORANTHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| DIBENZO(A,H)ANTHRACENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| INDENO(1,2,3-CD)PYRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| NAPHTHALENE | Chronic | 0.02 | mg/kg/day | >50% | 2.0E-02 | mg/kg/day | body weight | 3000/1 | IRIS | Sep-98 |
| TCDD TEQ (use 2,3,7,8-TCDD) | Chronic | 1.00E-09 | mg/kg/day | >50% | 1.00E-09 | mg/kg/day | developmental | NA | ATSDR | 12/1998 |
| PENTACHLOROPHENOL | Chronic | 5.00E-03 | mg/kg/day | >50% | 5.00E-03 | mg/kg/day | Liver (hepatox.) | 300/1 | IRIS | 9/2010 |
| **Pesticides/PCBs** | | | | | | | | | | |
| AROCLOR 1260 [3] | Chronic | 2.00E-05 | mg/kg/day | >50% | 2.00E-05 | mg/kg/day | eye, immunolog. | 300/1 | IRIS | 11/1996 |
| DELTA-HEXACHLOROCYCLOHEXANE [3] | Chronic | 8.00E-03 | mg/kg/day | >50% | 8.00E-03 | mg/kg/day | Liver (hepatox.) | 100 | ATSDR | 9/2005 |
| **Volatile Organic Compound** | | | | | | | | | | |
| BENZENE | Chronic | 4.00E-03 | mg/kg/day | >50% | 4.00E-03 | mg/kg/day | Hematological | 300/1 | IRIS | 4/2003 |
| TETRACHLOROETHYLENE | Chronic | 1.00E-02 | mg/kg/day | >50% | 1.00E-02 | mg/kg/day | Liver (hepatox.) | 1000 | IRIS | 3/1/1988 |
| **Inorganics** | | | | | | | | | | |
| ALUMINUM | Chronic | 1.0E+00 | mg/kg/day | not available | 1.0E+00 | mg/kg/day | CNS | 100 | PPRTV (per ORNL) | 10/23/2006 |
| ANTIMONY | Chronic | 4.0E-04 | mg/kg/day | 0.15 | 6.0E-05 | mg/kg/day | longevity | 1000 | IRIS | 2/1991 |
| ARSENIC | Chronic | 3.0E-04 | mg/kg/day | >50% | 3.0E-04 | mg/kg/day | Skin, CVS | 3/1 | IRIS | 4/2009 |
| BARIUM | Chronic | 2.0E-01 | mg/kg/day | 0.07 | 1.4E-02 | mg/kg/day | Kidney (nephrtox.) | 300 | IRIS | 7/2005 |
| CADMIUM | Chronic | 1.0E-03 | mg/kg/day | 0.025 | 2.5E-05 | mg/kg/day | Kidney (proteinuria) | 10/1 | IRIS | 2/1994 |
| CHROMIUM VI | Chronic | 3.0E-03 | mg/kg/day | 0.025 | 7.5E-05 | mg/kg/day | Fetotoxicity, GS, Bone | 300/3 | IRIS | 2/2/2009 |
| COBALT | Chronic | 3.0E-04 | mg/kg/day | not available | 3.0E-04 | mg/kg/day | Blood | NA | ORNL | 9/12/2008 |
| COPPER | Chronic | 4.0E-02 | | not available | 4.0E-02 | mg/kg/day | GI | NA | HEAST | 7/1997 |
| IRON | Chronic | 7.0E-01 | mg/kg/day | not available | 7.0E-01 | mg/kg/day | GS | 1.5 | PPRTV (per ORNL) | 9/11/2006 |
| MANGANESE | Chronic | 4.7E-02 | mg/kg/day | 0.04 | 1.9E-03 | mg/kg/day | CNS | 1/3 | IRIS | 4/2009 |
| MERCURY[4] | Chronic | 3.0E-04 | mg/kg/day | 0.07 | 2.1E-05 | mg/kg/day | Autoimmune | 1000/1 | IRIS | 2/2/2009 |
| VANADIUM | Chronic | 9.0E-03 | mg/kg/day | 0.026 | 2.3E-04 | mg/kg/day | Kidney | 100 | IRIS | 12/1/1996 |
| **SUBCHRONIC[5,6]** | | | | | | | | | | |
| ALUMINUM | Subchronic | 2.0E+00 | mg/kg/day | not available | 2.0E+00 | mg/kg/day | CNS | 30 | ATSDR | 7/1999 |
| ARSENIC | Subchronic | 5.0E-03 | mg/kg/day | >50% | 5.0E-03 | mg/kg/day | skin | 10 | EPA Region 8 | 8/2002 |
| Chromium VI | Subchronic | 2.0E-02 | mg/kg/day | 0.025 | 5.0E-04 | mg/kg/day | NOAEL | 100 | HEAST | 7/1997 |
| MERCURY[4] | Subchronic | 3.0E-03 | mg/kg/day | 0.07 | 2.1E-04 | mg/kg/day | Autoimmune | 100 | HEAST | 7/1997 |

Notes:
1 - USEPA, July 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.
2 - Adjusted dermal RfD = Oral RfD x Oral Absorption Efficiency for Dermal.
3 - No RfD; used surrogates (Aroclor 1254 for Aroclor 1260, and a-BHC for d-BHC)
4 - Values are for mercuric chloride.
5 - If a subchronic RfD was not available, then the chronic RfD was used as a surrogate for subchronic scenarios.
6 - Additional subchronic RfD values were recommended by IEPA comments (2011). These are presented and discussed in Section 5.7.4.2.
ATSDR = Agency for Toxic Substances and Disease Registry

Definitions:
CNS = Central nervous system
CVS = Cardiovascular system
GS = Gastrointestinal System
HEAST= Health Effects Assessment Summary Tables
IRIS = Integrated Risk Information System
NA = Not applicable
NCEA = USEPA National Center for Environmental Assessment
ORNL = Oak Ridge National Laboratory Regional Screening Level tables, June 2011
PPRTV = Provisional Peer Reviewed Toxicity Value

**TABLE 7**

**NON-CANCER TOXICITY DATA - INHALATION**
**SITE 21 - BUILDINGS 1517/1506 AREA**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**

| Chemical of Potential Concern | Chronic/ Subchronic | Inhalation RfC | | Primary Target Organ(s) | Combined Uncertainty/Modifying Factors | RfC : Target Organ(s) | |
|---|---|---|---|---|---|---|---|
| | | Value | Units | | | Source(s) | Date(s) |
| | | | | | | | |
| **Semivolatile Organic Compounds** | | | | | | | |
| BENZO(A)ANTHRACENE | NA | NA | NA | NA | NA | NA | NA |
| BENZO(A)PYRENE | NA | NA | NA | NA | NA | NA | NA |
| BENZO(B)FLUORANTHENE | NA | NA | NA | NA | NA | NA | NA |
| DIBENZO(A,H)ANTHRACENE | NA | NA | NA | NA | NA | NA | NA |
| INDENO(1,2,3-CD)PYRENE | NA | NA | NA | NA | NA | NA | NA |
| NAPHTHALENE | Chronic | 3.0E-03 | $mg/m^3$ | Nasal | 3000/1 | IRIS | 9/1998 |
| TCDD TEQs (use 2,3,7,8-TCDD tox value) | Chronic | 4.0E-08 | $mg/m^3$ | NA | NA | CA EPA (per ORNL) | NA |
| PENTACHLOROPHENOL | NA | NA | NA | NA | NA | NA | NA |
| **Pesticides/PCBs** | | | | | | | |
| AROCLOR 1260 | NA | NA | NA | NA | NA | NA | NA |
| DELTA-HEXACHLOROCYCLOHEXANE | NA | NA | NA | NA | NA | NA | NA |
| **Volatile Organic Compound** | | | | | | | |
| BENZENE | Chronic | 3.00E-02 | $mg/m^3$ | Hematological | 300/1 | IRIS | 4/2003 |
| TETRACHLOROETHYLENE | Chronic | 2.7E-01 | $mg/m^3$ | CNS | 100 | ATSDR | 9/1997 |
| **Inorganics** | | | | | | | |
| ALUMINUM | Chronic | 5.0E-03 | $mg/m^3$ | CNS | 300 | PPRTV (per ORNL) | 10/23/2006 |
| ARSENIC | Chronic | 1.50E-05 | $mg/m^3$ | CNS, GI, heart | not available | CA EPA (per ORNL) | not available |
| BARIUM | Chronic | 5.0E-04 | $mg/m^3$ | Fetus | 1000/1 | HEAST | 7/1997 |
| CADMIUM | Chronic | 1.0E-05 | $mg/m^3$ | Kidney | 9 | ATSDR | 9/2008 |
| CHROMIUM VI | Chronic | 1.0E-04 | $mg/m^3$ | Respiratory | 300/1 | IRIS | 4/2009 |
| COBALT | Chronic | 6.0E-06 | $mg/m^3$ | Respiratory | NA | PPRTV (per ORNL) | 9/12/2008 |
| IRON | NA | NA | NA | NA | NA | NA | NA |
| MANGANESE | Chronic | 5.0E-05 | $mg/m^3$ | CNS | 1000/1 | IRIS | 4/2009 |
| MERCURY | Chronic | 3.0E-05 | $mg/m^3$ | CNS | not available | CA EPA (per ORNL) | not available |
| VANADIUM | Chronic | 7.0E-06 | $mg/m^3$ | NA | not available | PPRTV (per ORNL) | not available |
| **SUBCHRONIC[1]** | | | | | | | |
| BARIUM | Subchronic | 5.0E-03 | $mg/m^3$ | Fetus | 100 | HEAST | 7/1997 |

Notes:
1 - If a subchronic RfC was not available, then the chronic RfC was used.

ORNL = Oak Ridge National Laboratory RSL tables, June 2011
PPRTV = Provisional Peer Reviewed Toxicity Value

Definitions:
IRIS = Integrated Risk Information System
CNS = Central Nervous System
HEAST= Health Effects Assessment Summary Tables
NA = Not Applicable
NCEA = USEPA National Center for Environmental Assessment
ORNL = Oak Ridge National Laboratory Screening Level Tables, September 2008
ATSDR = Agency for Toxic Substances and Disease Registry
CA EPA = California Envirnomental Protection Agency

**TABLE 8**

**CANCER TOXICITY DATA - ORAL/DERMAL**
**SITE 21 - BUILDINGS 1517/1506 AREA**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**

| Chemical of Potential Concern | Oral Cancer Slope Factor | | Oral Absorption Efficiency for Dermal[1] | Absorbed Cancer Slope Factor for Dermal[2] | | Weight of Evidence/ Cancer Guideline | Oral CSF | |
|---|---|---|---|---|---|---|---|---|
| | Value | Units | | Value | Units | Description | Source | Date |
| **Semivolatile Organic Compounds** | | | | | | | | |
| BENZO(A)ANTHRACENE | 7.3E-01 | $(mg/kg/day)^{-1}$ | >50% | 7.3E-01 | $(mg/kg/day)^{-1}$ | B2 | USEPA, 1993 | 7/1993 |
| BENZO(A)PYRENE | 7.3E+00 | $(mg/kg/day)^{-1}$ | >50% | 7.3E+00 | $(mg/kg/day)^{-1}$ | B2 | IRIS | 4/2009 |
| BENZO(B)FLUORANTHENE | 7.3E-01 | $(mg/kg/day)^{-1}$ | >50% | 7.3E-01 | $(mg/kg/day)^{-1}$ | B2 | USEPA, 1993 | 7/1993 |
| DIBENZO(A,H)ANTHRACENE | 7.3E+00 | $(mg/kg/day)^{-1}$ | >50% | 7.3E+00 | $(mg/kg/day)^{-1}$ | B2 | USEPA, 1993 | 7/1993 |
| INDENO(1,2,3-CD)PYRENE | 7.3E-01 | $(mg/kg/day)^{-1}$ | >50% | 7.3E-01 | $(mg/kg/day)^{-1}$ | B2 | USEPA, 1993 | 7/1993 |
| NAPHTHALENE | NA | NA | NA | NA | NA | C | IRIS | 9/1998 |
| TCDD TEQs (use 2,3,7,8-TCDD tox value) | 1.5E+05 | $(mg/kg/day)^{-1}$ | >50% | 1.5E+05 | $(mg/kg/day)^{-1}$ | B2 | HEAST | 7/1997 |
| PENTACHLOROPHENOL | 4.0E-01 | (mg/kg/day)-1 | >50% | 4.0E-01 | (mg/kg/day)-1 | "Likely to be carcinogenic to humans" | IRIS | 9/2010 |
| **Pesticides/PCBs** | | | | | | | | |
| AROCLOR 1260 (highly chlorinated PCB) | 2.0E+00 | (mg/kg/day)-1 | >50% | 2.0E+00 | (mg/kg/day)-1 | B2 | IRIS | 6/1997 |
| DELTA-HEXACHLOROCYCLOHEXANE [3] | 6.3E+00 | (mg/kg/day)-1 | >50% | 6.3E+00 | (mg/kg/day)-1 | B2 | IRIS | 7/1993 |
| **Volatile Organic Compound** | | | | | | | | |
| BENZENE | 5.5E-02 | (mg/kg/day)-1 | >50% | 5.5E-02 | (mg/kg/day)-1 | A | IRIS | 1/2000 |
| TETRACHLOROETHYLENE | 5.4E-01 | $(mg/kg/day)^{-1}$ | >50% | 5.4E-01 | (mg/kg/day)-1 | Not Classified | CA EPA (per ORNL) | NA |
| **Inorganics** | | | | | | | | |
| ALUMINUM | NA | NA | NA | NA | NA | NA | NA | NA |
| ARSENIC | 1.5E+00 | $(mg/kg/day)^{-1}$ | >50% | 1.5E+00 | $(mg/kg/day)^{-1}$ | A | IRIS | 4/2009 |
| BARIUM | NA | NA | NA | NA | NA | D | IRIS | 4/2009 |
| CHROMIUM | NA | NA | NA | NA | NA | D/Not classifiable as to human carcinogenicity | IRIS | 2/2/2009 |
| COBALT | NA | NA | NA | NA | NA | NA | NA | NA |
| COPPER | NA | NA | NA | NA | NA | D | IRIS | 8/1991 |
| IRON | NA | NA | NA | NA | NA | NA | NA | NA |
| MANGANESE | NA | NA | NA | NA | NA | D | IRIS | 4/2009 |
| MERCURY | NA | NA | NA | NA | NA | C/Possible Human Carcinogen | IRIS | 4/2009 |
| VANADIUM | NA | NA | NA | NA | NA | NA | IRIS | 6/1988 |

**Notes:**

1 - USEPA, 2004
2 - Adjusted dermal cancer slope factor = oral cancer slope factor/oral absorption efficiency for dermal
3 - No tox values for d-hexachlorocyclohexane (d-BHC); used surrogate tox values for a-BHC.

**EPA Group:**

A - Human carcinogen.

B1 - Probable human carcinogen - indicates that limited human data are available.
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans.
C - Possible human carcinogen.
D - Not classifiable as a human carcinogen.
E - Evidence of non-carcinogenicity.

**Definitions:**

IRIS = Integrated Risk Information System.
NA = Not available.
NCEA = National Center for Environmental Assessment, value from ORNL Regional Screening Level tables.
USEPA, 1993. Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons. EPA/600/R-93/089. July 1993
ORNL = Oak Ridge National Laboratory Regional Screening Level tables, June 2011
PPRTV = Provisional Peer Reviewed Toxicity Value
CA EPA = California Envirnomental Protection Agency

**TABLE 9**

**CANCER TOXICITY DATA - INHALATION**
**SITE 21 - BUILDINGS 1517/1506 AREA**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**

| Chemical of Potential Concern | Unit Risk | | Weight of Evidence/ Cancer Guideline Description | Unit Risk : Inhalation CSF | |
|---|---|---|---|---|---|
| | Value | Units | | Source | Date |
| **Semivolatile Organic Compounds** | | | | | |
| BENZO(A)ANTHRACENE | 1.1E-04 | $(ug/m^3)^{-1}$ | B2 | CAEPA | 4/2009 |
| BENZO(A)PYRENE | 1.1E-03 | $(ug/m^3)^{-1}$ | B2 | CAEPA | 4/2009 |
| BENZO(B)FLUORANTHENE | 1.1E-04 | $(ug/m^3)^{-1}$ | B2 | CAEPA | 4/2009 |
| DIBENZO(A,H)ANTHRACENE | 1.2E-03 | $(ug/m^3)^{-1}$ | B2 | CAEPA | 4/2009 |
| INDENO(1,2,3-CD)PYRENE | 1.1E-04 | $(ug/m^3)^{-1}$ | B2 | CAEPA | 4/2009 |
| NAPHTHALENE | NA | NA | C | IRIS | 9/1998 |
| TCDD TEQs | 3.8E+01 | $(ug/m^3)$-1 | B2 | CA EPA (per ORNL) | NA |
| **Pesticides/PCBs** | | | | | |
| AROCLOR 1260 | 5.7E-04 | $(ug/m^3)$-1 | B2 | IRIS | 6/1997 |
| **Volatile Organic Compound** | | | | | |
| BENZENE | 7.8E-06 | (ug/m3)-1 | A/Known human carcinogen | IRIS | 1/2000 |
| TETRACHLOROETHYLENE | 5.9E-06 | (ug/m3)-1 | Not Classified | CA EPA (per ORNL) | NA |
| **Inorganics** | | | | | |
| ALUMINUM | NA | NA | NA | NA | NA |
| ARSENIC | 4.3E-03 | $(ug/m^3)$-1 | A | IRIS | 4/2009 |
| BARIUM | NA | NA | NA | NA | NA |
| CADMIUM | 1.8E-03 | $(ug/m^3)^{-1}$ | B1 | IRIS | 6/1992 |
| CHROMIUM | 1.2E-02 | $(ug/m^3)^{-1}$ | A/Known human carcinogen | IRIS | 4/2009 |
| COBALT | 9.0E-03 | $(ug/m^3)^{-1}$ | NA | PPRTV (per ORNL) | 9/12/2008 |
| IRON | NA | NA | NA | NA | NA |
| MANGANESE | NA | NA | NA | NA | NA |
| MERCURY | NA | NA | C/Possible Human Carcinogen | IRIS | 4/2009 |
| VANADIUM | 8.0E-03 | $(ug/m^3)^{-1}$ | NA | PPRTV (per ORNL) | NA |

Definitions:
IRIS = Integrated Risk Information System.
HEAST= Health Effects Assessment Summary Tables
ORNL = Oak Ridge National Laboratory Regional Screening Level tables, June 2011.
PPRTV = Provisional Peer Reviewed Toxicity Value
CA EPA = California Envirnomental Protection Agency

A - Human carcinogen.
B1 - Probable human carcinogen - indicates that limited human data are available.
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans .
C - Possible human carcinogen.
D - Not classifiable as a human carcinogen.
E - Evidence of non-carcinogenicity.

**TABLE 10**

**SUMMARY OF CANCER RISKS AND HAZARD INDICES - REASONABLE MAXIMUM EXPOSURE (RME)[1]**
**SITE 21 - BUILDING 1517**
**NAVAL STATON GREAT LAKES, ILLINOIS**


| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Construction/Excavation Worker | Surface Soil | Ingestion | 2.E-06 | - - | - - | cPAHs | 1 | - - |
| | | Dermal Contact | 8.E-07 | - - | - - | - - | 0.07 | - - |
| | | Inhalation | 7.E-07 | - - | - - | - - | 12 | Manganese |
| | | Total | 4.E-06 | - - | - - | - - | 13 | Manganese |
| | Subsurface Soil | Ingestion | 2.E-06 | - - | - - | cPAHs | 0.9 | |
| | | Dermal Contact | 7.E-07 | - - | - - | - - | 0.04 | |
| | | Inhalation | 3.E-07 | - - | - - | - - | 9 | Manganese |
| | | Total | 3.E-06 | - - | - - | - - | 10 | Manganese |
| | Groundwater | Ingestion | NA | - - | - - | - - | NA | - - |
| | | Dermal Contact | 8.E-09 | - - | - - | - - | 0.4 | - - |
| | | Inhalation VOC | 9.E-11 | - - | - - | - - | 0.0002 | - - |
| | | Total | 8.E-09 | - - | - - | - - | 0.4 | - - |
| | | **Total Surface Soil** | 4.E-06 | - - | - - | cPAHs | 13 | Manganese |
| | | **Total Subsurface Soil** | 3.E-06 | - - | - - | - - | 10 | Manganese |
| | | **Total Groundwater** | 8.E-09 | - - | - - | - - | 0.4 | - - |
| | | **Total Across the Entire Site[2]** | **4.E-06** | - - | - - | cPAHs | **12** | Manganese |

| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Occupational/Maintenance Worker | Surface Soil | Ingestion | 5.E-05 | - - | cPAHs, Arsenic | TCDD-TEQs | 0.3 | - - |
| | | Dermal Contact | 3.E-05 | - - | cPAHs | Arsenic | 0.034 | - - |
| | | Inhalation | 0.E+00 | - - | - - | - - | 0.00001 | - - |
| | | Total | 8.E-05 | - - | - - | - - | 0.3 | - - |
| | | **Total Surface Soil** | 8.E-05 | - - | cPAHs, Arsenic | TCDD-TEQs | 0.3 | - - |
| | | **Total Across the Entire Site** | **8.E-05** | - - | cPAHs, Arsenic | TCDD-TEQs | **0.3** | - - |

| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Adolescent Trespasser | Surface Soil | Ingestion | 8.E-06 | - - | - - | cPAHs | 0.05 | - - |
| | | Dermal Contact | 6.E-06 | - - | - - | cPAHs | 0.006 | - - |
| | | Inhalation | 0.E+00 | - - | - - | - - | 0.0000003 | - - |
| | | Total | 1.E-05 | - - | - - | - - | 0.05 | - - |
| | | **Total Surface Soil** | 1.E-05 | - - | - - | cPAHs | 0.05 | - - |
| | | **Total Across the Entire Site** | **1.E-05** | - - | - - | cPAHs | **0.05** | - - |

**TABLE 10**

**SUMMARY OF CANCER RISKS AND HAZARD INDICES - REASONABLE MAXIMUM EXPOSURE (RME)[1]**
**SITE 21 - BUILDING 1517**
**NAVAL STATON GREAT LAKES, ILLINOIS**


| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Future Child Resident | Surface Soil | Ingestion | 2.E-03 | cPAHs | Arsenic | Aroclor 1260, TCDD-TEQs | 8 | Arsenic, Iron |
| | | Dermal Contact | 8.E-04 | cPAHs | - - | Arsenic | 0.4 | - - |
| | | Inhalation | 0.E+00 | - - | - - | - - | 0.0002 | - - |
| | | Total | 3.E-03 | cPAHs | Arsenic | Aroclor 1260, TCDD-TEQs | 8 | Arsenic, Iron |
| | Subsurface Soil | Ingestion | 2.E-03 | cPAHs, Arsenic | - - | - - | 7 | Arsenic, Cobalt, Iron |
| | | Dermal Contact | 6.E-04 | cPAHs | Arsenic | - - | 0.4 | - - |
| | | Total | 2.E-03 | cPAHs | Arsenic | - - | 8 | Arsenic, Cobalt, Iron |
| | Groundwater | Ingestion | 1.E-04 | - - | TCDD-TEQ, Pentachlorophenol, Arsenic | cPAHs, Tetrachloroethylene, Delta-BHC | 25 | Cobalt, Iron, Manganese |
| | | Dermal Contact | 1.E-06 | - - | - - | - - | 0.4 | - - |
| | | Inhalation - Showering | 1.E-07 | - - | - - | - - | 0.005 | - - |
| | | Total | 1.E-04 | - - | TCDD-TEQ, Pentachlorophenol, Arsenic | cPAHs, Tetrachloroethylene, Delta-BHC | 25 | Cobalt, Iron, Manganese |
| | | **Total Surface Soil** | 3.E-03 | cPAHs | Arsenic | Aroclor 1260, TCDD-TEQs | 8 | Arsenic, Iron |
| | | **Total Subsurface Soil** | 2.E-03 | cPAHs, Arsenic | | | 8 | Arsenic, Cobalt, Iron |
| | | **Total Groundwater** | 1.E-04 | - - | TCDD-TEQ, Pentachlorophenol, Arsenic | cPAHs, Tetrachloroethylene, Delta-BHC | 25 | Cobalt, Iron, Manganese |
| | | **Total Across the Entire Site[2]** | **3.E-03** | cPAHs, Arsenic | TCDD-TEQ, Pentachlorophenol | Tetrachloroethylene, Delta-BHC | **33** | Arsenic, Cobalt, Iron, Manganese |

| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Future Adult Resident | Surface Soil | Ingestion | 4.E-04 | cPAHs | Arsenic | TCDD-TEQs | 0.8 | - - |
| | | Dermal Contact | 2.E-04 | cPAHs | - - | Arsenic | 0.062 | - - |
| | | Inhalation | 0.E+00 | - - | - - | - - | 0.0002 | - - |
| | | Total | 5.E-04 | cPAHs | Arsenic | - - | 0.9 | - - |
| | Subsurface Soil | Ingestion | 3.E-04 | cPAHs | Arsenic | | 0.8 | - - |
| | | Dermal Contact | 1.E-04 | cPAHs | - - | Arsenic | 0.07 | - - |
| | | Total | 4.E-04 | cPAHs | Arsenic | | 0.8 | - - |
| | Groundwater | Ingestion | 2.E-04 | - - | TCDD-TEQ, Pentachlorophenol, Arsenic | cPAHs, Tetrachloroethylene, Delta-BHC | 7.0 | Cobalt, Iron, Manganese |
| | | Dermal Contact | 3.E-06 | - - | - - | Tetrachloroethylene | 0.3 | - - |
| | | Inhalation - Showering | 1.E-07 | - - | - - | - - | 0.001 | - - |
| | | Total | 2.E-04 | - - | TCDD-TEQ, Pentachlorophenol, Arsenic | cPAHs, Tetrachloroethylene, Delta-BHC | 7 | Cobalt, Iron, Manganese |
| | | **Total Surface Soil** | 5.E-04 | cPAHs | Arsenic | TCDD-TEQs | 0.9 | - - |
| | | **Total Subsurface Soil** | 4.E-04 | cPAHs | Arsenic | - - | 0.8 | - - |
| | | **Total Groundwater** | 2.E-04 | - - | TCDD-TEQ, Pentachlorophenol, Arsenic | cPAHs, Tetrachloroethylene, Delta-BHC | 7 | Cobalt, Iron, Manganese |
| | | **Total Across the Entire Site[2]** | **7.E-04** | cPAHs | TCDD-TEQ, Pentachlorophenol, Arsenic | Tetrachloroethylene, Delta-BHC | **8** | Cobalt, Iron, Manganese |

**TABLE 10**

**SUMMARY OF CANCER RISKS AND HAZARD INDICES - REASONABLE MAXIMUM EXPOSURE (RME)[1]**
**SITE 21 - BUILDING 1517**
**NAVAL STATON GREAT LAKES, ILLINOIS**


| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Total Residential Risks | Surface Soil | Ingestion | 3.E-03 | cPAHs | Arsenic | TCDD-TEQs | NA | - - |
| | | Dermal Contact | 1.E-03 | cPAHs | - - | Arsenic | NA | - - |
| | | Inhalation | 0.E+00 | - - | - - | - - | NA | |
| | | Total | 4.E-03 | cPAHs | Arsenic | Aroclor 1260, TCDD-TEQs | NA | - - |
| | Subsurface Soil | Ingestion | 2.E-03 | cPAHs | Arsenic | - - | NA | |
| | | Dermal Contact | 8.E-04 | cPAHs | - - | - - | NA | |
| | | Total | 3.E-03 | cPAHs, Arsenic | - - | - - | NA | |
| | Groundwater | Ingestion | 3.E-04 | - - | TCDD-TEQ, Pentachlorophenol, Arsenic | cPAHs, Tetrachloroethylene, Delta-BHC | NA | - - |
| | | Dermal Contact | 4.E-06 | - - | - - | Tetrachloroethylene | NA | - - |
| | | Inhalation - Showering | 3.E-07 | - - | - - | - - | NA | |
| | | Total | 3.E-04 | - - | TCDD-TEQ, Pentachlorophenol, Arsenic | cPAHs, Tetrachloroethylene, Delta-BHC | NA | - - |
| | | **Total Surface Soil** | 4.E-03 | cPAHs | Arsenic | Aroclor 1260, TCDD-TEQs | NA | - - |
| | | **Total Subsurface Soil** | 3.E-03 | cPAHs, Arsenic | - - | - - | NA | |
| | | **Total Groundwater** | 3.E-04 | - - | TCDD-TEQ, Pentachlorophenol, Arsenic | cPAHs, Aroclor 1260, Tetrachloroethylene, Delta-BHC | NA | - - |
| | | **Total Across the Entire Site[2]** | **4.E-03** | cPAHs, Arsenic | TCDD-TEQ, Pentachlorophenol | Tetrachloroethylene, Delta-BHC | See Child-only summed HI | - - |

[1] Includes very conservative inclusion of groundwater exposure pathways for residential receptors. There is a municipal water supply, and a groundwater use restriction ordinance exists.
[2] Total Site Risks average the risk/hazards for surface and subsurface soil because the risk assessment assumes full default exposure factors for both surface and subsurface soil. To add surface and subsurface risks/hazards would double count soil pathway risks.

cPAHs = Carcinogenic PAHs NA = Not applicable

**TABLE 11**

**SUMMARY OF CANCER RISKS AND HAZARD INDICES - CENTRAL TENDENCY EXPOSURE (CTE)[1]**
**SITE 21 - BUILDING 1517**
**NAVAL STATON GREAT LAKES, ILLINOIS**


| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Construction/Excavation Worker | Surface Soil | Ingestion | 1.E-07 | - - | - - | cPAHs | 0.2 | - - |
| | | Dermal Contact | 2.E-08 | - - | - - | - - | 0.008 | - - |
| | | Inhalation | 6.E-08 | - - | - - | - - | 1.47 | Manganese |
| | | Total | 2.E-07 | - - | - - | - - | 2 | Manganese |
| | Subsurface Soil | Ingestion | 1.E-07 | - - | - - | - - | 0.2 | |
| | | Dermal Contact | 2.E-08 | - - | - - | - - | 0.003 | |
| | | Inhalation | 2.E-08 | - - | - - | - - | 1.6 | Manganese |
| | | Total | 1.E-07 | - - | - - | - - | 2 | Manganese |
| | Groundwater | Ingestion | NA | - - | - - | - - | NA | - - |
| | | Dermal Contact | 5.E-09 | - - | - - | - - | 0.4 | - - |
| | | Inhalation VOC | --[2] | - - | - - | - - | --[1] | - - |
| | | Total | 5.E-09 | - - | - - | - - | 0.4 | - - |
| | | **Total Surface Soil** | 2.E-07 | - - | - - | - - | 2 | Manganese |
| | | **Total Subsurface Soil** | 1.E-07 | - - | - - | - - | 2 | Manganese |
| | | **Total Groundwater** | 5.E-09 | - - | - - | - - | 0.4 | - - |
| | | **Total Across the Entire Site[3]** | **2.E-07** | - - | - - | - - | **2** | Manganese |

| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Occupational/Maintenance Worker | Surface Soil | Ingestion | 3.E-06 | - - | - - | cPAHs, Arsenic | 0.08 | - - |
| | | Dermal Contact | 3.E-07 | - - | - - | - - | 0.002 | - - |
| | | Inhalation | 0.E+00 | - - | - - | - - | 0.0000008 | - - |
| | | Total | 3.E-06 | - - | - - | - - | 0.08 | - - |
| | | **Total Surface Soil** | 3.E-06 | - - | - - | cPAHs, Arsenic | 0.08 | - - |
| | | **Total Across the Entire Site[3]** | **3.E-06** | - - | - - | cPAHs, Arsenic | **0.08** | - - |

| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Adolescent Trespasser | Surface Soil | Ingestion | 6.E-07 | - - | - - | - - | 0.008 | - - |
| | | Dermal Contact | 2.E-07 | - - | - - | - - | 0.0004 | - - |
| | | Inhalation | 0.E+00 | - - | - - | - - | 0.00000002 | - - |
| | | Total | 8.E-07 | - - | - - | - - | 0.008 | - - |
| | | **Total Surface Soil** | 8.E-07 | - - | - - | - - | 0.008 | - - |
| | | **Total Across the Entire Site[3]** | **8.E-07** | - - | - - | - - | **0.008** | - - |

**TABLE 11**

**SUMMARY OF CANCER RISKS AND HAZARD INDICES - CENTRAL TENDENCY EXPOSURE (CTE)[1]**
**SITE 21 - BUILDING 1517**
**NAVAL STATON GREAT LAKES, ILLINOIS**


| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Future Child Resident | Surface Soil | Ingestion | 6.E-06 | - - | - - | cPAHs, Arsenic | 0.8 | - - |
| | | Dermal Contact | 6.E-07 | - - | - - | - - | 0.016 | - - |
| | | Inhalation | 0.E+00 | - - | - - | - - | 0.000009 | - - |
| | | Total | 7.E-06 | - - | - - | cPAHs, Arsenic | 0.8 | - - |
| | Subsurface Soil | Ingestion | 4.E-06 | - - | - - | cPAHs, Arsenic | 0.6 | - - |
| | | Dermal Contact | 4.E-07 | - - | - - | - - | 0.009 | - - |
| | | Total | 5.E-06 | - - | - - | cPAHs, Arsenic | 0.6 | - - |
| | Groundwater | Ingestion | 1.E-05 | - - | - - | TCDD-TEQ, Pentachlorophenol, Arsenic | 7 | Manganese |
| | | Dermal Contact | 2.E-07 | - - | - - | - - | 0.2 | - - |
| | | Inhalation - Showering | 3.E-08 | - - | - - | - - | 0.003 | - - |
| | | Total | 1.E-05 | - - | - - | TCDD-TEQ, Pentachlorophenol, Arsenic | 7 | Cobalt, Iron, Manganese |
| | | **Total Surface Soil** | 7.E-06 | - - | - - | cPAHs, Arsenic | 0.8 | - - |
| | | **Total Subsurface Soil** | 5.E-06 | - - | - - | cPAHs, Arsenic | 0.6 | - - |
| | | **Total Groundwater** | 1.E-05 | - - | - - | TCDD-TEQ, Pentachlorophenol, Arsenic | 7 | Cobalt, Iron, Manganese |
| | | **Total Across the Entire Site[3]** | **2.E-05** | - - | - - | cPAHs, TCDD-TEQ, Pentachlorophenol, Arsenic | **8** | Cobalt, Iron, Manganese |

| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Future Adult Resident | Surface Soil | Ingestion | 2.E-06 | - - | - - | cPAHs | 0.08 | - - |
| | | Dermal Contact | 2.E-07 | - - | - - | - - | 0.002 | - - |
| | | Inhalation | 0.E+00 | - - | - - | - - | 0.000009 | - - |
| | | Total | 3.E-06 | - - | - - | cPAHs | 0.08 | - - |
| | Subsurface Soil | Ingestion | 2.E-06 | - - | - - | - - | 0.07 | - - |
| | | Dermal Contact | 1.E-07 | - - | - - | - - | 0.001 | - - |
| | | Total | 2.E-06 | - - | - - | - - | 0.07 | - - |
| | Groundwater | Ingestion | 2.E-05 | - - | TCDD-TEQ, Pentachlorophenol | cPAHs, Tetrachloroethylene, Delta-BHC | 3 | Manganese |
| | | Dermal Contact | 4.E-07 | - - | - - | Pentachlorophenol | 0.1 | - - |
| | | Inhalation - Showering | 1.E-08 | - - | - - | - - | 0.0004 | - - |
| | | Total | 2.E-05 | - - | TCDD-TEQ, Pentachlorophenol, Arsenic | cPAHs, Tetrachloroethylene, Delta-BHC | 3 | Manganese |
| | | **Total Surface Soil** | 3.E-06 | - - | Arsenic | TCDD-TEQs | 0.08 | - - |
| | | **Total Subsurface Soil** | 2.E-06 | - - | Arsenic | - - | 0.07 | - - |
| | | **Total Groundwater** | 2.E-05 | - - | TCDD-TEQ, Pentachlorophenol | cPAHs, Tetrachloroethylene, Delta-BHC | 3 | Manganese |
| | | **Total Across the Entire Site[3]** | **2.E-05** | - - | TCDD-TEQ, Pentachlorophenol, Arsenic | cPAHs, Tetrachloroethylene, Delta-BHC | **3** | Manganese |

**TABLE 11**

**SUMMARY OF CANCER RISKS AND HAZARD INDICES - CENTRAL TENDENCY EXPOSURE (CTE)[1]**
**SITE 21 - BUILDING 1517**
**NAVAL STATON GREAT LAKES, ILLINOIS**


| Receptor | Medium | Exposure Route | Cancer Risk | Chemicals with Cancer Risks > 1E-4 | Chemicals with Cancer Risks > 1E-5 and ≤ 1E-4 | Chemicals with Cancer Risks > 1E-6 and ≤ 1E-5 | Hazard Index (HI) | Chemicals with HI > 1 |
|---|---|---|---|---|---|---|---|---|
| Total Residential Risks | Surface Soil | Ingestion | 8.E-06 | - - | - - | cPAHs, Arsenic | NA | - - |
| | | Dermal Contact | 8.E-07 | - - | - - | - - | NA | - - |
| | | Inhalation | 0.E+00 | - - | - - | - - | NA | |
| | | Total | 9.E-06 | - - | - - | cPAHs, Arsenic | NA | - - |
| | Subsurface Soil | Ingestion | 6.E-06 | - - | - - | cPAHs, Arsenic | NA | |
| | | Dermal Contact | 5.E-07 | - - | - - | - - | NA | |
| | | Total | 7.E-06 | - - | - - | cPAHs, Arsenic | NA | |
| | Groundwater | Ingestion | 4.E-05 | - - | TCDD-TEQ, Pentachlorophenol | cPAHs, Tetrachloroethylene, Delta-BHC | NA | - - |
| | | Dermal Contact | 7.E-07 | - - | - - | - - | NA | - - |
| | | Inhalation - Showering | 4.E-08 | - - | - - | - - | NA | |
| | | Total | 4.E-05 | - - | TCDD-TEQ, Pentachlorophenol | cPAHs, Tetrachloroethylene, Delta-BHC | NA | - - |
| | | **Total Surface Soil** | 9.E-06 | - - | - - | cPAHs, Arsenic | NA | - - |
| | | **Total Surbsurface Soil** | 7.E-06 | - - | - - | - - | NA | |
| | | **Total Groundwater** | 4.E-05 | - - | TCDD-TEQ, Pentachlorophenol | cPAHs, Tetrachloroethylene, Delta-BHC | NA | - - |
| | | **Total Across the Entire Site[3]** | **4.E-05** | - - | TCDD-TEQ, Pentachlorophenol | cPAHs, Arsenic, Tetrachloroethylene, Delta-BHC | See Child-only summed HI | - - |

[1] Includes very conservative inclusion of groundwater exposure pathways for residential receptors. There is a municipal water supply, and a groundwater use restriction ordinance exists.
[2] Not calculated for CTE because RME risk/HI insignificant for this pathway.
[3] Total Site Risks average the risk/hazards for surface and subsurface soil because the risk assessment assumes full default exposure factors for both surface and subsurface soil.
To add surface and subsurface risks/hazards would double count soil pathway risks.
cPAHs = Carcinogenic PAHs NA = Not applicable

**TABLE 12**

**VALUES USED FOR DAILY INTAKE CALCULATIONS**
**EXPOSURE OF CONSTRUCTION WORKERS BY INHALATION FROM SURFACE SOIL**
**SITE 21 - BUILDING 1517**
**NAVAL STATION GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Air
Exposure Point: Entire Site
Receptor Population: Construction Worker
Receptor Age: Adult

| Exposure Route | Parameter Code | Parameter Definition | Units | RME Value | RME Rationale/ Reference | CT Value | CT Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|
| Inhalation | CS | Chemical concentration in soil | mg/kg | 95% UCL or Max | USEPA, May 1993 | 95% UCL or Max | USEPA, May 1993 | Intake (mg/kg/day) = $\frac{CS \times \left[\frac{1}{VF} + \frac{1}{PEF}\right] \times ET \times EF \times ED}{AT \times 24}$ |
| | VF | Volatilization factor - Chemical Specific | $m^3/kg$ | (1) | USEPA, December 2002 | (1) | USEPA, December 2002 | |
| | PEF | Particulate emission factor | $m^3/kg$ | 1.24E+08 | IEPA, 2007. TACO. | 1.24E+08 | IEPA, 2007. TACO. | |
| | ET | Exposure Time | hours/day | 8 | USEPA, December 2002 | 4 | USEPA, December 2002 | |
| | EF | Exposure Frequency | days/year | 30 | IEPA, April 2004 | 30 | IEPA, April 2004 | |
| | ED | Exposure Duration | years | 1 | Professional Judgement | 1 | Professional Judgement | |
| | AT-C | Averaging Time (Cancer) | days | 25550 | USEPA, December 1989 | 25550 | USEPA, December 1989 | |
| | AT-N | Averaging Time (Non-Cancer) | days | 42 | IEPA, Janaury 2003 | 42 | IEPA, Janaury 2003 | |

Notes:

(1) - Calculated according to USEPA Soil Screening Guidance, December 2002.

**Daily Intake Calculations**

Inhalation Intake = (ET x EF x ED x (1/PEF)+(1/VF)) / (AT x 24)

Cancer Inhalation Intake(RME) = 3.91E-04
Noncancer Inhalation Intake(RME) = 2.38E-01
Cancer Inhalation Intake(CTE) = 1.96E-04
Noncancer Inhalation Intake(CTE) = 1.19E-01

Cancer risk from ingestion = Air concentration x Cancer Inhalation Intake x Cancer Inhalation Unit Risk (IUR)
Hazard Index from ingestion = Air concentration x Noncancer Inhalation Intake / Reference Air Concentration (RfCi)

**TABLE 13 REASONABLE MAXIMUM EXPOSURE (RME)**
**CALCULATION OF NON-CANCER HAZARDS**
**EXPOSURE OF CONSTRUCTION WORKERS BY INHALATION FROM SURFACE SOIL**
**SITE 21 - BUILDING 1517**
**NAVAL STATION GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Air
Exposure Point: Entire Site
Receptor Population: Construction Worker
Receptor Age: Adult

| Exposure Route | Chemical of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Hazard Calculation [1] | Intake (Non-Cancer) | Intake (Non-Cancer) Units | Reference Concentration (Subchronic [2] if available) | Reference Concentration Units | Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Inhalation | NAPHTHALENE (partic.) | 5.20E-01 | mg/kg | 4.2E-09 | $mg/m^3$ | R | 1.0E-09 | $mg/m^3$ | 3.0E-03 | $mg/m^3$ | 3.E-07 |
| | ALUMINUM | 2.95E+04 | mg/kg | 2.4E-04 | $mg/m^3$ | R | 5.7E-05 | $mg/m^3$ | 5.0E-03 | $mg/m^3$ | 1.E-02 |
| | ARSENIC | 4.84E+01 | mg/kg | 3.9E-07 | $mg/m^3$ | R | 9.3E-08 | $mg/m^3$ | 1.5E-05 | $mg/m^3$ | 6.E-03 |
| | BARIUM | 2.34E+02 | mg/kg | 1.9E-06 | $mg/m^3$ | R | 4.5E-07 | $mg/m^3$ | *5.0E-03* | $mg/m^3$ | 9.E-05 |
| | CADMIUM | 1.30E+01 | mg/kg | 1.0E-07 | $mg/m^3$ | R | 2.5E-08 | $mg/m^3$ | 1.0E-05 | $mg/m^3$ | 2.E-03 |
| | CHROMIUM | 1.63E+02 | mg/kg | 1.3E-06 | $mg/m^3$ | R | 3.1E-07 | $mg/m^3$ | 1.0E-04 | $mg/m^3$ | 3.E-03 |
| | COBALT | 1.77E+01 | mg/kg | 1.4E-07 | $mg/m^3$ | R | 3.4E-08 | $mg/m^3$ | 6.0E-06 | $mg/m^3$ | 6.E-03 |
| | MANGANESE | 2.42E+03 | mg/kg | 2.0E-05 | $mg/m^3$ | R | 4.6E-06 | $mg/m^3$ | 5.0E-05 | $mg/m^3$ | 9.E-02 |
| | MERCURY | 8.98E+00 | mg/kg | 7.2E-08 | $mg/m^3$ | R | 1.7E-08 | $mg/m^3$ | 3.0E-05 | $mg/m^3$ | 6.E-04 |
| | NAPHTHALENE (vol.) | 5.20E-01 | mg/kg | 7.4E-06 | $mg/m^3$ | R | 1.8E-06 | $mg/m^3$ | 3.0E-03 | $mg/m^3$ | 6.E-04 |
| | (total) | | | | | | | | | | 0.12 |

[1] Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

**Total Hazard Index Across All Exposure Routes/Pathways** **0.12**

[2] Subchronic values in *italics*.

**TABLE 14 REASONABLE MAXIMUM EXPOSURE (RME)**
**CALCULATION OF CANCER RISKS**
**EXPOSURE OF CONSTRUCTION WORKERS BY INHALATION FROM SURFACE SOIL**
**SITE 21 - BUILDING 1517**
**NAVAL STATION GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Air
Exposure Point: Entire Site
Receptor Population: Construction Worker
Receptor Age: Adult

| Exposure Route | Chemical of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation (1) | Intake (Cancer) | Intake (Cancer) Units | Cancer Unit Risk | Cancer Unit Risk Units | Cancer Risk |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Inhalation | ARSENIC | 4.84E+01 | mg/kg | 3.9E-07 | $mg/m^3$ | R | 1.5E-10 | $mg/m^3$ | 4.3E+00 | $(mg/m^3)^{-1}$ | 6.6E-10 |
| | CADMIUM | 1.30E+01 | mg/kg | 1.0E-07 | $mg/m^3$ | R | 4.1E-11 | $mg/m^3$ | 1.8E+00 | $(mg/m^3)^{-1}$ | 7.4E-11 |
| | CHROMIUM | 1.63E+02 | mg/kg | 1.3E-06 | $mg/m^3$ | R | 5.1E-10 | $mg/m^3$ | 1.2E+01 | $(mg/m^3)^{-1}$ | 6.2E-09 |
| | COBALT | 1.77E+01 | mg/kg | 1.4E-07 | $mg/m^3$ | R | 5.6E-11 | $mg/m^3$ | 9.0E+00 | $(mg/m^3)^{-1}$ | 5.0E-10 |
| | (total) | | | | | | | | | | 7.4E-09 |
| | | | | | | | | | | **Total Risk Across All Exposure Routes/Pathways** | **7.E-09** |

**TABLE 15**
**VALUES USED FOR DAILY INTAKE CALCULATIONS**
**EXPOSURE OF CONSTRUCTION WORKERS BY INHALATION FROM SUBSURFACE SOIL**
**SITE 21 - BUILDING 1517**
**NAVAL STATION GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future
Medium: Subsurface Soil
Exposure Medium: Air
Exposure Point: Entire Site
Receptor Population: Construction Worker
Receptor Age: Adult

| Exposure Route | Parameter Code | Parameter Definition | Units | RME Value | RME Rationale/ Reference | CT Value | CT Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|
| Inhalation | CS | Chemical concentration in soil | mg/kg | 95% UCL or Max | USEPA, May 1993 | Mean | USEPA, May 1993 | Intake (mg/kg/day) = $\frac{CS \times \left[\frac{1}{VF} + \frac{1}{PEF}\right] \times ET \times EF \times ED}{AT \times 24}$ |
| | VF | Volatilization factor - Chemical Specific | $m^3/kg$ | (1) | USEPA, December 2002 | (1) | USEPA, December 2002 | |
| | PEF | Particulate emission factor | $m^3/kg$ | 1.24E+08 | IEPA, 2007. TACO. | 1.24E+08 | IEPA, 2007. TACO. | |
| | ET | Exposure Time | hours/day | 8 | USEPA, December 2002 | 4 | USEPA, December 2002 | |
| | EF | Exposure Frequency | days/year | 30 | IEPA, April 2004 | 30 | IEPA, April 2004 | |
| | ED | Exposure Duration | years | 1 | Professional Judgement | 1 | Professional Judgement | |
| | AT-C | Averaging Time (Cancer) | days | 25550 | USEPA, December 1989 | 25550 | USEPA, December 1989 | |
| | AT-N | Averaging Time (Non-Cancer) | days | 42 | IEPA, Janaury 2003 | 42 | IEPA, Janaury 2003 | |

Notes:
(1) - Calculated according to USEPA Soil Screening Guidance, December 2002.

**Daily Intake Calculations**
Inhalation Intake = (ET x EF x ED x (1/PEF)+(1/VF)) / (AT x 24)

Cancer Inhalation Intake(RME) = 3.91E-04
Noncancer Inhalation Intake(RME) = 2.38E-01
Cancer Inhalation Intake(CTE) = 1.96E-04
Noncancer Inhalation Intake(CTE) = 1.19E-01

Cancer risk from ingestion = Air concentration x Cancer Inhalation Intake x Cancer Inhalation Unit Risk (IUR)
Hazard Index from ingestion = Air concentration x Noncancer Inhalation Intake / Reference Air Concentration (RfCi)

**TABLE 16 REASONABLE MAXIMUM EXPOSURE (RME)**
**CALCULATION OF NON-CANCER HAZARDS**
**EXPOSURE OF CONSTRUCTION WORKERS BY INHALATION FROM SUBSURFACE SOIL**
**SITE 21 - BUILDING 1517**
**NAVAL STATION GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future
Medium: Subsurface Soil
Exposure Medium: Air
Exposure Point: Entire Site
Receptor Population: Construction Worker
Receptor Age: Adult

| Exposure Route | Chemical of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Hazard Calculation [1] | Intake (Non-Cancer) | Intake (Non-Cancer) Units | Reference Concentration (Subchronic [2] if available) | Reference Concentration Units | Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | NAPHTHALENE (partic.) | 4.60E+00 | mg/kg | 3.7E-08 | $mg/m^3$ | R | 8.8E-09 | $mg/m^3$ | 3.0E-03 | $mg/m^3$ | 2.9E-06 |
| | ALUMINUM | 2.43E+04 | mg/kg | 2.0E-04 | $mg/m^3$ | R | 4.7E-05 | $mg/m^3$ | 5.0E-03 | $mg/m^3$ | 9.3E-03 |
| | ARSENIC | 8.50E+01 | mg/kg | 6.9E-07 | $mg/m^3$ | R | 1.6E-07 | $mg/m^3$ | 1.5E-05 | $mg/m^3$ | 1.1E-02 |
| | CADMIUM | 9.62E+00 | mg/kg | 7.8E-08 | $mg/m^3$ | R | 1.8E-08 | $mg/m^3$ | 1.0E-05 | $mg/m^3$ | 1.8E-03 |
| | CHROMIUM | 3.43E+01 | mg/kg | 2.8E-07 | $mg/m^3$ | R | 6.6E-08 | $mg/m^3$ | 1.0E-04 | $mg/m^3$ | 6.6E-04 |
| | COBALT | 2.38E+01 | mg/kg | 1.9E-07 | $mg/m^3$ | R | 4.6E-08 | $mg/m^3$ | 6.0E-06 | $mg/m^3$ | 7.6E-03 |
| | MANGANESE | 1.69E+03 | mg/kg | 1.4E-05 | $mg/m^3$ | R | 3.2E-06 | $mg/m^3$ | 5.0E-05 | $mg/m^3$ | 6.5E-02 |
| | MERCURY | 4.84E-01 | mg/kg | 3.9E-09 | $mg/m^3$ | R | 9.3E-10 | $mg/m^3$ | 3.0E-05 | $mg/m^3$ | 3.1E-05 |
| | NAPHTHALENE (vol.) | 4.60E+00 | mg/kg | 6.6E-05 | $mg/m^3$ | R | 1.6E-05 | $mg/m^3$ | 3.0E-03 | $mg/m^3$ | 5.2E-03 |
| | (total) | | | | | | | | | | 1.0E-01 |

[1] Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

**Total Hazard Index Across All Exposure Routes/Pathways** **0.1**

[2] Subchronic values in *italics.*

**TABLE 17 REASONABLE MAXIMUM EXPOSURE (RME)**
**CALCULATION OF CANCER RISKS**
**EXPOSURE OF CONSTRUCTION WORKERS BY INHALATION FROM SUBSURFACE SOIL**
**SITE 21 - BUILDING 1517**
**NAVAL STATION GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future
Medium: Subsurface Soil
Exposure Medium: Air
Exposure Point: Entire Site
Receptor Population: Construction Worker
Receptor Age: Adult

| Exposure Route | Chemical of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation (1) | Intake (Cancer) | Intake (Cancer) Units | Cancer Unit Risk | Cancer Unit Risk Units | Cancer Risk |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ARSENIC | 8.50E+01 | mg/kg | 6.9E-07 | $mg/m^3$ | R | 2.7E-10 | $mg/m^3$ | 4.3E+00 | $(mg/m^3)^{-1}$ | 1.2E-09 |
| | CADMIUM | 9.62E+00 | mg/kg | 7.8E-08 | $mg/m^3$ | R | 3.0E-11 | $mg/m^3$ | 1.8E+00 | $(mg/m^3)^{-1}$ | 5.5E-11 |
| | CHROMIUM | 3.43E+01 | mg/kg | 2.8E-07 | $mg/m^3$ | R | 1.1E-10 | $mg/m^3$ | 1.2E+01 | $(mg/m^3)^{-1}$ | 1.3E-09 |
| | COBALT | 2.38E+01 | mg/kg | 1.9E-07 | $mg/m^3$ | R | 7.5E-11 | $mg/m^3$ | 9.0E+00 | $(mg/m^3)^{-1}$ | 6.8E-10 |
| | (total) | | | | | | | | | | 3.2E-09 |
| | | | | | | | | | | **Total Risk Across All Exposure Routes/Pathways** | **3.2E-09** |

# Appendix B
# ARARs and To Be Considered Guidance

**TABLE B-1**

**FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs and TBCs**
**SITES 5, 9, AND 21 RECORD OF DECISION**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**


| Requirement | Citation | Status | Synopsis | Evaluation/Action To Be Taken | 5 | 9 | 21 |
|---|---|---|---|---|---|---|---|
| **Federal** | | | | | | | |
| Cancer Slope Factors (CSFs) | - | To Be Considered | These are guidance values used to evaluate the potential carcinogenic hazard caused by exposure to contaminants. Slope factors are developed by EPA from health effects assessments. Carcinogenic effects present the most up-to-date information on cancer risk potency. Potency factors are developed by EPA from Health Effects Assessments of evaluation by the Carcinogenic Assessment Group. | Used to compute the individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media. Risks due to carcinogens as assessed with slope factors are addressed through land use controls (LUCs). | X | X | X |
| Reference Doses (RfDs) | - | To Be Considered | Guidance used to compute human health hazard resulting from exposure to non-carcinogens in site media. RfDs are considered to be the levels unlikely to cause significant adverse health effects associated with a threshold mechanism of action in human exposure for a lifetime. | Used to calculate potential non-carcinogenic hazards caused by exposure to contaminants. Hazards due to noncarcinogens with EPA RfDs are addressed through LUC). | X | X | X |

**TABLE B-1**

**FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs and TBCs**
**SITES 5, 9, AND 21 RECORD OF DECISION**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**


| Requirement | Citation | Status | Synopsis | Evaluation/Action To Be Taken | 5 | 9 | 21 |
|---|---|---|---|---|---|---|---|
| **Federal (continued)** | | | | | | | |
| Guidelines for Carcinogen Risk Assessment | EPA/630/P-03/001F (March 2005) | To Be Considered | Guidance for assessing cancer risk. | Used to calculate potential carcinogenic risks caused by exposure to contaminants. Hazards due to carcinogens assessed through this guidance are addressed through LUCs. | X | X | X |
| Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens | EPA/630/R-03/003F (March 2005) | To Be Considered | Guidance of assessing cancer risks to children. | Used to calculate potential carcinogenic risks to children caused by exposure to contaminants. Carcinogenic risks to children assessed through this guidance are addressed through LUCs. | X | X | X |

**TABLE B-1**

**FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs and TBCs**
**SITES 5, 9, AND 21 RECORD OF DECISION**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**


| Requirement | Citation | Status | Synopsis | Evaluation/Action To Be Taken | 5 | 9 | 21 |
|---|---|---|---|---|---|---|---|
| **State** | | | | | | | |
| Illinois EPA Tiered Approach to Corrective Action Objectives (TACO) - Tier 1 Soil Remediation Objectives | 35 IAC 742.505 (a)(1) and (a)(2) - (Tier 1 Soil Remediation Objectives); 742.1012 - (Institutional Controls, Federally Owned Property); Section 742.Table G and Table H – Background Soil Concentrations | To Be Considered | This Part sets forth procedures for evaluating the risk to human health posed by environmental conditions and developing remediation objectives that achieve acceptable risk levels, and to provide for the adequate protection of human health and the environment based on the risks to human health posed by environmental conditions while incorporating site related information. A Tier 1 evaluation compares the concentration of contaminants detected at a site to the corresponding tabulated remediation objectives for residential and industrial/commercial properties. | These values were considered during soil PRG development, but none were selected as cleanup levels. Naval Station Great Lakes is in Metropolitan area where TACO background values apply, which are used as cleanup levels if greater than risk-based cleanup levels. | X | X | X |

**TABLE B-1**

**FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs and TBCs**
**SITES 5, 9, AND 21 RECORD OF DECISION**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**


| Requirement | Citation | Status | Synopsis | Evaluation/Action To Be Taken | 5 | 9 | 21 |
|---|---|---|---|---|---|---|---|
| Illinois EPA Tiered Approach to Corrective Action Objectives (TACO) - Tier 3 Evaluation | 35 IAC 742 Subpart I (Tier 3 Evaluation); 742.1012 - (Institutional Controls, Federally Owned Property); Section 742.Table G and Table H – Background Soil Concentrations | To Be Considered | This Part sets forth procedures for evaluating the risk to human health posed by environmental conditions and developing remediation objectives that achieve acceptable risk levels, and to provide for the adequate protection of human health and the environment based on the risks to human health posed by environmental conditions while incorporating site related information. Tier 3 sets forth a flexible framework to develop remediation objectives outside of the requirements of Tiers 1 and 2, specifically target cancer risk ranging between 1 in 1,000,000 and 1 in 10,000 at the point of human exposure or a target hazard quotient greater than 1. | This methodology was used to develop soil PRGs, but none were selected as cleanup levels. Naval Station Great Lakes is in Metropolitan area where TACO background values apply, which are used as cleanup levels if greater than risk-based cleanup levels. | X | X | X |

**TABLE B-1**

**FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs and TBCs**
**SITES 5, 9, AND 21 RECORD OF DECISION**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**


| Requirement | Citation | Status | Synopsis | Evaluation/Action To Be Taken | 5 | 9 | 21 |
|---|---|---|---|---|---|---|---|
| Illinois EPA Groundwater Quality Regulations | 35 IAC 620 Subpart B (Groundwater Classification); 620.410 (Groundwater Quality Standards for Class I: Potable Resource Groundwater); 620.450(a) (Alternative Groundwater Quality Standards - Groundwater Quality Restoration Standards) | Applicable | These regulations prescribe various aspects of groundwater quality, including method of classification of groundwater, standards for quality of groundwaters, and conditions for alternative standards. | These standards are used as cleanup levels for groundwater. The alternative standards may be implemented, if needed. | X | X | X |

**TABLE B-2**

**FEDERAL AND STATE LOCATION-SPECIFIC ARARs and TBCs**
**SITES 5, 9, AND 21 RECORD OF DECISION**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**

| Requirement | Citation | Status | Synopsis | Evaluation/Action to be Taken | 5 | 9 | 21 |
|---|---|---|---|---|---|---|---|
| **Federal** | | | | | | | |
| There are no federal location-specific ARARs. | | | | | X | X | X |
| **State** | | | | | | | |
| There are no State location-specific ARARs. | | | | | X | X | X |

**TABLE B-3**

**FEDERAL AND STATE ACTION-SPECIFIC ARARs and TBCs**
**SITES 5, 9, AND 21 RECORD OF DECISION**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**


| Requirement | Citation | Status | Synopsis | Evaluation/Action To Be Taken | 5 | 9 | 21 |
|---|---|---|---|---|---|---|---|
| **Federal** | | | | | | | |
| There are no federal action-specific ARARs. | | | | | | | |
| **State** | | | | | | | |
| Identification and Listing of Hazardous Waste | 35 IAC 721 Subparts C and D | Applicable | Identifies those solid wastes that are subject to regulation as hazardous wastes. | These regulations would apply when determining whether or not a solid waste, such as contaminated soil is hazardous, either by being listed or exhibiting a hazardous characteristic. | X | X | X |
| Standards Applicable to Generators of Hazardous Waste | 35 IAC 722.111 and Subpart C | Applicable | Characterization of waste is required to determine if it is a hazardous waste. Subpart C Establishes manifesting, pre-transport, and accumulation requirements for hazardous waste. | If contaminated soil is determined to be hazardous, these regulations would apply. | X | X | X |
| Fugitive Particulate Dust | 35 IAC 212 Subpart K | Applicable | No person shall cause or allow the emission of fugitive particulate matter from any process, including any material handling or storage activity, that is visible by an observer looking generally toward the zenith at a point beyond the property line of the source. | Control of dust during excavation and handling of soil would be implemented to prevent material from becoming airborne. | X | X | X |

**TABLE B-3**

**FEDERAL AND STATE ACTION-SPECIFIC ARARs and TBCs**
**SITES 5, 9, AND 21 RECORD OF DECISION**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**


| Requirement | Citation | Status | Synopsis | Evaluation/Action To Be Taken | 5 | 9 | 21 |
|---|---|---|---|---|---|---|---|
| **State (continued)** | | | | | | | |
| Illinois Urban Manual (2010) | None | To be considered | The standards and associated materials describe best management practices for controlling non-point source pollution impacts that affect ecosystems in existing communities and developing areas. The manual includes BMPs for soil erosion and sediment control; stormwater management; and special area protection. | Soil excavation activities would need to meet these requirements. | X | X | X |
| Solid Waste Regulations | 35 IAC 807.305(c) (Final Cover) | Relevant and Appropriate | Requires a compacted layer of not less than two feet of suitable material shall be placed of a solid waste landfill at closure. | The uncontaminated surface soil, asphalt pavement of the roads, and foundations and buildings over the ravine fill meets this requirement. | | X | |
| Solid Waste Regulations | 35 IAC 807.502 (Closure Standards) | Relevant and Appropriate | Requires site closure in a manner that minimizes the need for further maintenance and controls, minimizes, or eliminates post-closure releases. | Land use controls will be developed to provide for inspection of the cover. | | X | |

**TABLE B-3**

**FEDERAL AND STATE ACTION-SPECIFIC ARARs and TBCs**
**SITES 5, 9, AND 21 RECORD OF DECISION**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**


| Requirement | Citation | Status | Synopsis | Evaluation/Action To Be Taken | 5 | 9 | 21 |
|---|---|---|---|---|---|---|---|
| Standards for New Solid Waste Landfills | 35 IAC 811.110(g)(1) (Deed notation) | Relevant and Appropriate | Requires that the owner or operator shall record a notation on the deed to the landfill facility property. | The site is currently owned by the Navy, and there are no plans for property conveyance. In the event that the property is to be transferred, a notation will be made on the deed to indicate the presence of the ravine fill at Site 9. | | X | |
| Underground Injection Control Operating Requirements | 35 IAC 730.151; 730.110(c) | Applicable | Sets forth technical criteria and standards for the Underground Injection Control (UIC) Program. | These regulations apply to installation and abandonment of wells used for underground injection of oxidizing chemical. Wells for in-situ chemical oxidation injection would be Class V wells. | X | X | X |
| Uniform Environmental Covenants Act (UECA) | 765 Illinois Compiled Statutes (ILCS) 122 | Applicable | Ensures that land use restrictions, mandated environmental monitoring requirements, and a wide range of common engineering controls designed to control the potential environmental risk of residual contamination will be recorded in the land records and effectively enforced indefinitely. | If the property is transferred to a non-federal owner, then LUCs will be recorded in the deed through this act. | X | X | X |

**TABLE B-3**

**FEDERAL AND STATE ACTION-SPECIFIC ARARs and TBCs**
**SITES 5, 9, AND 21 RECORD OF DECISION**
**NAVAL STATION GREAT LAKES**
**GREAT LAKES, ILLINOIS**


| Requirement | Citation | Status | Synopsis | Evaluation/Action To Be Taken | 5 | 9 | 21 |
|---|---|---|---|---|---|---|---|
| Special Waste Classifications | 35 IAC 808.121 (Generator Obligations),<br>35 IAC 808.110 (Definitions),<br>35 IAC 809.103 (Definitions) | Applicable | Defines “special waste" and requires those who generate waste shall determine whether the waste is a special waste. Special wastes include all hazardous wastes and wastes resulting from the treatment of contaminated media. | Wastes generated during remediation will be evaluated to determine if they are special wastes or certified that the soil waste meets the exemptions. Wastes determined to be special wastes will be transported and disposed of according to the special waste regulations. | X | X | X |

# Appendix C
# Cost Estimates

# Appendix C.1
# Site 5 Cost Estimates

**NAVAL TRAINING CENTER GREAT LAKES**
**Great Lakes, Illinois**
**Site 5 - Transformer Storage Boneyard**
**Alternative 5-2: LUCs and Barrier**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1 PROJECT PLANNING & DOCUMENTS** | | | | | | | | | | | |
| 1.1 Prepare LUC Documents | 250 | hr | | | $40.00 | | $0 | $0 | $10,000 | $0 | $10,000 |
| **Subtotal** | | | | | | | $0 | $0 | $10,000 | $0 | $10,000 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $3,000 | | $3,000 |
| G & A Cost @ 10% | | | | | | | $0 | $0 | $1,000 | $0 | $1,000 |
| Tax on Materials and Equipment Cost @ 6.25% | | | | | | | | $0 | | $0 | $0 |
| **Total Direct Cost** | | | | | | | $0 | $0 | $14,000 | $0 | $14,000 |
| Indirects on Total Direct Cost @ 20% | | | | | | | | | | | $2,800 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $1,400 |
| **Subtotal** | | | | | | | | | | | $18,200 |
| Health & Safety Monitoring @ 0% | | | | | | | | | | | $0 |
| **Total Field Cost** | | | | | | | | | | | $18,200 |
| Contingency on Total Field Costs @ 10% | | | | | | | | | | | $1,820 |
| Engineering on Total Field Cost @ 0% | | | | | | | | | | | $0 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$20,020** |

**NAVAL TRAINING CENTER GREAT LAKES**
**Great Lakes, Illinois**
**Site 5 - Transformer Storage Boneyard**
**Alternative 5-2: LUCs and Barrier**
**Annual Cost**

| Item | Item Cost years 1 - 30 | Item Cost every 5 years | Notes |
|---|---|---|---|
| Annual Site Inspection & Report | $2,350 | | Labor and supplies for a yearly local inspection of Land Use Controls with Report |
| Cover Maintenance | $5,500 | | |
| Five Year Site Review | | $23,000 | Labor and supplies to evaluate site every five years for 5-year review |
| SUBTOTAL | $7,850 | $23,000 | |
| Contingency @ 10% | $785 | $2,300 | |
| **TOTAL** | **$8,635** | **$25,300** | |

**NAVAL TRAINING CENTER GREAT LAKES**
**Great Lakes, Illinois**
**Site 5 - Transformer Storage Boneyard**
**Alternative 5-2: LUCs and Barrier**
**Present Worth Analysis**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate 1.1% | Present Worth |
|---|---|---|---|---|---|
| 0 | $20,020 | | $20,020 | 1.000 | $20,020 |
| 1 | | $8,635 | $8,635 | 0.989 | $8,541 |
| 2 | | $8,635 | $8,635 | 0.978 | $8,448 |
| 3 | | $8,635 | $8,635 | 0.968 | $8,356 |
| 4 | | $8,635 | $8,635 | 0.957 | $8,265 |
| 5 | | $33,935 | $33,935 | 0.947 | $32,129 |
| 6 | | $8,635 | $8,635 | 0.936 | $8,086 |
| 7 | | $8,635 | $8,635 | 0.926 | $7,998 |
| 8 | | $8,635 | $8,635 | 0.916 | $7,911 |
| 9 | | $8,635 | $8,635 | 0.906 | $7,825 |
| 10 | | $33,935 | $33,935 | 0.896 | $30,418 |
| 11 | | $8,635 | $8,635 | 0.887 | $7,656 |
| 12 | | $8,635 | $8,635 | 0.877 | $7,573 |
| 13 | | $8,635 | $8,635 | 0.867 | $7,490 |
| 14 | | $8,635 | $8,635 | 0.858 | $7,409 |
| 15 | | $33,935 | $33,935 | 0.849 | $28,799 |
| 16 | | $8,635 | $8,635 | 0.839 | $7,248 |
| 17 | | $8,635 | $8,635 | 0.830 | $7,170 |
| 18 | | $8,635 | $8,635 | 0.821 | $7,092 |
| 19 | | $8,635 | $8,635 | 0.812 | $7,014 |
| 20 | | $33,935 | $33,935 | 0.803 | $27,266 |
| 21 | | $8,635 | $8,635 | 0.795 | $6,863 |
| 22 | | $8,635 | $8,635 | 0.786 | $6,788 |
| 23 | | $8,635 | $8,635 | 0.778 | $6,714 |
| 24 | | $8,635 | $8,635 | 0.769 | $6,641 |
| 25 | | $33,935 | $33,935 | 0.761 | $25,815 |
| 26 | | $8,635 | $8,635 | 0.752 | $6,497 |
| 27 | | $8,635 | $8,635 | 0.744 | $6,427 |
| 28 | | $8,635 | $8,635 | 0.736 | $6,357 |
| 29 | | $8,635 | $8,635 | 0.728 | $6,288 |
| 30 | | $33,935 | $33,935 | 0.720 | $24,441 |
| | | | | **TOTAL PRESENT WORTH** | **$365,545** |

# Appendix C.2
# Site 9 Cost Estimates

**NAVAL TRAINING CENTER GREAT LAKES**
**Great Lakes, Illinois**
**Site 9 - Camp Moffett Ravine Fill**
**Alternative 9-2: LUCs and Barrier**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1 PROJECT PLANNING & DOCUMENTS** | | | | | | | | | | | |
| 1.1 Prepare LUC Documents | 250 | hr | | | $40.00 | | $0 | $0 | $10,000 | $0 | $10,000 |
| **Subtotal** | | | | | | | $0 | $0 | $10,000 | $0 | $10,000 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $3,000 | | $3,000 |
| G & A Cost @ 10% | | | | | | | $0 | $0 | $1,000 | $0 | $1,000 |
| Tax on Materials and Equipment Cost @ 6.25% | | | | | | | | $0 | | $0 | $0 |
| **Total Direct Cost** | | | | | | | $0 | $0 | $14,000 | $0 | $14,000 |
| Indirects on Total Direct Cost @ 20% | | | | | | | | | | | $2,800 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $1,400 |
| **Subtotal** | | | | | | | | | | | $18,200 |
| Health & Safety Monitoring @ 0% | | | | | | | | | | | $0 |
| **Total Field Cost** | | | | | | | | | | | $18,200 |
| Contingency on Total Field Costs @ 10% | | | | | | | | | | | $1,820 |
| Engineering on Total Field Cost @ 0% | | | | | | | | | | | $0 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$20,020** |

**NAVAL TRAINING CENTER GREAT LAKES**
**Great Lakes, Illinois**
**Site 9 - Camp Moffett Ravine Fill**
**Alternative 9-2: LUCs and Barrier**
**Annual Cost**

| Item | Item Cost years 1 - 30 | Item Cost every 5 years | Notes |
|---|---|---|---|
| Annual Site Inspection & Report | $2,350 | | Labor and supplies for a yearly local inspection of Land Use Controls with Report |
| Cover Maintenance | $5,500 | | |
| Five Year Site Review | | $23,000 | Labor and supplies to evaluate site every five years for 5-year review |
| SUBTOTAL | $7,850 | $23,000 | |
| Contingency @ 10% | $785 | $2,300 | |
| **TOTAL** | **$8,635** | **$25,300** | |

**NAVAL TRAINING CENTER GREAT LAKES**
**Great Lakes, Illinois**
**Site 9 - Camp Moffett Ravine Fill**
**Alternative 9-2: LUCs and Barrier**
**Present Worth Analysis**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate 1.1% | Present Worth |
|---|---|---|---|---|---|
| 0 | $20,020 | | $20,020 | 1.000 | $20,020 |
| 1 | | $8,635 | $8,635 | 0.989 | $8,541 |
| 2 | | $8,635 | $8,635 | 0.978 | $8,448 |
| 3 | | $8,635 | $8,635 | 0.968 | $8,356 |
| 4 | | $8,635 | $8,635 | 0.957 | $8,265 |
| 5 | | $33,935 | $33,935 | 0.947 | $32,129 |
| 6 | | $8,635 | $8,635 | 0.936 | $8,086 |
| 7 | | $8,635 | $8,635 | 0.926 | $7,998 |
| 8 | | $8,635 | $8,635 | 0.916 | $7,911 |
| 9 | | $8,635 | $8,635 | 0.906 | $7,825 |
| 10 | | $33,935 | $33,935 | 0.896 | $30,418 |
| 11 | | $8,635 | $8,635 | 0.887 | $7,656 |
| 12 | | $8,635 | $8,635 | 0.877 | $7,573 |
| 13 | | $8,635 | $8,635 | 0.867 | $7,490 |
| 14 | | $8,635 | $8,635 | 0.858 | $7,409 |
| 15 | | $33,935 | $33,935 | 0.849 | $28,799 |
| 16 | | $8,635 | $8,635 | 0.839 | $7,248 |
| 17 | | $8,635 | $8,635 | 0.830 | $7,170 |
| 18 | | $8,635 | $8,635 | 0.821 | $7,092 |
| 19 | | $8,635 | $8,635 | 0.812 | $7,014 |
| 20 | | $33,935 | $33,935 | 0.803 | $27,266 |
| 21 | | $8,635 | $8,635 | 0.795 | $6,863 |
| 22 | | $8,635 | $8,635 | 0.786 | $6,788 |
| 23 | | $8,635 | $8,635 | 0.778 | $6,714 |
| 24 | | $8,635 | $8,635 | 0.769 | $6,641 |
| 25 | | $33,935 | $33,935 | 0.761 | $25,815 |
| 26 | | $8,635 | $8,635 | 0.752 | $6,497 |
| 27 | | $8,635 | $8,635 | 0.744 | $6,427 |
| 28 | | $8,635 | $8,635 | 0.736 | $6,357 |
| 29 | | $8,635 | $8,635 | 0.728 | $6,288 |
| 30 | | $33,935 | $33,935 | 0.720 | $24,441 |
| | | | | **TOTAL PRESENT WORTH** | **$365,545** |

# Appendix C.3
# Site 21 Cost Estimates

**NAVAL TRAINING CENTER GREAT LAKES**
**Great Lakes, Illinois**
**Site 21 - Buildings 1517/1506 Area**
**Alternative 21-2: LUCs and Barrier**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1 PROJECT PLANNING & DOCUMENTS** | | | | | | | | | | | |
| 1.1 Prepare LUC Documents | 250 | hr | | | $40.00 | | $0 | $0 | $10,000 | $0 | $10,000 |
| **Subtotal** | | | | | | | $0 | $0 | $10,000 | $0 | $10,000 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $3,000 | | $3,000 |
| G & A Cost @ 10% | | | | | | | $0 | $0 | $1,000 | $0 | $1,000 |
| Tax on Materials and Equipment Cost @ 6.25% | | | | | | | | $0 | | $0 | $0 |
| **Total Direct Cost** | | | | | | | $0 | $0 | $14,000 | $0 | $14,000 |
| Indirects on Total Direct Cost @ 20% | | | | | | | | | | | $2,800 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $1,400 |
| **Subtotal** | | | | | | | | | | | $18,200 |
| Health & Safety Monitoring @ 0% | | | | | | | | | | | $0 |
| **Total Field Cost** | | | | | | | | | | | $18,200 |
| Contingency on Total Field Costs @ 10% | | | | | | | | | | | $1,820 |
| Engineering on Total Field Cost @ 0% | | | | | | | | | | | $0 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$20,020** |

**NAVAL TRAINING CENTER GREAT LAKES**
**Great Lakes, Illinois**
**Site 21 - Buildings 1517/1506 Area**
**Alternative 21-2: LUCs and Barrier**
**Annual Cost**

| Item | Item Cost years 1 - 30 | Item Cost every 5 years | Notes |
|---|---|---|---|
| Annual Site Inspection & Report | $2,350 | | Labor and supplies for a yearly local inspection of Land Use Controls with Report |
| Cover Maintenance | $5,500 | | |
| Five Year Site Review | | $23,000 | Labor and supplies to evaluate site every five years for 5-year review |
| SUBTOTAL | $7,850 | $23,000 | |
| Contingency @ 10% | $785 | $2,300 | |
| **TOTAL** | **$8,635** | **$25,300** | |

**NAVAL TRAINING CENTER GREAT LAKES**
**Great Lakes, Illinois**
**Site 21 - Buildings 1517/1506 Area**
**Alternative 21-2: LUCs and Barrier**
**Present Worth Analysis**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate 1.1% | Present Worth |
|---|---|---|---|---|---|
| 0 | $20,020 | | $20,020 | 1.000 | $20,020 |
| 1 | | $8,635 | $8,635 | 0.989 | $8,541 |
| 2 | | $8,635 | $8,635 | 0.978 | $8,448 |
| 3 | | $8,635 | $8,635 | 0.968 | $8,356 |
| 4 | | $8,635 | $8,635 | 0.957 | $8,265 |
| 5 | | $33,935 | $33,935 | 0.947 | $32,129 |
| 6 | | $8,635 | $8,635 | 0.936 | $8,086 |
| 7 | | $8,635 | $8,635 | 0.926 | $7,998 |
| 8 | | $8,635 | $8,635 | 0.916 | $7,911 |
| 9 | | $8,635 | $8,635 | 0.906 | $7,825 |
| 10 | | $33,935 | $33,935 | 0.896 | $30,418 |
| 11 | | $8,635 | $8,635 | 0.887 | $7,656 |
| 12 | | $8,635 | $8,635 | 0.877 | $7,573 |
| 13 | | $8,635 | $8,635 | 0.867 | $7,490 |
| 14 | | $8,635 | $8,635 | 0.858 | $7,409 |
| 15 | | $33,935 | $33,935 | 0.849 | $28,799 |
| 16 | | $8,635 | $8,635 | 0.839 | $7,248 |
| 17 | | $8,635 | $8,635 | 0.830 | $7,170 |
| 18 | | $8,635 | $8,635 | 0.821 | $7,092 |
| 19 | | $8,635 | $8,635 | 0.812 | $7,014 |
| 20 | | $33,935 | $33,935 | 0.803 | $27,266 |
| 21 | | $8,635 | $8,635 | 0.795 | $6,863 |
| 22 | | $8,635 | $8,635 | 0.786 | $6,788 |
| 23 | | $8,635 | $8,635 | 0.778 | $6,714 |
| 24 | | $8,635 | $8,635 | 0.769 | $6,641 |
| 25 | | $33,935 | $33,935 | 0.761 | $25,815 |
| 26 | | $8,635 | $8,635 | 0.752 | $6,497 |
| 27 | | $8,635 | $8,635 | 0.744 | $6,427 |
| 28 | | $8,635 | $8,635 | 0.736 | $6,357 |
| 29 | | $8,635 | $8,635 | 0.728 | $6,288 |
| 30 | | $33,935 | $33,935 | 0.720 | $24,441 |
| | | | | **TOTAL PRESENT WORTH** | **$365,545** |