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FINAL RESOURCE CONSERVATION AND RECOVERY ACT FACILITY ASSESSMENT FOR UNEXPLODED ORDNANCE 9 (UXO 9) NSA CRANE IN
10/15/2015
RESOLUTION CONSULTANTS

# FINAL
# RESOURCE CONSERVATION AND RECOVERY ACT FACILITY ASSESSMENT FOR UXO 0009

**NAVAL SUPPORT ACTIVITY CRANE**
**CRANE, INDIANA**

**Revision: 0**

**Prepared for:**

**Naval Facilities Engineering Command Mid-Atlantic**
**9324 Virginia Avenue**
**Norfolk, Virginia 23511-3095**

**15 October 2015**

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**CRANE, INDIANA**

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**Prepared for:**

**Naval Facilities Engineering Command Mid-Atlantic**
**9324 Virginia Avenue**
**Norfolk, Virginia 23511-3095**

**Prepared by:**

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**Contract Number: N62470-11-D-8013**
**CTO WE63**

**October 2015**

**Jim Rathbone**
**Contract Task Order Manager**

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## Acronyms

| | |
|---|---|
| µg/L | micrograms per liter |
| HMX | octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine |
| MEC | munitions and explosives of concern |
| NSA | Naval Support Activity |
| RCRA | Resource Conservation and Recovery Act |
| RDX | hexahydro-1,3,5-trinitro-1,3,5-triazine |
| RFA | RCRA Facility Assessment |
| RFI | RCRA Facility Investigation |
| SWMU | Solid Waste Management Unit |
| U.S. EPA | United States Environmental Protection Agency |
| VSI | visual site inspection |

# 1.0 INTRODUCTION

Resolution Consultants has prepared this Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA) for the Naval Facilities Engineering Command Mid-Atlantic for Naval Support Activity (NSA) Crane in Crane, Indiana, under the Comprehensive Long-Term Environmental Action Navy Contract No. N62470-11-D-8013, Contract Task Order WE63. The RCRA corrective action program provides for the clean-up of releases of hazardous waste or hazardous constituents that threaten human health or the environment. The program applies to all operating, closed, or closing RCRA facilities. The first step in the RCRA corrective action process is the RFA. NSA Crane operates under RCRA permit number IN5170023498, issued 23 May 2013.

## 1.1 Purpose

The purpose of this RFA report is to determine if there are releases of concern for all environmental media, including soil, sediment, groundwater, surface water, subsurface gas, or air, at a location potentially impacted by munitions and explosives of concern (MEC) and designated as UXO 0009 in the Navy's Military Munitions Program. The major objectives of the RFA include the following: identify the site, collect existing information on contaminant releases, and identify releases or suspected releases needing further investigation.

This RFA report describes the findings of the preliminary review and the visual site inspection (VSI) of UXO 0009. The report includes the following: (1) a description of the facility and site UXO 0009; (2) an identification of the release potential of hazardous wastes or hazardous constituents through various migration pathways; and (3) a summary of conclusions and recommendations regarding further remediation activity, such as the need for confirmatory sampling, a RCRA Facility Investigation (RFI), interim measures, and/or additional assessment activities.

## 1.2 Procedures

Resolution Consultants personnel conducted a file and document review for UXO 0009 and related Solid Waste Management Units (SWMUs) and Areas of Concern. Following the completion of the file and document review, Resolution Consultants initiated a preliminary review of the material obtained to characterize the site. Following the preliminary review, a series of interviews were conducted with current and former NSA Crane employees. Information provided by personnel associated with the site is presented in Section 3.0. On 30 June 2015, Resolution Consultants visually inspected UXO 0009.

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# 2.0 SITE BACKGROUND

This section of the RFA report describes the UXO 0009 location (Figure 2-1) and background.

## 2.1 Facility Location and Description

NSA Crane is in a rural, sparsely populated region of south-central Indiana, approximately 75 miles southwest of Indianapolis, 60 miles northwest of Louisville, Kentucky, and immediately east of Burns City and Crane Village, Indiana. NSA Crane encompasses approximately 62,463 acres or approximately 98 square miles of the northern portion of Martin County and smaller portions of Greene, Daviess, and Lawrence Counties. The facility was opened in 1941 and continues to be an active military facility.

## 2.2 UXO 0009

NSA Crane identified UXO 0009 as a new site after detection of explosives in surface water at sample locations upgradient of SWMU 22. SWMU 22, Lead Azide Pond, is in the NSA Crane area referred to as the Explosive Actuated Device/Booster Area or the "Backline." During the SWMU 22 RFI field work conducted in 2011 and 2012, samples were collected from locations topographically higher and upstream from SWMU 22 (Tetra Tech 2014). Two surface water sample locations northeast of SWMU 22 (Figure 2-2) indicated two explosives, hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) and octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX), in samples from surface water features upstream of the site. A surface water sample collected on 20 January 2011 at location 22SW011, approximately 600 feet northeast of Building 2520, indicated RDX at 0.79 micrograms per liter (µg/L) and HMX at 0.88 µg/L. A surface water sample collected on 9 April 2011 at location 22SW013, approximately 950 feet north of Building 2520 within SWMU 22, indicated RDX at 0.98 µg/L and HMX at 11 µg/L. RDX and HMX are not naturally occurring, so these samples were considered a potential indicator of upstream contamination. Other surface water sample locations from the same general area north and northeast of SWMU 22 did not indicate explosives in either surface water or sediment samples. The two sample locations are separated by over 800 stream feet and location 22SW013 is upstream of location 22SW011. A sediment sample from location 22SW011/22SD011 did not identify explosives above the laboratory detection limit. A sediment sample was not collected at location 22SW013, because the stream bed consisted of exposed bedrock.

During the SWMU 22 RFI, the conservative baseline human health risk assessment compared the surface water results to the Indiana Department of Environmental Management Remedial Closure Guide 2013 Screening Levels Table groundwater values divided by 10 to achieve a hazard quotient of 0.1. The human health screening values were 0.61 µg/L for RDX and

78 µg/L for HMX. The SWMU 22 screening level ecological risk assessment compared the surface water sample results to the United States Environmental Protection Agency (U.S. EPA) Region 3 Biological Technical Assistance Group Freshwater Sediment Screening Benchmarks (U.S. EPA 2006). The ecological screening values were 360 µg/L for RDX and 150 µg/L for HMX. The RDX concentrations detected at locations 22SW013 and 22SW011 both exceeded the human health risk assessment screening values for RDX. The RDX concentrations did not exceed the ecological screening values. The HMX concentrations detected at locations 22SW013 and 22SW011 did not exceed with the human health or ecological screening values. Since other samples collected during the SWMU 22 investigation did not detect explosives in the same general area or upgradient of these locations, the source of explosives and the size of the area of contamination associated with sample locations 22SW011 and 22SW013 is not known. Pertinent sections of the SWMU 22 2014 RFI report, including tables and figures, are in Appendix A of this report.

During the SWMU 22 investigation, there were no sample locations upgradient of location 22SW013, while four surface water locations (22SW012, 22SW014, 22SW015, and 22SW016) upgradient of location 22SW011 indicated no exceedances of human health or ecological screening values. Soil and groundwater samples were collected from within the SWMU 22 boundary and based on the results of the human health and ecological risk assessments included in the RFI, no further action was recommended for SWMU 22 (Tetra Tech 2014). Although SWMU 22 has been recommended for no further action, an upgradient area of potential contamination has been designated UXO 0009 and is the subject of this document.

SWMU 15 is an area upstream of SWMU 22 sample locations 22SW011 and 22SW013. An RFI of SWMU 15 (Tetra Tech NUS, Inc. 2006) indicated potential concerns included an asphalt batch plant, waste oils, fuel oil, gasoline, solvents, paints, lubricants, and residues of pesticides and herbicides. Explosives were not investigated at SWMU 15 and not mentioned in the site's history. Several of the sediment and surface water samples collected at SWMU 15 were across the road and north or northeast of SWMU 22 sample location 22SW013. No areas upstream of sample location 22SW013 were sampled during the SWMU 15 RFI. Sediment and surface water locations at SWMU 15 which were upstream of sample location 22SW011 were also upstream of locations 22SW012 and 22SW014, which indicated no exceedances of human health or ecological screening values. Based on the SWMU 15 RFI report (Tetra Tech NUS 2006), there is no indication SWMU 15 is the source of explosives identified at two surface water sample locations upstream of SWMU 22.

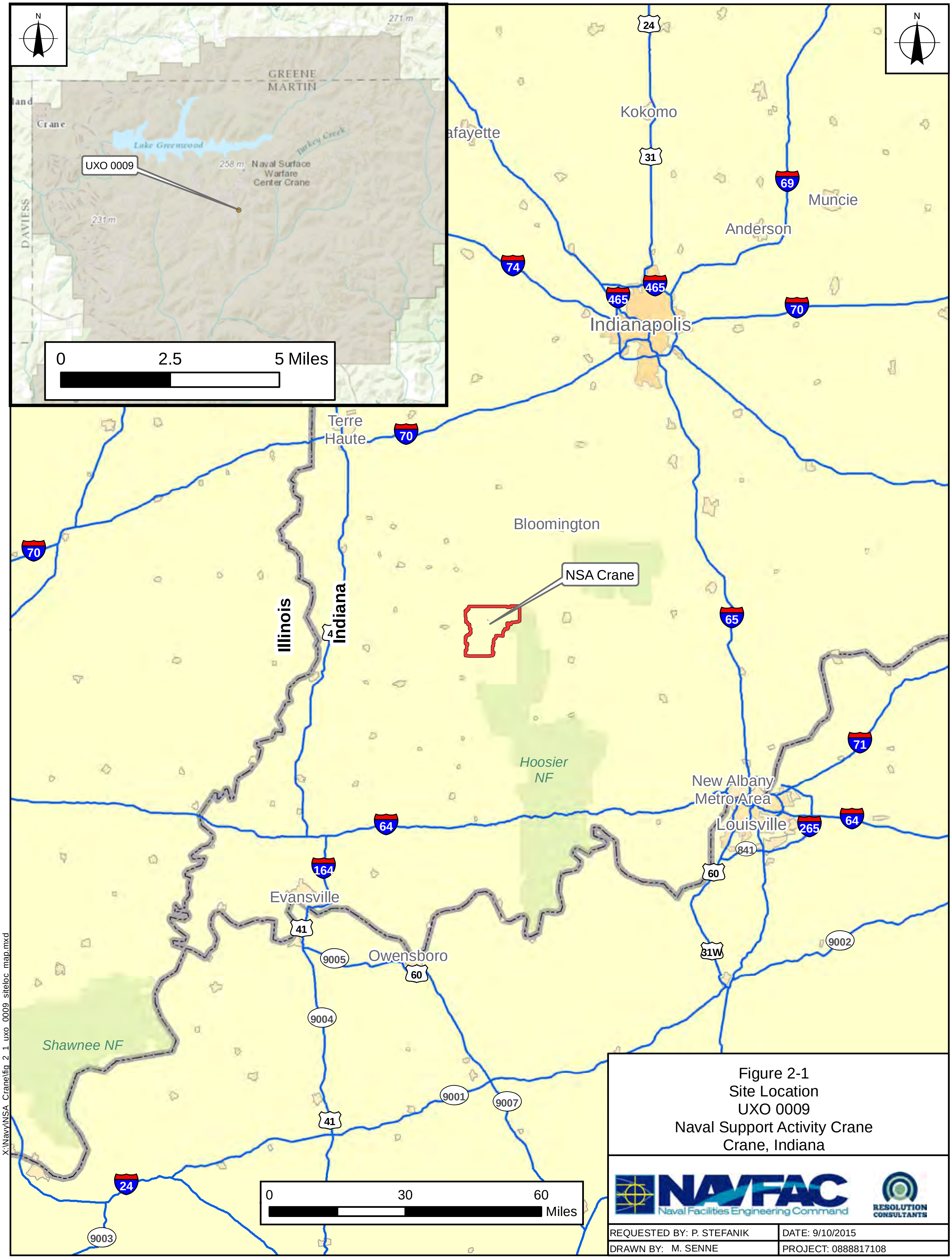


Figure 2-1
Site Location
UXO 0009
Naval Support Activity Crane
Crane, Indiana

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Service Layer Credits: Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo,

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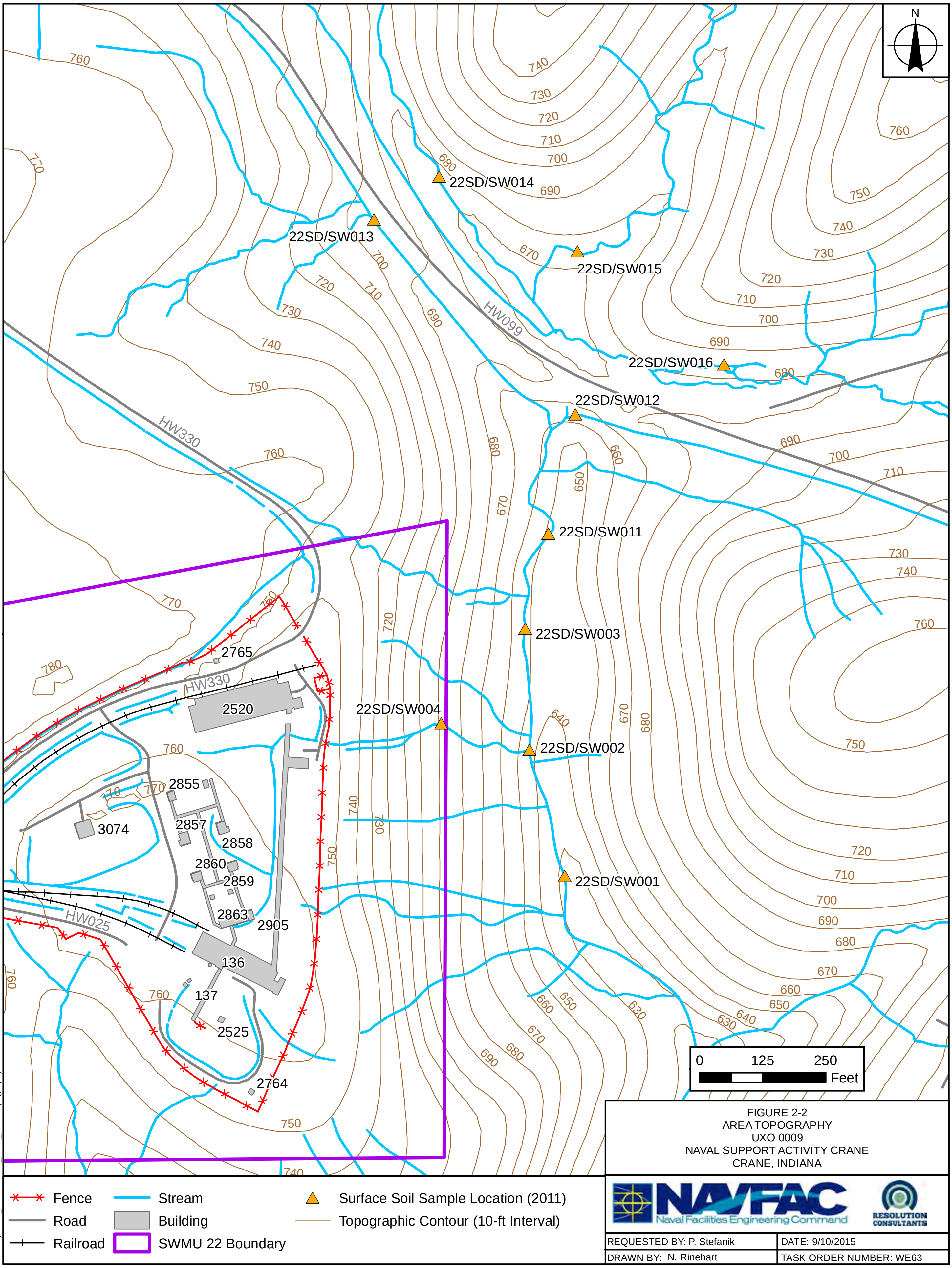


Service Layer Credits: USDA/NRCS - 10 meter National Elevation Dataset (NED)

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## 3.0 DESCRIPTION OF SITE ACTIVITIES AND HISTORY

Site history and activity information for UXO 0009 is limited to investigations at the adjacent SWMU 22 and NSA Crane personnel interviews. Thomas Brent, Environmental Restoration/Corrective Action Site Project Manager for NSA Crane, provided names of NSA Crane personnel familiar with the UXO 0009 area.

### 3.1 Phone Interviews

Resolution Consultants contacted Douglas Johnson concerning UXO 0009. Mr. Johnson has been an employee at NSA Crane for 24 years and currently holds the position of Crane Army Ammunition Activity Environmental Protection Specialist. He described the location of UXO 0009 as being northeast of Building 138 outside the fence. Building 138 is approximately 750 feet west of Building 2520. He was aware the chemical of concern was RDX since it was detected in a "surface sample"; however, he was unaware of whether this sample was surface water, soil, or sediment. Mr. Johnson did not know how or why RDX would be present in the area of sample locations 22SW013 and 22SW011, since the process of "pressing boosters" in the nearest building (Building 138) did not involve the use of RDX. Mr. Johnson made inquiries to current employees with longer tenures and retired employees knowledgeable of the general area and none were able to provide information concerning how RDX may have come to be at sample locations 22SW013 and 22SW011.

Resolution Consultants also contacted Dale Groh concerning UXO 0009. Mr. Groh retired in 2001 after working at NSA Crane for 33 years as a Senior Program Analyst/Explosives Safety Engineer. He stated Building 138 was used during World War II to load 5-inch rocket motors into projectiles. He did not know if RDX was used in this process, but stated 2,4,6-trinitrotulene may have been in the pre-processed projectiles coming from another production area. Mr. Groh stated RDX was processed on the Backline at Building 136, which is approximately 900 feet southeast of Building 138, during the 1960s to make detonators. This manufacturing stopped in 1978 and RDX could have been introduced into the surrounding area by wash water used in the detonator manufacturing process. Mr. Groh stated wash water was produced in small quantities and drained into a trench near Building 136. He also stated the majority of the wastewater was emptied into sumps and treated with a "kill solution" to eliminate the possibility of active explosives being discharged into the environment. Mr. Groh was unaware of any dumping occurring in the area of UXO 0009 and he thought the RDX detected at sample locations 22SW013 and 22SW011 must be from the aforementioned wastewater. Mr. Groh supplied several documents and figures concerning SWMU 22; these are in Appendix B.

## 3.2 Site Interview

Resolution Consultants conducted a site interview with Mr. Brent regarding UXO 0009. Mr. Brent has been employed at NSA Crane for 26 years. Mr. Brent confirmed the same information provided by Mr. Johnson and Mr. Groh about the unknown source of MEC contamination, in particular RDX and HMX, at sample locations 22SW013 and 22SW011. During the interview, aerial photographs dated 1966 and 2012 were reviewed and discussed regarding the SWMU 22 and UXO 0009 area. Copies of the 1966 and 2012 aerial photographs are in Appendix C. The current access road to SWMU 22 was discovered to bisect the interpreted upgradient portion of the UXO 0009 area.

## 3.3 Visual Site Investigation

On 30 June 2015, Resolution Consultants, accompanied by Mr. Brent of NSA Crane, conducted a VSI. The UXO 0009 area can be described as a grassy plateau on the western edge of a high tension power line clearance sloping moderately to the east through a densely wooded area. The slopes contain numerous small drainage channels that, at the time of the VSI, were dry. The toe of the slope is a grassy area maintained as roadway right-of-way approximately 0.1 mile northeast of SWMU 22. This area held approximately 2 inches of standing water and Mr. Brent stated it was the location of sample 22SW013, which initiated the creation of UXO 0009. The exact location of sample location 22SW011, which is along an unnamed drainage channel in a densely forested area, was not identified during the VSI.

Approximately 0.25 mile north of SWMU 22 is the southern portion of SWMU 15. According to Mr. Brent, this area is the former site of the NSA Crane road salt storage dome. Currently the area is temporary storage for nearby operations. During the VSI, several large shipping containers (contents unknown) were the only materials observed in this area. A clear, physiographic boundary capable of constraining contaminant transport could not be determined in this area.

A photo log of conditions observed during the VSI is in Appendix D.

## 4.0 ENVIRONMENTAL SETTING

The UXO 0009 area consists of drainage channels which are dry or have little to no flow during times of minimal precipitation. Sample location 22SW013 is grass covered, adjacent to a road, and ultimately the area drains to a concrete lined drainage channel parallel to the road (see aerial photographs in Appendix C and Figure 2-2). The 1966 aerial photograph showed the drainage channel parallel to the road and downstream of sample location 22SW013 was paved with concrete. The RFI report stated the stream bed consisted of exposed bedrock at location 22SW013, the stream depth was 1.0 foot and the stream flow rate was estimated to be 150 gallons per minute during the April 2011 sampling event (Tetra Tech 2014). Sample location 22SW011 is in a dense forest with no obvious access points. The RFI report stated sample location 22SW011 had a creek width of 5 to 6 feet, a creek depth of 6 to 8 inches, a rocky creek bottom, and the stream flow rate was estimated to be 15 to 20 gallons per minute during the January 2011 sampling event (Tetra Tech 2014).

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## 5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the 2013 SWMU 22 RFI, SWMU 22 is the most proximal potential contaminant source for UXO 0009. The source of HMX and RDX at sample locations 22SW011 and 22SW013 could not be determined during this RFA. These locations are upgradient of potential sources at SWMU 22 and there are no other known sources upgradient of the sample locations. Based on the results of the human health and ecological risk assessments in the SWMU 22 RFI, no further action was recommended for SWMU 22 (Tetra Tech 2014).

Additional assessment activities should be performed upstream/upgradient of sample locations 22SW011 and 22SW013. Sediment samples from 0 to 6 inches deep and surface water samples are proposed for collection from as many as three locations upstream of location 22SW011, as many as five locations upstream of location 22SW013, and one location downstream of location 22SW011 in a stream entering from the west-northwest. Figure 5-1 shows the approximate proposed sample locations. Most of the upstream drainage channels in the area are typically dry, so samples will likely need to be collected concurrent with a rain event. Proposed sample locations upstream of location 22SW011 include one to the north along the forested drainage channel, one in the upstream channel to the east-southeast, and one in the upstream channel to the northwest which includes sample location 22SW013. Proposed sample locations upstream of location 22SW013 include one each in three upslope forested area drainage swales to the west and southwest, one in the drainage swale to the northwest, and one in a seep area along an east-west trending utility right-of-way southwest of 22SW013. Sampling during the SWMU 22 RFI of the area north of sample location 22SW012 and the confluence of three drainage channels indicated no exceedances of human health or ecological screening values, so the area will not be investigated again. Evaluation of the results from the additional assessment will be compared to the risk assessment screening values established during the SWMU 22 RFI. This assessment will determine potential next steps for UXO 0009.

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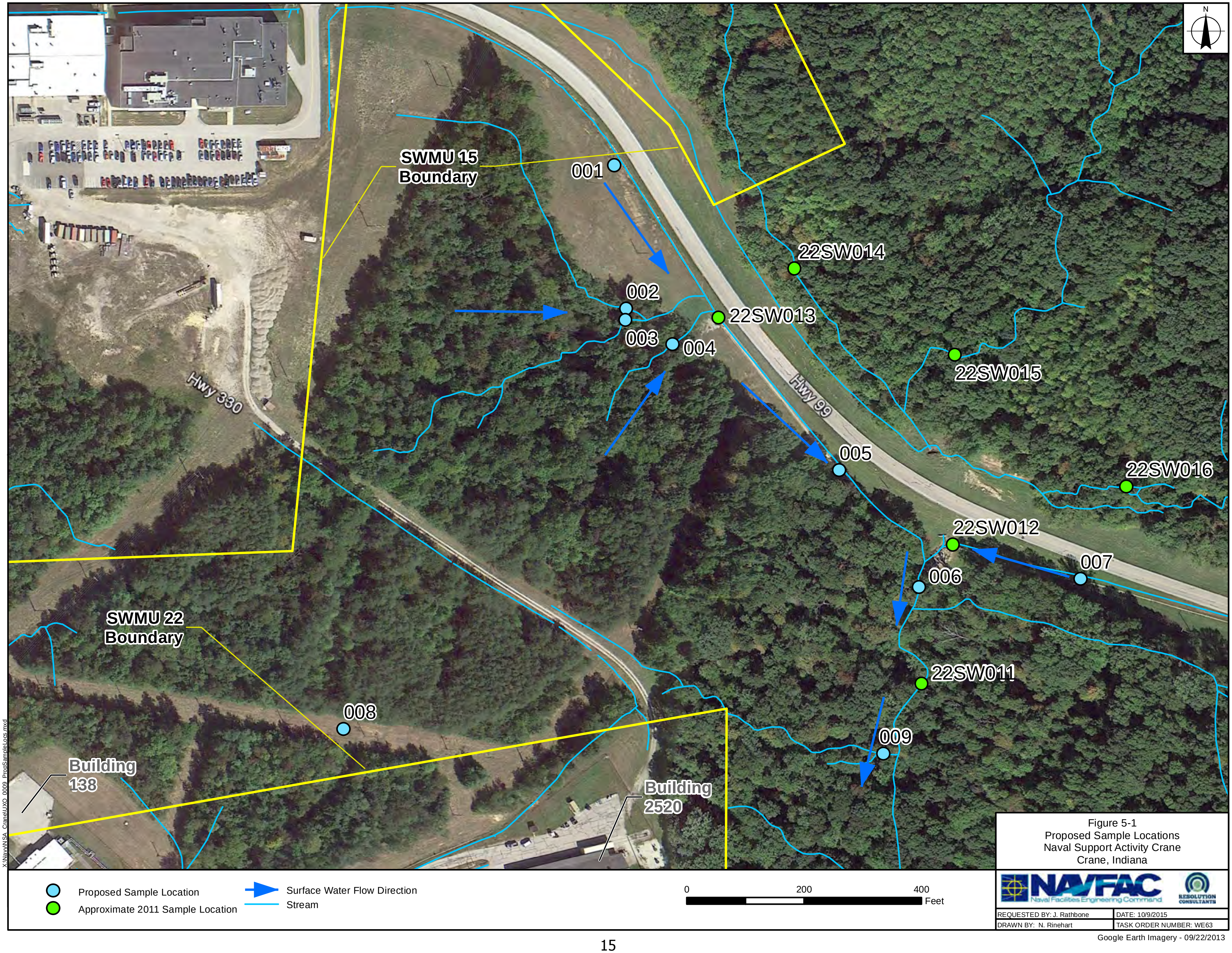


Figure 5-1
Proposed Sample Locations
Naval Support Activity Crane
Crane, Indiana

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## 6.0 REFERENCES

Tetra Tech. *Resource Conservation and Recovery Act Facility Investigation Report for SWMU 22 — Lead Azide Pond*. Naval Support Activity Crane, Crane, Indiana. Final, April 2014.

Tetra Tech NUS, Inc. *Resource Conservation and Recovery Act Facility Investigation Report for Roads and Grounds Area (SWMU 15)*. Naval Surface Warfare Center Crane, Crane, Indiana. November 2006.

United States Environmental Protection Agency. Region 3 Biological Technical Assistance Group, Freshwater Sediment Screening Benchmarks. August 2006.

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**Appendix A**

**Pertinent Sections of the SWMU 22 2014 RFI Report**

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# FINAL
# Resource Conservation and Recovery Act
# Facility Investigation Report
# For
# SWMU 22 – Lead Azide Pond

## Naval Support Activity Crane
### Crane, Indiana

Naval Facilities Engineering Command
Midwest

Contract Number N62470-08-D-1001

Contract Task Order F279

April 2014

# RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION REPORT FOR SWMU 22 - LEAD AZIDE POND

**NAVAL SUPPORT ACTIVITY CRANE**
**CRANE, INDIANA**

**COMPREHENSIVE LONG-TERM**
**ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT**

**Submitted to:**
**Naval Facilities Engineering Command Midwest**
**201 Decatur Avenue Building 1A, Code EV**
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**CONTRACT NUMBER N62470-08-D-1001**
**CONTRACT TASK ORDER F279**

**APRIL 2014**


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# EXECUTIVE SUMMARY

This Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Report for Solid Waste Management Unit (SWMU) 22 – Lead Azide Pond - was prepared for Naval Support Activity (NSA) Crane, located in Crane, Indiana, through Naval Facilities Engineering Command (NAVFAC) Midwest under Contract Task Order (CTO) F201 of the Comprehensive Long-Term Environmental Action Navy (CLEAN), Contract Number N62470-08-D-1001.

SWMU 22 is located in the north-central portion of NSA Crane. SWMU 22 is the area referred to as the Explosive Actuated Device (EAD)/Booster Area or the "Backline." The principal buildings in SWMU 22 are Buildings 136, 138, 2520, 2803, and 2855 through 2863 and 2905, as well as several ancillary buildings and an inert storage building (Building 2089). SWMU 22 is situated along an east-west trending ridge. It is bounded on the east, north, and south by drainages to Turkey Creek and on the west by Highway 45.

The Booster Area was designed and constructed to load 5-inch rockets during World War II. EADs were loaded with explosives such as lead azide, lead styphnate, tetryl, Royal Demolition Explosive (RDX), and black powder. Building 136 was used for the propellant portion of the EAD loading process, Building 138 was the pressing building for warheads, and Building 2520 was the final assembly building. A conveyor tunnel connected Buildings 136 and 2520 in support of the former process. Other primary explosives used in the Booster Area, principally in Building 138, included RDX, pentaerythritol tetranitrate (PETN), 2,4,6-trinitrotoluene (TNT), and nitroglycerin. The buildings associated with the Backline (i.e., the buildings between Buildings 136 and 2520) are scheduled for demolition.

An unlined retention pond (i.e., the Lead Azide Pond) was located at the northern end of the Backline. It received overflow wastewater from sumps associated with the process buildings. The retention pond was removed in 1981.

Field activities for SWMU 22 were conducted during three separate field events in January and April 2011, May 2012, and January 2013, in accordance with the UFP-SAP (Field Sampling Plan and Quality Assurance Plan) for SWMU 22 - Lead Azide Pond (Tetra Tech, 2011) and SAP Addendum (Tetra Tech, 2012). The field activities included:

- Mobilization/demobilization activities, including utility clearance.
- Surface and subsurface soil sampling using direct-push technology (DPT) and hand auger methods.

- Soil boring and monitoring well installation using hollow-stem auger (HSA) and air rotary drilling methods.
- Monitoring well development.
- Groundwater sampling.
- Water level measurement.
- Surface water and sediment sampling.
- In-situ hydraulic conductivity testing.
- Surveying.

Prior to evaluating the nature and extent of contaminants in soils, sediment, surface water, and groundwater, and conducting human health and ecological risk assessments for the subareas, the laboratory analytical data went through a Data Quality Review (DQR), including data verification and validation and a data usability assessment. In addition, metals concentrations in surface and subsurface soils were compared to the representative background soil data sets developed for NSA Crane.

Table ES-1 includes a summary of the human health risk assessment (HHRA) and screening-level ecological risk assessment (SLERA). A baseline HHRA was performed to characterize the potential risks to likely human receptors under current and potential future land use scenarios for SWMU 22. The HHRA identified no chemicals of potential concern (COPCs) for direct contact to surface soil and subsurface soil. RDX in subsurface soil was the only chemical identified as exceeding the screening levels for migration from soil to groundwater. RDX was not considered to be a chemical of concern (COC) for migration from soil to groundwater even though RDX was detected in groundwater because risks from RDX in groundwater were within acceptable levels. COPCs for direct contact to groundwater were RDX, arsenic, cadmium, hexavalent chromium, lead, and perchlorate; COPCs for direct contact to surface water were RDX, arsenic, and cadmium; and the COPC for direct contact to sediment was arsenic. The calculated cancer risks and hazard indices were for these COPCs were within acceptable risk levels. Analysis of lead in groundwater did not exceed the USEPA goal regarding lead exposures. Similarly, the SLERA, performed to characterize the potential risks to likely ecological receptors at SWMU 22 identified no chemicals of potential concern (COPC) in in surface soil, sediment, and surface water.

Based on the results of the human health and ecological risk assessments, NFA is recommended for SWMU 22. The NFA for SWMU 22 does not include potential sources of RDX and perchlorate upgradient of SWMU 22. Such potential sources would be addressed under separate investigations and remedial actions for those sources.

# 1.0 INTRODUCTION

This Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Report for Solid Waste Management Unit (SWMU) 22 – Lead Azide Pond - was prepared for Naval Support Activity (NSA) Crane, located in Crane, Indiana, through Naval Facilities Engineering Command (NAVFAC) Midwest under Contract Task Order (CTO) F279 of the Comprehensive Long-Term Environmental Action Navy (CLEAN), Contract Number N62470-08-D-1001. The RFI was conducted in accordance with the Unified Federal Policy (UFP) - Sampling and Analysis Plan (SAP) (Field Sampling Plan and Quality Assurance Plan) for SWMU 22 – Lead Azide Pond (Tetra Tech, 2011) and SAP Addendum (Tetra Tech, 2012).

## 1.1 PURPOSE

The purpose of this RFI Report is to describe the site investigation activities conducted at SWMU 22 and to present the results and interpretation thereof for SWMU 22. In addition, human health and ecological risks associated with SWMU 22 were evaluated through a baseline human health risk assessment (HHRA) and screening-level ecological risk assessment (SLERA).

## 1.2 SITE BACKGROUND

Locations and descriptions of NSA Crane and SWMU 22 are presented in the following subsections.

### 1.2.1 Facility Location and Description

NSA Crane is located in a rural sparsely populated region of south-central Indiana, approximately 75 miles southwest of Indianapolis, 60 miles northwest of Louisville, Kentucky, and immediately east of Burns City and Crane Village, Indiana. A location map of the NSA Crane facility is provided as Figure 1-1. NSA Crane is the third largest United States naval installation in the world. The base includes over 3,000 buildings and covers more than 63,000 acres in northern portion of Martin County and smaller portions of Greene, Daviess, and Lawrence Counties. More than 5,000 military and DoD civilian and contractor personnel work at NSA Crane (CNIC, 2010). Currently, NSA Crane hosts several commands and divisions, including Naval Surface Warfare Center (NSWC) Crane Division, which provides material, technical, and logistical support to the Department of the Navy for equipment, shipboard weapons systems, and nonexpendable ordnance items. In addition, NSA Crane supports the Crane Army Ammunition Activity (CAAA) with production, renovation, storage, shipment, demilitarization, and disposal of conventional ammunition.

The facility was commissioned in 1941 as the Naval Ammunition Depot (NAD) Burns City to serve as an inland munitions production and storage center for the Navy. Operations at the facility originally included production, testing, and storage of ordnance. The facility was constructed on land publicly acquired under the White River Land Utilization Project (35,000 acres) and land purchased from private ownership (26,830 acres) beginning in 1934. Prior to its acquisition by the Navy, the land was largely used for timber and agriculture (Tetra Tech, 2001). The name of the facility was changed in 1943 to NAD Crane, in 1975 to the Naval Weapons Support Center, and in 1992 to Naval Surface Warfare Center (NSWC) Crane. In 2003, NSWC Crane operations fell under the command structure of NSA Crane during regional reorganization by the Navy. DoD ammunition procurement responsibility was transferred to the Army in 1977. The Army assumed ordnance production, storage, and related responsibilities at the facility, which continues to the present.

### 1.2.2 SWMU 22 Location and Description

Figure 1-2 shows layout of SWMU 22. SWMU 22 is the area referred to as the Explosive Actuating Device (EAD)/Booster Area or the "Backline." The principal buildings in SWMU 22 are Buildings 136, 138, 2520, 2803, and 2855 through 2863 and 2905, as well as several ancillary buildings and an inert storage building (Building 2089). The Booster Area was designed and constructed to load 5-inch rockets during World War II. EADs were loaded with explosives such as lead azide, lead styphnate, tetryl, Royal Demolition Explosive (RDX), and black powder. Building 136 was used for the propellant portion of the EAD loading process, Building 138 was the pressing building for warheads, and Building 2520 was the final assembly building. A conveyor tunnel connected Buildings 136 and 2520 in support of the former process. Other primary explosives used in the Booster Area, principally in Building 138, included RDX, pentaerythritol tetranitrate (PETN), 2,4,6-trinitrotoluene (TNT), and nitroglycerin.

An unlined retention pond (i.e., the Lead Azide Pond) was located at the northern end of the Backline. It received overflow wastewater from sumps associated with the process buildings. The retention pond was removed in 1981. The buildings associated with the Backline (buildings between Buildings 136 and 2520) were demolished in 2012.

## 1.3 PREVIOUS INVESTIGATIONS

Surface water and sediment samples were collected in 1979 from the drainage ditch below (i.e., northeast) the former pond (USAEHA, 1979). Surface water from the drainage ditch had lead concentrations ranging from 0.18 to 1.99 milligrams per liter (mg/L) and RDX concentrations of 0.02 to

4.4 mg/L. Sediment from the drainage ditch had a lead concentration of 2,860 milligrams per kilogram (mg/kg), and a sediment sample from the bottom of the pond had a lead concentration of 12,900 mg/kg.

According to the Initial Assessment Study (IAS) (NEESA, 1983) sludge samples from the Lead Azide Pond (date and location of collection not identified) had concentrations of lead varying from 0.03 parts per million (ppm) to 17 ppm, barium from less than 0.1 to 1.0 ppm, antimony from 0.5 to 2.0 ppm, and chromium from less than 1.0 to about 1,300 ppm. (Note: units of ppm are as presented in the IAS.)

A water sample from a drainage outfall north of Building 2520 collected during a storm water event in April 1996 had an RDX concentration of 4.1 micrograms per liter (µg/L). Lead was not detected in this sample. Surface water samples collected as part of the Storm Water Pollution Prevention Plan from the same location in 2005, 2006, 2007, 2008, and 2009 had no detections of RDX greater than laboratory detection limits (DLs). Lead was detected at concentrations of 0.0048, 0.001, and 0.001 mg/L in 2005, 2006, and 2007, respectively. Lead was not detected in storm water sampled in 2008 and 2009.

## 1.4 REPORT ORGANIZATION

This RFI report is organized as follows:

- Section 1.0 of this report is the introduction, including the purpose of the report, background information for the facility and site, summaries of previous investigations, and report organization.
- Section 2.0 describes the study area field sampling activities and procedures associated with data collection.
- Section 3.0 describes the general physical characteristics for SWMU 22.
- Section 4.0 presents the data quality review.
- Section 5.0 presents the nature and extent of contamination.
- Section 6.0 presents the fate and transport analysis and conceptual site model (CSM).
- Section 7.0 presents the HHRA.

- Section 8.0 presents the SLERA.

- Section 9.0 provides a summary and conclusions of the RFI.

Supporting documentation for this report is presented in Appendices A through G. The information included in each appendix is as follows:

- Appendix A – Field investigation documentation (boring logs, well construction diagrams, groundwater level measurement forms, sample log sheets, and slug test data).

- Appendix B – Miscellaneous field documentation (equipment calibration forms, work permits, Field Task Modification Request (FTMR) forms, and survey data).

- Appendix C – Data Quality Review (DQR).

- Appendix D – Analytical data.

- Appendix E – Supporting documentation for the HHRA.

- Appendix F – Supporting documentation for the SLERA.

The DQR (Appendix C) included evaluation of the laboratory analytical data collected during RFI activities conducted between January 2011 and May 2013. Complete analytical data sets are provided in Appendix D.

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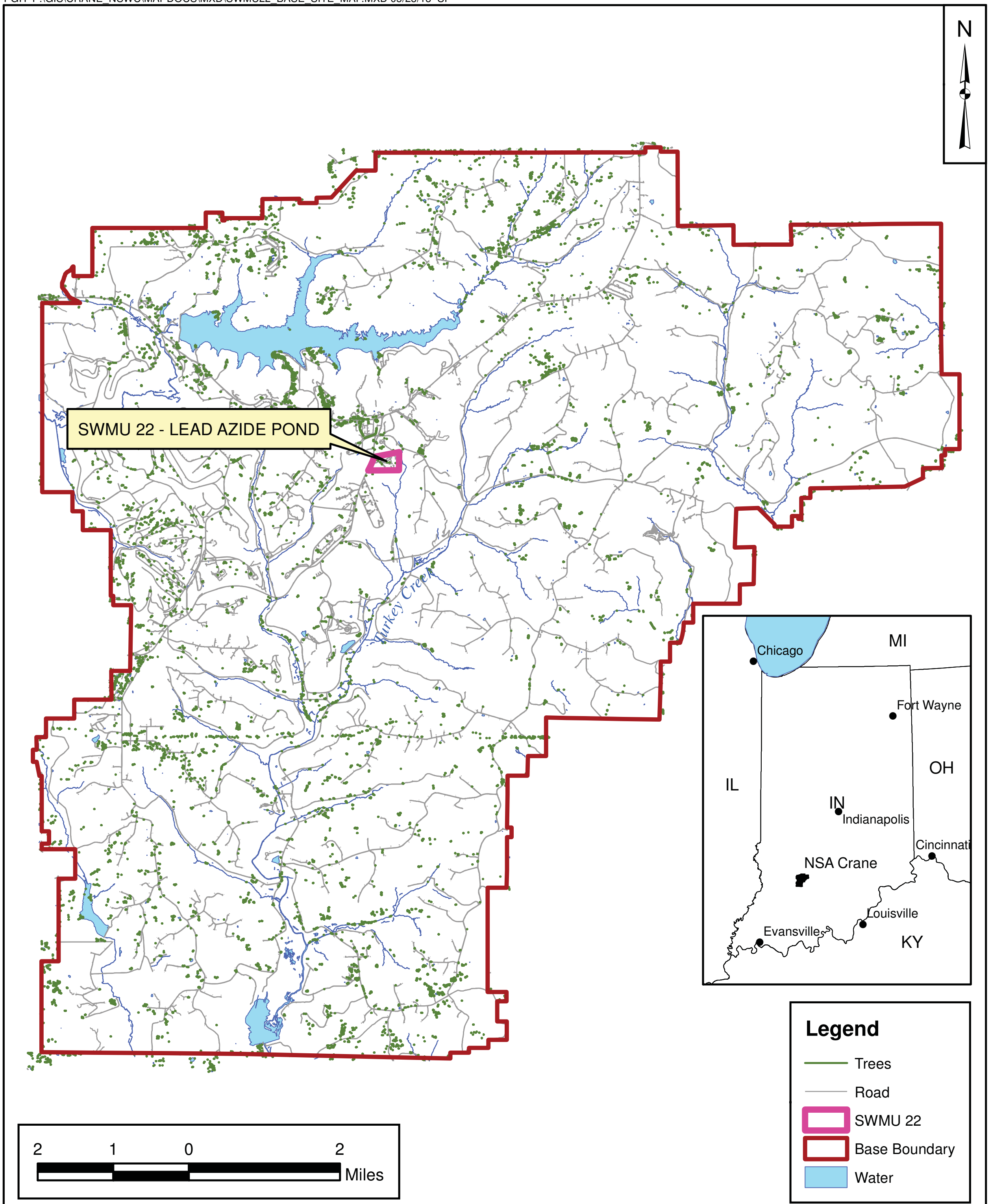
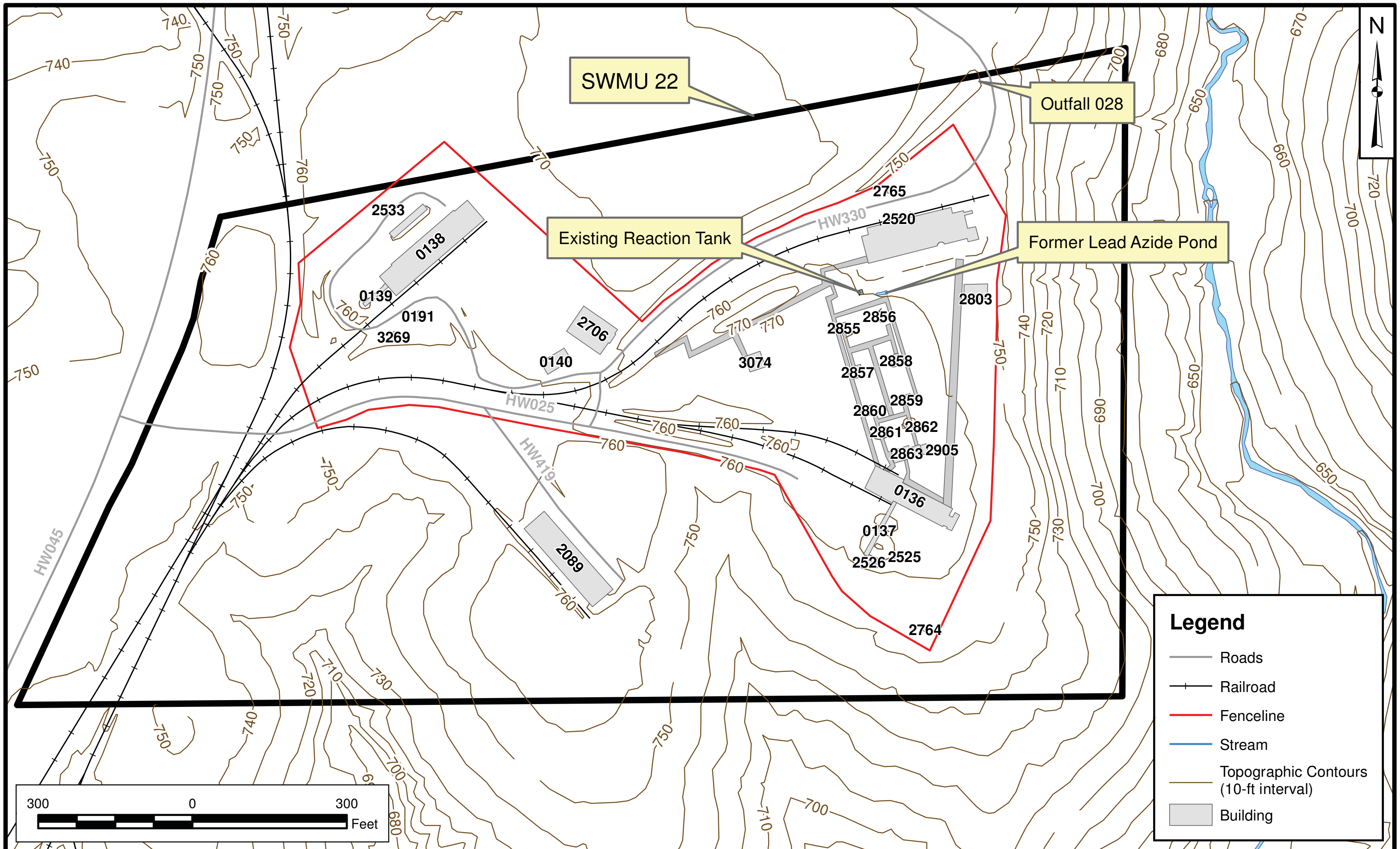



| | | | | |
|---|---|---|---|---|
| DRAWN BY J. ENGLISH | DATE 07/14/09 | TETRA TECH | CONTRACT NUMBER CTO F279 | |
| CHECKED BY S. HILL | DATE 05/23/13 | BASE AND SITE LOCATION MAP<br>SWMU 22 - LEAD AZIDE POND<br>NSA CRANE<br>CRANE, INDIANA | APPROVED BY ___ | DATE ___ |
| REVISED BY S. PAXTON | DATE 05/23/13 | | APPROVED BY ___ | DATE ___ |
| SCALE AS NOTED | | | FIGURE NO. FIGURE 1-1 | REV 0 |

PGH P:\GIS\CRANE_NSWC\MAPDOCS\MXD\SWMU22_SITE_MAP_TOPO.MXD 05/23/13 SP




| DRAWN BY T. WHEATON | DATE 08/26/09 | TETRA TECH | CONTRACT NUMBER CTO F279 | |
|---|---|---|---|---|
| CHECKED BY S. HILL | DATE 05/23/13 | SITE LAYOUT - ELEVATION CONTOUR MAP<br>SWMU 22 - LEAD AZIDE POND<br>NSA CRANE<br>CRANE, INDIANA | APPROVED BY ___ | DATE ___ |
| REVISED BY S. PAXTON | DATE 05/23/13 | | APPROVED BY ___ | DATE ___ |
| SCALE AS NOTED | | | FIGURE NO. FIGURE 1-2 | REV 0 |

# 2.0 FIELD INVESTIGATION

This section presents sampling activities, sampling procedures, and field documentation used during field activities performed for NSA Crane SWMU 22 – Lead Azide Pond.

## 2.1 OVERVIEW

Field activities for SWMU 22 were conducted during three separate field events in January and April 2011, May 2012, and January 2013. RFI field activities were conducted in accordance with the procedures and methodologies in the Navy- and Indiana Department of Environmental Management (IDEM)-approved UFP-SAP (Field Sampling Plan and Quality Assurance Plan) for SWMU 22 - Lead Azide Pond (Tetra Tech, 2011) and SAP Addendum (Tetra Tech, 2012), with deviations from the UFP-SAP as noted in Section 2.13. Additional sampling was performed under Field Task Modification Requests dated December 2012 and provided in Appendix A. Standard Operating Procedures (SOPs) that governed the field work were as provided in the SAP and SAP Addendum.

The RFI field activities included the following:

- Mobilization/demobilization activities, including utility clearance.
- Surface and subsurface soil sampling using direct-push technology (DPT) and hand auger methods.
- Soil boring and monitoring well installation using hollow-stem auger (HSA) and air rotary drilling methods.
- Monitoring well development.
- Groundwater sampling.
- Water level measurement.
- Surface water and sediment sampling.
- In-situ hydraulic conductivity testing.
- Surveying.

Boring logs, well construction diagrams, sample log sheets, and slug test data are provided in Appendix A, and chain-of-custody forms, equipment calibration forms, groundwater level measurement forms, work permits, FTMR forms, and survey data are provided in Appendix B.

## 2.2 MOBILIZATION/DEMOBILIZATION

Prior to each field event, field team members reviewed the approved UFP-SAP and Health and Safety Plan (HASP) prior to the start of field activities and attended an orientation given by the Field Operations Leader (FOL) to ensure that personnel were familiar with the scope of field activities. The FOL coordinated with base personnel and Indiana Underground Plant Protection Services (IUPPS) to obtain utility clearance for the areas under investigation. Safety and building availability (explosives safety) permits were obtained from Army explosive safety officers. Work permits were requested from and issued by the NSA Crane fire department (Appendix B). Equipment requirements, including transport to the site, decontamination, and demobilization of all necessary equipment, were managed by the FOL.

## 2.3 SOIL INVESTIGATION

### 2.3.1 Surface and Subsurface Soil Sampling

Soil samples were collected using both hand auger and DPT methods. Soil samples were collected for chemical analyses and for lithologic logging. Boring logs and soil sample log sheets for the soil samples are provided in Appendix A. Summaries of soil sample analyses and depths are provided in Tables 2-1 and 2-3. Figure 2-1 shows the locations of soil samples collected during the RFI at SWMU 22.

The soil samples were collected in accordance with the SAP (Tetra Tech, 2011). Surface soil samples were collected from 0 to 2 feet below ground surface (bgs), and subsurface soil samples were collected from below 2 feet bgs. If refusal on bedrock was encountered before the desired subsurface sample depth, the sample was collected from the 2-foot soil interval (if possible) above the bedrock surface.

The following discussion summarizes the soil samples collected during the three RFI field events.

**January 2011**

A total of 22 soil samples were collected as part of January 2011 field activities. Two surface soil samples (0 to 2 feet bgs) were collected at locations 22SS01 and 22SS02 using a stainless steel hand auger. Twenty soil samples were collected from 11 soil boring locations (Figure 2-1). Ten soil boring locations were sampled using DPT sampling methods. Due to access limitations, samples at location 22SB007 were collected using a hand auger. At three locations (22SB001, 22SB005, and 22SB008), sampler refusal was encountered before the target depth, and one subsurface soil sample interval was not collected. The January 2011 soil samples were analyzed for explosives, perchlorate, and RCRA metals. At two locations (22SB001 and 22SB008), samples were also analyzed for pH.

**May 2012**

A total of 13 soil samples were collected as part of May 2012 field activities. Of the 20 soil samples proposed (SAP Worksheet 18), 13 soil samples were collected from eight soil boring locations, and two samples were collected from surface soil locations (Figure 2-1). At four locations (22SB012, 22SB013, 22SB015, and 22SB017), sampler refusal was encountered and the bottom soil interval sample(s) was not collected. One location, 22SB019, not included in the SAP Addendum, was added in the field based on Navy recommendation because it was in a drainage swale that may have been impacted by past site operations [see FTMR in Appendix B]. Soil samples from two locations (22SB014 and 22SB018) were collected using split-spoon sampling techniques with a track-mounted HSA drilling rig. Location 22SB014 was converted to monitoring well 22MWT03, and the soil samples from this location were collected during boring advancement for well installation. Location 22SB018 was not accessible with the truck-mounted DPT rig and was sampled using the track-mounted HSA rig. Two surface soil locations (22SS022 and 22SS025) were listed in the SAP as sediment/surface water locations; both locations were dry (i.e., no water present) at the time of sampling and therefore proposed sediment samples were collected as surface soil samples. Location 22SS022 was collected using a soil probe, and 22SS025 was collected using a disposable plastic trowel. The remaining six soil boring locations were sampled using DPT methods. All May 2012 soil samples were analyzed for explosives, PETN, nitrogylcerin, and RCRA metals. At two locations (22SB001 and 22SB008) pH analysis was also conducted.

**January 2013**

A total of seven soil samples were collected as part of January 2013 field activities. Of the nine soil samples proposed, seven soil samples were collected from six soil boring locations (Figure 2-1). Surface soil samples were collected from five locations (22SS004, 22SS005, 22SS006, 22SS007, and 22SS008). At locations 22SS005 and 22SS007, subsurface soil samples were proposed to be collected from 2 to 3 feet bgs, but sampler refusal was encountered at both locations at less than 2 feet bgs. Surface and subsurface (2 to 3 feet bgs) soil samples were collected from location 22SB020. The January 2013 soil samples were analyzed for RDX and TNT. The 0- to 2-foot sample from location 22SB020 was also analyzed for chromium speciation.

### 2.3.2 Soil Boring Advancement and Abandonment

Soil borings were advanced to collect soil samples for lithological characterization and chemical analyses. A total of 20 soil borings were advanced at SWMU 22 for the RFI, as summarized in Table 2-1. Locations of soil samples are illustrated on Figure 2-1.

The soil borings were advanced using DPT methods, HSA with split-spoon sampling, or where access or terrain prohibited use of the DPT rig, a hand auger, in accordance with SOP-08 (Borehole Advancement and Soil Coring Using DPT and Hand Auger Techniques) of the UFP-SAP (Tetra Tech, 2011). Soil samples were collected during borehole advancement at 2-foot (split-spoon) or 4-foot (DPT) intervals. Upon retrieval, the soil samples from the borings were screened with a photoionization detector (PID) for volatile organic compounds (VOCs), and the PID readings were recorded on the boring logs. In addition, descriptions of soil classification, lithology changes, moisture content, depth to water, drilling methods, and total depth of each borehole were included on each boring log. Boring logs are provided in Appendix B.

Soil borings for soil sampling only were abandoned following advancement. Soil borings advanced via DPT probing or hand augering were backfilled with the excess soil removed during borehole advancement. If additional fill material was needed, bentonite chips were used to backfill the boring to within a few inches of the surface. The ground surface at each abandoned boring location was restored to its original condition (i.e., soil, asphalt or concrete patch).

## 2.4 GROUNDWATER INVESTIGATION

### 2.4.1 Monitoring Well Installation and Development

Six monitoring wells were installed for the RFI at SWMU 22. A summary of monitoring well construction is provided in Table 2-2, and monitoring well locations are shown on Figure 2-1.

Bedrock drilling and logging were conducted in accordance with SOP-13 (Drilling and Geologic Logging of Boreholes) of the UFP-SAP (Tetra Tech, 2011). The well boreholes for the monitoring wells were drilled using HSA techniques to drill through overburden material and air coring techniques to drill in bedrock. In the overburden, 4.25- or 10-inch inside diameter HSAs were advanced to the top of bedrock, and split-spoon samples were collected continuously during auger advancement for soil characterization and screening for VOCs with a PID. Prior to advancing the boreholes into bedrock, temporary casing was installed to the top of bedrock, or the 10-inch inside diameter HSAs was used as temporary casing. One borehole (22MWT005) was cored using NX-sized, wire-line, air coring techniques for characterization of bedrock lithology and fracturing patterns. The cored borehole and the remaining boreholes were reamed or advanced using 6-inch-diameter air rotary techniques.

The six monitoring wells (22MWT01 through 22MWT006) were installed in the boreholes in accordance with SOP-12 (Monitoring Well Installation) of the UFP-SAP (Tetra Tech, 2011). The monitoring wells were constructed of 2-inch-diameter, Schedule 40, flush-joint, polyvinyl chloride (PVC) riser pipe and 10-foot-long slotted screens with a slot size of 0.010-inch. Sand filter packs were installed in the annulus around the well screens from approximately 0.5 to 1 foot below the bottom of the well screen to 2 feet above the top of the well screen. A 2-foot-thick bentonite seal was installed above the filter pack, and the remaining annulus was sealed with cement-bentonite grout to within 2 to 3 feet the ground surface.

A 6-inch steel protective surface casing with a locking cap and pad lock was set in a 4-foot by 4-foot by 6-inch-thick concrete pad around each well to protect the PVC well casing. Four steel bollards were placed just outside the corners of each concrete pad and filled with concrete. The protective casings and bollards were painted with enamel safety yellow paint. Stainless steel tags, listing the well IDs, dates installed, total depths, screen lengths, coordinates, survey information, and contact information were installed on the protective casings. Copies of the boring log and well construction sheets are provided in Appendix A.

The monitoring wells were developed to remove fine sediment from within and around the well screens. The wells were developed no sooner than 48 hours after installation (i.e., grouting), in accordance with SOP-14 of the UFP-SAP (Tetra Tech, 2011). The wells were developed by surging and pumping, or for wells that were slow to recover, repeated pumping or bailing dry over several days. All purge water removed from the wells during the development process was stored in a portable holding tank and discharged into a designated manhole for treatment at the NSA Crane water treatment facility. Monitoring well development logs can be found in Appendix A.

### 2.4.2 Groundwater Purging and Sampling

All six newly installed monitoring wells were purged and sampled during the May 2012 field effort, and well 22MWT005 was purged and sampled in April and May 2013 (for hexavalent chromium). Purging was performed using low-flow techniques with a bladder pump, except 22MWT005, in accordance with SOP-16 (Low Flow Well Purging and Stabilization) of the UFP-SAP (Tetra Tech, 2011). Well 22MWT005 was purged and sampled using a dedicated, disposable bailer due to a low water level in the well. Sampling of groundwater was performed in accordance with SOP-17 (Groundwater Sampling). A summary of groundwater samples and analyses is provided in Table 2-1.

The wells were purged and sampled using bladder pumps with Teflon® bladders and Teflon®-lined polyethylene tubing, except for wells 22MWT005 and 22MWT006. These two wells had an insufficient water column for purging and sampling with a bladder pump and so were purged and sampled using dedicated disposable bailers. During purging of all wells, water quality parameters of pH, specific conductance, temperature, dissolved oxygen (DO), turbidity, and oxidation-reduction potential (ORP) were measured and recorded at 5- to 10-minute intervals using a multi-parameter water quality meter and flow-through cell. Water levels and pumping rates were measured during purging and recorded at 5- to 10-minute intervals. Purging continued at each well until a minimum of one well volume was removed from the well and the parameters stabilized within the limits of pH +/-0.1 unit, specific conductance +/-5 percent, temperature +/-5 percent, turbidity less than 10 Nephelometric Turbidity Units (NTUs), and dissolved oxygen +/-10 percent. If, after 2 hours of purging, the stabilization conditions were not met, purging was considered complete and sampling was performed. At well locations where turbidity readings remained greater than 10 NTUs, sample aliquots were collected for dissolved metals and field-filtered with a 0.45-micron in-line filter prior to preservation. Sample containers were filled directly from the low-flow bladder pump by allowing the pump discharge to flow gently down the inside of each container with minimal turbulence.

Pertinent field data including sampling methods, purge information, and pump intake depths were recorded on low-flow purge data sheets and groundwater sample log sheets (Appendix A).

### 2.4.3 Groundwater Level Measurements

One round of synoptic water level measurements was obtained from the SMWU 22 monitoring wells as part of the RFI. Groundwater level measurements were taken within a 24-hour period using an electronic water level meter. Water level elevations were recorded to within 0.01-foot accuracy from marked reference points on the well riser pipes. Water levels were recorded on a groundwater level measurement form, provided in Appendix A. Groundwater elevations are summarized in Table 2-2, and interpretation of the groundwater flow direction is discussed in Section 3.

### 2.4.4 In-Situ Hydraulic Conductivity Testing

In-situ hydraulic conductivity testing (i.e., slug tests) was conducted to estimate the bulk hydraulic conductivity of the shallow bedrock aquifer at SWMU 22. The hydraulic conductivity estimates assist with determination of the advective groundwater flow rate.

Rising-head slug tests were performed in three wells (22MWT002, 22MWT003, and 22MWT006) in July 2013. The rising-head tests were performed by inserting a solid plastic slug into the well and allowing the water level to recover to its initial position. The solid slug was then removed, and the rate of rise in the water level back to equilibrium was measured. The changes in water levels were induced as quickly as possible to approximate an instantaneous change in head. Water level data (i.e., water levels and elapsed times) were collected electronically using a Schlumberger Water Services Diver pressure transducer.

Slug test data were used to calculate values of horizontal hydraulic conductivity for the aquifer in the immediate vicinity of each well tested. The data were analyzed using the Bouwer-Rice Method (Bouwer and Rice, 1976) with the Windows®-based program AquiferTest. Slug test results are provided in Appendix A and discussed in Section 3.

## 2.5 SURFACE WATER/SEDIMENT INVESTIGATION

A total of 23 surface water and 18 co-located sediment samples were collected for the SWMU 22 RFI. Surface water and sediment samples were collected from the headwater to Turkey Creek and four drainage areas that flow to the headwater of Turkey Creek. With the exception of sediment sample 22SD26, which was collected from the settling basin northwest of Building 138, sediment samples were co-located with surface water sample locations. At a number of the proposed surface water and sediment locations, the stream was dry; therefore, no surface water was collected. Similarly, at a number of the surface water locations, the stream bed consisted of exposed bedrock and therefore no sediment sample was collected.

The surface water and sediment samples were collected in accordance with SOPs 05 (Surface Water Sampling) and 07 (Sediment Sampling) of the UFP-SAP (Tetra Tech, 2011). Locations were sampled in order from downstream to upstream, and surface water samples were collected prior to sediment sampling at each location. Surface water quality parameters (pH, specific conductivity, temperature, DO, turbidity, and ORP) were measured and recorded at each location, and all surface water samples were collected by direct filling of the sample bottles. Sediment samples were collected at the same locations as surface water samples, except as noted above. Field data including water quality parameter measurements, sampling methods, and locations were recorded on sediment and surface water sample log sheets (Appendix A). Sample locations were marked with a labeled pin flag to facilitate relocation of the locations for surveying purposes. Sampling methods, depths of the stream channel, and estimated flow rates were also recorded on the sample log sheets (see Appendix A).

A summary of surface water and sediment samples is provided in Table 2-1, and locations of surface water and sediment samples are illustrated on Figure 2-1.

The following discussion summarizes the surface water and sediment samples collected during the three field events.

**January 2011**

Nineteen surface water samples were collected at SWMU 22 during the January 2011 field effort. Samples 22SW005 and 22SW008 were not collected due to the absence of water. Surface water samples were analyzed for explosives, perchlorate, and total and dissolved RCRA metals including mercury. (The dissolved metals fraction was collected by collecting surface water in an unpreserved bottle, then filtering the sample through a 0.45-micron filter into a pre-preserved sample bottle with a peristaltic pump in the field trailer at NSA Crane.)

Twelve sediment samples were collected as part of the sampling effort. Sediment samples were collected at depths of 0 to 6 inches bgs, except at locations 22SD006, 22SD007, and 22SD008, where an upper sediment sample was collected at 0 to 6 inches and a second sample was collected from 6 to 24 inches bgs. The January 2011 sediment samples were analyzed for explosives, RCRA metals, and total organic carbon (TOC). At location 22SD006, pH analysis was conducted for both sample intervals (0 to 6 inches and 6 and 24 inches).

**May 2012**

Four surface water samples were collected during the May 2013 field effort and analyzed for total and dissolved RCRA metals, pH, explosives, PETN, and nitroglycerin. Six sediment samples were collected as part of the May 2012 sampling effort and analyzed for TOC, PETN, and nitroglycerin. Samples from select locations were also analyzed for explosives, pH, and RCRA metals.

Surface water locations 22SW10 and 22SW17 and sediment location 22SD18 were sampled during both January 2011 and May 2012. During the May 2012 event, additional analyses for TOC, PETN, and nitroglycerin were conducted at both sediment locations, and additional analyses for PETN and nitroglycerin were conducted at both surface water locations; RCRA metals was also analyzed for location 22SW17.

**January 2013 Field Effort**

One surface water sample was proposed for the January 2013 field effort but was not collected due to the absence of water at the location. One sediment sample was collected as part of the January 2013 sampling effort and analyzed for RDX and TNT.

## 2.6 SETTLEMENT BASIN INVESTIGATION

One sediment sample (22SD026) was collected from the base of the settling basin located north of Building 138. The sediment was sampled using a stainless steel pitcher attached to a section of pipe to reach to the bottom of the basin. Field data including sampling methods, conditions in the basin, and location of the sample within the basin were recorded on a sediment sample log sheet (Appendix A). The settling basin sediment sample was analyzed for explosives, PETN, nitroglycerin, and RCRA metals.

## 2.7 FIELD SAMPLE DOCUMENTATION

SWMU 22 RFI field activities were documented in accordance with SOP-03 (Sample Custody and Documentation of Field Activity) of the UFP-SAP (Tetra Tech, 2011). Documentation included boring logs, well construction sheets, well development sheets, medium-specific sample log sheets, chain-of-custody records, equipment calibration log sheets, and work permits. Copies of this documentation are provided in Appendices A and B.

## 2.8 SAMPLE HANDLING, PACKAGING, AND SHIPPING

Sample handling activities included field-related considerations concerning the selection of sample containers, preservatives, allowable holding times, sample custody, and maintaining samples at the appropriate storage temperature. Sample handling activities were conducted in accordance with SOP-04 (Sample Preservation, Packaging, and Shipment) of the UFP-SAP (Tetra Tech, 2011). Sample containers were provided by the laboratory. Following collection of a sample, sample containers were sealed in Ziploc® plastic bags, and glass containers were wrapped in plastic bubble wrap. Sample containers were then packed in ice in a large, plastic, garbage bag within a cooler. A temperature blank was placed in each cooler prior to shipment. The chain-of-custody form for the associated samples was sealed in a Ziploc® bag and taped to the inside of the cooler lid. A signed and dated custody seal was applied to each end of the cooler and then covered with strapping tape to provide a tamper-evident chain-of-custody seal. Samples were shipped to the laboratories [APPL, Inc. of Clovis, California, and ALS of Rochester York, New York (chromium speciation only)] via overnight delivery. Tetra Tech maintained custody of the samples until they were relinquished to FedEx® for shipment. FedEx® tracking numbers (airbill numbers) were recorded on the appropriate chain-of-custody forms, and the sender's copy of the airbill was maintained for shipment tracking, if needed. Samples were received within sample holding times and at required temperatures.

## 2.9 QUALITY CONTROL SAMPLES

Quality assurance (QA) and quality control (QC) samples were generated and collected during sampling activities for the SWMU 22 RFI to monitor both field and laboratory procedures, in accordance with the UFP-SAP. Field QA/QC samples included field duplicates, equipment blanks, rinsate blanks, trip blanks, and temperature blanks. Matrix spike/matrix spike duplicate (MS/MSD) samples were also collected for laboratory QA/QC, at the rate of 1 in 20 per medium. QA/QC samples are defined as follows:

- Field Duplicates – Field duplicates consisted of two samples collected either independently at a sampling location at approximately the same time in the case of soil and sediment VOC samples, groundwater, and surface water samples, or as a single sample split into two portions in the case of non-VOC soil and sediment samples. Field duplicates were collected at the rate of 1 in 20 per medium and were used to assess the overall precision of the sampling and analysis program.

- Trip Blanks – Laboratory-prepared trip blanks, consisting of analyte-free water, were used to indicate whether contamination of VOC samples had occurred during bottleware shipment or storage. One trip blank was placed in each cooler containing samples for VOC analysis.

- Equipment Rinsate Blanks – Equipment rinsate blanks were collected at the rate of 1 in 20 for non-dedicated equipment and once per batch for disposable equipment. Equipment rinsate blanks were obtained under representative field conditions by collecting the rinse water generated by running reagent-grade water through or over sample collection equipment after decontamination and before use. When pre-cleaned, dedicated, or disposable sampling equipment was used (i.e., no decontamination was required), one equipment rinsate blank was collected as a batch blank. Equipment rinsate blanks were analyzed for the same chemical constituents as the associated environmental samples.

- Temperature blanks – Temperature blanks were used to determine if samples were adequately cooled during shipment and consisted of a sample container of water supplied by the laboratory and placed in each cooler. The temperature of each container was checked upon receipt at the laboratory.

## 2.10 FIELD INSTRUMENT MEASUREMENTS

Field measurements recorded during the SWMU 22 field sampling activities included temperature, pH, specific conductance, ORP, DO, and turbidity for groundwater and surface water samples; PID readings for soil samples; and groundwater level measurements. The following field instruments were used to obtain these measurements:

- Multi-parameter water-quality meter (Horiba U-52)
- Water level indicator (Heron Dipper-T)
- PID (MiniRAE Plus with 10.6-electron volt lamp)

### 2.10.1 Equipment Calibration

Field instruments (water quality meters and PIDs) were calibrated daily prior to use according to manufacturers' requirements. Copies of equipment calibration logs are provided in Appendix B.

### 2.10.2 Field Investigation Preventative Maintenance Procedures/Schedules

An appropriate daily maintenance check was made on each piece of equipment. No instruments were damaged or defective through the course of the several field events, which may have impacted the accuracy of readings.

## 2.11 SURVEYING

SWMU 22 RFI soil, sediment, and surface water sample locations and monitoring wells were surveyed by an Indiana-licensed surveyor to obtain both horizontal locations and vertical elevations. NSA Crane-established survey control points were used. Horizontal coordinates were surveyed to the nearest 0.1 foot and referenced to the Indiana State Plane Coordinate System (SPCS), North American Datum of 1927 (NAD 27). Vertical elevations were surveyed to the nearest 0.01 foot and referenced to Mean Sea Level, North American Vertical Datum of 1988 (NAVD88). Vertical elevations were measured for the tops of PVC well casings, tops of steel protection casings, and the ground surface for all of the newly installed wells. A copy of the survey data is provided in Appendix A.

## 2.12 DECONTAMINATION

Non-dedicated (reusable) sampling equipment was decontaminated before beginning work, during drilling and sampling activities (i.e., between sample intervals and between sampling/boring locations), and at the completion of the drilling and sampling in accordance with SOP-20 (Decontamination of Field Sampling Equipment). Equipment included drilling rigs, downhole tools, and soil, sediment, and water sampling equipment.

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**TABLE 2-1**

**SUMMARY OF ENVIRONMENTAL SAMPLES AND LABORATORY ANALYSIS**
**SWMU 22 - LEAD AZIDE POND**
**NSWC CRANE**
**CRANE, INDIANA**


| Sample Location | Sample Identification | Sample Type | Date Sampled | Sample Depth Interval Sampled (feet bgs) | Energetics | | | | | Metals | | | Miscellaneous | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Nitroaromatics / Nitramines | RDX/HMX | RDX/TNT | NG/PETN | Perchlorate | RCRA Metals | RCRA Metals (dissolved) | Chrom. $^{+}3/^{+}6$ | pH | TOC | |
| 22SS001 | 22SS0010002 | Surface Soil | 21-Jan-11 | 0-2 | X | | | | X | X | | | | | Field Duplicate 22SSDUP01 |
| 22SS002 | 22SS0020002 | Surface Soil | 21-Jan-11 | 0-2 | X | | | | X | X | | | | | |
| 22SS003 | 22SS0030002 | Surface Soil | 23-Jan-13 | NA | | | | | | | | | | | Advanced as a SB020 (no SS003 sample) |
| 22SS004 | 22SS0040002 | Surface Soil | 23-Jan-13 | 0-2 | | | X | | | | | | | | |
| 22SS005 | 22SS0050002 | Surface Soil | 23-Jan-13 | 0-2 | | | X | | | | | | | | |
| 22SS006 | 22SS0060002 | Surface Soil | 23-Jan-13 | 0-2 | | | X | | | | | | | | |
| 22SS007 | 22SS0070002 | Surface Soil | 23-Jan-13 | 0-2 | | | X | | | | | | | | |
| 22SS008 | 22SS0080002 | Surface Soil | 23-Jan-13 | 0-2 | | | X | | | | | | | | |
| 22SS022 | 22SS0220002 | Surface Soil | 12-May-12 | 0-2 | X | | | X | | X | | | | X | Listed as sediment in SAP, no flow sampled as surface soil |
| 22SS025 | 22SS0250002 | Surface Soil | 11-May-12 | 0-2 | X | | | X | | X | | | | X | Field Duplicate 22SSDUP01. Listed as sediment in SAP, no flow sampled as surface soil |
| 22SB001 | 22SB0010002 | Surface Soil | 19-Jan-11 | 0-2 | X | | | | X | X | | | X | | |
| | 22SB0010305 | Subsurface Soil | 19-Jan-11 | 3-5 | X | | | | X | X | | | X | | Field Duplicate 22SSDUP001 |
| | 22SB001XXXX | Subsurface Soil | NA | NA | -- | | | | -- | -- | | | -- | | Sample not collected due to boring refusal before sample depth |
| 22SB002 | 22SB0020002 | Surface Soil | 19-Jan-11 | 0-2 | X | | | | X | X | | | | | |
| | 22SB0020607 | Subsurface Soil | 19-Jan-11 | 6-7 | X | | | | X | X | | | | | |
| 22SB003 | 22SB0030002 | Surface Soil | 19-Jan-11 | 0-2 | X | | | | X | X | | | | | |
| | 22SB0030305 | Subsurface Soil | 19-Jan-11 | 3-5 | X | | | | X | X | | | | | |
| 22SB004 | 22SB0040002 | Surface Soil | 19-Jan-11 | 0-2 | X | | | | X | X | | | | | |
| | 22SB0040305 | Subsurface Soil | 19-Jan-11 | 3-5 | X | | | | X | X | | | | | |
| 22SB005 | 22SB0050002 | Surface Soil | 19-Jan-11 | 0-2 | X | | | | X | X | | | | | |
| | 22SB005XXXX | Subsurface Soil | NA | NA | -- | | | | -- | -- | | | | | Sample not collected due to boring refusal before sample depth |
| 22SB006 | 22SB0060002 | Surface Soil | 19-Jan-11 | 0-2 | X | | | | X | X | | | | | |
| | 22SB0060304 | Subsurface Soil | 19-Jan-11 | 3-4 | X | | | | X | X | | | | | |
| 22SB007 | 22SB0070002 | Surface Soil | 21-Jan-11 | 0-2 | X | | | | X | X | | | | | |
| | 22SB0070304 | Subsurface Soil | 21-Jan-11 | 3-4 | X | | | | X | X | | | | | |
| 22SB008 | 22SB0080002 | Surface Soil | 19-Jan-11 | 0-2 | X | | | | X | X | | | X | | |
| | 22SB008XXXX | Subsurface Soil | NA | NA | -- | | | | -- | -- | | | -- | | Sample not collected due to boring refusal before sample depth |
| 22SB009 | 22SB0090002 | Surface Soil | 19-Jan-11 | 0-2 | X | | | | X | X | | | | | |
| | 22SB0090305 | Subsurface Soil | 19-Jan-11 | 3-5 | X | | | | X | X | | | | | |
| 22SB010 | 22SB0100002 | Surface Soil | 19-Jan-11 | 0-2 | X | | | | X | X | | | | | |
| | 22SB0100305 | Subsurface Soil | 19-Jan-11 | 3-5 | X | | | | X | X | | | | | |
| 22SB011 | 22SB0110002 | Surface Soil | 19-Jan-11 | 0-2 | X | | | | X | X | | | | | |
| | 22SB0110304 | Subsurface Soil | 19-Jan-11 | 3-4 | X | | | | X | X | | | | | |
| 22SB012 | 22SB0120002 | Surface Soil | 10-May-12 | 0-2 | X | | | X | | X | | | X | | Field Duplicate 22FD051212-01 |
| | 22SB012XXXX | Subsurface Soil | NA | NA | -- | | | -- | | -- | | | -- | | Sample not collected due to boring refusal before sample depth |

**TABLE 2-1**

**SUMMARY OF ENVIRONMENTAL SAMPLES AND LABORATORY ANALYSIS**
**SWMU 22 - LEAD AZIDE POND**
**NSWC CRANE**
**CRANE, INDIANA**


| Sample Location | Sample Identification | Sample Type | Date Sampled | Sample Depth Interval Sampled (feet bgs) | Energetics | | | | | Metals | | | Miscellaneous | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Nitroaromatics / Nitramines | RDX/HMX | RDX/TNT | NG/PETN | Perchlorate | RCRA Metals | RCRA Metals (dissolved) | Chrom. $^{+}3/^{+}6$ | pH | TOC | |
| 22SB013 | 22SB0130002 | Surface Soil | 9-May-12 | 0-2 | X | | | X | | X | | | | | |
| | 22SB013XXXX | Subsurface Soil | NA | NA | -- | | | -- | | -- | | | | | Sample not collected due to boring refusal before sample depth |
| 22SB014 | 22SB0140002 | Surface Soil | 9-May-12 | 0-2 | X | | | X | | X | | | | | |
| | 22SB0140203 | Subsurface Soil | 10-May-12 | 2-3 | X | | | X | | X | | | | | |
| 22SB015 | 22SB0150002 | Surface Soil | 10-May-12 | 0-2 | X | | | X | | X | | | | | |
| | 22SB015XXXX | Subsurface Soil | NA | NA | -- | | | -- | | -- | | | | | Sample not collected due to boring refusal before sample depth |
| | 22SB015XXXX | Subsurface Soil | NA | NA | -- | | | -- | | -- | | | | | Sample not collected due to boring refusal before sample depth |
| 22SB016 | 22SB0160002 | Surface Soil | 9-May-12 | 0-2 | X | | | X | | X | | | | | |
| | 22SB0160305 | Subsurface Soil | 9-May-12 | 3-5 | X | | | X | | X | | | | | |
| | 22SB0160608 | Subsurface Soil | 9-May-12 | 6-8 | X | | | X | | X | | | | | |
| 22SB017 | 22SB0170002 | Surface Soil | 9-May-12 | 0-2 | X | | | X | | X | | | | | |
| | 22SB0170305 | Subsurface Soil | 9-May-12 | 3-5 | X | | | X | | X | | | | | |
| | 22SB017XXXX | Subsurface Soil | NA | NA | -- | | | -- | | -- | | | | | Sample not collected due to boring refusal before sample depth |
| 22SB018 | 22SB0180002 | Surface Soil | 10-May-12 | 0-2 | X | | | X | | X | | | | | |
| | 22SB0180406 | Subsurface Soil | 11-May-12 | 4-6 | | | | | | | | | | | |
| 22SB019 | 22SB0190002 | Surface Soil | 10-May-12 | 0-2 | X | | | X | | X | | | | | Sample added due to field observations |
| 22SB020 | 22SB0200002 | Surface Soil | 23-Jan-13 | 0-2 | | | X | | | | | X | | | Field Duplicate 22FD012313-01 |
| | 22SB0200203 | Subsurface Soil | 23-Jan-13 | 2-3 | | | X | | | | | | | | |
| 22SD001 | 22SD0010006 | Sediment | 20-Jan-11 | 0-.5 | X | | | | | X | | | | X | |
| 22SD002 | 22SD0020006 | Sediment | 20-Jan-11 | 0-.5 | X | | | | | X | | | | X | |
| 22SD003 | 22SD0030006 | Sediment | 20-Jan-11 | 0-.5 | X | | | | | X | | | | X | |
| 22SD004 | 22SD0040006 | Sediment | 20-Jan-11 | 0-.5 | X | | | | | X | | | | X | |
| 22SD005 | 22SD0050006 | Sediment | 20-Jan-11 | 0-.5 | X | | | | | X | | | | X | |
| 22SD006 | 22SD0060006 | Sediment | 18-Jan-11 | 0-.5 | X | | | | | X | | | X | X | |
| | 22SD0060624 | Sediment | 18-Jan-11 | .5-2 | X | | | | | X | | | X | X | |
| 22SD007 | 22SD0070006 | Sediment | 18-Jan-11 | 0-.5 | X | | | | | X | | | | X | |
| | 22SD0070624 | Sediment | 18-Jan-11 | .5-2 | X | | | | | X | | | | X | |
| 22SD008 | 22SD0080006 | Sediment | 18-Jan-11 | 0-.5 | X | | | | | X | | | | X | |
| | 22SD0080624 | Sediment | 18-Jan-11 | .5-2 | X | | | | | X | | | | X | |
| 22SD009 | 22SD0090006 | Sediment | 20-Jan-11 | 0-.5 | X | | | | | X | | | | X | Field Duplicate 22SDDUP01 |
| 22SD010 | 22SD0100006 | Sediment | 20-Jan-11 | 0-.5 | X | | | | | X | | | | X | |
| 22SD010 | 22SD0100006 | Sediment | 12-May-12 | 0-.5 | | | | X | | | | | | X | |
| 22SD011 | 22SD0110006 | Sediment | 20-Jan-11 | 0-.5 | X | | | | | X | | | | X | |
| 22SD017 | 22SD0170006 | Sediment | 11-May-12 | 0-.5 | | | | X | | X | | | | X | |
| 22SD017 | 22SD0170006 | Sediment | 23-Jan-13 | 0-.5 | | | X | | | | | | | | |
| 22SD018 | 22SD0180006 | Sediment | 9-Apr-11 | 0-.5 | X | | | | | X | | | | X | Field Duplicate 22FD04091102 |
| 22SD018 | 22SD0180006 | Sediment | 12-May-12 | 0-.5 | | | | X | | | | | | X | |
| 22SD022 | 22SD0220006 | Sediment | NA | NA | -- | | | -- | | -- | | | | -- | Listed as sediment in SAP, no flow sampled as surface soil, see above 22SS022 |

**TABLE 2-1**

**SUMMARY OF ENVIRONMENTAL SAMPLES AND LABORATORY ANALYSIS**
**SWMU 22 - LEAD AZIDE POND**
**NSWC CRANE**
**CRANE, INDIANA**


| Sample Location | Sample Identification | Sample Type | Date Sampled | Sample Depth Interval Sampled (feet bgs) | Energetics | | | | | Metals | | | Miscellaneous | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Nitroaromatics / Nitramines | RDX/HMX | RDX/TNT | NG/PETN | Perchlorate | RCRA Metals | RCRA Metals (dissolved) | Chrom. $^{+}3/^{+}6$ | pH | TOC | |
| 22SD023 | 22SD0230006 | Sediment | 11-May-12 | 0-.5 | X | | | X | | X | | | X | X | |
| 22SD024 | 22SD0240006 | Sediment | 11-May-12 | 0-.5 | X | | | X | | X | | | | X | |
| 22SD025 | 22SD0250006 | Sediment | NA | NA | -- | | | -- | | -- | | | | -- | Listed as sediment in SAP, no flow sampled as surface soil, see above 22SS022 |
| 22SD026 | 22SD0260006 | Sediment | 11-May-12 | 0-.5 | X | | | X | | X | | | | X | Sample added due to field observations |
| 22SW001 | 22SW001 | Surface Water | 20-Jan-11 | -- | X | | | | X | X | X | | | | |
| 22SW002 | 22SW002 | Surface Water | 20-Jan-11 | -- | X | | | | X | X | X | | | | |
| 22SW003 | 22SW003 | Surface Water | 20-Jan-11 | -- | X | | | | X | X | X | | | | |
| 22SW004 | 22SW004 | Surface Water | 20-Jan-11 | -- | X | | | | X | X | X | | | | |
| 22SW005 | 22SW005 | Surface Water | 20-Jan-11 | NA | -- | | | | -- | -- | -- | | | | Dry, not sampled |
| 22SW006 | 22SW006 | Surface Water | 18-Jan-11 | -- | X | | | | X | X | X | | | | |
| 22SW007 | 22SW007 | Surface Water | 18-Jan-11 | -- | X | | | | X | X | X | | | | |
| 22SW008 | 22SW008 | Surface Water | 18-Jan-11 | -- | -- | | | | -- | -- | -- | | | | Dry, not sampled |
| 22SW009 | 22SW009 | Surface Water | 20-Jan-11 | -- | X | | | | X | X | X | | | | Field Duplicate 22SWDUP01 |
| 22SW010 | 22SW010 | Surface Water | 20-Jan-11 | -- | X | | | | X | X | X | | | | |
| 22SW010 | 22SW010 | Surface Water | 12-May-12 | -- | | | | X | | | | | | | |
| 22SW011 | 22SW011 | Surface Water | 20-Jan-11 | -- | X | | | | X | X | X | | | | |
| 22SW012 | 22SW012 | Surface Water | 9-Apr-11 | -- | | X | | | | | | | | | |
| 22SW013 | 22SW013 | Surface Water | 9-Apr-11 | -- | | X | | | | | | | | | |
| 22SW014 | 22SW014 | Surface Water | 9-Apr-11 | -- | | X | | | | | | | | | |
| 22SW015 | 22SW015 | Surface Water | 9-Apr-11 | -- | | X | | | | | | | | | |
| 22SW016 | 22SW016 | Surface Water | 9-Apr-11 | -- | | X | | | | | | | | | |
| 22SW017 | 22SW017 | Surface Water | 9-Apr-11 | -- | | X | | | | | | | | | |
| 22SW017 | 22SW017 | Surface Water | 11-May-12 | -- | | | | X | | X | | | | | |
| 22SW018 | 22SW018 | Surface Water | 9-Apr-11 | -- | X | | | | | X | X | | | | Field Duplicate 22FD04091101 |
| 22SW018 | 22SW018 | Surface Water | 12-May-12 | NA | | | | -- | | | | | | | Dry, not sampled |
| 22SW019 | 22SW019 | Surface Water | 9-Apr-11 | -- | | X | | | | | | | | | |
| 22SW020 | 22SW020 | Surface Water | 9-Apr-11 | -- | | X | | | | | | | | | |
| 22SW021 | 22SW021 | Surface Water | 9-Apr-11 | -- | | X | | | | | | | | | |
| 22SW022 | 22SW022 | Surface Water | 12-May-12 | NA | | | | | | | | | | | Dry, not sampled |
| 22SW023 | 22SW023 | Surface Water | 11-May-12 | -- | X | | | X | | X | | | X | | |
| 22SW024 | 22SW024 | Surface Water | 11-May-12 | -- | X | | | X | | X | | | | | Field Duplicate 22SWDUP01 |
| 22SW025 | 22SW025 | Surface Water | 11-May-12 | NA | | | | | | | | | | | Dry, not sampled |
| 22SW025 | 22SW025 | Surface Water | 23-Jan-13 | NA | | | | | | | | | | | Dry, not sampled |
| 22MWT001 | 22GWT001 | Groundwater | 22-May-12 | 15-25 | X | | | X | X | X | X | | | | |
| 22MWT002 | 22GWT002 | Groundwater | 22-May-12 | 11-21 | X | | | X | X | X | X | | | | Field Duplicate 22GWDUP01 |
| 22MWT003 | 22GWT003 | Groundwater | 23-May-12 | 13-23 | X | | | X | X | X | | | | | |
| 22MWT004 | 22GWT004 | Groundwater | 23-May-12 | 15-25 | X | | | X | X | X | X | | | | |
| 22MWT005 | 22GWT005 | Groundwater | 21-May-12 | 9-19 | X | | | X | X | X | X | | | | |
| 22MWT005 | 22GWT005 | Groundwater | 23-Jan-13 | 9-19 | | | | | | | | X | | | Field Duplicate 22FD012312-02 |
| 22MWT005 | 22GWT005 | Groundwater | 16-Apr-13 | 9-19 | | | | | | | | X | | | |
| 22MWT006 | 22GWT006 | Groundwater | 21-May-12 | 15-25 | X | | | X | X | X | X | | | | |

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TABLE 2-3

SOIL, SEDIMENT, AND SURFACE WATER SAMPLING SUMMARY
SWMU 22 - LEAD AZIDE POND
NSWC CRANE
CRANE, INDIANA


| Sample Location | Total Depth | Sample Method | Sample Date | Depth Interval(s) of Samples | QA Collected | Comments |
|---|---|---|---|---|---|---|
| **Surface Soil** | **feet bgs** | | | **feet bgs** | | |
| 22SS001 | 2 | HA | 21-Jan-11 | 0-2 | Duplicate | |
| 22SS002 | 2 | HA | 21-Jan-11 | 0-2 | NA | |
| 22SS004 | 2 | HA | 23-Jan-13 | 0-2 | NA | |
| 22SS005 | 2 | HA | 23-Jan-13 | 0-2 | NA | |
| 22SS006 | 2 | HA | 23-Jan-13 | 0-2 | NA | |
| 22SS007 | 2 | HA | 23-Jan-13 | 0-2 | MS/MSD | |
| 22SS008 | 2 | HA | 23-Jan-13 | 0-2 | NA | |
| 22SS022 | 2 | Soil Probe | 12-May-12 | 0-2 | MS/MSD | |
| 22SS025 | 2 | PT | 11-May-12 | 0-2 | Duplicate & MS/MSD | |
| **Surface Water** | **inches[1]** | | | **inches** | | |
| 22SW001 | 4 | Direct Fill | 20-Jan-11 | 0-4 | NA | |
| 22SW002 | 4 | Direct Fill | 20-Jan-11 | 2-4 | NA | |
| 22SW003 | 6 | Direct Fill | 20-Jan-11 | 4-6 | NA | |
| 22SW004 | 1 | Direct Fill | 20-Jan-11 | 0-1 | NA | |
| 22SW005 | NA | NA | 20-Jan-11 | NA | NA | Dry, not sampled |
| 22SW006 | 4 | Direct Fill | 18-Jan-11 | 0-4 | NA | |
| 22SW007 | 4 | Direct Fill | 18-Jan-11 | 0-4 | NA | |
| 22SW008 | NA | NA | 18-Jan-11 | NA | NA | Dry, not sampled |
| 22SW009 | 2 | Direct Fill | 20-Jan-11 | 1-2 | Duplicate | |
| 22SW010 | 6 | Direct Fill | 20-Jan-11 | 4-6 | NA | |
| 22SW010 | 5 | Direct Fill | 12-May-12 | 0-5 | NA | |

TABLE 2-3

SOIL, SEDIMENT, AND SURFACE WATER SAMPLING SUMMARY
SWMU 22 - LEAD AZIDE POND
NSWC CRANE
CRANE, INDIANA


| Sample Location | Total Depth | Sample Method | Sample Date | Depth Interval(s) of Samples | QA Collected | Comments |
|---|---|---|---|---|---|---|
| **Surface Water (cont.)** | **inches[1]** | | | **inches** | | |
| 22SW011 | 8 | Direct Fill | 20-Jan-11 | 6-8 | MS/MSD | |
| 22SW012 | 18 | Direct Fill | 9-Apr-11 | 0-2 | NA | |
| 22SW013 | 12 | Direct Fill | 9-Apr-11 | 0-2 | NA | |
| 22SW014 | 12 | Direct Fill | 9-Apr-11 | 0-2 | NA | |
| 22SW015 | 2 | Direct Fill | 9-Apr-11 | 0-1 | NA | |
| 22SW016 | 6 | Direct Fill | 9-Apr-11 | 0-2 | NA | |
| 22SW017 | 1 | Direct Fill | 9-Apr-11 | 0-1 | NA | |
| 22SW017 | 6 | Direct Fill | 11-May-12 | 0-6 | NA | |
| 22SW018 | 1 | Direct Fill | 9-Apr-11 | 0-1 | Duplicate & MS/MSD | |
| 22SW018 | NA | NA | 12-May-12 | NA | NA | Dry, not sampled |
| 22SW019 | 6 | Direct Fill | 9-Apr-11 | 0-2 | NA | |
| 22SW020 | 2 | Direct Fill | 9-Apr-11 | 0-1 | NA | |
| 22SW021 | 8 | Direct Fill | 9-Apr-11 | 0-2 | NA | |
| 22SW022 | NA | NA | 12-May-12 | NA | NA | Dry, not sampled |
| 22SW023 | 6 | Direct Fill | 11-May-12 | 0-6 | NA | |
| 22SW024 | 6 | Direct Fill | 11-May-12 | 0-6 | Duplicate & MS/MSD | |
| 22SW025 | NA | NA | 11-May-12 | NA | NA | Dry, not sampled |
| 22SW025 | NA | NA | 23-Jan-13 | NA | NA | Dry, not sampled |
| **Sediment** | **inches bgs** | | | **inches bgs** | | |
| 22SD001 | 6 | ST | 20-Jan-11 | 0-6 | NA | |
| 22SD002 | 6 | ST | 20-Jan-11 | 0-6 | NA | |

TABLE 2-3

SOIL, SEDIMENT, AND SURFACE WATER SAMPLING SUMMARY
SWMU 22 - LEAD AZIDE POND
NSWC CRANE
CRANE, INDIANA


| Sample Location | Total Depth | Sample Method | Sample Date | Depth Interval(s) of Samples | QA Collected | Comments |
|---|---|---|---|---|---|---|
| **Sediment (cont.)** | **inches bgs** | | | **inches bgs** | | |
| 22SD003 | 6 | ST | 20-Jan-11 | 0-6 | NA | |
| 22SD004 | 6 | ST | 20-Jan-11 | 0-6 | NA | |
| 22SD005 | 6 | ST | 20-Jan-11 | 0-6 | NA | |
| 22SD006 | 24 | ST | 18-Jan-11 | 0-6, 6-24 | NA | |
| 22SD007 | 24 | ST | 18-Jan-11 | 0-6, 6-24 | NA | |
| 22SD008 | 24 | ST | 18-Jan-11 | 0-6, 6-24 | NA | |
| 22SD009 | 6 | ST | 20-Jan-11 | 0-6 | Duplicate | |
| 22SD010 | 6 | ST | 20-Jan-11 | 0-6 | NA | |
| 22SD010 | 6 | PT | 12-May-12 | 0-6 | NA | |
| 22SD011 | 6 | ST | 20-Jan-11 | 0-6 | MS/MSD | |
| 22SD017 | 6 | PT | 11-May-12 | 0-6 | NA | |
| 22SD017 | 6 | PT | 23-Jan-13 | 0-6 | NA | |
| 22SD018 | 6 | PT | 9-Apr-11 | 0-6 | Duplicate & MS/MSD | |
| 22SD018 | 6 | PT | 12-May-12 | 0-6 | NA | |
| 22SD023 | 6 | PT | 11-May-12 | 0-6 | NA | |
| 22SD024 | 6 | ST | 11-May-12 | 0-6 | NA | |
| 22SD026 | 6 | Scoop | 11-May-12 | 0-6 | NA | Settling Basin Sample |

**Footnotes**

1 Stream depth

bgs - Below ground surface
DPT = Direct-push technology
HA = Hand augering

PT = Plastic trowel
ST = Stainless steel trowel
NA = Not applicable

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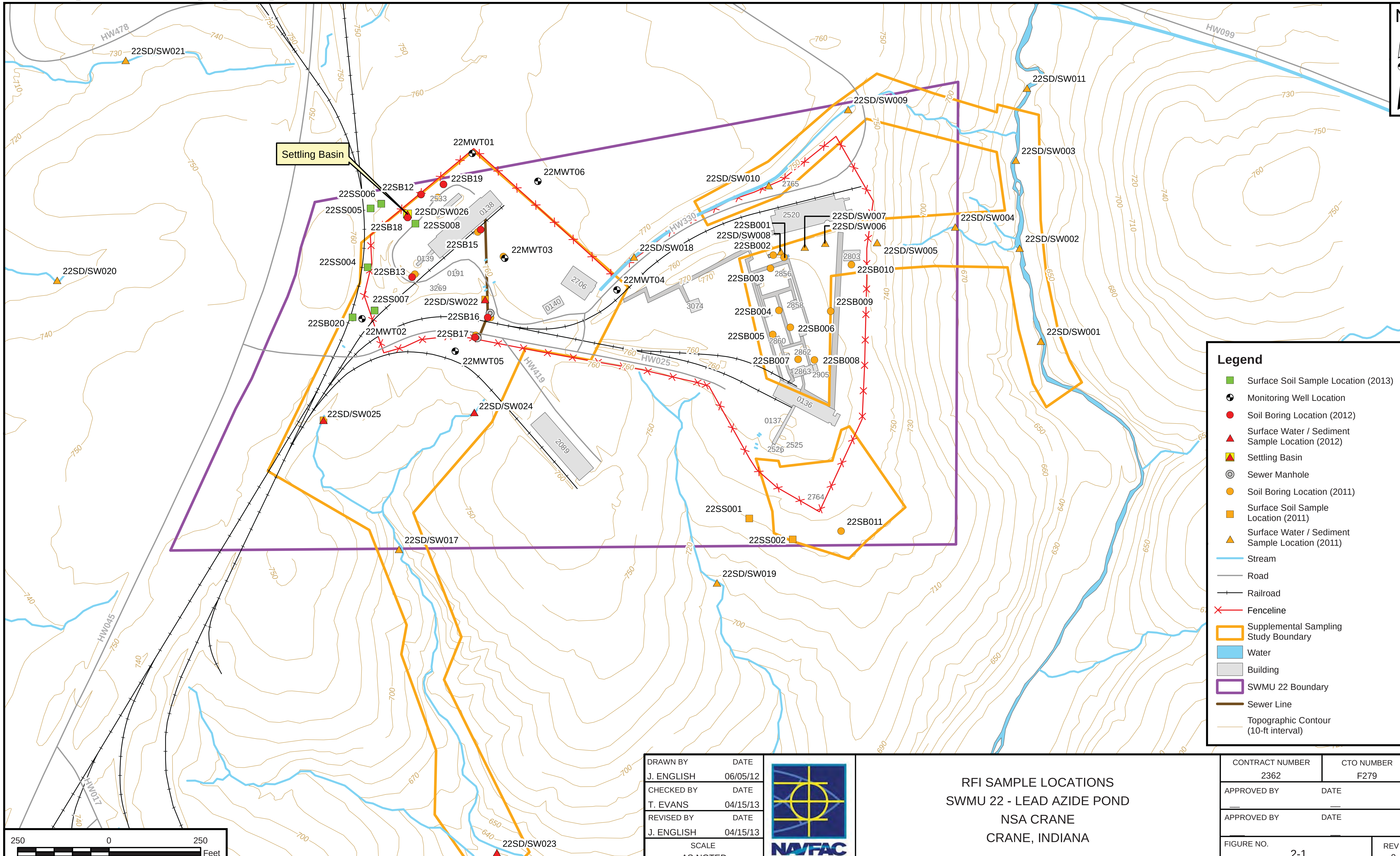
PGH P:\GIS\CRANE_NSWC\MAPDOCS\MXD\SWMU22_SUPP_SURVEYED_PROPLOCS.MXD 04/15/13 JEE




| DRAWN BY | DATE |
|---|---|
| J. ENGLISH | 06/05/12 |
| CHECKED BY | DATE |
| T. EVANS | 04/15/13 |
| REVISED BY | DATE |
| J. ENGLISH | 04/15/13 |
| SCALE | |
| AS NOTED | |

NAVFAC

RFI SAMPLE LOCATIONS
SWMU 22 - LEAD AZIDE POND
NSA CRANE
CRANE, INDIANA

| CONTRACT NUMBER | CTO NUMBER |
|---|---|
| 2362 | F279 |
| APPROVED BY | DATE |
| — | — |
| APPROVED BY | DATE |
| — | — |
| FIGURE NO. 2-1 | REV 0 |

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# 5.0 NATURE AND EXTENT OF CONTAMINATION

This section presents data collected during the SWMU 22 RFI followed by an evaluation of the nature and extent of contamination and whether the contamination was site related. Site-related contaminants are those that were released as a result of operations at SWMU 22 and therefore do not represent naturally occurring conditions or contamination from sources other than SWMU 22.

For metal concentrations in soil, basewide background soil data collected for NSA Crane (Tetra Tech, 2001) were used to determine whether SWMU 22 data represent naturally occurring conditions. The background data are divided into groups representing soils of similar chemical composition and geology. Soil groups to which Crane SWMU 22 soil samples belong were determined as described in the NSA Crane Basewide Soil Background Study (Tetra Tech, 2001). Surface soils at SWMU 22 belong to Soil Group 3; subsurface soils belong to Groups 8 and 9. Because there is only one data point for Soil Group 9, SWMU 22 subsurface soil data were compared to Soil Group 8 background data. Tables 5-1 and 5-2 present summary statistics representing background Soil Groups 3 (surface soil) and 8 (subsurface soil). Organic target analytes are assumed not to occur naturally in soil. If detected, their presence in SWMU 22 soil is interpreted as evidence of site-related contamination unless they are shown to be from another source such as laboratory contamination. Perchlorate data were interpreted similarly, although perchlorate is known to occur naturally as a result of lightning discharges and in nitrate fertilizers. If nitrate compounds containing perchlorate were released as a result of SWMU 22 operations, perchlorate associated with the nitrates would be viewed as a site-related contaminant. More detail is provided in Section 5.1.1.

For mobile media (surface water, sediment, and groundwater), evaluation of site-related contamination usually involves a comparison of conditions upgradient or upstream of the site to downgradient or downstream conditions. If downstream or downgradient target analyte concentrations exceed upstream/upgradient concentrations, there may have been an impact from the site because upgradient/upstream conditions are unaffected by site operations, whereas downgradient/downstream conditions may have been affected by site operations.

## 5.1 INVESTIGATION RESULTS

Analytical results for samples collected during the SWMU 22 data RFI are summarized in Tables 5-3 through 5-9. Odd-numbered tables, beginning with "5-3", present summary statistics such as the frequency at which each chemical was detected, maximum and minimum measured concentrations, and locations of maximum detected concentrations. Even-numbered tables beginning with "5-4" present data for each chemical that was detected in at least one sample for the applicable environmental medium. Complete site characterization data are presented in Appendix C, Tables C-1 through C-4. Included in the tables are the screening values used to assess whether analytes may represent a concern and to select COPCs in the risk characterization process (Sections 6 and 7).

SWMU 22 data are presented on Figures 5-1 through 5-4. These figures identify with an "**H**" or "**E**" whether a human health or ecological screening criterion, respectively, is exceeded by a result. Only dissolved metals concentrations were compared to ecological screening criteria because the dissolved metals portion of a sample most closely represents the bioavailable metal.

The data quality and overall usability evaluations are presented in Section 4.0. All collected data, except two lead and two chromium results (described later), were found to be suitable for achieving project objectives.

### 5.1.1 Soil Results and Extent of Soil Contamination

Tables 5-3a and 5-3b are the summary tables identifying the frequency of detection for each analyte in surface and subsurface soil samples, respectively. Table 5-4 is a summary of results for all analytes that were detected in at least one soil sample. Appendix C, Table C-1, is a complete tabulation of all soil data collected for this project and includes results for chemicals that were not detected in any soil sample. Figure 5-1 presents the distribution of concentrations of analytes in soil.

Metals concentrations in SWMU 22 surface and subsurface soil samples were compared to metal-specific 95/95 upper tolerance limits (UTLs) for NSA Crane, as published in the Basewide Soil Background Study (Tetra Tech, 2001). SWMU 22 surface soil data were compared to Soil Group 3 UTLs (alluvial, Mississippian, and Pennsylvanian surface soil), and subsurface soil data were compared to Soil Group 8 UTLs (Pennsylvanian subsurface clay and silt). A 95/95 UTL represents the concentration that separates the lower 95 percent of a data distribution from the upper 5 percent with 95-percent confidence. There is a 5-percent (1 in 20) chance that uncontaminated site soil data for a particular metal would exceed the corresponding UTL.

Human health or ecological risk-based screening values were exceeded for five metals in soil: arsenic, cadmium, chromium (hexavalent), lead, and mercury.

Arsenic, barium, cadmium, selenium, and silver concentrations were all within the applicable background soil concentration ranges (i.e., less than UTLs); therefore, these metals are not considered site-related soil contaminants. Total chromium concentrations ranged from 49 to 25.4 mg/kg which was less than the human health and ecological screening levels for total chromium. These concentrations exceeded the human health soil-to-groundwater criterion of 0.12 mg/kg and the direct contact criterion of 0.29 mg/kg and the ecological criterion of 0.4 mg/kg for hexavalent chromium. The concentration of 1.31 mg/kg detected in the surface soil sample at 22SB020 also exceeded the hexavalent chromium criteria.

Surface soil lead concentrations exceed the 27.0 mg/kg lead surface soil background value in two samples (31.4 mg/kg in 22SS0220002 and 31.7 mg/kg in 22SS0250002). The exceedances are within about 20 percent of the UTL. Metals concentrations in SWMU 22 subsurface soil samples did not exceed the background value.

Surface soil mercury concentrations from 22SS025 (0.6 mg/kg) and 22SB007 (0.079 mg/kg) exceeded the 0.077 mg/kg UTL.

Perchlorate was not detected in any soil samples.

RDX was detected in one surface soil sample, 22SS0250002, at a concentration of 0.37 mg/kg. The concentration exceeded the soil-to-groundwater human health criterion (0.0046 mg/kg) but was less than the direct contact criterion of 5.6 mg/kg. No other organic analytes were detected in surface or subsurface soil samples from SWMU 22.

### 5.1.2 Groundwater Results and Extent of Groundwater Contamination

Table 5-5 is a summary table identifying the frequency of detection for each target analyte in groundwater samples, and Table 5-6 is a summary of results for all target analytes detected in at least one groundwater sample. Appendix C, Table C-2, is a complete tabulation of all groundwater data collected for this project. Screened intervals for wells are tabulated in Table 2-2. Figure 5-2 displays groundwater data for each sampling location, including dissolved and total metal concentrations

Water levels were the greatest in well 22MWT06 (water elevation 753.40 feet), as shown on Figure 3-8. The groundwater potentiometric surface gradient from this point is toward the south and southwest. There are no SWMU 22 buildings or known operations immediately upgradient of wells 22MWT01 and 22MWT06; therefore, these well are expected to be unaffected by SWMU 22 operations and have been identified as “UPGRADIENT” in Tables 5-6. Wells 22MWT002 through 22MWT005 are either cross gradient within or downgradient of SWMU 22.

Chemicals detected in groundwater at concentrations greater than human health screening values were RDX, arsenic, cadmium, chromium, lead, selenium, perchlorate, TNT, and the TNT biotic degradation product, 4-amino-2,6-dinitrotoluene (4ADNT). The presence of 4ADNT is confirmation that TNT contamination is degrading naturally, but the detection of TNT indicates that degradation is not complete. None of these energetic organic compounds were detected in well 22MWT06, which is furthest upgradient from SWMU 22, but both compounds were detected in well 22MWT01, which is also upgradient of SWMU 22. The presence of energetic compounds in well 22MWT01 is an indication that these contaminants may be entering SWMU 22 groundwater from an upgradient source. The maximum energetic compound concentration (15 µg/L RDX) was detected in well 22MTW02. This well, which is also the only well in which TNT, 4ADNT, and HMX were detected, is downgradient of Building 138; therefore, Building 138, or a source nearby, appears to be the source of the energetic organic groundwater contamination.

Perchlorate was detected in well 22MWT06 at a concentration of 0.44 µg/L and in well 22MWT02 at a concentration of 5.9 µg/L. Because the perchlorate concentration in the downgradient well (22MWT02) is significantly greater than in the upgradient well, SWMU 22 may be a source of perchlorate to groundwater, but not necessarily the sole source. Well 22MWT01, also upgradient of SWMU 22 operations, had perchlorate at 0.25 µg/L, which is an indication that the perchlorate contamination source in groundwater may not be limited to SWMU 22 operations.

Well 22MWT02 had the greatest number of detections and risk-based screening value exceedances. Topography and groundwater elevations indicate that shallow groundwater flow, which generally follows topography, is predominantly southward near Building 138. Groundwater flow may intercepted by unnamed drainage channels south of SWMU 22.

Maximum total metals concentration for arsenic (11 µg/L), cadmium (7.1 µg/L), chromium (19.3 µg/L), lead (49.7 µg/L), and selenium (8.1 µg/L) were detected in well 22MWT06. Because well 22MWT06 is upgradient of SWMU 22 operations, it is likely that these elevated metals concentrations are not attributable to SWMU 22 operations. Barium concentrations were less than human health risk-based screening values in every well; therefore, barium is not discussed further. The dissolved concentrations of these metals were generally equal to or less than the corresponding total metal concentrations, an indication that the elevated metals concentrations are attributable to suspended solids in the groundwater in at least some samples. Concentrations of arsenic, cadmium, chromium, lead, and selenium decrease from well 22MWT06 to well 22MWT03 to well 22MWT05. This type of pattern is typical of a contaminant source being located at or upgradient of well 22MWT06, with the contaminants becoming more dilute as groundwater migrates further from the contaminant source. The elevated metals concentrations, however, could also be attributed to groundwater sample turbidity that varies from location to location. The groundwater sample log sheet indicates that the groundwater sample from well 22MWT06 was visibly turbid and became more so as the well was bailed. Based on these observations, SWMU 22 is not considered a source of metals contamination in groundwater, but there could be a source of metals contamination north of SWMU 22. This area north of well 22MWT06 has not been investigated as a potential contaminant source.

### 5.1.3 Settling Basin Sediment Results

Sediment data are presented in Tables 5-7 and 5-8, including one sediment sample collected from a settling basin located west of Building 138. The basin sampling location is numbered 22SD026. If the settling basin were to leak, however, the basin could represent a contamination source for groundwater.

The settling basin sediment sample was analyzed for energetic compounds and metals. Four nitroaromatic compounds were detected. Of these four compounds, only TNT and its degradation product, 4ANDT, were detected at concentrations exceeding risk-based screening values. The presence of the parent compound and breakdown product is evidence that TNT is degrading but that degradation is not yet complete. Both of these compounds exhibit measurable solubility in water; therefore, the settling basin could serve as a contamination source for groundwater if water in the basin leaks into the surrounding soil. However, TNT was not detected in groundwater at SWMU 22.

Arsenic and chromium concentrations in the settling basin sediment sample were greater than residential risk-based criteria, but neither of the concentrations (5.6 mg/kg for arsenic and 16.2 mg/kg for chromium) exceed naturally occurring background UTLs for surface or subsurface soil. Because of the fine-grained nature of sediment, naturally occurring sediment would be expected to have a natural metals content even greater than soil; therefore, the sediment metal concentrations are within the range of naturally occurring soil concentrations.

### 5.1.4 Stream Sediment/Surface Water Results and Extent of Sediment/Surface Water Contamination

Several sediment and surface water samples were collected from water conveyances associated with SWMU 22. These samples were analyzed for energetic compounds and metals. For metals analyses, the surface water samples were analyzed both before and after filtration to determine whether the metals were primarily in the suspended solids or dissolved portion of each sample, respectively.

Sediment data are presented in Tables 5-7 and 5-8. Surface water data are presented in Tables 5-9 and 5-10. Tables 5-7 and 5-9 are summaries identifying the frequency of detection for each target analyte in sediment and surface water, respectively. Tables 5-8 and 5-10 are summaries of results for all target analytes detected in at least one sediment or surface water sample, respectively. Appendix C, Tables C-3 and C-4 are complete tabulations of all sediment and surface water characterization data, respectively.

#### 5.1.4.1 Sediment

Concentrations of two metals in sediment samples collected at three locations exceeded surface soil background values, arsenic at locations 22SD011 (12.3 mg/kg) and 22SD023 (14.7 mg/kg) and mercury at location 22SD009 (0.26 mg/kg). Naturally occurring metals concentrations are usually greater in sediment than in soil because sediment typically has smaller grain sizes that adsorb metals more completely than soil.

The surface soil background value for arsenic is 11.83 mg/kg; the arsenic concentration at upgradient location 22SD011 (12.3 mg/kg) was slightly greater than this value. Only the 14.7 mg/kg arsenic concentration at location 22SD023 exceeded the upgradient concentration. Location 22SD023 receives drainage from other areas as well as SWMU 22, and further upstream/up drainage from this location, at location 22SD024, the arsenic concentration was 5.9 mg/kg. These suggest that the SWMU 22 arsenic concentrations in sediment do not represent site-related contamination. The mercury background value is 0.073 mg/kg. The mercury concentration at location 22SD009 was greater than the background value by approximately a factor of four. Mercury is used in explosives initiators and in pumps and other industrial equipment and could therefore have been released at SWMU 22. The available evidence suggests mercury might be a site-related sediment contaminant. Elevated sediment mercury concentrations are bounded by upstream and downstream locations where mercury concentrations do not exceed background levels (see Figure 5-3).

Organic analytes were not detected in any of the stream sediment samples. Perchlorate was not analyzed in sediment because it is so soluble in water that it is readily washed out of sediments.

#### 5.1.4.2 Surface Water

All eight of the metals analyzed for, HMX, and RDX were detected in at least one unfiltered surface water sample, and all eight metals and perchlorate were detected in at least one filtered surface water sample. Organic analytes were not analyzed for in filtered samples.

As expected, the metals concentrations were typically greater in unfiltered samples than in filtered samples because unfiltered sample concentrations can include suspended solids that may have been entrained in the samples. Filtered samples do not include suspended solids. Some exceptions did occur, but only two were significant. The dissolved chromium (0.93 µg/L) and lead (2.2 µg/L) concentrations in sample 22SW003 were significantly greater than the total concentrations (0.43 µg/L chromium and 0.22 µg/L lead) for that sample.

Barium, lead, and selenium concentrations in surface water did not exceed applicable screening criteria at any location; therefore, these metals are not discussed further.

Arsenic was detected in several surface water samples (see Figure 5-4), one of which was the upstream sampling location 22SW011 (0.41 µg/L). There is no known source of arsenic contamination at SWMU 22, and the surface water arsenic concentrations are relatively uniform across and downstream of SWMU 22. Soil, sediment, and groundwater arsenic concentrations appear to be within naturally occurring arsenic concentration ranges. However, the upstream arsenic concentration at location 22SW011 (0.41 µg/L) is one-fourth of the maximum total arsenic concentration (1.5 µg/L at 22SW004). This suggests that arsenic at 22SW004 might be a site-related surface water contaminant.

One dissolved cadmium result (0.26 µg/L) exceeded the 0.25 µg/L ecological screening value, but the total metals concentration from the same sample (0.24 µg/L) did not. No other dissolved cadmium results exceeded ecological screening values. The total cadmium concentration at location 22SW024 (1.7 µg/L) exceeded the 0.69 µg/L human health screening criterion by a factor of approximately three. Location 22SW017, about 500 feet downstream, also had detectable cadmium (0.29 µg/L). All other cadmium results were less than 0.3 µg/L. Location 22SW011, which is unaffected by SWMU 22 operations, had no detectable cadmium. Based on these observations, cadmium might be a site-related contaminant. If cadmium was released to the environment as a result of SWMU 22 activities, the source of cadmium is in the western half of SWMU 22.

Total chromium concentrations exceeded the 0.031 µg/L human health risk-based screening criterion in 13 samples. The maximum chromium concentration was 3 µg/L at location 22SW004. This concentration exceeds the 0.45 µg/L upgradient concentration at location 22SW011 by nearly an order of magnitude. These are indications that chromium could be a site-related contaminant, but the data are inconclusive. If chromium is a site-related contaminant, the data indicate that the contamination source is on the eastern side of SWMU 22.

RDX concentrations exceeded the human health risk-based screening criterion at seven locations (see Figure 5-4). RDX does not occur naturally and, therefore, considered a site-related contaminant. However, although observed RDX concentrations in surface water might represent site-related contamination, there also could be a contributing source of RDX contamination north of SWMU 22. Locations 22SW011 and 22SW013 are upgradient of SWMU 22 and are likely not to have been affected by SWMU 22. The RDX concentrations at these locations are the third and fourth highest RDX surface water concentrations. HMX was detected in surface water but at concentrations that did not exceed screening criteria. Although the 11 µg/L HMX concentration at location 22SW013, upgradient of SWMU 22, did not exceed a screening value, it is significantly greater than HMX concentrations at any other location. This supports a conclusion that energetic contamination is present in surface water as a result of SWMU 22 operations, but it also indicates that there is a potential contamination source north of SWMU 22. RDX contamination is unbounded in the stream channel east of SWMU 22 that flows north to south but is bounded everywhere else. The most downstream sampling location east of SWMU 22 had HMX and RDX concentrations of 0.82 and 0.78 µg/L, respectively.

Perchlorate was detected at one surface water sampling location (22SW02), but the concentration did not exceed its screening value. The presence of this target analyte is an additional indication that SWMU 22 operations resulted in release of energetic contaminants.

## 5.2 SUMMARY

The matrix below summarizes the status of various target analtyes with regard to whether they are considered to be site-related contamination. If a target analyte is not included for a particular environmental medium, it is not considered to be a contaminant for that medium.

**Site-Related Contaminants and Affected Media**

| Medium | Metal | Status |
|---|---|---|
| Soil | Lead | Minor SWMU 22-related contaminant but appears to be environmentally insignificant. Contamination appears to be limited to the former pond area. Evaluated in the risk assessments (Sections 7 and 8). |

| Medium | Metal | Status |
|---|---|---|
| Soil (continued) | Mercury | Site contaminant. Evaluated in the risk assessments (Sections 7 and 8). |
| | RDX | Site contaminant. Evaluated in the risk assessments (Sections 7 and 8). |
| Groundwater | HMX, RDX, TNT, 4-amino-2,6-dinitrotoluene, perchlorate | Site-related contaminants but may be coming on site from an upgradient source. Building 138 appears to be a source of energetic compound contamination at SWMU 22. Evaluated in the risk assessments (Sections 7 and 8). |
| Sediment in Settling Basin | Nitroaromatic compounds | Contamination source for groundwater if water in the basin leaks into the surrounding soil. Contamination is limited to the settling basin. Evaluated in the risk assessments (Sections 7 and 8). |
| Stream Sediment | Mercury | Low level mercury contamination is present. The available evidence is inconclusive as to whether this metal is actually related to site operations. Contamination is bounded by upgradient and downgradient non-detects. Evaluated in the risk assessments (Sections 7 and 8). |
| Surface Water | RDX | Site-related contaminant but also possibly associated with a contaminant source upgradient of SWMU 22. Evaluated in the risk assessments (Sections 7 and 8). |
| | HMX, perchlorate | Site-related contaminant but also possibly associated with a contaminant source upgradient of SWMU 22. Did not exceed screening values. |
| | Arsenic, cadmium, chromium | Possible site-related contaminants but data are inconclusive. Evaluated in the risk assessments (Sections 7 and 8). |

**TABLE 5-7**

**SUMMARY STATISTICS FOR SEDIMENT ANALYTICAL RESULTS**
**SWMU22 – LEAD AZIDE POND**
**NSA CRANE**
**CRANE, INDIANA**
**PAGE 1 OF 2**

| Parameter | Frequency of Detection | Minimum Result | Maximum Result | Location of Maximum Detection | Sample of Maximum Detection | Minimum Non-detect | Maximum Non-detect | Average of Detections | Overal Average | Standard Deviation |
|---|---|---|---|---|---|---|---|---|---|---|
| **EXPLOSIVES (mg/kg)** | | | | | | | | | | |
| 1,3,5-Trinitrobenzene | 0/18 | | | | | 0.158 | 0.158 | | | |
| 1,3-Dinitrobenzene | 0/18 | | | | | 0.126 | 0.126 | | | |
| 2,4,6-Trinitrotoluene | 0/18 | | | | | 0.166 | 0.166 | | | |
| 2,4-Dinitrotoluene | 0/18 | | | | | 0.166 | 0.166 | | | |
| 2,6-Dinitrotoluene | 0/18 | | | | | 0.166 | 0.166 | | | |
| 2-Amino-4,6-Dinitrotoluene | 0/18 | | | | | 0.15 | 0.15 | | | |
| 2-Nitrotoluene | 0/18 | | | | | 0.132 | 0.132 | | | |
| 3-Nitrotoluene | 0/18 | | | | | 0.142 | 0.142 | | | |
| 4-Amino-2,6-Dinitrotoluene | 0/18 | | | | | 0.15 | 0.15 | | | |
| 4-Nitrotoluene | 0/18 | | | | | 0.16 | 0.16 | | | |
| HMX | 0/18 | | | | | 0.16 | 0.16 | | | |
| Nitrobenzene | 0/18 | | | | | 0.15 | 0.15 | | | |
| Nitroglycerin | 0/18 | | | | | 0.17 | 0.17 | | | |
| PETN | 0/18 | | | | | 1.158 | 1.158 | | | |
| RDX | 0/18 | | | | | 0.16 | 0.16 | | | |
| Tetryl | 0/18 | | | | | 0.182 | 0.182 | | | |
| **METALS (mg/kg)** | | | | | | | | | | |
| Arsenic | 18/18 | 1.2 J | 14.7 | 22SD/SW023 | 22SD0230006 | | | 4.06 | 4.06 | 3.72 |
| Barium | 18/18 | 8.6 J | 173 J | 22SD/SW003 | 22SD0030006 | | | 37.3 | 37.3 | 37.0 |
| Cadmium | 18/18 | 0.071 J | 0.88 J | 22SD/SW006 | 22SD0060006 | | | 0.269 | 0.269 | 0.188 |
| Chromium (Total) | 18/18 | 2.5 J | 13.9 J | 22SD/SW003 | 22SD0030006 | | | 7.45 | 7.45 | 4.71 |
| Lead | 18/18 | 4 J | 20 J | 22SD/SW008 | 22SD0080624 | | | 9.68 | 9.68 | 4.15 |
| Mercury | 5/18 | 0.038 J | 0.26 | 22SD/SW009 | 22SD0090006 | 0.03 | 0.056 | 0.101 | 0.045 | 0.057 |
| Selenium | 18/18 | 0.044 J | 0.61 | 22SD/SW023 | 22SD0230006 | | | 0.184 | 0.184 | 0.142 |
| Silver | 3/18 | 0.02 J | 0.025 J | 22SD/SW001 | 22SD0010006 | 0.04 | 0.04 | 0.022 | 0.020 | 0.001 |
| **MISCELLANEOUS PARAMETERS** | | | | | | | | | | |
| Percent Moisture (%) | 5/5 | 21.4 | 44.1 | 22SD/SW010 | 22SD0100006_20120512 | | | 28.8 | 28.8 | 9.43 |
| pH | 3/3 | 6.1 | 7.3 | 22SD/SW006 | 22SD0060624 | | | 6.67 | 6.667 | 0.603 |
| Total Organic Carbon (mg/kg) | 19/19 | 670 | 39000 | 22SD/SW018 | 22SD0180006_20120512 | | | 11988 | 11988 | 10828 |

**TABLE 5-7**

**SUMMARY STATISTICS FOR SEDIMENT ANALYTICAL RESULTS**
**SWMU22 – LEAD AZIDE POND**
**NSA CRANE**
**CRANE, INDIANA**


**Associated Samples:**
22SD0010006
22SD0020006
22SD0030006
22SD0040006
22SD0050006
22SD0060006
22SD0060624
22SD0070006
22SD0070624
22SD0080006
22SD0080624
22SD0090006
22SD0100006
22SD0100006_20120512
22SD0110006
22SD0170006
22SD017_20130123
22SD0180006
22SD0180006_20120512
22SD0230006
22SD0240006

J - Indicates that the parameter was detected but the concentration is considered an estimate due to imprecision.
mg/kg - Milligrams per kilogram.
% - Percent

TABLE 5-8

SUMMARY OF ANALYSIS RESULTS FOR CHEMICALS DETECTED IN AT LEAST ONE SEDIMENT SAMPLE
SWMU 22 - LEAD AZIDE POND
NSA CRANE
CRANE, INDIANA


| LOCATION<br>SAMPLE ID<br>SAMPLE DATE<br>MATRIX<br>SUBMATRIX | ECO (1) | ECO REF | HH (2) | HH REF | 22SD/SW001<br>22SD0010006<br>01/20/2011<br>SD<br>SD | 22SD/SW002<br>22SD0020006<br>01/20/2011<br>SD<br>SD | 22SD/SW003<br>22SD0030006<br>01/20/2011<br>SD<br>SD | 22SD/SW004<br>22SD0040006<br>01/20/2011<br>SD<br>SD | 22SD/SW005<br>22SD0050006<br>01/20/2011<br>SD<br>SD |
|---|---|---|---|---|---|---|---|---|---|
| **EXPLOSIVES (MG/KG)** | | | | | | | | | |
| 1,3,5-Trinitrobenzene | 8 | (5) | 220 | (7) | 0.158 U | 0.158 U | 0.158 U | 0.158 U | 0.158 U |
| 2,4,6-Trinitrotoluene | 4 | (5) | 3.6 | (7) | 0.166 U | 0.166 U | 0.166 U | 0.166 U | 0.166 U |
| 2,4-Dinitrotoluene | 0.0144 | (3) | 1.6 | (7) | 0.166 U | 0.166 U | 0.166 U | 0.166 U | 0.166 U |
| 4-Amino-2,6-Dinitrotoluene | NA | NA | 15 | (7) | 0.15 U | 0.15 U | 0.15 U | 0.15 U | 0.15 U |
| **METALS (MG/KG)** | | | | | | | | | |
| Arsenic | 9.79 | (3) | 0.39 | (7) | **6.1 J** | **5.2 J** | **3.8 J** | **2.4 J** | **1.8 J** |
| Barium | 48 | (6) | 1500 | (7) | 34.8 J | 17 J | **173 J** | 27.1 J | 18.9 J |
| Cadmium | 0.99 | (3) | 7 | (7) | 0.31 J | 0.11 J | 0.2 J | 0.1 J | 0.16 J |
| Chromium | 43.4 | (3) | 0.29 | (7) | **12.4 J** | **13.2 J** | **13.9 J** | **4.5 J** | **3.2 J** |
| Lead | 35.8 | (3) | 400 | (7) | 9 J | 6.2 J | 7.6 J | 5.6 J | 4.7 J |
| Mercury | 0.174 | (3) | 2.3 | (7) | 0.03 U | 0.033 U | 0.037 U | 0.054 U | 0.045 U |
| Selenium | 2 | (4) | 39 | (7) | 0.21 J | 0.11 J | 0.11 J | 0.14 J | 0.083 J |
| Silver | 0.5 | (3) | 39 | (7) | 0.025 J | 0.04 UJ | 0.04 UJ | 0.04 UJ | 0.04 UJ |
| **MISCELLANEOUS PARAMETERS (%)** | | | | | | | | | |
| Percent Moisture | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **MISCELLANEOUS PARAMETERS (mg/kg)** | | | | | | | | | |
| Total Organic Carbon | NA | NA | NA | NA | 11000 | 1200 | 2900 | 13000 | 31000 |
| **MISCELLANEOUS PARAMETERS** | | | | | | | | | |
| pH | NA | NA | NA | NA | NA | NA | NA | NA | NA |

TABLE 5-8

SUMMARY OF ANALYSIS RESULTS FOR CHEMICALS DETECTED IN AT LEAST ONE SEDIMENT SAMPLE
SWMU 22 - LEAD AZIDE POND
NSA CRANE
CRANE, INDIANA


| LOCATION | ECO (1) | ECO REF | HH (2) | HH REF | 22SD/SW006 | | 22SD/SW007 | | 22SD/SW008 | |
|---|---|---|---|---|---|---|---|---|---|---|
| SAMPLE ID | | | | | 22SD0060006 | 22SD0060624 | 22SD0070006 | 22SD0070624 | 22SD0080006 | 22SD0080624 |
| SAMPLE DATE | | | | | 01/18/2011 | 01/18/2011 | 01/18/2011 | 01/18/2011 | 01/18/2011 | 01/18/2011 |
| MATRIX | | | | | SD | SD | SD | SD | SD | SD |
| SUBMATRIX | | | | | SD | SD | SD | SD | SD | SD |
| **EXPLOSIVES (MG/KG)** | | | | | | | | | | |
| 1,3,5-Trinitrobenzene | 8 | (5) | 220 | (7) | 0.158 U | 0.158 U | 0.158 U | 0.158 U | 0.158 U | 0.158 U |
| 2,4,6-Trinitrotoluene | 4 | (5) | 3.6 | (7) | 0.166 U | 0.166 U | 0.166 U | 0.166 U | 0.166 U | 0.166 U |
| 2,4-Dinitrotoluene | 0.0144 | (3) | 1.6 | (7) | 0.166 U | 0.166 U | 0.166 U | 0.166 U | 0.166 U | 0.166 U |
| 4-Amino-2,6-Dinitrotoluene | NA | NA | 15 | (7) | 0.15 U | 0.15 U | 0.15 U | 0.15 U | 0.15 U | 0.15 U |
| **METALS (MG/KG)** | | | | | | | | | | |
| Arsenic | 9.79 | (3) | 0.39 | (7) | **1.7 J** | **1.6 J** | **2.7 J** | **1.6 J** | **5.6 J** | **5.1 J** |
| Barium | 48 | (6) | 1500 | (7) | 25 J | 17.9 J | 23.2 J | 19.6 J | 41.1 J | 46.1 J |
| Cadmium | 0.99 | (3) | 7 | (7) | 0.88 J | 0.071 J | 0.15 J | 0.51 J | 0.24 J | 0.13 J |
| Chromium | 43.4 | (3) | 0.29 | (7) | **4.7 J** | **4 J** | **3.7 J** | **2.9 J** | **10.4 J** | **11.4 J** |
| Lead | 35.8 | (3) | 400 | (7) | 11.3 J | 4 J | 8.8 J | 8.3 J | 14.8 J | 20 J |
| Mercury | 0.174 | (3) | 2.3 | (7) | 0.041 U | 0.04 U | 0.034 U | 0.039 U | 0.045 U | 0.056 U |
| Selenium | 2 | (4) | 39 | (7) | 0.1 J | 0.061 J | 0.11 J | 0.12 J | 0.22 J | 0.19 J |
| Silver | 0.5 | (3) | 39 | (7) | 0.02 J | 0.04 UJ | 0.04 UJ | 0.04 UJ | 0.02 J | 0.04 UJ |
| **MISCELLANEOUS PARAMETERS (%)** | | | | | | | | | | |
| Percent Moisture | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **MISCELLANEOUS PARAMETERS (mg/kg)** | | | | | | | | | | |
| Total Organic Carbon | NA | NA | NA | NA | 10000 | 2000 | 8300 | 5500 | 18000 | 2100 |
| **MISCELLANEOUS PARAMETERS** | | | | | | | | | | |
| pH | NA | NA | NA | NA | 6.6 | 7.3 | NA | NA | NA | NA |

TABLE 5-8

SUMMARY OF ANALYSIS RESULTS FOR CHEMICALS DETECTED IN AT LEAST ONE SEDIMENT SAMPLE
SWMU 22 - LEAD AZIDE POND
NSA CRANE
CRANE, INDIANA


| LOCATION | ECO [1] | ECO REF | HH [2] | HH REF | 22SD/SW009 | 22SD/SW010 | | 22SD/SW011 | 22SD/SW017 | |
|---|---|---|---|---|---|---|---|---|---|---|
| SAMPLE ID | | | | | 22SD0090006 | 22SD0100006 | 22SD0100006_201205 | 22SD0110006 | 22SD0170006 | 22SD0170006_20130123 |
| SAMPLE DATE | | | | | 01/20/2011 | 01/20/2011 | 05/12/2012 | 01/20/2011 | 05/11/2012 | 01/23/2013 |
| MATRIX | | | | | SD | SD | SD | SD | SD | SD |
| SUBMATRIX | | | | | SD | SD | SD | UPSTREAM SD | SD | SD |
| **EXPLOSIVES (MG/KG)** | | | | | | | | | | |
| 1,3,5-Trinitrobenzene | 8 | (5) | 220 | (7) | 0.158 U | 0.158 U | NA | 0.158 U | NA | NA |
| 2,4,6-Trinitrotoluene | 4 | (5) | 3.6 | (7) | 0.166 U | 0.166 U | NA | 0.166 U | NA | 0.2 U |
| 2,4-Dinitrotoluene | 0.0144 | (3) | 1.6 | (7) | 0.166 U | 0.166 U | NA | 0.166 U | NA | NA |
| 4-Amino-2,6-Dinitrotoluene | NA | NA | 15 | (7) | 0.15 U | 0.15 U | NA | 0.15 U | NA | NA |
| **METALS (MG/KG)** | | | | | | | | | | |
| Arsenic | 9.79 | (3) | 0.39 | (7) | **2.2 J** | **2 J** | NA | **12.3 J** | **5.5** | NA |
| Barium | 48 | (6) | 1500 | (7) | 16.7 J | 8.6 J | NA | 38.3 J | 42.1 | NA |
| Cadmium | 0.99 | (3) | 7 | (7) | 0.24 J | 0.37 J | NA | 0.26 J | 0.28 | NA |
| Chromium | 43.4 | (3) | 0.29 | (7) | **3.8 J** | **2.5 J** | NA | **16.2 J** | **10** | NA |
| Lead | 35.8 | (3) | 400 | (7) | 7.2 J | 7.9 J | NA | 11.3 J | 11.3 | NA |
| Mercury | 0.174 | (3) | 2.3 | (7) | **0.26** | 0.051 U | NA | 0.049 U | 0.086 J | NA |
| Selenium | 2 | (4) | 39 | (7) | 0.1 J | 0.044 J | NA | 0.19 J | 0.42 | NA |
| Silver | 0.5 | (3) | 39 | (7) | 0.04 UJ | 0.04 UJ | NA | 0.04 UJ | 0.04 U | NA |
| **MISCELLANEOUS PARAMETERS (%)** | | | | | | | | | | |
| Percent Moisture | NA | NA | NA | NA | NA | NA | 44.1 | NA | 31.1 | NA |
| **MISCELLANEOUS PARAMETERS (mg/kg)** | | | | | | | | | | |
| Total Organic Carbon | NA | NA | NA | NA | 18000 | 8800 | 29000 | 2800 | 670 | NA |
| **MISCELLANEOUS PARAMETERS** | | | | | | | | | | |
| pH | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

TABLE 5-8

SUMMARY OF ANALYSIS RESULTS FOR CHEMICALS DETECTED IN AT LEAST ONE SEDIMENT SAMPLE
SWMU 22 - LEAD AZIDE POND
NSA CRANE
CRANE, INDIANA


| LOCATION<br>SAMPLE ID<br>SAMPLE DATE<br>MATRIX<br>SUBMATRIX | ECO (1) | ECO REF | HH (2) | HH REF | 22SD/SW018<br>22SD0180006<br>04/09/2011<br>SD<br>SD | 22SD/SW018<br>22SD0180006_201205<br>05/12/2012<br>SD<br>SD | 22SD/SW023<br>22SD0230006<br>05/11/2012<br>SD<br>SD | 22SD/SW024<br>22SD0240006<br>05/11/2012<br>SD<br>SD | 22SD/SW026<br>22SD0260006<br>05/11/2012<br>SD<br>SETTLING BASIN |
|---|---|---|---|---|---|---|---|---|---|
| **EXPLOSIVES (MG/KG)** | | | | | | | | | |
| 1,3,5-Trinitrobenzene | 8 | (5) | 220 | (7) | 0.158 U | NA | 0.158 U | 0.158 U | 0.88 |
| 2,4,6-Trinitrotoluene | 4 | (5) | 3.6 | (7) | 0.166 U | NA | 0.166 U | 0.166 U | **2100** |
| 2,4-Dinitrotoluene | 0.0144 | (3) | 1.6 | (7) | 0.166 U | NA | 0.166 U | 0.166 U | 0.27 J |
| 4-Amino-2,6-Dinitrotoluene | NA | NA | 15 | (7) | 0.15 U | NA | 0.15 U | 0.15 U | **46 J** |
| **METALS (MG/KG)** | | | | | | | | | |
| Arsenic | 9.79 | (3) | 0.39 | (7) | **1.2 J** | NA | **14.7** | **5.9** | **5.6** |
| Barium | 48 | (6) | 1500 | (7) | 12.8 J | NA | **67.4** | 43.2 | 515 |
| Cadmium | 0.99 | (3) | 7 | (7) | 0.24 J | NA | 0.36 | 0.22 | 0.43 |
| Chromium | 43.4 | (3) | 0.29 | (7) | **2.8 J** | NA | **11.3** | **11.9** | **16.5** |
| Lead | 35.8 | (3) | 400 | (7) | 12.1 J | NA | 16.3 | 9.4 | 181 |
| Mercury | 0.174 | (3) | 2.3 | (7) | 0.038 J | NA | 0.073 J | 0.047 J | 0.99 |
| Selenium | 2 | (4) | 39 | (7) | 0.17 J | NA | 0.61 | 0.33 | 0.4 |
| Silver | 0.5 | (3) | 39 | (7) | 0.04 UJ | NA | 0.04 U | 0.04 U | 0.025 J |
| **MISCELLANEOUS PARAMETERS (%)** | | | | | | | | | |
| Percent Moisture | NA | NA | NA | NA | NA | 21.4 | 25.7 | 21.6 | 19.3 |
| **MISCELLANEOUS PARAMETERS (mg/kg)** | | | | | | | | | |
| Total Organic Carbon | NA | NA | NA | NA | 6900 J | 39000 | 14000 | 6400 | NA |
| **MISCELLANEOUS PARAMETERS** | | | | | | | | | |
| pH | NA | NA | NA | NA | NA | NA | 6.1 | NA | NA |

**NOTES:**
Only analytes with at least one detection are shown on this table.
(1) Minimum Ecological Risk Criteria
(2) Minimum Human Health Risk Criteria
(3) Region 5 (USEPA, 2003a)
(4) Region 3, freshwater (USEPA, 2006b)
(5) Sunahara (Sunahara, et al., 2009)
(6) NOAA sediment screening value (Buchman, 2008)
(7) Adjusted USEPA Regional Screening Level Direct Contact Residential (USEPA, 2012b)
mg/kg - Milligrams per kilogram
NA - Not Available / Not Analyzed
Light gray shading indicates detection.
Dark shading indicates exceedance of at least one criterion.

**DATA QUALIFIERS:**
U - Indicates that parameter was not detected at the numerical detection limit.
J - Indicates that the parameter was detected but the concentration is considered an estimate due to imprecision.
UJ - Indicates that the parameter was not detected and the result is estimated.

## TABLE 5-9

**SUMMARY STATISTICS FOR SURFACE WATER ANALYTICAL RESULTS**
**SWMU22 – LEAD AZIDE POND**
**NSA CRANE**
**CRANE, INDIANA**


| Parameter | Frequency of Detection | Minimum Result | Maximum Result | Location of Maximum Detection | Sample of Maximum Detection | Minimum Non-detect | Maximum Non-detect | Average of Detections | Overal Average | Standard Deviation |
|---|---|---|---|---|---|---|---|---|---|---|
| **EXPLOSIVES (µg/L)** | | | | | | | | | | |
| 1,3,5-Trinitrobenzene | 0/11 | | | | | 0.260 | 0.520 | | 0.154 | 0.0526 |
| 1,3-Dinitrobenzene | 0/11 | | | | | 0.262 | 0.520 | | 0.154 | 0.0522 |
| 2,4,6-Trinitrotoluene | 0/11 | | | | | 0.266 | 0.520 | | 0.156 | 0.0514 |
| 2,4-Dinitrotoluene | 0/11 | | | | | 0.250 | 0.520 | | 0.150 | 0.0546 |
| 2,6-Dinitrotoluene | 0/11 | | | | | 0.250 | 0.520 | | 0.150 | 0.0546 |
| 2-Amino-4,6-Dinitrotoluene | 0/11 | | | | | 0.250 | 0.520 | | 0.150 | 0.0546 |
| 2-Nitrotoluene | 0/11 | | | | | 0.252 | 0.520 | | 0.150 | 0.0542 |
| 3-Nitrotoluene | 0/11 | | | | | 0.266 | 0.520 | | 0.156 | 0.0514 |
| 4-Amino-2,6-Dinitrotoluene | 0/11 | | | | | 0.200 | 0.400 | | 0.118 | 0.0405 |
| 4-Nitrotoluene | 0/11 | | | | | 0.266 | 0.520 | | 0.156 | 0.0514 |
| HMX | 7/15 | 0.15 J | 0.87 | 22SD/SW003 | 22SW003 | 0.230 | 0.480 | 0.586 | 0.351 | 0.298 |
| Nitrobenzene | 0/11 | | | | | 0.252 | 0.520 | | 0.150 | 0.0542 |
| Nitroglycerin | 0/4 | | | | | 0.260 | 0.260 | | 0.130 | 0.000 |
| PETN | 0/4 | | | | | 1.21 | 1.21 | | 0.607 | 0.000 |
| RDX | 7/15 | 0.39 J | 2.5 | 22SD/SW017 | 22SW017 | 0.246 | 0.480 | 1.04 | 0.567 | 0.664 |
| Tetryl | 0/11 | | | | | 0.266 | 0.520 | | 0.156 | 0.0514 |
| **TOTAL METALS (µg/L)** | | | | | | | | | | |
| Arsenic | 8/12 | 0.18 J | 1.5 | 22SD/SW004 | 22SW004 | 0.180 | 0.180 | 0.58 | 0.417 | 0.406 |
| Barium | 12/12 | 26.4 | 74.8 | 22SD/SW003 | 22SW003 | | | 55.1 | 55.1 | 15.6 |
| Cadmium | 6/12 | 0.23 J | 1.7 J | 22SD/SW024 | 22SW024 | 0.0400 | 0.0830 | 0.535 | 0.281 | 0.473 |
| Chromium | 11/11 | 0.4 J | 3 | 22SD/SW004 | 22SW004 | | | 0.924 | 0.924 | 0.772 |
| Lead | 7/11 | 0.86 J | 9.6 | 22SD/SW006 | 22SW006 | 0.220 | 0.220 | 4.25 | 2.75 | 3.27 |
| Mercury | 5/12 | 0.065 J | 0.1 J | 22SD/SW017 | 22SW017_20120511 | 0.120 | 0.120 | 0.0838 | 0.0699 | 0.0157 |
| Selenium | 5/12 | 0.1 J | 0.56 J | 22SD/SW024 | 22SW024 | 0.200 | 0.200 | 0.212 | 0.147 | 0.132 |
| Silver | 1/12 | 0.032 J | 0.032 J | 22SD/SW009 | 22SW009 | 0.0600 | 0.190 | 0.0320 | 0.036 | 0.019 |
| **DISSOLVED METALS (µg/L)** | | | | | | | | | | |
| Arsenic | 5/9 | 0.19 J | 0.35 | 22SD/SW018 | 22SW018 | 0.180 | 0.180 | 0.240 | 0.173 | 0.0911 |
| Barium | 9/9 | 26 | 73.9 | 22SD/SW003 | 22SW003 | | | 46.9 | 46.9 | 19.2 |
| Cadmium | 3/9 | 0.066 J | 0.26 J | 22SD/SW007 | 22SW007 | 0.0400 | 0.0430 | 0.189 | 0.0764 | 0.0997 |
| Chromium | 8/8 | 0.27 J | 0.75 | 22SD/SW004 | 22SW004 | | | 0.395 | 0.395 | 0.162 |
| Lead | 3/8 | 0.11 J | 0.69 J | 22SD/SW007 | 22SW007 | 0.22 | 0.22 | 0.390 | 0.215 | 0.212 |
| Mercury | 2/9 | 0.067 J | 0.068 J | 22SD/SW004 | 22SW004 | 0.12 | 0.12 | 0.0675 | 0.0617 | 0.00332 |
| Selenium | 0/9 | | | | | 0.2 | 0.2 | | 0.100 | 0.000 |
| Silver | 2/9 | 0.057 J | 0.067 J | 22SD/SW006 | 22SW006 | 0.06 | 0.06 | 0.0620 | 0.0371 | 0.0143 |

TABLE 5-9

**SUMMARY STATISTICS FOR SURFACE WATER ANALYTICAL RESULTS**
**SWMU22 – LEAD AZIDE POND**
**NSA CRANE**
**CRANE, INDIANA**


| Parameter | Frequency of Detection | Minimum Result | | Maximum Result | | Location of Maximum Detection | Sample of Maximum Detection | Minimum Non-detect | Maximum Non-detect | Average of Detections | Overal Average | Standard Deviation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MISCELLANEOUS PARAMETERS** | | | | | | | | | | | | |
| Perchlorate (ug/L) | 1/8 | 0.4 | J | 0.4 | J | 22SD/SW002 | 22SW002 | 0.4 | 0.4 | 0.400 | 0.225 | 0.0707 |
| pH | 1/1 | 6.3 | | 6.3 | | 22SD/SW023 | 22SW023 | | | 6.30 | 6.30 | |

**Associated Samples:**
22SW001
22SW002
22SW003
22SW004
22SW006
22SW007
22SW009
22SW010
22SW010_20120512
22SW017
22SW017_20120511
22SW018
22SW019
22SW020
22SW021
22SW023
22SW024

J - Indicates that the parameter was detected but the concentration is considered an estimate due to imprecision.
ug/kg = Micrograms per kilogram.

**SUMMARY OF SURFACE WATER ANALYSIS RESULTS FOR CHEMICALS DETECTED IN AT LEAST ONE SURFACE WATER SAMPLE**
**SWMU22 – LEAD AZIDE POND**
**NSA CRANE**
**CRANE, INDIANA**



| LOCATION<br>SAMPLE ID<br>SAMPLE DATE<br>MATRIX<br>SAMPLE TYPE<br>SUBMATRIX | ECO [1] | ECO REF | HH [2] | HH REF | 22SD/SW001<br>22SW001<br>01/20/2011<br>SW<br>NORMAL<br>NA | 22SD/SW002<br>22SW002<br>01/20/2011<br>SW<br>NORMAL<br>NA | 22SD/SW003<br>22SW003<br>01/20/2011<br>SW<br>NORMAL<br>NA | 22SD/SW004<br>22SW004<br>01/20/2011<br>SW<br>NORMAL<br>NA | 22SD/SW006<br>22SW006<br>01/18/2011<br>SW<br>NORMAL<br>NA | 22SD/SW007<br>22SW007<br>01/18/2011<br>SW<br>NORMAL<br>NA | 22SD/SW009<br>22SW009<br>01/20/2011<br>SW<br>NORMAL<br>NA |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **DISSOLVED METALS (µg/L)** | | | | | | | | | | | |
| Arsenic | 150 | (3) | 0.045 | (7) | 0.18 U | 0.18 U | 0.18 U | 0.18 U | **0.19 J** | **0.23 J** | **0.23 J** |
| Barium | 220 | (4) | 290 | (7) | **68** | **68.4** | **73.9** | **26** | **36 J** | **53.8 J** | **34.5 J** |
| Cadmium | 0.25 | (3) | 0.69 | (7) | 0.04 U | 0.04 U | 0.04 U | 0.04 U | **0.24 J** | **0.26 J** | 0.04 U |
| Chromium | 11 | (3) | 0.031 | (7) | **0.5** | **0.39 J** | 0.92 R | **0.75** | **0.29 J** | **0.28 J** | **0.31 J** |
| Lead | 2.5 | (3) | 15 | (7) | 0.22 U | 0.22 U | 2.2 R | 0.22 U | **0.37 J** | **0.69 J** | **0.11 J** |
| Mercury | 0.77 | (3) | 0.43 | (7) | 0.12 U | 0.12 U | 0.12 U | **0.068 J** | 0.12 U | **0.067 J** | 0.12 U |
| Selenium | 5 | (3) | 7.8 | (7) | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 UJ | 0.2 UJ | 0.2 UJ |
| Silver | 3.2 | (3) | 7.1 | (7) | 0.06 UJ | 0.06 UJ | 0.06 UJ | 0.06 UJ | **0.067 J** | **0.057 J** | 0.06 UJ |
| **EXPLOSIVES (µg/L)** | | | | | | | | | | | |
| HMX | 150 | (5) | 78 | (7) | **0.82** | **0.79** | **0.87** | 0.23 U | 0.48 U | 0.48 U | **0.15 J** |
| RDX | 360 | (5) | 0.61 | (7) | **0.78** | **0.75** | **0.82** | 0.246 U | 0.48 U | 0.48 U | **0.39 J** |
| **METALS (µg/L)** | | | | | | | | | | | |
| Arsenic | 150 | (3) | 0.045 | (7) | 0.18 U | 0.18 U | 0.18 U | **1.5** | **0.38** | 0.18 U | **0.46 J** |
| Barium | 220 | (4) | 290 | (7) | **69** | **69.2** | **74.8** | **57.7** | **45.9** | **54.3** | **36.9 J** |
| Cadmium | 0.25 | (3) | 0.69 | (7) | 0.04 U | 0.04 U | 0.04 U | 0.04 U | **0.5** | **0.24** | 0.073 U |
| Chromium | 11 | (3) | 0.031 | (7) | **0.55** | **0.48 J** | 0.43 R | **3** | **1.5** | **0.47 J** | **0.4 J** |
| Lead | 2.5 | (3) | 15 | (7) | 0.22 U | 0.22 U | 0.11 R | **6.1** | **9.6** | **1.8** | **1 J** |
| Mercury | 0.77 | (3) | 0.43 | (7) | 0.12 U | 0.12 U | 0.12 U | 0.12 U | **0.065 J** | 0.12 U | **0.089 J** |
| Selenium | 5 | (3) | 7.8 | (7) | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | **0.1 J** |
| Silver | 3.2 | (3) | 7.1 | (7) | 0.06 UJ | 0.06 UJ | 0.06 UJ | 0.06 UJ | 0.06 UJ | 0.06 UJ | **0.032 J** |
| **MISCELLANEOUS PARAMETERS** | | | | | | | | | | | |
| PH | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Perchlorate (µg/L) | 9300 | (6) | 1.1 | (7) | 0.4 U | **0.4 J** | 0.4 U | 0.4 U | 0.4 U | 0.4 U | 0.4 U |

TABLE 5-10

SUMMARY OF SURFACE WATER ANALYSIS RESULTS FOR CHEMICALS DETECTED IN AT LEAST ONE SURFACE WATER SAMPLE
SWMU22 – LEAD AZIDE POND
NSA CRANE
CRANE, INDIANA


| LOCATION | ECO [1] | ECO REF | HH [2] | HH REF | 22SD/SW010 | | 22SD/SW011 | 22SD/SW012 | 22SD/SW013 | 22SD/SW014 |
|---|---|---|---|---|---|---|---|---|---|---|
| SAMPLE ID | | | | | 22SW010 | 22SW010_20120512 | 22SW011 | 22SW012 | 22SW013 | 22SW014 |
| SAMPLE DATE | | | | | 01/20/2011 | 5/12/2012 | 01/20/2011 | 04/09/2011 | 04/09/2011 | 04/09/2011 |
| MATRIX | | | | | SW | SW | SW | SW | SW | SW |
| SAMPLE TYPE | | | | | NORMAL | NORMAL | NORMAL | NORMAL | NORMAL | NORMAL |
| SUBMATRIX | | | | | NA | NA | UPSTREAM SW | UPSTREAM SW | UPSTREAM SW | UPSTREAM SW |
| **DISSOLVED METALS (µg/L)** | | | | | | | | | | |
| Arsenic | 150 | (3) | 0.045 | (7) | **0.2 J** | NA | **0.44 J** | NA | NA | NA |
| Barium | 220 | (4) | 290 | (7) | **34.4 J** | NA | **77.4 J** | NA | NA | NA |
| Cadmium | 0.25 | (3) | 0.69 | (7) | 0.043 U | NA | 0.04 UJ | NA | NA | NA |
| Chromium | 11 | (3) | 0.031 | (7) | **0.27 J** | NA | **0.46 J** | NA | NA | NA |
| Lead | 2.5 | (3) | 15 | (7) | 0.22 UJ | NA | **0.12 J** | NA | NA | NA |
| Mercury | 0.77 | (3) | 0.43 | (7) | 0.12 U | NA | **0.084 J** | NA | NA | NA |
| Selenium | 5 | (3) | 7.8 | (7) | 0.2 UJ | NA | **0.28 J** | NA | NA | NA |
| Silver | 3.2 | (3) | 7.1 | (7) | 0.06 UJ | NA | 0.06 UJ | NA | NA | NA |
| **EXPLOSIVES (µg/L)** | | | | | | | | | | |
| HMX | 150 | (5) | 78 | (7) | **0.23 J** | NA | **0.88** | 0.23 U | **11** | 0.23 U |
| RDX | 360 | (5) | 0.61 | (7) | **0.55** | NA | **0.79** | 0.246 U | **0.98** | 0.246 U |
| **METALS (µg/L)** | | | | | | | | | | |
| Arsenic | 150 | (3) | 0.045 | (7) | **0.49 J** | NA | **0.41** | NA | NA | NA |
| Barium | 220 | (4) | 290 | (7) | **36.1 J** | NA | **76.5** | NA | NA | NA |
| Cadmium | 0.25 | (3) | 0.69 | (7) | 0.083 U | NA | 0.04 U | NA | NA | NA |
| Chromium | 11 | (3) | 0.031 | (7) | **0.43 J** | NA | **0.45 J** | NA | NA | NA |
| Lead | 2.5 | (3) | 15 | (7) | **0.86 J** | NA | 0.22 U | NA | NA | NA |
| Mercury | 0.77 | (3) | 0.43 | (7) | 0.12 U | NA | 0.12 U | NA | NA | NA |
| Selenium | 5 | (3) | 7.8 | (7) | 0.2 UJ | NA | **0.24 J** | NA | NA | NA |
| Silver | 3.2 | (3) | 7.1 | (7) | 0.06 UJ | NA | 0.06 UJ | NA | NA | NA |
| **MISCELLANEOUS PARAMETERS** | | | | | | | | | | |
| PH | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Perchlorate (µg/L) | 9300 | (6) | 1.1 | (7) | 0.4 U | NA | 0.4 U | NA | NA | NA |

TABLE 5-10

SUMMARY OF SURFACE WATER ANALYSIS RESULTS FOR CHEMICALS DETECTED IN AT LEAST ONE SURFACE WATER SAMPLE
SWMU22 – LEAD AZIDE POND
NSA CRANE
CRANE, INDIANA


| LOCATION | ECO [1] | ECO REF | HH [2] | HH REF | 22SD/SW015 | 22SD/SW016 | 22SD/SW017 | | 22SD/SW018 | 22SD/SW019 |
|---|---|---|---|---|---|---|---|---|---|---|
| SAMPLE ID | | | | | 22SW015 | 22SW016 | 22SW017 | 22SW017_20120511 | 22SW018 | 22SW019 |
| SAMPLE DATE | | | | | 04/09/2011 | 04/09/2011 | 04/09/2011 | 05/11/2012 | 04/09/2011 | 04/09/2011 |
| MATRIX | | | | | SW | SW | SW | SW | SW | SW |
| SAMPLE TYPE | | | | | NORMAL | NORMAL | NORMAL | NORMAL | NORMAL | NORMAL |
| SUBMATRIX | | | | | UPSTREAM SW | UPSTREAM SW | NA | NA | NA | NA |
| **DISSOLVED METALS (µg/L)** | | | | | | | | | | |
| Arsenic | 150 | (3) | 0.045 | (7) | NA | NA | NA | NA | **0.35** | NA |
| Barium | 220 | (4) | 290 | (7) | NA | NA | NA | NA | **27.1 J** | NA |
| Cadmium | 0.25 | (3) | 0.69 | (7) | NA | NA | NA | NA | **0.066 J** | NA |
| Chromium | 11 | (3) | 0.031 | (7) | NA | NA | NA | NA | **0.37 J** | NA |
| Lead | 2.5 | (3) | 15 | (7) | NA | NA | NA | NA | 0.22 U | NA |
| Mercury | 0.77 | (3) | 0.43 | (7) | NA | NA | NA | NA | 0.12 U | NA |
| Selenium | 5 | (3) | 7.8 | (7) | NA | NA | NA | NA | 0.2 UJ | NA |
| Silver | 3.2 | (3) | 7.1 | (7) | NA | NA | NA | NA | 0.06 U | NA |
| **EXPLOSIVES (µg/L)** | | | | | | | | | | |
| HMX | 150 | (5) | 78 | (7) | 0.23 U | 0.23 U | **0.61** | NA | **0.63** | 0.23 U |
| RDX | 360 | (5) | 0.61 | (7) | 0.246 U | 0.246 U | **2.5** | NA | **1.5** | 0.246 U |
| **METALS (µg/L)** | | | | | | | | | | |
| Arsenic | 150 | (3) | 0.045 | (7) | NA | NA | NA | **0.18 J** | **0.72** | NA |
| Barium | 220 | (4) | 290 | (7) | NA | NA | NA | **67.1** | **26.4** | NA |
| Cadmium | 0.25 | (3) | 0.69 | (7) | NA | NA | NA | **0.29 J** | **0.25** | NA |
| Chromium | 11 | (3) | 0.031 | (7) | NA | NA | NA | **0.51** | **1** | NA |
| Lead | 2.5 | (3) | 15 | (7) | NA | NA | NA | 0.22 U | **6 J** | NA |
| Mercury | 0.77 | (3) | 0.43 | (7) | NA | NA | NA | **0.1 J** | 0.12 U | NA |
| Selenium | 5 | (3) | 7.8 | (7) | NA | NA | NA | **0.12 J** | **0.17 J** | NA |
| Silver | 3.2 | (3) | 7.1 | (7) | NA | NA | NA | 0.06 U | 0.06 U | NA |
| **MISCELLANEOUS PARAMETERS** | | | | | | | | | | |
| PH | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Perchlorate (µg/L) | 9300 | (6) | 1.1 | (7) | NA | NA | NA | NA | NA | NA |

TABLE 5-10

**SUMMARY OF SURFACE WATER ANALYSIS RESULTS FOR CHEMICALS DETECTED IN AT LEAST ONE SURFACE WATER SAMPLE**
**SWMU22 – LEAD AZIDE POND**
**NSA CRANE**
**CRANE, INDIANA**


| LOCATION<br>SAMPLE ID<br>SAMPLE DATE<br>MATRIX<br>SAMPLE TYPE<br>SUBMATRIX | ECO (1) | ECO REF | HH (2) | HH REF | 22SD/SW020<br>22SW020<br>04/09/2011<br>SW<br>NORMAL<br>NA | 22SD/SW021<br>22SW021<br>04/09/2011<br>SW<br>NORMAL<br>NA | 22SD/SW023<br>22SW023<br>05/11/2012<br>SW<br>NORMAL<br>NA | 22SD/SW024<br>22SW024<br>05/11/2012<br>SW<br>NORMAL<br>NA |
|---|---|---|---|---|---|---|---|---|
| **DISSOLVED METALS (µg/L)** | | | | | | | | |
| Arsenic | 150 | (3) | 0.045 | (7) | NA | NA | NA | NA |
| Barium | 220 | (4) | 290 | (7) | NA | NA | NA | NA |
| Cadmium | 0.25 | (3) | 0.69 | (7) | NA | NA | NA | NA |
| Chromium | 11 | (3) | 0.031 | (7) | NA | NA | NA | NA |
| Lead | 2.5 | (3) | 15 | (7) | NA | NA | NA | NA |
| Mercury | 0.77 | (3) | 0.43 | (7) | NA | NA | NA | NA |
| Selenium | 5 | (3) | 7.8 | (7) | NA | NA | NA | NA |
| Silver | 3.2 | (3) | 7.1 | (7) | NA | NA | NA | NA |
| **EXPLOSIVES (µg/L)** | | | | | | | | |
| HMX | 150 | (5) | 78 | (7) | 0.23 U | 0.23 U | 0.23 U | 0.23 U |
| RDX | 360 | (5) | 0.61 | (7) | 0.246 U | 0.246 U | 0.246 U | 0.246 U |
| **METALS (µg/L)** | | | | | | | | |
| Arsenic | 150 | (3) | 0.045 | (7) | NA | NA | **0.29** | **0.62** |
| Barium | 220 | (4) | 290 | (7) | NA | NA | **57.5** | **66.6** |
| Cadmium | 0.25 | (3) | 0.69 | (7) | NA | NA | **0.23 J** | **1.7 J** |
| Chromium | 11 | (3) | 0.031 | (7) | NA | NA | **0.72** | **1.1** |
| Lead | 2.5 | (3) | 15 | (7) | NA | NA | 0.22 U | **4.4** |
| Mercury | 0.77 | (3) | 0.43 | (7) | NA | NA | **0.068 J** | **0.097 J** |
| Selenium | 5 | (3) | 7.8 | (7) | NA | NA | **0.11 J** | **0.56 J** |
| Silver | 3.2 | (3) | 7.1 | (7) | NA | NA | 0.19 U | 0.06 U |
| **MISCELLANEOUS PARAMETERS** | | | | | | | | |
| PH | NA | NA | NA | NA | NA | NA | **6.3** | NA |
| Perchlorate (µg/L) | 9300 | (6) | 1.1 | (7) | NA | NA | NA | NA |

**NOTES:**
Only analytes with at least one detection are shown on this table.
(1) Minimum Ecological Risk Criteria
(2) Minimum Human Health Risk Criteria
(3) Ambient Water Quality Criteria (AWQC) (USEPA, 2009a)
(4) Region 5 (USEPA, 2003a)
(5) Region 3, freshwater (USEPA, 2006b)
(6) Dean (Dean, et al., 2004)
(7) Adjusted USEPA Regional Screening Level Tap Water (USEPA, 2012b)
µg/L - Micrograms per liter
NA - Not Available / Not Analyzed
Light gray shading indicates detection.
Dark shading indicates exceedance of at least one criterion.

**DATA QUALIFIERS:**
U - Indicates that parameter was not detected at the numerical detection limit.
J - Indicates that the parameter was detected but the concentration is considered an estimate due to imprecision.
UJ - Indicates that the parameter was not detected and the result is estimated.

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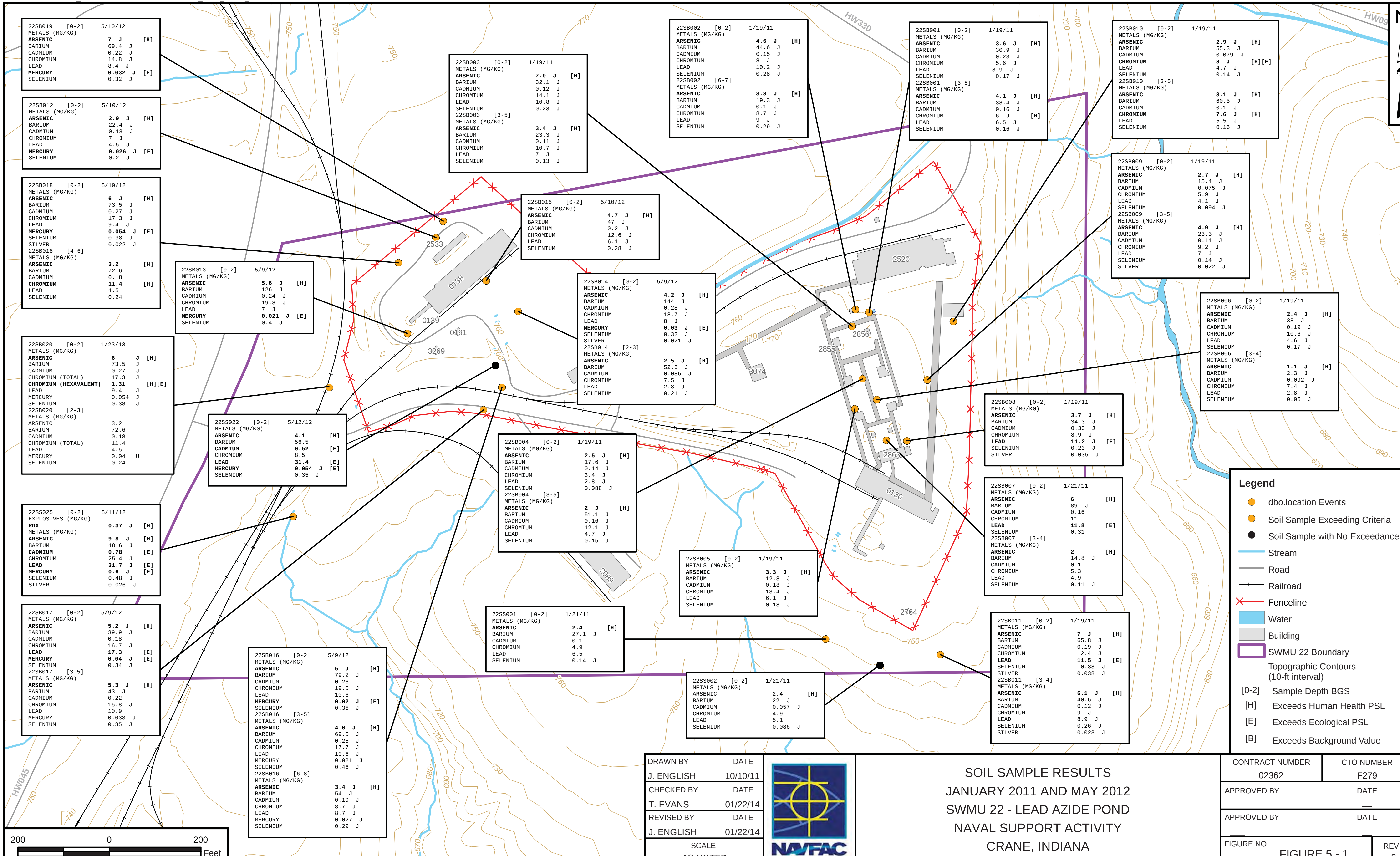


| | | |
|---|---|---|
| DRAWN BY J. ENGLISH | DATE 10/10/11 | |
| CHECKED BY T. EVANS | DATE 01/22/14 | |
| REVISED BY J. ENGLISH | DATE 01/22/14 | |
| SCALE AS NOTED | | |

NAVFAC

SOIL SAMPLE RESULTS
JANUARY 2011 AND MAY 2012
SWMU 22 - LEAD AZIDE POND
NAVAL SUPPORT ACTIVITY
CRANE, INDIANA

| | |
|---|---|
| CONTRACT NUMBER 02362 | CTO NUMBER F279 |
| APPROVED BY | DATE |
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| FIGURE NO. FIGURE 5 - 1 | REV 0 |

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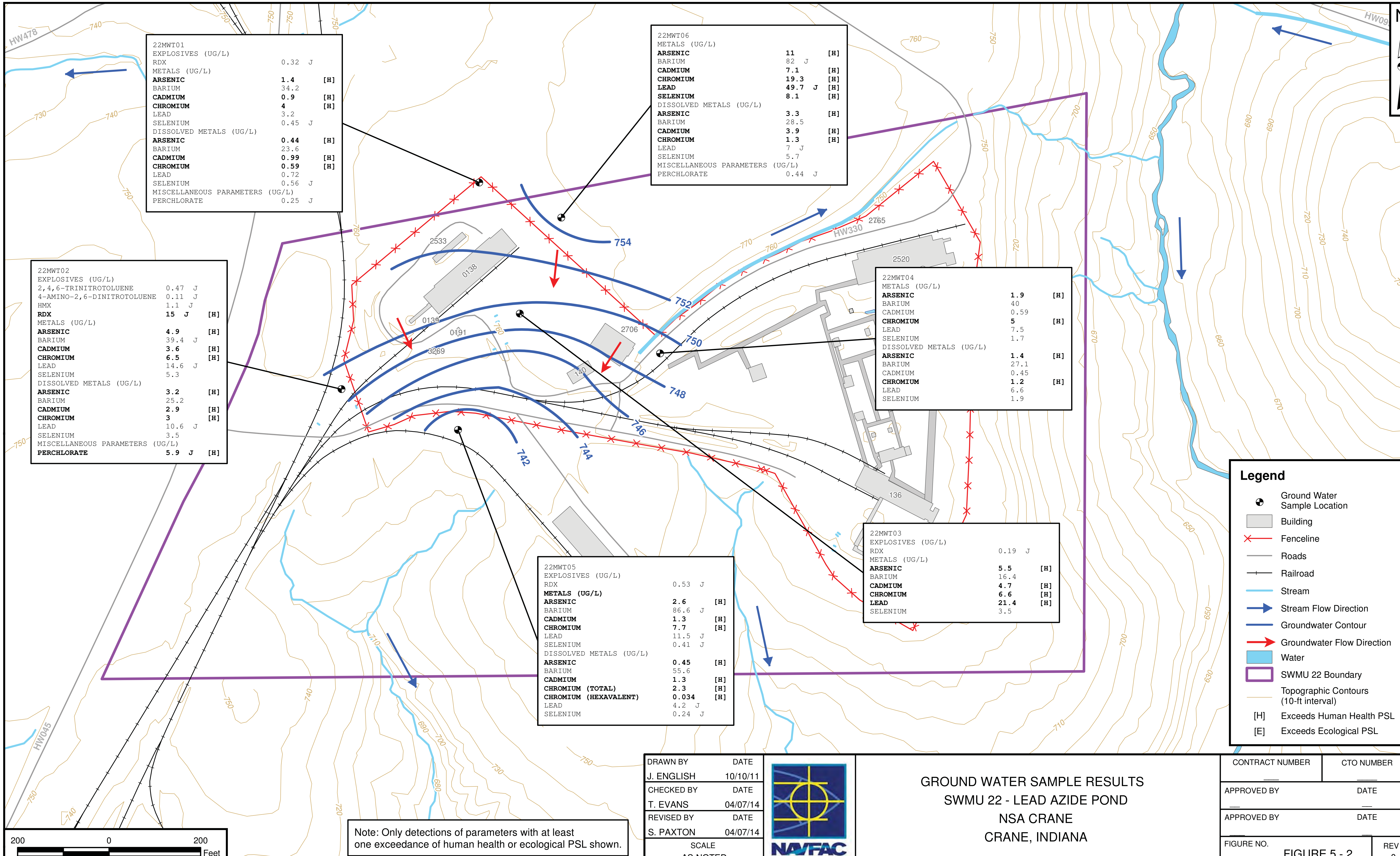

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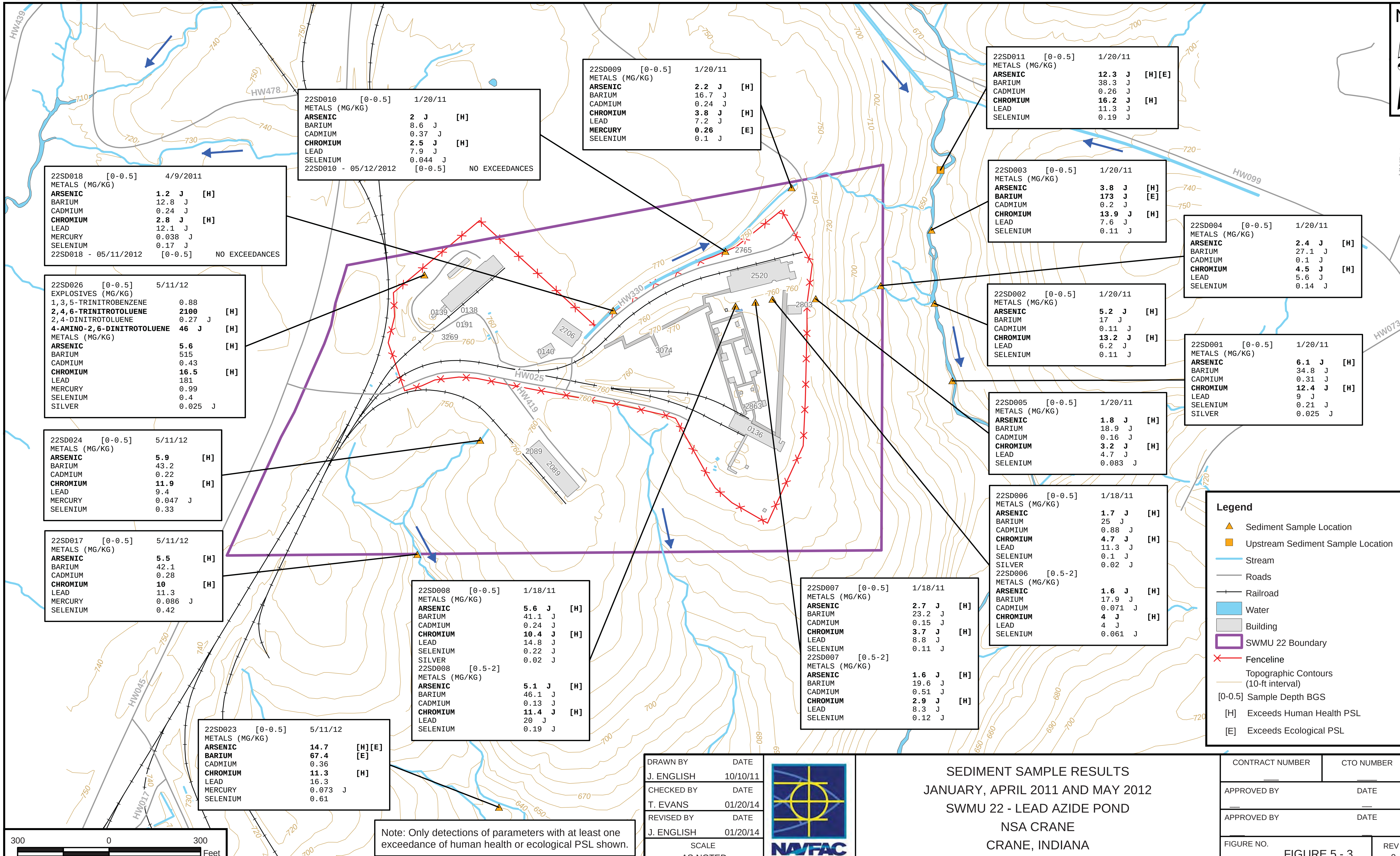


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| J. ENGLISH | 10/10/11 |
| CHECKED BY | DATE |
| T. EVANS | 01/20/14 |
| REVISED BY | DATE |
| J. ENGLISH | 01/20/14 |
| SCALE | |
| AS NOTED | |

NAVFAC

SEDIMENT SAMPLE RESULTS
JANUARY, APRIL 2011 AND MAY 2012
SWMU 22 - LEAD AZIDE POND
NSA CRANE
CRANE, INDIANA

| CONTRACT NUMBER | CTO NUMBER |
|---|---|
| APPROVED BY | DATE |
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| FIGURE NO. FIGURE 5 - 3 | REV 0 |

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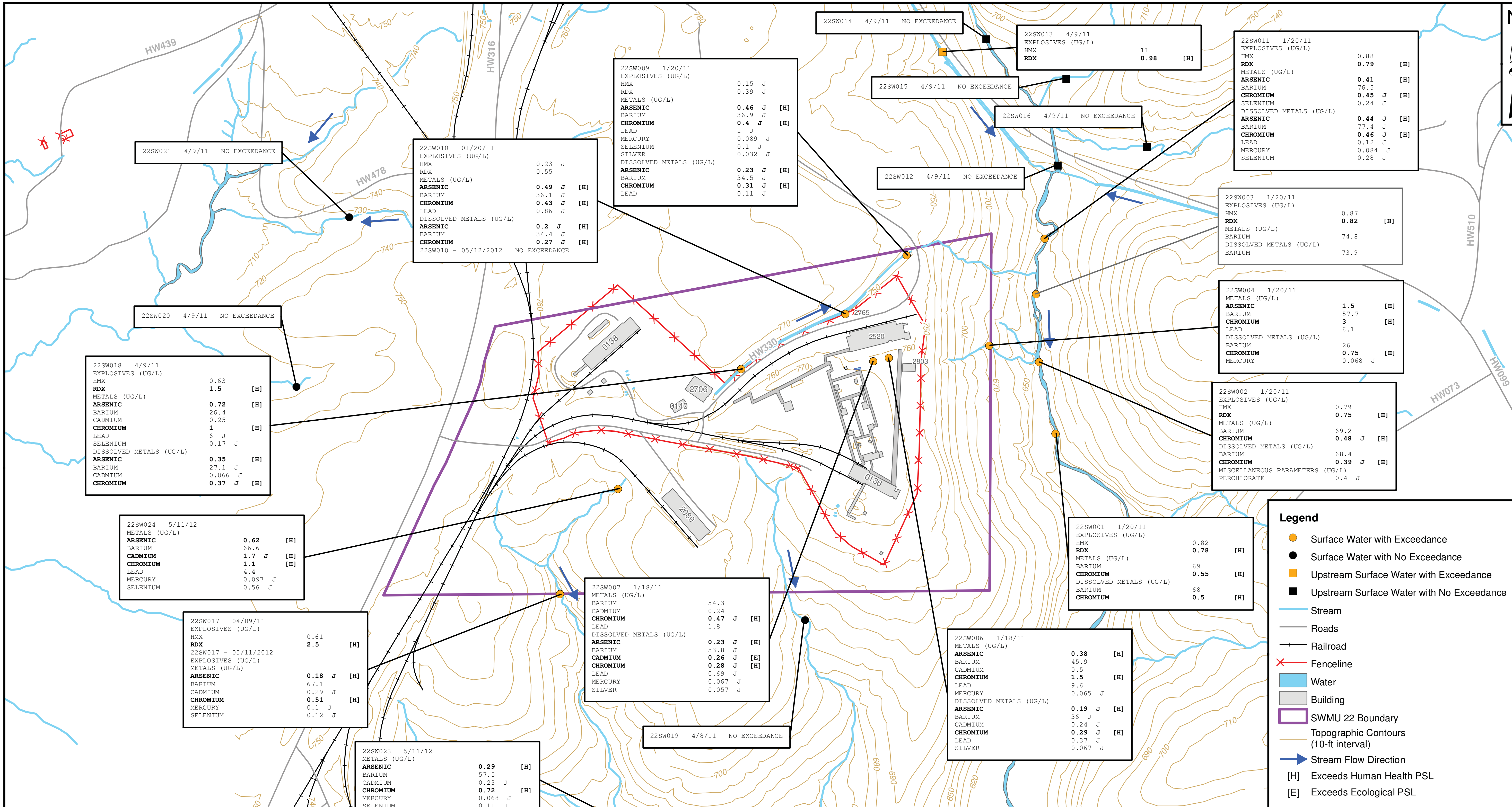


350 0 350 Feet

Notes:
1) Only detections of parameters with at least one exceedance of human health or ecological PSL shown.
2) Because dissolved metal concentrations more closely approximate the bioavailable fraction of metal in the water column than total metal, the ecological screening values were only compared to dissolved metal concentrations.

| DRAWN BY | DATE |
|---|---|
| J. ENGLISH | 10/10/11 |
| CHECKED BY | DATE |
| T. JOHNSTON | 9/20/12 |
| REVISED BY | DATE |
| S. PAXTON | 9/20/12 |
| SCALE AS NOTED | |

NAVFAC

SURFACE WATER SAMPLE RESULTS - JANUARY, APRIL 2011 AND MAY 2012
SWMU 22 - LEAD AZIDE POND
NSA CRANE
CRANE, INDIANA

| CONTRACT NUMBER | CTO NUMBER |
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| FIGURE NO. FIGURE 5 - 4 | REV 0 |

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# 7.0 HUMAN HEALTH RISK ASSESSMENT METHODOLOGY

## 7.1 INTRODUCTION

This section presents the HHRA for the SWMU 22 – Lead Azide Pond at NSA Crane. The objective of the HHRA is to determine whether detected concentrations of chemicals within the study area pose a significant threat to potential human receptors under current and/or future land use. The potential risks to human receptors were estimated based on the assumption that no actions were taken to control contaminant releases.

The following current United States Environmental Protection Agency (USEPA) and IDEM guidance documents were used to develop the framework for the baseline HHRA:

- Conducting Human Health Risk Assessments Under the Environmental Restoration Program (Navy, 2001).
- Navy Policy on the Use of Background Chemical Levels (Navy, 2004).
- Navy Human Health Risk Assessment Guidance (Navy, 2008)
- Risk Assessment Guidance for Superfund: Volume I, Human Health Evaluation Manual (Part A) (USEPA, 1989).
- Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors (USEPA, 1991).
- Distribution of Preliminary Review Draft: Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure (USEPA, 1993a).
- Exposure Factors Handbook. (USEPA, 1997b).
- Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites (USEPA, 2002a).

- Guidance for Characterizing Background and Chemical Concentrations in Soil for CERCLA Sites (USEPA, 2002b).

- Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) (USEPA, 2004).

- Guidelines for Carcinogen Risk Assessment (USEPA, 2005e).

- Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens (USEPA, 2005f).

- Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment) (USEPA, 2009b).

- Remediation Closure Guide (IDEM, 2013).

The HHRA is structured and reported according to the guidelines of the Risk Assessment Guidance for Superfund (RAGS), Human Health Evaluation Manual, Part D: Standardized Planning, Reporting, and Review of Superfund Risk Assessments (RAGS Part D) (USEPA, 2001).

An HHRA provides the framework for developing risk information necessary to assist in developing potential remedial alternatives for a site. An HHRA consists of five components: data evaluation, exposure assessment, toxicity assessment, risk characterization, and uncertainty analysis.

Three major aspects of chemical contamination and environmental fate and transport must be considered to evaluate potential risks: (1) contaminants with toxic characteristics must be found in environmental media and must be released by either natural processes or by human action; (2) potential exposure points must exist; and (3) human receptors must be present at the point of exposure. Risk is a function of both toxicity and exposure. If any one of these factors is absent for a site, the exposure pathway is incomplete, and no potential risks are considered to exist for human receptors.

## 7.2 DATA EVALUATION

Data evaluation, the first component of a baseline HHRA, is a medium-specific task involving compilation of analytical data as the first step. The second step and main objective of data evaluation is to develop a medium-specific list of COPCs that will be used to quantitatively and/or qualitatively determine potential human health risks for site media. COPCs are selected based on a toxicity screen (i.e., a comparison of site contaminant concentrations to conservative toxicity screening values) and a background screen (i.e., a comparison of site concentrations to background concentrations).

### 7.2.1 Data Usability

Section 3.0 presents a discussion of the data usability evaluation. Soil, surface water, and sediment samples collected in 2011 and 2012 and groundwater samples collected in 2012 and 2013 were used in this HHRA. Both total (unfiltered) and dissolved (filtered) groundwater sampling results are presented in the COPC selection tables, although only the total results were used to quantify risks. Field measurements and data regarded as unreliable (e.g., qualified as "R" during the data validation process) were not used in the quantitative HHRA. The sediment sample collected from within the settling basin was not used in this HHRA because it is unlikely that receptors would have significant exposure to this material. Risks from potential exposures to the material in the settling basin are discussed in Section 7.5.3.5. Samples used in this HHRA are listed on the COPC selection Tables 7-5 through 7-12 and in Appendix E.1.

### 7.2.2 Derivation of Screening Criteria

The primary criteria used to identify COPCs are based on USEPA Regional Screening Levels (RSLs) (2012a) and IDEM screening levels (2013). The RSLs are based on exposure pathways for which generally accepted methods, models, and assumptions have been developed (i.e., ingestion, dermal contact, and inhalation) for specific land use conditions and do not consider ecological receptors. The screening concentrations based on the RSLs correspond to a systemic hazard quotient (HQ) of 0.1 for non-carcinogens or an incremental lifetime cancer risk (ILCR) of $1x10^{-6}$ for carcinogens. The RSLs for non-carcinogens are based on an HQ of 1, whereas the screening concentrations used in the selection of COPCs were based on an HQ of 0.1 to account for the potential cumulative effects of several chemicals affecting the same target organ or producing the same adverse non-carcinogenic effect.

The IDEM screening levels for soil are based on the USEPA RSLs; however the IDEM screening levels are not necessarily the same as the RSLs. The IDEM screening levels for direct contact correspond to systemic HQs of 1 (for noncarcinogens) or ILCRs of $1x10^{-5}$ (for carcinogens). The USEPA RSLs for carcinogens corresponds to an ILCR of $1x10^{-6}$. The IDEM screening levels for soil can also be based on the soil saturation limit or capped at 100,000 mg/kg (direct contact) or 1,000,000 mg/kg (migration from soil to groundwater).

**Screening Levels for Soil**

Screening concentrations based on USEPA residential RSLs and IDEM residential soil screening levels were used to select COPCs for surface and subsurface soil. Maximum chemical concentrations in soil were also compared to USEPA risk-based soil screening levels (SSLs) for groundwater protection and to IDEM screening levels for migration from soil to groundwater. The SSLs and IDEM screening levels for migration from soil to groundwater were not used for the selection of COPCs for direct contact exposure; however, they do allow qualitative evaluation of the potential for chemical migration from soil to groundwater. Chemicals with concentrations exceeding the SSLs/IDEM default closure levels may potentially migrate from the soil to groundwater in sufficient quantities to pose groundwater quality problems.

The risk-based screening levels used in the COPC selection for soil are presented in Table 7-1.

**Screening Levels for Groundwater**

Screening levels based on the following criteria were used to select COPCs for groundwater:

- USEPA RSLs for tap water (2012a)
- USEPA Maximum Contaminant Levels (MCLs) (2012b)
- IDEM tap water screening levels for groundwater (2013)

Table 7-2 presents the screening criteria used for groundwater.

**Screening Levels for Surface Water**

Screening levels based on the following criteria were used to select COPCs for surface water:

- USEPA RSLs for tap water (2012a)
- USEPA MCLs (USEPA, 2012b)
- IDEM tap water screening levels for groundwater (2013)

In general, the use of tap water screening levels is regarded as a highly conservative approach to COPC selection at SWMU 22 because surface water is not used as a potable water source.

Table 7-3 presents the screening criteria used for surface water.

**Screening Levels for Sediment**

Screening concentrations based on USEPA residential RSLs and IDEM residential soil screening levels were used to select COPCs for sediment. The use of residential soil screening levels to select COPCs for sediments is highly conservative because residential screening criteria assume that receptors are exposed to soil 350 days of the year, whereas exposures to sediments will likely occur on a much less frequent basis.

Table 7-4 presents the screening criteria used for sediment.

**Screening Levels for Chromium**

Chromium speciation was only performed on one surface soil sample, collected at location 22SB020, and two groundwater samples collected from monitoring well 22MWT05. Hexavalent chromium was detected at a concentration of 1.31 mg/kg in the surface soil sample. The concentration of total chromium in this same sample was 16.5 mg/kg. Hexavalent chromium was not detected in the groundwater sample collected at monitoring well 22MWT05 in January 2013. The detection limit of 10 µg/L was greater than USEPA and IDEM screening levels; therefore, this monitoring well was resampled in April 2013. Hexavalent chromium was detected at an estimated concentration of 0.046 µg/L in the sampled collected in April 2013; total chromium was not detected above the detection limit of 10 µg/L. Based on available information, hexavalent chromium was not known to have been used at SWMU 22. Because chromium was detected at a low concentration in soil and in groundwater and because there is no evidence to support the conclusion that hexavalent chromium was used at the site, total chromium was treated as trivalent chromium in this HHRA. The uncertainty associated with this is discussed in the uncertainty analysis in Section 7.6.1.

**Update to RSLs**

The HHRA was prepared using the November 2012 RSLs. The RSLs were updated in November 2013. Arsenic is the only chemical for which the RSLs have changed. The RSL for residential soil changed from 0.39 mg/kg to 0.61 mg/kg. The changes in the RSL for arsenic do not affect the conclusions of the HHRA. Concentrations of arsenic were within background levels in surface soil and subsurface soil. Arsenic was retained as a COPC in sediment and would still be a COPC using the November 2013 RSLs.

**Background Evaluation**

In accordance with Navy policy (2004), chemicals present at background concentrations were not retained as COPCs in this HHRA. Background data are only available for soils at NSA Crane; consequently, a background comparison was not performed for groundwater, surface water, or sediment. The background evaluation was conducted in accordance with the Navy guidance titled Guidance for Environmental Background Analysis, Volume I: Soil (NFEC, 2002).

In the COPC selection process, if the results of the background evaluation indicated that concentrations of a chemical detected in site soils did not exceed background concentrations, that chemical was not selected as a COPC and was not carried through the quantitative risk assessment. However, chemicals present at concentrations exceeding risk-based screening criteria but not selected as COPCs on the basis of background evaluations are further discussed in the risk characterization section. The results of the background comparison analysis for surface soil and subsurface soil are presented in Section 5.

The elimination of chemicals as site-related COPCs on the basis of background follows Navy Policy on the Use of Background Chemical Levels (2004). This document also presents the Navy's interpretation of USEPA guidance provided in the document titled Role of Background in the CERCLA Cleanup Program (2002c) and details the methodology to be used in evaluating background under the Navy's Environmental Restoration and Base Realignment and Closure (BRAC) programs. Navy policy has been accepted by the USEPA as not contradicting the USEPA guidance (2002c). Navy policy applies to both the screening-level and baseline risk assessments and requires the following:

1. A clear and concise understanding of chemicals released from a site thus ensuring that the Navy is focusing on remediating the release.

2. The use of background data in the screening-level risk assessment.

   a. The comparison of site chemical levels to risk-based screening criteria.
   b. The comparison of site chemical levels to background concentrations.
   c. The identification of site-related COPCs based on screening criteria comparisons AND background comparisons. Site-related COPCs are those chemicals with concentrations exceeding risk-based screening criteria AND background concentrations. To the extent possible, site-related COPCs are further evaluated quantitatively in the baseline risk assessment (non-site-related COPCs are further discussed in the risk characterization sections of the baseline risk assessment).

3. The consideration of background in the baseline risk assessment.

   a. The calculation of risk estimates for site-related COPCs only.
   b. The further evaluation of non-site-related COPCs in the risk characterization section only (e.g., the evaluation of chemicals detected at concentrations exceeding screening criteria but less than background concentrations). The Navy considers this evaluation to be consistent with USEPA's Role of Background in the CERCLA Cleanup Program (2002c).

4. The selection of site cleanup remedial goals at levels not less than background levels. Additionally, cleanup levels should not be developed for chemicals not identified as chemicals of concern (COCs). As defined in the Navy guidance, COCs are site-related COPCs found to be the risk drivers in the baseline risk assessment and that may pose unacceptable human or ecological risks.

### 7.2.3 Decision Rules for Establishing COPCs

The following decision rules were used to select initial lists of COPCs for SWMU 22:

- A chemical detected in soil was selected as a COPC for soil if any detected chemical concentration exceeded the USEPA or IDEM direct contact screening levels for soil and, for inorganics, if the background comparison indicated that site concentrations are statistically greater than corresponding background concentrations.

- A chemical detected in groundwater was selected as a COPC for groundwater if the maximum detected concentration in any on-site monitoring well exceeded the USEPA or IDEM direct contact screening level for domestic use of a water supply (e.g., the tap water RSLs).

- A chemical detected in surface water was selected as a COPC for surface water if the maximum detected concentration in a potentially impacted surface water body exceeded the USEPA or IDEM direct contact screening level for domestic use of a water supply (e.g., the tap water RSLs).

- A chemical detected in sediment was selected as a COPC for sediment if any detected concentration exceeded the USEPA or IDEM direct contact screening level for residential exposures to soil.

Chemicals detected in any sample at concentrations greater than screening levels but eliminated as COPCs on the basis of background comparisons are further discussed in Section 7.4.3.4.

### 7.2.4 COPCs Selected for HHRA

COPCs were selected for surface soil, subsurface soil, groundwater, surface water, and sediment using the risk-based COPC screening levels described in Section 7.1.2. A discussion of the chemicals identified as COPCs and the rationale for COPC selection is provided in the following subsections. A discussion of the nature and extent of the chemicals detected in site media is presented in Section 5.0. COPC selection information for each medium is presented in Tables 7-5 through 7-11, and chemicals retained as COPCs are presented in Table 7-12. RAGS Part D tables for COPC selection are included in Appendix E.2.

#### 7.2.4.1 Surface Soil

A comparison of maximum detected surface soil concentrations to screening levels based on RSLs and IDEM screening levels for residential exposures to soil is presented in Table 7-5. Concentrations of arsenic exceeded the screening levels but were within the site background level and are not considered to be site related. Concentrations of hexavalent chromium also exceeded the screening levels. No background data are available for hexavalent chromium. Concentrations of total chromium were within background levels; consequently, concentrations of hexavalent chromium are also considered to be within background levels. Therefore, no chemicals were retained as COPCs for direct contact exposures to surface soil at SWMU 22.

A comparison of maximum detected surface soil concentrations to USEPA SSLs and IDEM screening levels for chemical migration from soil to groundwater is presented in Table 7-6. RDX was detected in surface soil at a maximum concentration exceeding the screening level for migration from soil to groundwater and was retained as a COPC for direct contact exposures to surface soil at SWMU 22.

Concentrations of arsenic and hexavalent chromium also exceeded the screening levels but were within site background levels and are not considered to be site related; therefore, arsenic and hexavalent chromium were not retained as COPCs for migration from surface soil to groundwater at SWMU 22.

#### 7.2.4.2 Subsurface Soil

A comparison of maximum detected subsurface soil concentrations to screening levels based on RSLs and IDEM screening levels for residential exposures to soil is presented in Table 7-7. Concentrations of arsenic exceeded the screening levels but were within the site background level and are not considered to be site related. Therefore, no chemicals were retained as COPCs for direct contact exposures to subsurface soil at SWMU 22.

A comparison of maximum detected subsurface soil concentrations to USEPA SSLs and IDEM screening levels for chemical migration from soil to groundwater is presented in Table 7-8. Concentrations of arsenic exceeded the screening levels but were within the site background level and are not considered to be site related; therefore, no chemicals were retained as COPCs for migration from surface soil to groundwater at SWMU 22.

#### 7.2.4.3 Groundwater

A comparison of maximum detected groundwater concentrations in on-site monitoring wells to screening levels based on RSLs, IDEM screening levels for tap water, and MCLs is presented in Table 7-9. The following chemicals were detected at maximum concentrations exceeding COPC screening levels and were retained as COPCs for direct contact exposures to groundwater at SWMU 22:

- RDX
- Total arsenic, cadmium, hexavalent chromium, and lead
- Dissolved arsenic and cadmium
- Perchlorate

#### 7.2.4.4 Surface Water

A comparison of maximum detected surface water concentrations to screening levels based on RSLs, IDEM screening levels for tap water, and MCLs is presented in Table 7-10. The following chemicals were detected at maximum concentrations exceeding COPC screening levels and were retained as COPCs for direct contact exposures to surface water at SWMU 22:

- RDX
- Total arsenic and cadmium
- Dissolved arsenic

Concentrations of all chemicals were less than the IDEM screening levels for tap water and USEPA MCLs.

#### 7.2.4.5 Sediment

A comparison of maximum detected sediment concentrations to screening levels based on RSLs and IDEM screening levels for residential exposures to soil is presented in Table 7-11. Arsenic was detected in sediment at a maximum concentration exceeding direct contact risk-based COPC screening levels for residential land use and was retained as a COPC for direct contact exposures to sediment at SWMU 22:

#### 7.2.4.6 Summary

Table 7-12 summarizes the chemicals retained as COPCs for surface soil, subsurface soil, groundwater, surface water, and sediment at SWMU 22. RAGS Part D tables for COPC selection are included in Appendix E.2.

## 7.3 EXPOSURE ASSESSMENT

The exposure assessment component of the risk assessment defines and evaluates, quantitatively or qualitatively, the type and magnitude of human exposure to the chemicals present at or migrating from a site. The exposure assessment is designed to depict the physical setting of the site, to identify potentially exposed populations and applicable exposure pathways, to calculate concentrations of COPCs to which receptors might be exposed, and to estimate chemical intakes under the identified exposure scenarios.

Actual or potential exposures at SWMU 22 were determined based on the most likely pathways of contaminant release and transport and on human activity patterns. A complete exposure pathway has three components: a source of chemicals that can be released to the environment, a route of contaminant transport through an environmental medium, and an exposure or contact point for a human receptor.

### 7.3.1 Conceptual Site Model

A CSM facilitates consistent and comprehensive evaluation of potential risks to human health by creating a framework for identifying the pathways by which human receptors may come in contact with environmental media contaminated by site activities. A CSM depicts the relationships among the following elements, which are necessary for defining complete exposure pathways:

- Site sources of contamination
- Contaminant release mechanisms and transport/migration pathways
- Exposure routes
- Potential receptors

These elements of the CSM establish the manner and degree to which a potential receptor may be exposed to chemicals present at the site. The degree of risk incurred by a potential receptor varies according to the means of exposure, duration of exposure, and specific chemical(s) to which the receptor is exposed.

The CSM for SWMU 22 is presented in the Section 6. Section 6 also discusses contaminant fate and transport at SWMU 22. Table 7-13 provides a site-specific summary of the potential receptors evaluated for SWMU 22. A summary of the exposure routes addressed quantitatively in the HHRA for each human receptor is provided in Table 7-14. Figure 7-1 illustrates the CSM for SWMU 22.

**Potential Current and Future Receptors of Concern and Exposure Pathways**

NSA Crane is an active naval base and will remain active for the foreseeable future. Current site receptors include industrial and construction workers and adolescent trespasses. However, for purposes of completeness, the baseline risk assessment also considered receptor exposure under residential and recreational land use scenarios. As discussed in Sections 7.2.4.1 and 7.2.4.2, no COPCs were identified for surface soil or subsurface soil; consequently, there are no complete exposures pathways for surface soil and subsurface soil at SWMU 22. Based on current and potential future land use, the following potential receptors may be exposed to contaminated environmental media within the study area:

- **Construction Workers** – A plausible receptor under current or future land use. No construction activities are currently planned for the study area. However, this receptor could be exposed to shallow groundwater (dermal contact) and airborne contaminants emanating from groundwater (inhalation). Significant exposures by a construction worker to groundwater is unlikely because if a construction worker were to have prolonged contact with groundwater, he/she would most likely wear protective clothing such as rubber boots and/or hip waders, which would limit exposure. In addition, most excavation activities would use construction equipment such as a backhoe, which would limit worker exposure. Also, if significant groundwater were encountered during excavation of a trench or foundation, the groundwater would most likely be pumped out of the excavation so that the construction activities could be completed.

- **Industrial Worker** – A plausible receptor under current and future land use. This includes adult military or civilian personnel assigned to routine daily work tasks in the SWMU 22 area. If this receptor were to work in an on-site structure, this receptor could be exposed to VOCs migrating to the indoor air of a building from contaminated groundwater via vapor intrusion. However, no VOCs were detected in groundwater; therefore, there are no complete exposure pathways for current or future industrial workers.

- **Adolescent Trespassers** – A plausible receptor under current or future land use. Although access to the base is controlled, once inside the base, access to the site is not limited by any physical constraints. This receptor may be exposed to potentially contaminated surface water (via incidental ingestion and dermal contact) and sediments (via incidental ingestion and dermal contact) in the drainage ditches and intermittent streams. However, exposure to surface water is likely to be limited in some areas because of the intermittent nature of the surface water in the streams at the site. Also, potential exposures to surface water would be limited to wading because the streams at the sites are not deep enough for swimming. Direct contact with groundwater is not anticipated for this receptor.

- **Recreational Users (Child and Adult)** – A plausible receptor under future land use. If NSA Crane were to close, the property could be converted to a park. A recreational user may be exposed to potentially contaminated surface water (via incidental ingestion and dermal contact) and sediments (via incidental ingestion and dermal contact). Exposures to surface water would be limited to wading because the streams at the sites are not deep enough for swimming. NSA Crane is not expected to close because principal base operations, the demilitarization of munitions, are critical to the support of the United States Naval fleet.

- **Residents (Child and Adult)** – Given the anticipated future land use for much of SWMU 22 (commercial/industrial), residents are very unlikely future receptors. However, the hypothetical future residential scenario is typically evaluated in a risk assessment for decision-making purposes. For example, the need for deed restrictions at a site may be eliminated prior to site closure if minimal risks are estimated for residential receptors. It is assumed that a hypothetical resident may be exposed to groundwater (via ingestion and dermal contact), surface water (via ingestion and dermal contact), and sediment (via incidental ingestion and dermal contact). Potential exposures to surface water would be limited to wading because the streams at the sites are not deep enough for swimming. Also, hypothetical residents could be exposed to VOCs migrating from contaminated groundwater to the indoor air of a home; however, no VOCs were detected in groundwater.

### 7.3.2 Central Tendency Exposure and Reasonable Maximum Exposure

Traditionally, exposures evaluated in the HHRA were based on the concept of a reasonable maximum exposure (RME) only, which is defined as "the maximum exposure that is reasonably expected to occur at a site" (USEPA, 1989). However, subsequent risk assessment guidance (USEPA, 1992) indicates the need to address an average case or central tendency exposure (CTE).

To provide a full characterization of potential exposure, both RME and CTE scenarios were evaluated in the HHRA for SWMU 22. The available guidance (USEPA, 1993a) concerning the evaluation of CTE is limited. Therefore, professional judgment was exercised when defining CTE conditions for a particular receptor at a site.

### 7.3.3 Exposure Point Concentrations

The exposure point concentration (EPC), which is calculated for COPCs only, is an estimate of the chemical concentration within an exposure unit (EU). The EPC is assumed to be the concentration to which the receptor is exposed and is used to estimate exposure intakes. An EU is the area over which receptor activity is expected to occur. The entire site was used as the EU for SWMU 22. As discussed in Section 7.1.3, no COPCs were identified for surface soil and subsurface soil; therefore, EPCs were not calculated for these media.

The following guidelines were used to calculate EPCs:

- For surface water and sediment, the 95-percent upper confidence limit (UCL) on the arithmetic mean, which was based on the distribution of the data set, was selected as the EPC. EPCs were calculated following USEPA's Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites (2002a) and using USEPA's ProUCL software Version 4.1.01. If ProUCL was unable to calculate an UCL, the maximum detected concentration was used as the EPC.

- There were only four groundwater samples, so the maximum detected concentration was used as the EPC for groundwater.

- As stated in the guidance manual for the Integrated Exposure Uptake Biokinetic (IEUBK) model (USEPA, 1994), the arithmetic mean concentration was used as the EPC for lead.

- Non-detected values were evaluated in accordance with the ProUCL guidance (USEPA, 2010a).

- The same EPCs were used to evaluate both RME and CTE scenarios.

Table 7-15 summarizes the EPCs used in this HHRA. ProUCL Outputs are included in Appendix E.3, and RAGS Part D Tables for the EPCs are presented in Appendix E.2.

### 7.3.4 Chemical Intake Estimation

The methodologies and techniques used to estimate exposure intakes are presented in this section. Intakes for the identified potential receptor groups were calculated using current USEPA risk assessment guidance and are presented in the risk assessment spreadsheets. Risk assessment results are presented using USEPA RAGS Part D table format. Assumptions regarding exposure are presented in Tables 7-16 and 7-17 for the RME and CTE scenarios, respectively. The exposure assumptions presented in Table 7-16 and 7-17 are based on current USEPA risk assessment guidance.

Non-carcinogenic intakes were estimated using the concept of an average annual exposure. Carcinogenic intakes were calculated as incremental lifetime exposures, which assume a life expectancy of 70 years. The exposure assumptions reflect current USEPA guidance. The majority of the exposure assumptions used to estimate chemical intakes were based on default assumptions described in several USEPA guidance documents (e.g., USEPA December 1989, 1991, 1997b, and 2004). The following paragraphs discuss the non-default receptor-specific exposure assumptions used in the risk assessment.

#### 7.3.4.1 Incidental Ingestion of Sediment

Direct physical contact with sediment may result in the incidental ingestion of chemicals. Chemical intake for the incidental ingestion of sediment was estimated in the following manner (USEPA, 1989):

$$\text{Intake} = \frac{(C_s)(IR)(FI)(EF)(ED)(CF)}{(BW)(AT)}$$

where:

| | | |
|---|---|---|
| Intake | = | intake of chemical from sediment (mg/kg/day) |
| $C_s$ | = | concentration of chemical in sediment (mg/kg) |
| IR | = | ingestion rate (mg/day) |
| FI | = | fraction ingested from contaminated source (dimensionless) |
| EF | = | exposure frequency (days/year) |
| ED | = | exposure duration (year) |
| CF | = | conversion factor (1 x $10^{-6}$ kg/mg) |
| BW | = | body weight (kg) |

AT = averaging time (days);
for non-carcinogens, AT = ED x 365 days per year
for carcinogens, AT = 70 years x 365 days per year

Most of the exposure assumptions used to estimate chemical intakes from incidental ingestion of sediment were based on default assumptions for exposures to soil described in standard USEPA guidance and are summarized in Tables 7-16 and 7-17. The following paragraphs briefly discuss the non-default receptor-specific exposure assumptions for incidental ingestion of sediment that were used in the HHRA.

Child and adult recreational users are assumed to be exposed to sediment for 2 days a week during the warmer weather months (52 days per year) under the RME scenario and for 1 day a week (26 days per year) under the CTE scenario. The adolescent trespasser is assumed to be exposed to sediment on a somewhat less frequent basis (26 and 13 days per year for the RME and CTE cases, respectively).

#### 7.3.4.2 Dermal Contact with Sediment

Direct physical contact with sediment may result in the dermal absorption of chemicals. Exposure associated with dermal contact with sediment was estimated in the following manner (USEPA, 1989):

$$\text{Intake} = \frac{(C_s)(SA)(AF)(ABS)(CF)(EF)(ED)}{(BW)(AT)}$$

where:

Intake = amount of chemical absorbed during contact with sediment (mg/kg/day)
$C_s$ = concentration of chemical in sediment (mg/kg)
SA = skin surface area available for contact ($cm^2$/day)
AF = skin adherence factor ($mg/cm^2$)
ABS = absorption factor (dimensionless)
CF = conversion factor ($1 \times 10^{-6}$ kg/mg)
EF = exposure frequency (days/year)
ED = exposure duration (year)
BW = body weight (kg)
AT = averaging time (days);
for non-carcinogens, AT = ED x 365 days per year
for carcinogens, AT = 70 years x 365 days per year

Most of the exposure assumptions used to estimate chemical intakes from dermal contact with sediment were based on the default assumptions for exposures to soil described in standard USEPA guidance and are summarized in Tables 7-16 and 7-17. The following paragraphs briefly discuss non-default receptor-specific exposure assumptions for dermal contact with sediment that were used in the HHRA.

The exposed skin surface areas of the body available for dermal contact with sediment were determined on a receptor-specific basis because they correspond with assumed human activities and clothing worn during exposure events. With the exception of the skin surface area recommended for adolescent trespassers, all of the skin surface areas presented in Tables 7-16 and 7-17 are based on USEPA default values. For an adolescent trespasser (7 to 16 years old), it was assumed that 25 percent of the body surface area was exposed to sediment (i.e., 3,280 $cm^2$). This value represents the $50^{th}$-percentile areas presented in Table 4-6 of the Exposure Factors Handbook (USEPA, 1997b).

The same exposure frequencies and durations recommended for the evaluation of incidental ingestion of sediment were used to estimate chemical intakes for dermal contact with sediment. The soil adherence factors presented in Exhibits 3.3 and 3.5 of RAGS Part E were used to evaluate dermal contact with sediment. Table 7-18 presents the absorption factor values used in this HHRA.

#### 7.3.4.3 Direct and Incidental Ingestion of Groundwater and Incidental Ingestion of Surface Water

Direct ingestion of groundwater is expected to be limited to exposure that would occur under a future hypothetical residential scenario. Incidental ingestion of groundwater by construction workers may occur during excavation activities. In addition, hypothetical residents, recreational users, and trespassers may incidentally ingest surface water while at SWMU 22. Intakes associated with ingestion of groundwater and surface water were evaluated using the following equation (USEPA, 1989):

$$\text{Intake} = \frac{(C_W)(CF)(IR_W)(EF)(ED)}{(BW)(AT)}$$

where:

| | | |
|---|---|---|
| Intake | = | intake of chemical from groundwater/surface water (mg/kg/day) |
| $C_w$ | = | concentration of chemical in groundwater/surface water (mg/L) |
| CF | = | conversion factor (0.001 mg/µg) |
| $IR_w$ | = | ingestion rate for groundwater (L/day) |

| | | |
|---|---|---|
| $IR_w$ | = | surface water ingestion rate (L/day) = (CR)(ET) |
| CR | = | contact rate (L/hr) |
| ET | = | exposure time (hours/day) |
| EF | = | exposure frequency (days/year) |
| ED | = | exposure duration (year) |
| BW | = | body weight (kg) |
| AT | = | averaging time (days); |
| | | for non-carcinogens, AT = ED x 365 days per year |
| | | for carcinogens, AT = 70 years x 365 days per year |

USEPA standard default exposure assumptions were used to evaluate residential exposures to groundwater. The following paragraphs briefly discuss non-default receptor-specific exposure assumptions for ingestion of groundwater and surface water that were used in the HHRA.

There are no USEPA or IDEM default exposure assumptions for exposures to groundwater by construction workers; consequently, values were derived based on site-specific information and professional judgment. It was assumed that a construction worker would be exposed to groundwater for 4 hours per day for 30 days per year under the RME scenario and for 2 hours per day for 15 days per year under the CTE scenario. A shorter exposure frequency is recommended for a construction worker exposed to groundwater than is recommended for exposure to soil because it is unlikely that a construction worker will have direct contact with groundwater on a daily basis during a construction project. Trespassers, recreational users, and residents were assumed to be exposed to surface water for 4 hours per day under the RME scenario and for 2 hours per day under the CTE scenario. It was assumed that trespassers, recreational users, and hypothetical residents would incidentally ingest 0.01 liters per hour of surface water under the RME and CTE scenarios (USEPA, 2011).

A summary of the receptor-specific input values used to estimate chemical intakes from ingestion of groundwater are presented in Tables 7-16 and 7-17.

#### 7.3.4.4 Dermal Contact with Groundwater and Surface Water

The same equation was used to estimate intakes for dermal contact with both groundwater and surface water. Hypothetical residential receptors were assumed to use groundwater for domestic purposes (e.g., bathing, showering, and dish washing) that can result in dermal exposure. Construction workers could contact groundwater during excavation activities. Trespassers, recreational users, and hypothetical residents may have dermal contact with surface water while wading in the streams at site. The following equation was used to assess exposures resulting from dermal contact with groundwater and surface water (USEPA, 2004):

$$DAD = \frac{(DA_{event})(EV)(ED)(EF)(SA)}{(BW)(AT)}$$

where:

| | | |
|---|---|---|
| DAD | = | dermally absorbed dose of chemical from water (mg/kg/day) |
| $DA_{event}$ | = | dermally absorbed dose per event (mg/cm$^2$-event) |
| EV | = | event frequency (events/day) |
| ED | = | exposure duration (year) |
| EF | = | exposure frequency (days/year) |
| SA | = | skin surface area available for contact (cm$^2$) |
| BW | = | body weight (kg) |
| AT | = | averaging time (days); for non-carcinogens, AT = ED x 365 days per year; for carcinogens, AT = 70 years x 365 days per year |

Most of the exposure assumptions used to estimate chemical intakes from dermal contact with groundwater were based on default assumptions described in standard USEPA guidance and are summarized in Tables 7-16 and 7-17.

Dermal intakes for residents exposed to groundwater assumed total body exposure on a daily basis. For construction workers exposed to groundwater and trespassers, recreational users, and residents exposed to surface water, the exposed surface area of the body available for contact was based on assumed activities and was similar to the assumptions outlined for dermal contact with soil and sediment.

The absorbed dose per event ($DA_{event}$) was estimated using a non-steady-state approach for organic compounds and a traditional steady-state approach for inorganics. For organics, the following equations apply:

$$\text{If } t_{event} < t^{*}, \text{ then}: DA_{event} = (2)(K_p)(FA)(C_w)(CF)\left(\sqrt{\frac{6\,\tau\, t_{event}}{\pi}}\right)$$

$$\text{If } t_{event} > t^{*}, \text{ then}: DA_{event} = (K_p)(FA)(C_w)(CF)\left(\frac{t_{event}}{1+B} + 2\,\tau\left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right)$$

where:

| | | |
|---|---|---|
| $t_{event}$ | = | duration of event (hour/event) |
| t* | = | time to reach steady-state conditions (hour) |
| $K_p$ | = | permeability coefficient from water through skin (cm/hour) |
| FA | = | chemical-specific fraction absorbed (dimensionless) |
| $C_w$ | = | concentration of chemical in water (mg/L) |
| $\tau$ | = | lag time (hour) |
| $\pi$ | = | Pi (dimensionless; equal to 3.1416) |
| CF | = | conversion factor (0.001 L/cm$^3$) |
| B | = | Dimensionless ratio of the permeability of the stratum corneum relative to the permeability across the viable epidermis (dimensionless) |

Values for the chemical-specific parameters (t*, $K_p$, FA,$\tau$, and B) were obtained from the current dermal guidance (USEPA, 2004, Exhibit B-3) and are presented in Table 7-18. If published values were not available for a particular compound, they were calculated using equations provided in the USEPA dermal guidance.

The following steady-state equation was used to estimate $DA_{event}$ for inorganics:

$$DA_{event} = (K_p)(C_W)(t_{event})$$

The dermal permeability coefficient ($K_p$) values recommended in the USEPA dermal guidance (USEPA, 2004) were used to calculate $DA_{event}$ for inorganic COPCs.

#### 7.3.4.5 Assessing Cancer Risks from Early Life Exposures

USEPA's Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens (2005f) recommends making adjustments to the toxicity values of carcinogenic chemicals that act via the mutagenic mode of action when evaluating early-life exposures. The guidance recommends using age-dependent adjustment factors (ADAFs) combined with age-specific exposure estimates when assessing cancer risks. In the absence of chemical-specific data, the supplement guidance recommends the following default adjustments, which reflect the fact that cancer risks are generally higher from early-life exposures than from similar exposures later in life:

- For exposures before 2 years of age (i.e., spanning a 2-year interval from the first day of birth until a child's second birthday), a 10-fold adjustment.

- For exposures between 2 and 16 years of age (i.e., spanning a 14-year time interval from a child's second birthday until their sixteenth birthday), a three-fold adjustment.

- For exposures after turning 16 years of age, no adjustment.

The adjustments were applied using the same method as that used by Oak Ridge National Laboratory (ORNL) in the development of RSLs. Children were evaluated as two age groups, ages 0 to 2 years and 2 to 6 years, and adults were evaluated as two age groups, ages 6 to 16 and greater than 16 years old. Using this approach, the intakes for hypothetical residents were calculated as follows:

$$Intake_{Child} = Intake_{(ages\ 0-2\ years)} \times 10 + Intake_{(ages\ 2-6\ years)} \times 3$$

$$Intake_{Adult} = Intake_{(ages\ 6-16\ years)} \times 3 + Intake_{(ages > 16\ years)}$$

The above approach was used only for those chemicals identified as mutagenic in the ORNL screening table (e.g., hexavalent chromium). Sample calculations showing how this approach was applied are included in Appendix E.4.

#### 7.3.4.6 Exposure to Lead

The equations and methodology presented in the previous section cannot be used to evaluate exposure to lead because of the absence of published dose-response parameters. Exposure to lead was assessed using the latest version of USEPA's IEUBK Model for lead, Version 1.1 Build 11 (2010b). This model is typically used to evaluate lead exposure assuming a residential land use scenario.

The IEUBK Model for lead is designed to estimate blood levels of lead in children (under 7 years of age) based on either default or site-specific input values for air, drinking water, diet, dust, and soil exposure. Studies indicate that infants and young children are extremely susceptible to adverse effects from exposure to lead. Considerable behavioral and developmental impairments have been noted in children with elevated blood-lead levels. The threshold for toxic effects from this chemical is believed to be in the range of 10 to 15 micrograms per deciliter (μg/dL). Blood-lead levels greater than 10 μg/dL are considered to be a "concern."

## 7.4 TOXICITY ASSESSMENT

The toxicity assessment weighs the evidence regarding the potential for exposure to chemicals to produce adverse effects in exposed receptors, and when possible, the assessment estimates the relationship between the exposure to a chemical and the increased likelihood and/or severity of adverse effects. Quantitative estimates of the relationship between the magnitude and type of exposures and the severity or probability of human health effects are defined for the identified constituents of concern. Quantitative toxicity values determined during this component of the risk assessment are integrated with exposure assessment outputs to characterize the potential occurrence of adverse health effects for each receptor group.

The reference dose (RfD) is the toxicity value used to evaluate non-carcinogenic health effects for ingestion and dermal exposures. The reference concentration (RfC) is used to evaluate non-carcinogenic health effects for inhalation exposures. The RfD and RfC estimate a daily exposure level for a human population that is unlikely to pose an appreciable risk during a portion or for all of a human lifetime. It is based on a review of animal and/or human toxicity data, with adjustments for various data uncertainties. Carcinogenic effects are quantified using the cancer slope factor (CSF) for ingestion and dermal exposures and using inhalation unit risks (IUR) for inhalation exposure that are plausible upper-bound estimates of the probability of the development of cancer per unit intake of the chemical over a lifetime. These are typically based on dose-response data from human and/or animal studies.

### 7.4.1 <u>Toxicity Criteria for Oral and Inhalation Exposures</u>

Oral RfDs and CSFs and inhalation RfCs and IURs used in this HHRA were obtained from the following primary USEPA literature sources (2003b):

- Tier 1 - Integrated Risk Information System (IRIS).

- Tier 2 - USEPA Provisional Peer Reviewed Toxicity Values (PPRTVs) – The Office of Research and Development/National Center for Environmental Assessment (NCEA) Superfund Health Risk Technical Support Center develops PPRTVs on a chemical-specific basis when requested by USEPA's Superfund program.

- Tier 3 - Other Toxicity Values – These sources include but are not limited to California Environmental Protection Agency (Cal EPA) toxicity values, Agency for Toxic Substances and Disease Registry (ATSDR) values, and the Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997c).

Although toxicity criteria can be found in several toxicological sources, USEPA's IRIS online database is the preferred source of toxicity values. This database is continuously updated, and the presented values have been verified by USEPA. The toxicity criteria for the constituents selected as COPCs are presented in Tables 7-19 through 7-22.

### 7.4.2 Toxicity Criteria for Dermal Exposure

RfDs and CSFs in the scientific literature are typically expressed as "administered" (i.e., not absorbed) doses; therefore, these values are considered inappropriate for estimating risks associated with dermal exposures. Oral dose-response parameters based on administered doses must be adjusted to absorbed doses before they can be compared to estimated dermal exposure intakes.

When oral absorption is essentially complete (i.e., 100 percent), an absorbed dose is equivalent to the administered dose, and therefore no toxicity adjustment is necessary. Conversely, when the gastrointestinal absorption of a chemical is poor (e.g., 1 percent), the absorbed dose is smaller than the administered dose; thus, toxicity factors based on absorbed dose should be adjusted to account for the difference in the absorbed dose relative to the administered dose. USEPA (2004) recommends a 50-percent absorption cutoff to reflect the intrinsic variability in analyzing absorption studies. Therefore, the adjustment from administered to absorbed dose was only performed when the chemical-specific gastrointestinal absorption efficiency was less than 50 percent. The adjustment from administered to absorbed dose was made using chemical-specific gastrointestinal absorption efficiencies published in numerous sources of guidance [e.g., 2004 (the primary reference), IRIS, ATSDR toxicological profiles, etc.] and the following equations:

$$RfD_{dermal} = (RfD_{oral})(ABS_{GI})$$

$$CSF_{dermal} = (CSF_{oral}) / (ABS_{GI})$$

where:

| | | |
|---|---|---|
| $ABS_{GI}$ | = | absorption efficiency in the gastrointestinal tract |
| $RfD_{dermal}$ | = | RfD for the dermal route of exposure |
| $RfD_{oral}$ | = | RfD for the oral route of exposure |
| $CSF_{dermal}$ | = | CSF for the dermal route of exposure |
| $CSF_{oral}$ | = | CSF of the oral route of exposure |

As noted above, the preceding adjustment of the oral toxicity criteria (e.g., RfDs, CSFs) was necessary to allow quantitative evaluation of the dermal route of exposure in the baseline risk assessment. Explanations of this procedure and the need for this procedure are presented in Appendix A of USEPA RAGS Part A.

### 7.4.3 Toxicity Values for Construction Workers

Under the guidelines established by the Superfund program, exposures to construction workers of 1 year or less are classified as subchronic exposures. Risks for non-carcinogenic effects associated with subchronic exposures should incorporate toxicity values for subchronic and not chronic effects. Tables 7-19 and 7-20 present the available subchronic RfDs and RfCs that were used for the construction worker. Uncertainty associated with the lack of subchronic RfCs for many chemicals is discussed in Section 7.6.3.

## 7.5 RISK CHARACTERIZATION

This section provides a characterization of human health risks associated with potential exposures to COPCs at the site. Potential risks (non-carcinogenic and carcinogenic) for human receptors resulting from exposures outlined in the exposure assessment were quantitatively determined and are discussed in this section. Sections 7.5.1 and 7.5.2 outline the methods used to quantitatively estimate the type and magnitude of potential risks for human receptors. Summaries of the risk characterization for SWMU 22 are provided in Section 7.5.3.

### 7.5.1 Quantitative Analysis for Chemicals Other Than Lead

Quantitative estimates of risk for chemicals were calculated according to risk assessment methods outlined in USEPA guidance (1989). Lifetime cancer risks are expressed in the form of dimensionless probabilities, referred to as ILCRs, based on CSFs and IURs. Non-carcinogenic risk estimates are presented in the form of HQs that are determined through a comparison of intakes with published RfDs and RfCs.

ILCR estimates for ingestion and dermal exposures were generated for each COPC using estimated exposure intakes and published CSFs, as follows:

$$\text{ILCR} = (\text{Estimated Exposure Intake})(\text{CSF})$$

ILCRs estimates for inhalation exposures were generated for each COPC using estimated exposure concentrations and published IURs, as follows:

$$ILCR = (IUR)(Exposure\ Concentration)(1{,}000\ \mu g/mg)$$

An ILCR of $1x10^{-6}$ indicates that the exposed receptor has a one-in-one-million chance of developing cancer under the defined exposure scenario. Alternatively, such a risk may be interpreted as representing one additional case of cancer in an exposed population of 1 million people.

Non-carcinogenic risks were assessed using the concept of HQs and hazard indices (HIs). The HQ for a COPC is the ratio of the estimated intake to the RfD and is calculated for ingestion and dermal exposures as follows:

$$HQ = (Estimated\ Exposure\ Intake)/(RfD)$$

For inhalation exposures, HQ is calculated as follows:

$$HQ = (Exposure\ Concentration)/(RfC)$$

An HI was generated by summing the individual HQs for all COPCs. The HI is not a mathematical prediction of the severity of toxic effects and therefore is not a true "risk"; it is simply a numerical indicator of the possibility of the occurrence of non-carcinogenic (threshold) effects.

### 7.5.2 Comparison of Quantitative Risk Estimates to Benchmarks

To interpret the quantitative risks and to aid risk managers in determining the need for remediation at a site, quantitative risk estimates are compared to typical risk benchmarks. Calculated ILCRs for SWMU 22 were interpreted using the USEPA's "target range" of $1x10^{-6}$ to $1x10^{-4}$. Current USEPA policy regarding lead exposures is to limit the childhood risk of exceeding a 10 µg/dL blood-lead level to 5 percent.

USEPA has defined the range of $1x10^{-6}$ to $1x10^{-4}$ as the ILCR target risk range for most hazardous waste facilities addressed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and RCRA. IDEM has defined this same risk range. Individual or cumulative ILCRs greater than $1x10^{-4}$ will typically not be considered as protective of human health, and ILCRs less than $1x10^{-6}$ will typically be regarded as protective. Risk management decisions are necessary when the ILCR is within the $1x10^{-4}$ to $1x10^{-6}$ cancer risk range.

An HI exceeding unity (1) indicates that there may be potential non-carcinogenic health risks associated with exposure. If an HI exceeds unity, a segregation of target organ effects associated with exposure to COPCs is typically performed. Only those chemicals that affect the same target organ(s) or exhibit similar critical effect(s) are regarded as truly additive. Consequently, it may be possible for a cumulative HI to exceed 1, but no adverse health effects are anticipated if the COPCs do not affect the same target organ or exhibit the same critical effect.

### 7.5.3 Results of the Risk Characterization

This section contains a summary of the results of the risk characterization for SWMU 22. Quantitative risk estimates for potential human receptors are developed for chemicals detected in groundwater, surface water, and sediment. No COPCs were identified for soil; consequently, cancer risks and HIs were not calculated for exposures to surface soil and subsurface soil. Industrial workers were assumed to only be exposed to soil; therefore, no risks were estimated for industrial workers. Uncertainties associated with the risk estimates are discussed in Section 7.6. The methodology used to calculate the risks presented in this section is provided in Sections 7.5.1 and 7.5.2. Potential cancer risks and HIs were calculated for current and future construction workers, future child and adult recreational users, adolescent trespassers, and hypothetical future residents under the RME and CTE scenarios and are summarized in Tables 7-23 and 7-24. Sample calculations are presented in Appendix E.4, and the results of the risk assessment in RAGS Part D format are included in Appendix E.2.

#### 7.5.3.1 Non-Carcinogenic Risks

RME Scenario

Table 7-23 and Figures 7-2 and 7-3 presents the HIs for the RME scenario at SWMU 22. Cumulative HIs for all receptors exposed to groundwater, surface water, and sediment were less than unity (1) with the exception of hypothetical child residents, indicating that adverse non-carcinogenic effects are not anticipated for these receptors under the defined exposure conditions.

Medium-specific HIs for hypothetical child residents exposed to surface water and sediment were less than unity. The HI for hypothetical child residents exposed to groundwater was 3, although as shown below, the HIs for the individual target organs were all less than or equal to 1.

| Hypothetical Child Residents | |
|---|---|
| **Target Organ** | **Hazard Quotient** |
| Cardiovascular System | 1 |
| Kidney | 0.7 |
| Skin | 1 |
| Thyroid | 0.5 |
| None Specified | 0.001 |

CTE Scenario

Table 7-24 and Figures 7-4 and 7-5 presents the HIs for the CTE scenario at SWMU 22. Cumulative HIs for all receptors were less than unity (1), indicating that adverse non-carcinogenic effects are not anticipated for these receptors under the defined exposure conditions.

#### 7.5.3.2 Carcinogenic Risks

RME Scenario

Table 7-23 and Figures 7-6 and 7-7 presents the ILCRs for the RME scenario at SWMU 22. ILCRs for all receptors exposed to groundwater, surface water, and sediment under the RME scenario were less than or within USEPA's and IDEM's target risk range of $10^{-4}$ to $10^{-6}$ with the exception of the lifelong resident. The ILCR of $1x10^{-4}$ for the lifelong resident exposed to groundwater was equal to the upper bound of USEPA's and IDEM's target risk range.

CTE Scenario

Table 7-24 and Figures 7-8 and 7-9 presents the ILCRs for the CTE scenario at SWMU 22. ILCRs for all receptors exposed to groundwater, surface water, and sediment under the CTE scenario were less than or within USEPA's and IDEM's target risk range of $10^{-4}$ to $10^{-6}$

#### 7.5.3.3 Risks from Lead

Lead was identified as a COPC in groundwater at SWMU 22. Concentrations of total lead in one sample (22GWT003 at 21.4 µg/L) exceeded the federal Action Level promulgated under the Safe Drinking Water Act and IDEM screening level, both 15 µg/L.

Hypothetical future residential exposures to lead in groundwater were evaluated using the most recent version of the IEUBK lead model (Version 1.1 Build 11). As recommended in the IEUBK Model documentation (USEPA, 1994), the average lead concentrations of 13.8 μg/L in groundwater and 10.1 mg/kg in surface soil were used as the EPCs. Default values were used for the remaining model input parameters. IEUBK Model outputs are included in Appendix E.5. The lead concentration of 13.8 μg/L in groundwater and 10.1 mg/kg in surface soil results in a geometric mean blood-lead level of 1.723 μg/dL and results in 0.009 percent of future on-site child residents having blood-lead levels greater than 10 μg/dL. This value is less than the USEPA goal, as described in the 1994 Office of Solid Waste and Emergency Response (OSWER) Directive, of no more than 5 percent of children exceeding a 10 μg/dL blood-lead level.

#### 7.5.3.4 Risk Estimates Due to Chemicals Attributable to Background

COPCs for surface soil and subsurface soil at SWMU 22 were selected, in part, using available background concentrations for soil. The background comparison is presented in Section 5.0. At SWMU 22, arsenic and hexavalent chromium were within background levels in surface soil, and arsenic was within the background level in subsurface soil. Tables 7-25 and 7-26 present the cancer risks and HIs associated with these metals for the RME and CTE scenarios. RAGS Part D tables for these chemicals are presented in Appendix E.6.

HIs were less than the acceptable level of 1 and ILCRs were within USEPA's and IDEM's target risk range for all receptors at SWMU 22 under the RME and CTE scenarios, respectively.

#### 7.5.3.5 Sediment in Settling Basin

As discussed in Section 5.1.3, concentrations of several chemicals in sediment in the settling basin at SWMU 22 exceeded human health screening levels. There are no potential exposures to the material in the sumps under current land use. Future construction workers could be exposed to the sediment in the settling basin if the settling basin were excavated, although such exposures are expected to be negligible because it is anticipated it would take 1 day at most to remove the settling basin. If the sediment in the settling basins was somehow deposited on surrounding surface soil, future receptors could potentially be exposed to the material. Risk estimates were developed for future industrial workers and hypothetical residents hypothetically exposed to those sediments using USEPA RSLs (representing the $1\text{x}10^{-6}$ cancer risk level or an HI of 1), the chemical concentrations detected in the sediment, and the following simple ratio technique:

$$\frac{\text{USEPA RSLs}}{\text{Chemical Concentration}} = \frac{\text{HI of 1 or Cancer Risk Estimate of } 1\text{x}10^{-6}}{\text{HI or Cancer Risk Estimate}}$$

Tables 7-27 and 7-28 presents the estimated risks for future industrial workers and hypothetical future residents exposed to sediment from the settling basin. HIs were less than the acceptable level of 1, and ILCRs were within USEPA's and IDEM's target risk range for industrial workers and hypothetical residents.

The settling basin is currently intact, but if the integrity of the settling basin were compromised in the future, chemicals present in the sediments could migrate to underlying soil and groundwater. Table 7-29 presents a comparison of chemical concentrations in settling basin sediment to screening criteria for migration from soil to groundwater. The detected concentration of arsenic exceeds both USEPA SSLs and IDEM screening levels. The impact of the risk to the groundwater resource is limited by the small volume of sediment in the settling basin.

## 7.6 UNCERTAINTY ANALYSIS

Uncertainty is associated with all aspects of the HHRA. This section presents a summary of these uncertainties and discusses how they might affect the final risk numbers.

Uncertainty in the selection of COPCs is related to the current status of the predictive databases, the grouping of samples, numbers, types, and distributions of samples, and procedures used to include or exclude constituents as COPCs. Uncertainty associated with the exposure assessment includes the values used as input variables for a given intake route or scenario, assumptions made to determine EPCs, and predictions regarding future land use and population characteristics. Uncertainty in the toxicity assessment includes the quality of the existing toxicity data needed to support dose-response relationships and the weight-of-evidence used to determine the carcinogenicity of COPCs. Uncertainty in risk characterization includes that associated with exposure to multiple chemicals and the cumulative uncertainty from combining conservative assumptions made in earlier steps of the risk assessment process.

Whereas there are various sources of uncertainty, the direction of uncertainty can be influenced by the assumptions made throughout the risk assessment, including selection of COPCs and selection of values for dose-response relationships. Throughout the entire risk assessment, assumptions are biased toward a margin of safety so that the final calculated risks are overestimated.

Generally, risk assessments include two types of uncertainty, measurement and informational uncertainty. Measurement uncertainty refers to the usual variance that accompanies scientific measurements. For example, this type of uncertainty is associated with analytical data collected for each site. The risk assessment reflects the accumulated variances of the individual values used. Informational uncertainty stems from inadequate availability of information needed to complete the toxicity and exposure assessments. Often, this gap is significant, such as the absence of information on the effects of human exposure to low doses of a chemical, on the biological mechanism of action of a chemical, or on the behavior of a chemical in soil.

After the risk assessment is complete, the results must be reviewed and evaluated to identify the type and magnitude of uncertainty involved. Reliance on results from a risk assessment without consideration of uncertainties, limitations, and assumptions inherent in the process can be misleading. For example, to account for uncertainties in the development of exposure assumptions, conservative estimates must be made to ensure that the particular assumptions made are protective of sensitive subpopulations or the maximum exposed individuals. If a number of conservative assumptions are combined in an exposure model, the resulting calculations can propagate the uncertainties associated with those assumptions, thereby producing a much larger uncertainty for the final results. This uncertainty is biased toward over predicting both carcinogenic and non-carcinogenic risks. Thus, both the results of the risk assessment and the uncertainties associated with those results must be considered when making risk management decisions.

This interpretation is especially relevant when the risks exceed the point of departure for defining "acceptable" risk. For example, when risks calculated using a high degree of uncertainty are less than an acceptable risk level (i.e., $1x10^{-6}$ to $1x10^{-4}$), the interpretation of no significant risk is typically straightforward. However, when risks calculated using a high degree of uncertainty exceed an acceptable risk level (i.e., $1x10^{-4}$); a conclusion can be difficult unless uncertainty is considered.

### 7.6.1 Uncertainty in Data Evaluation

The most significant issues related to uncertainty in the data evaluation are the usability of the existing database, COPC screening levels used, and evaluation of total chromium as hexavalent chromium. A brief discussion of each of these issues is provided in this section.

**Usability of Existing Databases**

All the data used in the HHRA were validated as discussed in Section 4.0. The qualification of data during the formal data validation process is not expected to compromise the results of the baseline HHRA. Analytical data qualified as estimated were used, even though the reported concentrations or sample-specific quantitation limits may be somewhat imprecise. The use of estimated data adds to the uncertainty associated with the risk assessment; however, the associated uncertainty is expected to be negligible compared to the other uncertainties inherent in the risk evaluation process (i.e., uncertainties with land uses, exposure scenarios, toxicological criteria, etc.). Because all data have been validated, the uncertainty in the calculated risks associated with the data is minimal.

As discussed in the DQR in Appendix C, chromium and lead results in two surface water samples were rejected due to comparability issues. The rejection of these results do not affect the conclusions of the risk assessment because the rejected results fall within the middle of the observed concentration ranges for these metals or they do not exceed screening criteria.

**COPC Screening Levels**

The use of risk-based screening values based on conservative land use scenarios (i.e., residential land use for soil and domestic use for groundwater) corresponding to ILCRs of $10^{-6}$ and HIs of 0.1 ensured that all the significant contributors to risk from the site were evaluated. The elimination of chemicals present at concentrations that correspond to ILCRs less than $10^{-6}$ and HIs less than 0.1 should not affect the final conclusions of the risk assessment because those chemicals are not expected to cause a potential health concern at the detected concentrations.

**Evaluation of Chromium**

As discussed in Section 7.1.2, total chromium was evaluated as trivalent chromium in this HHRA. A qualitative evaluation of the risks associated with evaluating total chromium as hexavalent chromium is presented below.

Total chromium was detected in surface soil and subsurface soil at maximum concentrations of 25.4 and 17.7 mg/kg, respectively. The maximum concentrations of total chromium in surface soil and subsurface soil are within two orders of magnitude of the USEPA residential RSL of 0.29 mg/kg for hexavalent chromium; therefore, the cancer risks would be less than $1 \times 10^{-4}$ if total chromium had been evaluated as hexavalent chromium in surface and subsurface soil. Consequently, risks from exposures to surface and subsurface soil would be within USEPA's and IDEM's target risk range if total chromium in soil had been evaluated as hexavalent chromium.

Unfiltered total chromium was detected at concentrations ranging from 5 to 90.8 μg/L in groundwater. All detected concentrations of unfiltered total chromium exceed the tap water RSL of 0.031 μg/L by more than two orders of magnitude. Consequently, risks from exposures to unfiltered total chromium in groundwater would exceed USEPA's and IDEM's target risk range if unfiltered total chromium had been evaluated as hexavalent chromium. The filtered total chromium concentrations were less than the corresponding unfiltered total chromium concentrations in all samples, an indication that the unfiltered total chromium concentrations are attributable to suspended solids in the groundwater. Filtered concentrations of total chromium in groundwater ranged from non-detected to 3 µg/L, within two orders of magnitude of the tap water RSL. Therefore, risks from exposures to filtered total chromium in groundwater would be within USEPA and IDEM's target risk range if filtered chromium had been evaluated as hexavalent chromium in this HHRA.

Total chromium was detected in surface water at a maximum concentration of 3 µg/L, which is within two orders of magnitude of the USEPA tap water RSL of 0.031 µg/L for hexavalent chromium. The cancer risks would be less than $1x10^{-4}$ if total chromium had been evaluated as hexavalent chromium in surface water. The tap water RSL is based on water being used as a potable water supply; consequently, recreational exposures to surface water would be less than those for using surface water as a potable water supply. Therefore, risks from exposures to surface water would be within the USEPA and IDEM target risk range if total chromium had been evaluated as hexavalent chromium.

Total chromium was detected in sediment at a maximum concentration of 12.6 mg/kg, which is within two orders of magnitude of the USEPA residential RSL of 0.29 mg/kg for hexavalent chromium. The cancer risks would be less than $1x10^{-4}$ if total chromium had been evaluated as hexavalent chromium in sediment. Receptors would not be exposed to sediments as frequently as they are exposed to soils; therefore, risks from exposures to sediment would be within the USEPA and IDEM target risk range if total chromium had been evaluated as hexavalent chromium.

### 7.6.2 Uncertainty in the Exposure Assessment

Uncertainty in the exposure assessment arises because of the methods used to calculate EPCs, determination of land use conditions, selection of receptors and scenarios, and selection of exposure parameters. Each of these is discussed below.

**Land Use**

The current land use patterns at NSA Crane are well established, thereby limiting the uncertainty associated with land use assumptions. Land use at SWMU 22 is currently limited and is expected to be limited in the future as long as NSA remains open (industrial workers and construction workers are the only current and likely future receptors). To be conservative, risks to potential and future recreational users, trespassers, and hypothetical residents were estimated for the site.

**Exposure Point Concentrations**

Uncertainty is associated with the use of 95-percent UCLs on the mean concentration as EPCs. As a result of using 95-percent UCLs, the estimations of potential risk for the RME scenario were most likely overstated because UCLs represent the upper limit that potential receptors would be exposed to over the entire exposure period. In some cases (because the UCL was greater than the maximum concentration or there were less than five samples), the maximum concentration was used as the EPC. Use of the maximum concentration tends to overestimate potential risks because receptors are assumed to be exposed continuously to the maximum concentration for the entire exposure period.

**Exposure Routes and Receptor Identification**

The determination of various receptor groups and exposure routes of potential concern was based on current land use observed at the site and anticipated future land use. Therefore, the uncertainty associated with the selection of exposure routes and potential receptors is minimal because these uses are considered to be well defined.

**Exposure Parameters**

Each exposure factor (for RME and CTE scenarios) selected for use in the risk assessment has some associated uncertainty. Generally, exposure factors are based on surveys of physiological parameters and lifestyle profiles across the United States. The attributes and activities studied in these surveys generally have a broad distribution. To avoid underestimation of exposure, in most cases, the USEPA guidelines (USEPA, 1991 and 1993a) for the RME receptor were used, which generally specify the use of the $95^{th}$ percentile for most parameters. Therefore, the selected values for the RME receptor represent the upper bound of the observed or expected habits of the majority of the population.

Generally, the uncertainty can be assessed quantitatively for many assumptions made in determining factors for calculating exposures and intakes. Many of these parameters were determined from statistical analyses on human population characteristics. Often, the database used to summarize a particular exposure parameter (i.e., body weight) is quite large. Consequently, the values chosen for such variables in the RME scenario have low uncertainty.

Many of the exposure parameters used to calculate exposures and risks in this report are selected from a distribution of possible values, including USEPA guidance (1991 and 1993a) and dermal guidance (USEPA, 2004). For the RME scenario, the value representing the 95$^{th}$ percentile is generally selected for each parameter to ensure that the assessment bounds the actual risks from a postulated exposure. This risk number is used in risk management decisions but does not indicate what a more average or typical exposure might be or what risk range might be expected for individuals in the exposed population.

To address these issues, USEPA (1992) suggested the use of the CTE receptor whose intake variables are often set at approximately the 50$^{th}$ percentile of the distribution. The risks for this receptor seek to incorporate the range of uncertainty associated with various intake assumptions. Some of the parameters presented in this risk assessment were estimated using professional judgment, although USEPA does provide limited guidance for the CTE evaluation (1993a).

### 7.6.3 Uncertainty in the Toxicological Evaluation

Uncertainties associated with the toxicity assessment (determination of RfDs and CSFs and use of available criteria) are presented in this section.

**Derivation of Toxicity Criteria**

Uncertainty in the toxicity assessment is associated with hazard assessment and dose-response evaluations for the COPCs. The hazard assessment deals with characterizing the nature and strength of the evidence of causation or the likelihood that a chemical that induces adverse effects in animals will also induce adverse effects in humans. Hazard assessment of carcinogenicity is evaluated as a weight-of-evidence determination using USEPA methods. Positive animal cancer test data suggest that humans contain tissue(s) that may manifest a carcinogenic response; however, the animal data cannot necessarily be used to predict the target tissue in humans.

Uncertainty in hazard assessment arises from the nature and quality of the animal and human data. Uncertainty is reduced when similar effects are observed across species, strain, sex, and exposure route; when the magnitude of the response is clearly dose related; when pharmacokinetic data indicate a similar fate in humans and animals; when postulated mechanisms of toxicity are similar for humans and animals; and when the COC is structurally similar to other chemicals for which the toxicity is more completely characterized.

Uncertainty in the dose-response evaluation includes the determination of a CSF for the carcinogenic assessment. Uncertainty is introduced from interspecies (animal-to-human) extrapolation, which in the absence of quantitative pharmacokinetic or mechanistic data, is usually based on consideration of interspecies differences in basal metabolic rate. Uncertainty also results from intraspecies variation. Most toxicity experiments are performed with animals that are very similar in age and genotype, so intragroup biological variation is minimal, but the human population of concern may reflect a great deal of heterogeneity, including unusual sensitivity or tolerance to the COPC. Even toxicity data from human occupational exposure reflect a bias because only those individuals sufficiently healthy to attend work regularly (the "healthy worker effect") and those not unusually sensitive to the chemical are likely to be occupationally exposed. Finally, uncertainty arises from the quality of the key study from which the quantitative estimate is derived and the database. For cancer effects, the uncertainty associated with dose-response factors is mitigated by assuming the 95-percent upper bound for the slope factor. Another source of uncertainty in carcinogenic assessment is the method by which data from high doses in animal studies are extrapolated to the dose range expected for environmentally exposed humans. The linearized multistage model, which is used in nearly all quantitative estimations of human risk from animal data, is based on a non-threshold assumption of carcinogenesis. Evidence suggests, however, that epigenetic carcinogens, as well as many genotoxic carcinogens, have a threshold below which they are non-carcinogenic. Therefore, the use of the linearized multistage model is conservative for chemicals that exhibit a threshold for carcinogenicity.

**Use of Chronic Toxicity Values for Construction Workers**

Under the guidelines established by the Superfund program, exposures to construction workers of 1 year or less are classified as subchronic exposures. Risks for non-carcinogenic effects associated with subchronic exposures should incorporate toxicity values for subchronic and not chronic effects; however, subchronic toxicity values are not as widely available as chronic values. Subchronic toxicity values used in this HHRA were obtained from USEPA’s PPRTV internet site if available. Also ATSDR Minimal Risk Levels (MRLs) were used as subchronic toxicity values when PPRTV values were not available. Chronic toxicity values were used when subchronic toxicity values were not available. Using chronic toxicity criteria to evaluate subchronic exposures for construction workers tends to overestimate potential non-carcinogenic risks; however, this overestimation of non-carcinogenic risks does not affect the conclusions of this HHRA because non-carcinogenic risks for construction workers were within acceptable levels.

### 7.6.4 Uncertainty in the Risk Characterization

Uncertainty in risk characterization resulted from assumptions made regarding additivity of effects from exposure to multiple COPCs from various exposure routes. High uncertainty exists when summing non-cancer risks for several substances across different exposure pathways. This assumes that each substance has a similar effect and/or mode of action. Even when compounds affect the same target organs, they may have different mechanisms of action or differ in their fate in the body, so additivity may not have been an appropriate assumption. However, the assumption of additivity was considered acceptable because in most cases it represented a conservative estimate of risk.

Risks to any individual may also have been overestimated by summing multiple assumed exposure pathway risks for any single receptor. Although every effort was made to develop reasonable scenarios, not all individual receptors may have been exposed via all pathways considered.

Also, the risk characterization did not consider antagonistic or synergistic effects. Little or no information was available to determine the potential for antagonism or synergism for the COPCs. Because chemical-specific interactions could not be predicted, the likelihood for risks to be over predicted or under predicted could not be defined, but the methodology used was based on current USEPA guidance.

## 7.7 SUMMARY AND CONCLUSIONS

This section summarizes the results of the baseline HHRA for SWMU 22, which was performed to characterize the potential risks to likely human receptors under current and potential future land uses. Potential receptors under current land use are industrial workers and construction workers. Potential receptors under future land use are industrial and construction workers, child and adult recreational users, adolescent trespassers, and hypothetical child and adult residents. Although future land use is likely to be the same as current land use, potential future recreational user and resident receptors were evaluated in the baseline HHRA primarily for decision-making purposes.

No COPCs were identified for direct contact to surface soil and subsurface soil. COPCs for direct contact to groundwater were RDX, arsenic, cadmium, hexavalent chromium, lead, and perchlorate. COPCs for direct contact to surface water were RDX, arsenic, and cadmium, and the COPC for direct contact to sediment was arsenic.

Quantitative estimates of non-carcinogenic and carcinogenic risks (HIs and ILCRs, respectively) were developed for potential human receptors. Cumulative HIs under the RME scenario for all receptors with the exception of hypothetical child residents were less than unity (1), indicating that adverse non-carcinogenic effects are not anticipated for these receptors under the defined exposure conditions. HIs on a target-organ basis for all receptors under the RME and CTE scenarios were less than unity (1).

ILCRs for all receptors exposed to groundwater, surface water, and sediment under the RME scenario were less than or within USEPA's and IDEM's target risk range, with the exception of the hypothetical lifelong resident. The cumulative ILCRs for hypothetical lifelong residents were equal to the upper bound of USEPA's and IDEM's target risk range.

ILCRs for all receptors exposed to groundwater, surface water, and sediment under the CTE scenario were less than or within USEPA's and IDEM's target risk range of $10^{-4}$ to $10^{-6}$, with the exception of hypothetical child and lifelong residents. The cumulative ILCRs for hypothetical child residents and lifelong residents were equal to the upper bound of USEPA's and IDEM's target risk range.

Lead was identified as a COPC in groundwater at SWMU 22. Hypothetical residential exposures to lead in groundwater were evaluated using USEPA's IEUBK lead model. Results of the analysis do not exceed the USEPA goal regarding lead exposures (i.e., no more than 5 percent of children [or fetuses of exposed woman] having blood-lead levels exceeding a 10 µg/L blood-lead level).

RDX in subsurface soil was the only chemical identified as exceeding the screening levels for migration from soil to groundwater. RDX is not considered to be a COC for migration from soil to groundwater even though RDX was detected in groundwater because risks from exposures to RDX in groundwater were within acceptable levels.

**TABLE 7-1**

**SCREENING CRITERIA USED IN SELECTION OF COPCS - SOIL**
**SWMU 22 - LEAD AZIDE POND**
**NSA CRANE**
**CRANE, INDIANA**

| CAS No. | Chemical | USEPA Regional Screening Levels[1] | | Indiana Department of Environmental Management[2] | |
|---|---|---|---|---|---|
| | | Adjusted Direct Contact Residential | Protection of Groundwater | Residential | Migration to Groundwater |
| **Explosives (mg/kg)** | | | | | |
| 121-82-4 | RDX | 5.6 C | 0.0046 | 78 C | 0.046 C |
| **Metals (mg/kg)** | | | | | |
| 7440-38-2 | Arsenic | 0.39 C | 0.026 | 5.5 C | 5.9 M |
| 7440-39-3 | Barium | 1,500 N | 2,400 | 21,000 N | 1,700 M |
| 7440-43-9 | Cadmium | 7 N | 10.4 | 98 N | 7.5 M |
| 7440-47-3 | Chromium | 12,000 N[3] | 56,000,000 [3] | 100,000 L[3] | 1,000,000 R[3] |
| 7439-92-1 | Lead | 400 | 280 [4] | 400 | 270 M |
| 7439-97-6 | Mercury | 2.3 N[5] | 0.66 | 32 N[5] | 2.1 M |
| 7782-49-2 | Selenium | 39 N | 8 | 550 N | 5.3 M |
| 7440-22-4 | Silver | 39 N | 12 | 550 N | 12 N |
| **Miscellaneous Parameters (mg/kg)** | | | | | |
| 18540-29-9 | Hexavalent Chromium | 0.29 C | 0.012 | 4.1 C | 0.12 C |
| 14797-73-0 | Perchlorate | 5.5 N | NA | 77 N | NA |

**Notes:**

1 - USEPA Regional Screening Level (RSL), November 2012 (USEPA, 2012a). Carcinogenic values represent an incremental cancer risk of 1x10-6. The noncarcinogenic values are the RSL divided by 10 to correspond to a Target Hazard Quotient of 0.1. Protection of groundwater values are risk-based SSLs and have been multiplied by 20 to represent a dilution attenuation factor of 20.
2 - IDEM Closure Guide, March 1, 2013 (IDEM, 2013).
3 - Value is for trivalent chromium.
4 - Value is MCL based soil screening level.
5 - Value is for mercuric chloride (and other mercury salts).

C = Carcinogenic.
CAS = Chemical Abstract Service.
IDEM = Indiana Department of Environmental Management.
L = Capped at 100,000.
M = Maximum contaminant level.
mg/kg = Milligram per kilogram.
N = Noncarcinogenic.
R = Capped at 1,000,000.
USEPA = United States Environmental Protection Agency.

**TABLE 7-2**

**SCREENING CRITERIA USED IN SELECTION OF COPCS - GROUNDWATER**
**SWMU 22 - LEAD AZIDE POND**
**NSA CRANE**
**CRANE, INDIANA**

| CAS No. | Parameter | Adjusted USEPA Regional Screening Level(1) Tap Water | USEPA Maximum Contaminant Level(2) | IDEM(3) Tap Water |
|---|---|---|---|---|
| **Explosives (ug/L)** | | | | |
| 118-96-7 | 2,4,6-Trinitrotoluene | 0.76 N(4) | NA | 7.6 N |
| 19406-51-0 | 4-Amino-2,6-Dinitrotoluene | 3 N | NA | 30 N |
| 2691-41-0 | HMX | 78 N | NA | 780 N |
| 121-82-4 | RDX | 0.61 C | NA | 6.1 C |
| **Metals (ug/L)** | | | | |
| 7440-38-2 | Arsenic | 0.045 C | 10 | 10 M |
| 7440-39-3 | Barium | 290 N | 2,000 | 2,000 M |
| 7440-43-9 | Cadmium | 0.69 N | 5 | 5 M |
| 7440-47-3 | Chromium | 1,600 N(5) | 100 (6) | 16,000 N(5) |
| 7439-92-1 | Lead | 15 | 15 (7) | 15 M |
| 7782-49-2 | Selenium | 7.8 N | 50 | 50 M |
| **Miscellaneous Parameters (ug/L)** | | | | |
| 14797-73-0 | Perchlorate (ug/L) | 1.1 N | 15 | 15 M |

1 - USEPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites, November 2012. [Cancer benchmark value = 1E-06, Hazard index (HI) = 0.1] (USEPA, 2012a).
2 - 2012 Edition of the Drinking Water Standards and Health Advisories (USEPA, 2012b).
3 - IDEM Closure Guide, March 1, 2013 (IDEM, 21013).
4 - Ten percent of the noncarcinogenic value is less than the carcinogenic value, therefore the noncarcinogenic value is presented.
5 - Values are for trivalent chromium.
6 - Value is for total chromium.
7 - The MCL for this parameter is actually a treatment technique. The SDWA action level (at the tap) has been presented.
C = Carcinogenic.
CAS = Chemical Abstract Service.
M = Maximum Contaminant Level.
N = Noncarcinogenic.
NA = Not available.
SDWA = Safe Water Drinking Act.
ug/L = Microgram per liter.
USEPA = United States Environmental Protection Agency.

## TABLE 7-3

## SCREENING CRITERIA USED IN SELECTION OF COPCS - SURFACE WATER
## SWMU 22 - LEAD AZIDE POND
## NSA CRANE
## CRANE, INDIANA

| CAS No. | Parameter | Adjusted USEPA Regional Screening Level(1) Tap Water | USEPA Maximum Contaminant Level(2) | IDEM Groundwater Residential(3) |
|---|---|---|---|---|
| **Explosives (ug/L)** | | | | |
| 2691-41-0 | HMX | 78 N | NA | 780 N |
| 121-82-4 | RDX | 0.61 C | NA | 6.1 C |
| **Metals (ug/L)** | | | | |
| 7440-38-2 | Arsenic | 0.045 C | 10 | 10 M |
| 7440-39-3 | Barium | 290 N | 2,000 | 2,000 M |
| 7440-43-9 | Cadmium | 0.69 N | 5 | 5 M |
| 7440-47-3 | Chromium | 1,600 N(5) | 100 (6) | 16,000 N(5) |
| 7439-92-1 | Lead | 15 | 15 (5) | 15 M |
| 7439-97-6 | Mercury | 0.43 N(7) | 2 | 2 M |
| 7782-49-2 | Selenium | 7.8 N | 50 | 50 M |
| 7440-22-4 | Silver | 7.1 N | NA | 71 N |
| **Miscellaneous Parameters (ug/L)** | | | | |
| 14797-73-0 | Perchlorate | 1.1 N | 15 | 15 M |

1 - USEPA Regional Screening Levels for Chemical Contaminants at Superfund Sites, November, 2012. [Cancer benchmark value = 1E-06, Hazard index (HI) = 0.1] (USEPA, 2012a).
2 - 2012 Edition of the Drinking Water Standards and Health Advisories (USEPA, 2012n).
3 - IDEM Closure Guide, March 1, 2013 (IDEM, 2013).
4 - Values are for trivalent chromium.
5 - The MCL for this parameter is actually a treatment technique. The SDWA action level (at the tap) has
6 - Value is for total chromium.
7 - Value is for mercuric chloride (and other mercury salts).

C = Carcinogenic.
CAS = Chemical Abstract Service.
M = Maximum Contaminant Level.
N = Noncarcinogenic.
SDWA = Safe Water Drinking Act.
ug/L = Microgram per liter.
USEPA = United States Environmental Protection Agency.

## TABLE 7-4

## SCREENING CRITERIA USED IN SELECTION OF COPCS - SEDIMENT
## SWMU 22 - LEAD AZIDE POND
## NSA CRANE
## CRANE, INDIANA

| CAS No, | Chemical | Adjusted USEPA RSL Direct Contact Residential[1] | | IDEM Soil Direct[2] | |
|---|---|---|---|---|---|
| **Metals (mg/kg)** | | | | | |
| 7440-38-2 | Arsenic | 0.39 | C | 5.5 | C |
| 7440-39-3 | Barium | 1,500 | N | 21,000 | N |
| 7440-43-9 | Cadmium | 7 | N | 98 | N |
| 7440-47-3 | Chromium | 12,000 | N[4] | 100,000 | L[4] |
| 7439-92-1 | Lead | 400 | | 400 | |
| 7439-97-6 | Mercury | 2.3 | N[5] | 32 | N[5] |
| 7782-49-2 | Selenium | 39 | N | 550 | N |
| 7440-22-4 | Silver | 39 | N | 550 | N |

**Notes:**

1 - USEPA Regional Screening Level (RSL), November 2012. Carcinogenic values represent an incremental cancer risk of $1x10^{-6}$. The noncarcinogenic values are the RSL divided by 10 to correspond to a Target Hazard Quotient of 0.1 (USEPA, 2012a).

2 - IDEM Closure Guide, March 1, 2013 (IDEM, 2013).

3 - Ten percent of the noncarcinogenic value is less than the carcinogenic value, therefore the noncarcinogenic value is presented.

4 - Value is for trivalent chromium.

5 - Value is for mercuric chloride (and other mercury salts).

C - Carcinogenic.
CAS = Chemical Abstract Service.
IDEM = Indiana Department of Environmental Management.
L = Capped at 100,000.
mg/kg = Milligram per kilogram.
N - Noncarcinogenic.
USEPA = United States Environmental Protection Agency.

**TABLE 7-5**

**OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - DIRECT CONTACT WITH SURFACE SOIL**
**SWMU 22 - LEAD AZIDE POND**
**NSA CRANE, CRANE, INDIANA**

| CAS Number | Chemical | Minimum Concentration | Maximum Concentration | Units | Sample of Maximum Concentration | Frequency of Detection | Range of Nondetects[(1)] | Concentration Used for Screening[(2)] | Background 95% Upper Tolerance Limit[(3)] | Adjusted USEPA RSL Residential Soil[(4)] | IDEM Residential Soil[(5)] | COPC Flag | Rationale for Contaminant Deletion or Selection[(6)] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Explosives** | | | | | | | | | | | | | |
| 121-82-4 | RDX | 0.37 J | 0.37 J | mg/kg | 22SS0250002 | 1/29 | 0.16 - 0.2 | 0.37 | NA | 5.6 C | 78 C | No | BSL |
| **Metals** | | | | | | | | | | | | | |
| 7440-38-2 | Arsenic | 2.4 J | 9.8 J | mg/kg | 22SS0250002 | 23/23 | - | 9.8 | 11.83 | 0.39 C | 5.5 C | No | BKG |
| 7440-39-3 | Barium | 12.8 J | 144 J | mg/kg | 22SB0140002 | 23/23 | - | 144 | 211 | 1,500 N | 21,000 N | No | BSL, BKG |
| 7440-43-9 | Cadmium | 0.057 J | 0.78 | mg/kg | 22SS0250002 | 23/23 | - | 0.78 | 6.05 | 7 N | 98 N | No | BSL, BKG |
| 7440-47-3 | Chromium | 3.4 J | 25.4 J | mg/kg | 22SS0250002 | 24/24 | - | 25.4 | 28.7 | 12,000 N[(7)] | 100,000 L[(7)] | No | BSL, BKG |
| 7439-92-1 | Lead | 2.8 J | 31.7 J | mg/kg | 22SS0250002 | 23/23 | - | 31.7 | 27 | 400 | 400 | No | BSL |
| 7439-97-6 | Mercury | 0.02 J | 0.6 J | mg/kg | 22SS0250002 | 9/23 | 0.02 - 0.079 | 0.6 | 0.077 | 2.3 N[(8)] | 32 N[(8)] | No | BSL |
| 7782-49-2 | Selenium | 0.086 J | 0.48 J | mg/kg | 22SS0250002 | 23/23 | - | 0.48 | 0.81 | 39 N | 550 N | No | BSL, BKG |
| 7440-22-4 | Silver | 0.021 J | 0.038 J | mg/kg | 22SB0110002 | 5/23 | 0.04 - 0.04 | 0.038 | 0.13 | 39 N | 550 N | No | BSL, BKG |
| **Miscellaneous Compounds** | | | | | | | | | | | | | |
| 18540-29-9 | Hexavalent Chromium | 1.31 | 1.31 | mg/kg | 22SB0200002 | 1/1 | - | 1.31 | (9) | 0.29 C | 4.1 C | No | BKG |

**Footnotes:**
1 - Values presented are sample-specific quantitation limits.
2 - The maximum detected concentration is used for screening purposes.
3 - Final Basewide Background Soil Investigation Report (Tetra Tech, 2001).
4 - USEPA Regional Screening Levels for Chemical Contaminants at Superfund Sites, November 2012 (USEPA, 2012a). The noncarcinogenic values (denoted with a "N" flag) are the screening level divided by 10 to correspond to a target hazard quotient of 0.1. Carcinogenic values represent an incremental cancer risk of 1.0E-06 (carcinogens denoted with a "C" flag).
5 - IDEM Closure Guide, March 1, 2013 (IDEM., 2013).
6 - The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and is statistically determined to be greater than site background.
7 - Value is for trivalent chromium.
8 - Value is for mercuric chloride (and other mercury salts).
9 - Since concentrations of total chromium are within background levels it is assumed that concentrations of hexavalent chromium are also within background levels.
Shaded criterion indicates that the maximum detected concentration exceeds one or more screening criteria. Shaded chemical name indicates that the chemical was retained as a COPC.

**Definitions:**
C = Carcinogen
COPC = Chemical Of Potential Concern
J = Estimated value
L = Capped at 100,000
N = Noncarcinogen
NA = Not Applicable/Not Available

**Rationale Codes:**
For selection as a COPC:
ASL = Above Screening Level and site background.

For elimination as a COPC:
BKG = Less than Background Concentration
BSL = Below COPC Screening Level

**Associated Samples**

| | | |
|---|---|---|
| 22SB0010002 | 22SB0140002 | 22SS0080002 |
| 22SB0020002 | 22SB0150002 | 22SS0220002 |
| 22SB0030002 | 22SB0160002 | 22SS0250002 |
| 22SB0040002 | 22SB0170002 | |
| 22SB0050002 | 22SB0180002 | |
| 22SB0060002 | 22SB0190002 | |
| 22SB0070002 | 22SB0200002 | |
| 22SB0080002 | 22SS0010002 | |
| 22SB0090002 | 22SS0020002 | |
| 22SB0100002 | 22SS0040002 | |
| 22SB0110002 | 22SS0050002 | |
| 22SB0120002 | 22SS0060002 | |
| 22SB0130002 | 22SS0070002 | |

**TABLE 7-6**

**OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - MIGRATION FROM SURFACE SOIL TO GROUNDWATER**
**SWMU 22 - LEAD AZIDE POND**
**NSA CRANE, CRANE, INDIANA**

| CAS Number | Chemical | Minimum Concentration | Maximum Concentration | Units | Sample of Maximum Concentration | Frequency of Detection | Range of Nondetects(1) | Concentration Used for Screening(2) | Background 95% Upper Tolerance Limit(3) | USEPA RSL Protection of Groundwater(4) | IDEM Migration to Groundwater(5) | COPC Flag | Rationale for Contaminant Deletion or Selection(6) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Explosives** | | | | | | | | | | | | | |
| 121-82-4 | RDX | 0.37 J | 0.37 J | mg/kg | 22SS0250002 | 1/29 | 0.16 - 0.2 | 0.37 | NA | 0.0046 | 0.046 C | Yes | ASL |
| **Metals** | | | | | | | | | | | | | |
| 7440-38-2 | Arsenic | 2.4 J | 9.8 J | mg/kg | 22SS0250002 | 23/23 | - | 9.8 | 11.83 | 0.026 | 5.9 M | No | BKG |
| 7440-39-3 | Barium | 12.8 J | 144 J | mg/kg | 22SB0140002 | 23/23 | - | 144 | 211 | 2400 | 1700 M | No | BSL, BKG |
| 7440-43-9 | Cadmium | 0.057 J | 0.78 | mg/kg | 22SS0250002 | 23/23 | - | 0.78 | 6.05 | 10.4 | 7.5 M | No | BSL, BKG |
| 7440-47-3 | Chromium | 3.4 J | 25.4 J | mg/kg | 22SS0250002 | 24/24 | - | 25.4 | 28.7 | 56,000,000 (7) | 1,000,000 R(7) | No | BSL, BKG |
| 7439-92-1 | Lead | 2.8 J | 31.7 J | mg/kg | 22SS0250002 | 23/23 | - | 31.7 | 27 | 280 (8) | 270 M | No | BSL |
| 7439-97-6 | Mercury | 0.02 J | 0.6 J | mg/kg | 22SS0250002 | 9/23 | 0.02 - 0.079 | 0.6 | 0.077 | 0.66 | 2.1 M | No | BSL |
| 7782-49-2 | Selenium | 0.086 J | 0.48 J | mg/kg | 22SS0250002 | 23/23 | - | 0.48 | 0.81 | 8 | 5.3 M | No | BSL, BKG |
| 7440-22-4 | Silver | 0.021 J | 0.038 J | mg/kg | 22SB0110002 | 5/23 | 0.04 - 0.04 | 0.038 | 0.13 | 12 | 12 N | No | BSL, BKG |
| **Miscellaneous Compounds** | | | | | | | | | | | | | |
| 18540-29-9 | Hexavalent Chromium | 1.31 | 1.31 | mg/kg | 22SB0200002 | 1/1 | - | 1.31 | (9) | 0.012 (7) | 0.12 C(7) | No | BKG |

**Footnotes:**
1 - Values presented are sample-specific quantitation limits.
2 - The maximum detected concentration is used for screening purposes.
3 - To determine whether chemical concentrations were within background levels, a statistical analysis was conducted using the site and background datasets.
4 - USEPA Regional Screening Levels for Chemical Contaminants at Superfund Sites, November 2012 (USEPA, 2013b). Values are based on a dilution attenuation factor of 20.
5 - IDEM Closure Guide, March 1, 2013 (IDEM, 2013).
6 - The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and is statistically determined to be greater than site background.
7 - Value is for hexavalent chromium.
8 - Value is MCL based soil screening level.
9 - Since concentrations of total chromium are within background levels it is assumed that concentrations of hexavalent chromium are also within background levels.
Shaded criterion indicates that the maximum detected concentration exceeds one or more screening criteria. Shaded chemical name indicates that the chemical was retained as a COPC.

**Associated Samples**

| | |
|---|---|
| 22SB0010002 | 22SB0160002 |
| 22SB0020002 | 22SB0170002 |
| 22SB0030002 | 22SB0180002 |
| 22SB0040002 | 22SB0190002 |
| 22SB0050002 | 22SB0200002 |
| 22SB0060002 | 22SS0010002 |
| 22SB0070002 | 22SS0020002 |
| 22SB0080002 | 22SS0040002 |
| 22SB0090002 | 22SS0050002 |
| 22SB0100002 | 22SS0060002 |
| 22SB0110002 | 22SS0070002 |
| 22SB0120002 | 22SS0080002 |
| 22SB0130002 | 22SS0220002 |
| 22SB0140002 | 22SS0250002 |
| 22SB0150002 | |

**Definitions:**
C = Carcinogen
COPC = Chemical Of Potential Concern
J = Estimated value
M = Maximum Contaminant Level
N = Noncarcinogen
NA = Not Applicable/Not Available
R = Capped at 1,000,000

**Rationale Codes:**
For selection as a COPC:
ASL = Above Screening Level and site background.

For elimination as a COPC:
BKG = Less than Background Concentration
BSL = Below COPC Screening Level

**TABLE 7-7**

**OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - DIRECT CONTACT WITH SUBSURFACE SOIL**
**SWMU 22 - LEAD AZIDE POND**
**NSA CRANE, CRANE, INDIANA**

| CAS Number | Chemical | Minimum Concentration | Maximum Concentration | Units | Sample of Maximum Concentration | Frequency of Detection | Range of Nondetects[1] | Concentration Used for Screening[2] | Background 95% Upper Tolerance Limit[3] | Adjusted USEPA RSL Residential Soil[4] | IDEM Residential Soil[5] | COPC Flag | Rationale for Contaminant Deletion or Selection[6] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Metals** | | | | | | | | | | | | | |
| 7440-38-2 | Arsenic | 1.1 J | 6.1 J | mg/kg | 22SB0110304 | 14/14 | - | 6.1 | 12.5 | 0.39 C | 5.5 C | No | BKG |
| 7440-39-3 | Barium | 2.3 J | 72.6 | mg/kg | 22SB0180406 | 14/14 | - | 72.6 | 115 | 1500 N | 21000 N | No | BSL, BKG |
| 7440-43-9 | Cadmium | 0.086 J | 0.25 J | mg/kg | 22SB0160305 | 14/14 | - | 0.25 | 0.8 | 7 N | 98 N | No | BSL, BKG |
| 7440-47-3 | Chromium | 5.3 | 17.7 J | mg/kg | 22SB0160305 | 14/14 | - | 17.7 | 33 | 12,000 N[7] | 100,000 L[7] | No | BSL, BKG |
| 7439-92-1 | Lead | 2.8 J | 10.9 | mg/kg | 22SB0170305 | 14/14 | - | 10.9 | 19.6 | 400 | 400 | No | BSL, BKG |
| 7439-97-6 | Mercury | 0.021 J | 0.033 J | mg/kg | 22SB0170305 | 3/14 | 0.025 - 0.086 | 0.033 | 0.18 | 2.3 N[8] | 32 N[8] | No | BSL, BKG |
| 7782-49-2 | Selenium | 0.06 J | 0.46 J | mg/kg | 22SB0160305 | 14/14 | - | 0.46 | 1.07 | 39 N | 550 N | No | BSL, BKG |
| 7440-22-4 | Silver | 0.022 J | 0.023 J | mg/kg | 22SB0110304 | 2/14 | 0.04 - 0.04 | 0.023 | 0.14 | 39 N | 550 N | No | BSL, BKG |

**Footnotes:**
1 - Values presented are sample-specific quantitation limits.
2 - The maximum detected concentration is used for screening purposes.
3 - Final Basewide Background Soil Investigation Report (Tetra Tech, 2001).
4 - USEPA Regional Screening Levels for Chemical Contaminants at Superfund Sites, November 2012 (USEPA, 2012a). The noncarcinogenic values (denoted with a "N" flag) are the screening level divided by 10 to correspond to a target hazard quotient of 0.1. Carcinogenic values represent an incremental cancer risk of 1.0E-06 (carcinogens denoted with a "C" flag).
5 - IDEM Closure Guide, March 1, 2013 (IDEM, 2013).
6 - The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and is statistically determined to be greater than site background.
7 - Value is for trivalent chromium.
8 - Value is for mercuric chloride (and other mercury salts).
Shaded criterion indicates that the maximum detected concentration exceeds one or more screening criteria. Shaded chemical name indicates that the chemical was retained as a COPC.

**Associated Samples**
22SB0010305
22SB0020607
22SB0030305
22SB0040305
22SB0060304
22SB0070304
22SB0090305
22SB0100305
22SB0110304
22SB0140203
22SB0160305
22SB0160608
22SB0170305
22SB0180406
22SB0200203

**Definitions:**
C = Carcinogen
COPC = Chemical Of Potential Concern
J = Estimated value
L = Capped at 100,000
N = Noncarcinogen
NA = Not Applicable/Not Available

**Rationale Codes:**
For selection as a COPC:
ASL = Above Screening Level and site background.

For elimination as a COPC:
BKG = Less than Background Concentration
BSL = Below COPC Screening Level

**TABLE 7-8**

**OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - MIGRATION FROM SUBSURFACE SOIL TO GROUNDWATER**
**SWMU 22 - LEAD AZIDE POND**
**NSA CRANE, CRANE, INDIANA**

| CAS Number | Chemical | Minimum Concentration | Maximum Concentration | Units | Sample of Maximum Concentration | Frequency of Detection | Range of Nondetects(1) | Concentration Used for Screening(2) | Background 95% Upper Tolerance Limit(3) | USEPA RSL Protection of Groundwater(4) | IDEM Migration to Groundwater(5) | COPC Flag | Rationale for Contaminant Deletion or Selection(6) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Metals** | | | | | | | | | | | | | |
| 7440-38-2 | Arsenic | 1.1 J | 6.1 J | mg/kg | 22SB0110304 | 14/14 | - | 6.1 | 12.5 | 0.026 | 5.9 M | No | BKG |
| 7440-39-3 | Barium | 2.3 J | 72.6 | mg/kg | 22SB0180406 | 14/14 | - | 72.6 | 115 | 2400 | 1700 M | No | BSL, BKG |
| 7440-43-9 | Cadmium | 0.086 J | 0.25 J | mg/kg | 22SB0160305 | 14/14 | - | 0.25 | 0.8 | 10.4 | 7.5 M | No | BSL, BKG |
| 7440-47-3 | Chromium | 5.3 | 17.7 J | mg/kg | 22SB0160305 | 14/14 | - | 17.7 | 33 | 56,000,000 (7) | 1,000,000 R(7) | No | BSL, BKG |
| 7439-92-1 | Lead | 2.8 J | 10.9 | mg/kg | 22SB0170305 | 14/14 | - | 10.9 | 19.6 | 280 (8) | 270 M | No | BSL, BKG |
| 7439-97-6 | Mercury | 0.021 J | 0.033 J | mg/kg | 22SB0170305 | 3/14 | 0.025 - 0.086 | 0.033 | 0.18 | 0.66 | 2.1 M | No | BSL, BKG |
| 7782-49-2 | Selenium | 0.06 J | 0.46 J | mg/kg | 22SB0160305 | 14/14 | - | 0.46 | 1.07 | 8 | 5.3 M | No | BSL, BKG |
| 7440-22-4 | Silver | 0.022 J | 0.023 J | mg/kg | 22SB0110304 | 2/14 | 0.04 - 0.04 | 0.023 | 0.14 | 12 | 12 N | No | BSL, BKG |

**Footnotes:**
1 - Values presented are sample-specific quantitation limits.
2 - The maximum detected concentration is used for screening purposes.
3 - Final Basewide Background Soil Investigation Report (Tetra Tech, 2001).
4 - USEPA Regional Screening Levels for Chemical Contaminants at Superfund Sites, November 2012 (USEPA, 2012a). Values are based on a dilution attenuation factor of 20.
5 - IDEM Closure Guide, March 1, 2013 (IDEM, 2013).
6 - The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and is statistically determined to be greater than site background.
7 - Value is for trivalent chromium.
8 - Value is MCL based soil screening level.
Shaded criterion indicates that the maximum detected concentration exceeds one or more screening criteria. Shaded chemical name indicates that the chemical was retained as a COPC.

**Associated Samples**
22SB0010305
22SB0020607
22SB0030305
22SB0040305
22SB0060304
22SB0070304
22SB0090305
22SB0100305
22SB0110304
22SB0140203
22SB0160305
22SB0160608
22SB0170305
22SB0180406
22SB0200203

**Definitions:**
COPC = Chemical Of Potential Concern
J = Estimated value
M = Maximum Contaminant Level
N = Noncarcinogen
NA = Not Applicable/Not Available
R = Capped at 1,000,000

**Rationale Codes:**
For selection as a COPC:
ASL = Above Screening Level and site background.

For elimination as a COPC:
BKG = Less than Background Concentration
BSL = Below COPC Screening Level

**TABLE 7-9**

**OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - DIRECT CONTACT WITH GROUNDWATER**
**SWMU 22 - LEAD AZIDE POND**
**NSA CRANE, CRANE, INDIANA**

| CAS Number | Chemical | Minimum Concentration | Maximum Concentration | Units | Sample of Maximum Concentration | Frequency of Detection | Range of Nondetects[1] | Concentration Used for Screening[2] | Range of Background Concentrations[3] | Adjusted USEPA RSL Tapwater[4] | USEPA MCL[5] | IDEM Groundwater Residential[6] | COPC Flag | Rationale for Contaminant Deletion or Selection[7] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Explosives** | | | | | | | | | | | | | | |
| 118-96-7 | 2,4,6-Trinitrotoluene | 0.47 J | 0.47 J | ug/L | 22GWT002 | 1/4 | 0.266 - 0.266 | 0.47 | **ND** | 0.76 N[8] | NA | 7.6 N | No | BSL |
| 19406-51-0 | 4-Amino-2,6-Dinitrotoluene | 0.11 J | 0.11 J | ug/L | 22GWT002 | 1/4 | 0.2 - 0.2 | 0.11 | **ND** | 3 N | NA | 30 N | No | BSL |
| 2691-41-0 | HMX | 1.1 J | 1.1 J | ug/L | 22GWT002 | 1/4 | 0.23 - 0.23 | 1.1 | **ND** | 78 N | NA | 780 N | No | BSL |
| 121-82-4 | **RDX** | 0.19 J | 15 J | ug/L | 22GWT002 | 3/4 | 0.246 - 0.246 | 15 | **0.32** | **0.61 C** | NA | **6.1 C** | **Yes** | ASL |
| **Metals (Total)** | | | | | | | | | | | | | | |
| 7440-38-2 | **Arsenic** | 1.9 | 5.5 | ug/L | 22GWT003 | 4/4 | - | 5.5 | 1.4 - 11 | **0.045 C** | 10 | 10 M | **Yes** | ASL |
| 7440-39-3 | Barium | 16.4 | 86.6 J | ug/L | 22GWT005 | 4/4 | - | 86.6 | **34.2 - 82** | 290 N | 2,000 | 2,000 M | No | BSL |
| 7440-43-9 | **Cadmium** | 0.59 | 4.7 | ug/L | 22GWT003 | 4/4 | - | 4.7 | 0.9 - 7.1 | **0.69 N** | 5 | 5 M | **Yes** | ASL |
| 7440-47-3 | Chromium | 5 | 90.8 J | ug/L | 22GWT005_20130123 | 6/6 | - | 90.8 | **4 - 19.3** | 1,600 N[9] | 100 [10] | 16,000 N[9] | No | BSL |
| 18540-29-9 | **Hexavalent Chromium** | 0.046 | 0.046 | ug/L | 22GWT005 | 1/1 | - | 0.046 | NA | **0.031 C** | 100 [10] | 0.31 C | **Yes** | ASL |
| 7439-92-1 | **Lead** | 7.5 | 21.4 | ug/L | 22GWT003 | 4/4 | - | 21.4 | **3.2 - 49.7** | **15** | **15 [11]** | **15 M** | **Yes** | ASL |
| 7782-49-2 | Selenium | 0.41 J | 5.3 | ug/L | 22GWT002 | 4/4 | - | 5.3 | **0.45 - 8.1** | 7.8 N | 50 | 50 M | No | BSL |
| **Metals (Dissolved)** | | | | | | | | | | | | | | |
| 7440-38-2 | **Arsenic** | 0.45 | 3.2 | ug/L | 22GWT002 | 3/3 | - | 3.2 | **0.44 - 3.3** | **0.045 C** | 10 | 10 M | **Yes** | ASL |
| 7440-39-3 | Barium | 25.2 | 55.6 | ug/L | 22GWT005 | 3/3 | - | 55.6 | 23.6 - 28.5 | 290 N | 2,000 | 2,000 M | No | BSL |
| 7440-43-9 | **Cadmium** | 0.45 | 2.9 | ug/L | 22GWT002 | 3/3 | - | 2.9 | 0.99 - 3.9 | **0.69 N** | 5 | 5 M | **Yes** | ASL |
| 7440-47-3 | Chromium | 1.2 | 3 | ug/L | 22GWT002 | 3/5 | 1.5 - 1.5 | 3 | **0.59 - 1.3** | 1,600 N[9] | 100 [10] | 16,000 N[9] | No | BSL |
| 18540-29-9 | **Hexavalent Chromium** | 0.034 | 0.034 | ug/L | 22GWT005 | 1/1 | - | 0.034 | **NA** | **0.031 C** | 100 [10] | 0.31 C | **Yes** | ASL |
| 7439-92-1 | Lead | 4.2 J | 10.6 J | ug/L | 22GWT002 | 3/3 | - | 10.6 | **0.72 - 7** | 15 | 15 [11] | 15 M | No | BSL |
| 7782-49-2 | Selenium | 0.24 J | 3.5 | ug/L | 22GWT002 | 3/3 | - | 3.5 | 0.56 - 5.7 | 7.8 N | 50 | 50 M | No | BSL |
| **Miscellaneous Parameters** | | | | | | | | | | | | | | |
| 14797-73-0 | **Perchlorate** | 5.9 J | 5.9 J | ug/L | 22GWT002 | 1/4 | 0.4 - 0.4 | 5.9 | 0.25 - 0.44 | **1.1 N** | 15 | 15 M | **Yes** | ASL |

**Footnotes:**

1 - Values presented are sample-specific quantitation limits.
2 - The maximum detected concentration is used for screening purposes.
3 - Concentrations in upgradient monitor wells 22MWT01 and 22MWT06. Data is presented for information purposes only.
4 - USEPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites, November 2012 (USEPA, 2012a). RSLs for carcinogens correspond to an integrated lifetime cancer risk (ILCR) of 1E-06; adjusted RSLs for noncarcinogens correspond to a hazard quotient (HQ) of 0.1.
5 - 2012 Edition of the Drinking Water Standards and Health Advisories (USEPA, 2012b).
6 - IDEM Closure Guide, March 1, 2013 (IDEM., 2013).
7 - The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level.
8 - Ten percent of the noncarcinogenic value is less than the carcinogenic value, therefore the noncarcinogenic value is presented.
9 - Values are for trivalent chromium.
10 - Value is for total chromium.
11 - The MCL for this parameter is actually a treatment technique. The SDWA action level (at the tap) has been presented.
Shaded criterion indicates that the maximum detected concentration exceeds one or more screening criteria. Shaded chemical name indicates that the chemical was retained as a COPC.

**Associated Samples**

22GWT002
22GWT003
22GWT004
22GWT005
22GWT005_20130123

**Definitions:**

C = Carcinogen
CAS = Chemical Abstracts Service
COPC = Chemical Of Potential Concern
M = Maximum Contaminant Level
J = Estimated value
N = Noncarcinogen
NA = Not Applicable/Not Available

**Rationale Codes:**

For selection as a COPC:
ASL = Above Screening Level.

For elimination as a COPC:
BSL = Below COPC Screening Level

TABLE 7-10

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - DIRECT CONTACT WITH SURFACE WATER
SWMU 22 - LEAD AZIDE POND
NSA CRANE, CRANE, INDIANA

| CAS Number | Chemical | Minimum Concentration | Maximum Concentration | Units | Sample of Maximum Concentration | Frequency of Detection | Range of Nondetects[(1)] | Concentration Used for Screening[(2)] | Range of Background Concentrations[(3)] | Adjusted USEPA RSL Tapwater[(4)] | USEPA MCL[(5)] | IDEM Groundwater Residential[(6)] | COPC Flag | Rationale for Contaminant Deletion or Selection[(7)] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Explosives** | | | | | | | | | | | | | | |
| 2691-41-0 | HMX | 0.15 J | 0.87 | ug/L | 22SW003 | 7/15 | 0.23 - 0.48 | 0.87 | 0.88 - 11 | 78 N | NA | 780 N | No | BSL |
| 121-82-4 | RDX | 0.39 J | 2.5 | ug/L | 22SW017 | 7/15 | 0.246 - 0.48 | 2.5 | 0.79 - 0.98 | 0.61 C | NA | 6.1 C | Yes | ASL |
| **Metals (Total)** | | | | | | | | | | | | | | |
| 7440-38-2 | Arsenic | 0.18 J | 1.5 | ug/L | 22SW004 | 8/12 | 0.18 - 0.18 | 1.5 | 0.41 | 0.045 C | 10 | 10 M | Yes | ASL |
| 7440-39-3 | Barium | 26.4 | 74.8 | ug/L | 22SW003 | 12/12 | - | 74.8 | 76.5 | 290 N | 2,000 | 2,000 M | No | BSL |
| 7440-43-9 | Cadmium | 0.23 J | 1.7 J | ug/L | 22SW024 | 6/12 | 0.04 - 0.083 | 1.7 | ND | 0.69 N | 5 | 5 M | Yes | ASL |
| 7440-47-3 | Chromium | 0.4 J | 3 | ug/L | 22SW004 | 11/11 | - | 3 | 0.45 J | 1,600 N[(8)] | 100 | 16,000 N[(8)] | No | BSL |
| 7439-92-1 | Lead | 0.86 J | 9.6 | ug/L | 22SW006 | 7/11 | 0.22 - 0.22 | 9.6 | ND | 15 | 15 [(9)] | 15 M | No | BSL |
| 7439-97-6 | Mercury | 0.065 J | 0.1 J | ug/L | 22SW017_20120511 | 5/12 | 0.12 - 0.12 | 0.1 | ND | 0.43 N[(10)] | 2 | 2 M | No | BSL |
| 7782-49-2 | Selenium | 0.1 J | 0.56 J | ug/L | 22SW024 | 5/12 | 0.2 - 0.2 | 0.56 | 0.24 J | 7.8 N | 50 | 50 M | No | BSL |
| 7440-22-4 | Silver | 0.032 J | 0.032 J | ug/L | 22SW009 | 1/12 | 0.06 - 0.19 | 0.032 | ND | 7.1 N | NA | 71 N | No | BSL |
| **Metals (Dissolved)** | | | | | | | | | | | | | | |
| 7440-38-2 | Arsenic | 0.19 J | 0.35 | ug/L | 22SW018 | 5/9 | 0.18 - 0.18 | 0.35 | 0.44 J | 0.045 C | 10 | 10 M | Yes | ASL |
| 7440-39-3 | Barium | 26 | 73.9 | ug/L | 22SW003 | 9/9 | - | 73.9 | 77.4 J | 290 N | 2000 | 2000 M | No | BSL |
| 7440-43-9 | Cadmium | 0.066 J | 0.26 J | ug/L | 22SW007 | 3/9 | 0.04 - 0.043 | 0.26 | ND | 0.69 N | 5 | 5 M | No | BSL |
| 7440-47-3 | Chromium | 0.27 J | 0.75 | ug/L | 22SW004 | 8/8 | - | 0.75 | 0.46 J | 1,600 N[(8)] | 100 | 16,000 N[(8)] | No | BSL |
| 7439-92-1 | Lead | 0.11 J | 0.69 J | ug/L | 22SW007 | 3/8 | 0.22 - 0.22 | 0.69 | 0.12 J | 15 | 15 [(9)] | 15 M | No | BSL |
| 7439-97-6 | Mercury | 0.067 J | 0.068 J | ug/L | 22SW004 | 2/9 | 0.12 - 0.12 | 0.068 | 0.084 J | 0.43 N[(10)] | 2 | 2 M | No | BSL |
| 7440-22-4 | Silver | 0.057 J | 0.067 J | ug/L | 22SW006 | 2/9 | 0.06 - 0.06 | 0.067 | ND | 7.1 N | NA | 71 N | No | BSL |
| **Miscellaneous Parameters** | | | | | | | | | | | | | | |
| 14797-73-0 | Perchlorate | 0.4 J | 0.4 J | ug/L | 22SW002 | 1/8 | 0.4 - 0.4 | 0.4 | ND | 1.1 N | 15 | 15 M | No | BSL |

**Footnotes:**
1 - Values presented are sample-specific quantitation limits.
2 - The maximum detected concentration is used for screening purposes.
3 - Surface water samples 22SW011, 22SW012, 22SW013, 22SW014, 22SW015, and 22SW016. Only sample 22SW011 was analyzed for metals, therefore a background comparison could not be performed. Concentrations are presented for information purposes only.
4 - USEPA Regional Screening Levels for Chemical Contaminants at Superfund Sites, November 2012 (USEPA, 2012a). The noncarcinogenic values (denoted with a "N" flag) are the screening level divided by 10 to correspond to a target hazard quotient of 0.1. Carcinogenic values represent an incremental cancer risk of 1.0E-06 (carcinogens denoted with a "C" flag).
5 - 2012 Edition of the Drinking Water Standards and Health Advisories (USEPA, 2012b).
6 - IDEM Closure Guide, March 1, 2013 (IDEM, 2013).
7 - The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level.
8 - Values are for trivalent chromium.
9 - The MCL for this parameter is actually a treatment technique. The SDWA action level (at the tap) has been presented.
Shaded criterion indicates that the maximum detected concentration exceeds one or more screening criteria. Shaded chemical name indicates that the chemical was retained as a COPC.

**Associated Samples**
22SW001 22SW017_20120511
22SW002 22SW018
22SW003 22SW019
22SW004 22SW020
22SW006 22SW021
22SW007 22SW023
22SW009 22SW024
22SW010 22SW010_20120512
22SW017

**Definitions:**
C = Carcinogen
CAS = Chemical Abstracts Service
COPC = Chemical Of Potential Concern
J = Estimated value
M = Maximum Contaminant Level
N = Noncarcinogen
NA = Not Applicable/Not Available
ND = Not Detected

**Rationale Codes:**
For selection as a COPC:
ASL = Above Screening Level/ARAR/TBC

For elimination as a COPC:
BSL = Below COPC Screening Level

TABLE 7-11

**OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - DIRECT CONTACT WITH SEDIMENT**
**SWMU 22 - LEAD AZIDE POND**
**NSA CRANE, CRANE, INDIANA**

| CAS Number | Chemical | Minimum Concentration | Maximum Concentration | Units | Sample of Maximum Concentration | Frequency of Detection | Range of Nondetects[1] | Concentration Used for Screening[2] | Range of Background Concentrations[3] | Adjusted USEPA RSL Residential Soil[4] | IDEM Residential Soil[5] | COPC Flag | Rationale for Contaminant Deletion or Selection[6] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Metals** | | | | | | | | | | | | | |
| 7440-38-2 | Arsenic | 1.2 J | 14.7 | mg/kg | 22SD0230006 | 17/17 | - | 14.7 | 5.5 | 0.39 C | 5.5 C | Yes | ASL |
| 7440-39-3 | Barium | 8.6 J | 173 J | mg/kg | 22SD0030006 | 17/17 | - | 173 | 42.1 | 1500 N | 21000 N | No | BSL |
| 7440-43-9 | Cadmium | 0.071 J | 0.88 J | mg/kg | 22SD0060006 | 17/17 | - | 0.88 | 0.28 | 7 N | 98 N | No | BSL |
| 7440-47-3 | Chromium | 2.5 J | 16.2 J | mg/kg | 22SD0030006 | 17/17 | - | 13.9 | 10 | 12,000 N[7] | 100,000 L[7] | No | BSL |
| 7439-92-1 | Lead | 4 J | 20 J | mg/kg | 22SD0080624 | 17/17 | - | 20 | 11.3 | 400 | 400 | No | BSL |
| 7439-97-6 | Mercury | 0.038 J | 0.26 | mg/kg | 22SD0090006 | 4/17 | 0.03 - 0.056 | 0.26 | 0.086 J | 2.3 N[8] | 32 N[8] | No | BSL |
| 7782-49-2 | Selenium | 0.044 J | 0.61 | mg/kg | 22SD0230006 | 17/17 | - | 0.61 | 0.42 | 39 N | 550 N | No | BSL |
| 7440-22-4 | Silver | 0.02 J | 0.025 J | mg/kg | 22SD0010006 | 3/17 | 0.04 - 0.04 | 0.025 | ND | 39 N | 550 N | No | BSL |

**Footnotes:**
1 - Values presented are sample-specific quantitation limits.
2 - The maximum detected concentration is used for screening purposes.
3 - Sediment sample 22SD0170006. There is only one upgradient sediment sample, therefore a background comparison could not be performed. Concentrations are presented for information purposes only.
4 - USEPA Regional Screening Levels for Chemical Contaminants at Superfund Sites, November 2012 (USEPA, 2012a). The noncarcinogenic values (denoted with a "N" flag) are the screening level divided by 10 to correspond to a target hazard quotient of 0.1. Carcinogenic values represent an incremental cancer risk of 1.0E-06 (carcinogens denoted with a "C" flag).
5 - IDEM Closure Guide, March 1, 2013 (IDEM, 2013).
6 - The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level.
7 - Value is for trivalent chromium.
8 - Value is for mercuric chloride (and other mercury salts).
Shaded criterion indicates that the maximum detected concentration exceeds one or more screening criteria. Shaded chemical name indicates that the chemical was retained as a COPC.

**Associated Samples**
22SD0010006
22SD0020006
22SD0030006
22SD0040006
22SD0050006
22SD0060006
22SD0060624
22SD0070006
22SD0070624
22SD0080006
22SD0080624
22SD0090006
22SD0100006
22SD0100006_20120512
22SD0110006
22SD0180006
22SD0180006_20120512
22SD0230006
22SD0240006

**Definitions:**
C = Carcinogen
COPC = Chemical Of Potential Concern
J = Estimated value
L = Capped at 100,000
N = Noncarcinogen
NA = Not Applicable/Not Available
ND = Not Detected

**Rationale Codes:**
For selection as a COPC:
ASL = Above Screening Level

For elimination as a COPC:
BSL = Below COPC Screening Level

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## TABLE 7-12

## CHEMICALS RETAINED AS CHEMICALS OF POTENTIAL CONCERN (COPCs)
## SWMU 22 - LEAD AZIDE POND
## NSA CRANE
## CRANE, INDIANA

| Chemical | Surface Soil | | Subsurface Soil | | Groundwater | Surface Water | Sediment |
|---|---|---|---|---|---|---|---|
| | Direct Contact | Soil to Groundwater | Direct Contact | Soil to Groundwater | | | |
| **Explosives** | | | | | | | |
| RDX | | E, I | | | E, I | E | |
| **Metals** | | | | | | | |
| Arsenic | | | | | E, I | E | E, I |
| Cadmium | | | | | E, I | E | |
| Hexavalent Chromium | | | | | E | | |
| Lead | | | | | E, I | | |
| **Miscellaneous Parameters** | | | | | | | |
| Perchlorate | | | | | E | | |

Notes
E - Chemical exceeded USEPA screening criteria and was retained as a COPC.
I - Chemical exceeded IDEM screening criteria and was retained as a COPC.

## TABLE 7-13

## SELECTION OF EXPOSURE PATHWAYS
## SWMU 22 – LEAD AZIDE POND
## NSA CRANE, CRANE INDIANA


| Scenario Timeframe | Medium | Exposure Medium | Exposure Point | Receptor Population | Receptor Age | Exposure Route | Type of Analysis | Rationale for Selection or Exclusion of Exposure Pathway |
|---|---|---|---|---|---|---|---|---|
| Current/Future | Surface Soil | Surface Soil | SWMU 22 | Construction Workers | Adult | Ingestion<br>Dermal | None<br>None | No COPCs were identified for surface soil. |
| | | | | Industrial Worker | Adult | Ingestion<br>Dermal | None<br>None | No COPCs were identified for surface soil. |
| | | | | Trespassers | Adolescent | Ingestion<br>Dermal | None<br>None | No COPCs were identified for surface soil. |
| | | Air | SWMU 22 | Construction Workers | Adult | Inhalation | None | No COPCs were identified for surface soil. |
| | | | | Industrial Worker | Adult | Inhalation | None | No COPCs were identified for surface soil. |
| | | | | Trespassers | Adolescent | Inhalation | None | No COPCs were identified for surface soil. |
| | Subsurface Soil | Subsurface Soil | SWMU 22 | Construction Workers | Adult | Ingestion<br>Dermal | None<br>None | No COPCs were identified for subsurface soil. |
| | | | | Industrial Worker | Adult | Ingestion<br>Dermal | None<br>None | No COPCs were identified for subsurface soil. |
| | | | | Trespassers | Adolescent | Ingestion<br>Dermal | None<br>None | No COPCs were identified for subsurface soil. |
| | | Air | SWMU 22 | Construction Workers | Adult | Inhalation | None | No COPCs were identified for subsurface soil. |
| | | | | Industrial Worker | Adult | Inhalation | None | No COPCs were identified for subsurface soil. |
| | | | | Trespassers | Adolescent | Inhalation | None | No COPCs were identified for subsurface soil. |
| | Groundwater | Groundwater | SWMU 22 | Construction Workers | Adult | Ingestion<br>Dermal | None<br>Quant | Construction workers may have contact with groundwater during excavation activities. |
| | | | | Industrial Worker | Adult | Ingestion<br>Dermal | None<br>None | Industrial workers are not exposed to groundwater. |
| | | | | Trespassers | Adolescent | Ingestion<br>Dermal | None<br>None | Current trespassers are not exposed to groundwater. |
| | | Air | SWMU 22 | Construction Workers | Adult | Inhalation | None | No volatile COPCs were identified in groundwater. |
| | | | | Industrial Worker | Adult | Inhalation | None | Industrial workers are not expected to be exposed to COPCs that have volatilized from groundwater. |
| | | | | Trespassers | Adolescent | Inhalation | None | Current trespassers are not exposed to groundwater. |
| | | | Vapor Intrusion | Industrial Worker | Adult | Inhalation | None | No COPCs were identified for vapor intrusion. |

## TABLE 7-13

## SELECTION OF EXPOSURE PATHWAYS
## SWMU 22 – LEAD AZIDE POND
## NSA CRANE, CRANE INDIANA


| Scenario Timeframe | Medium | Exposure Medium | Exposure Point | Receptor Population | Receptor Age | Exposure Route | Type of Analysis | Rationale for Selection or Exclusion of Exposure Pathway |
|---|---|---|---|---|---|---|---|---|
| Current/Future | Surface Water | Surface Water | SWMU 22 | Construction Workers | Adult | Ingestion<br>Dermal | None<br>None | Construction workers are not exposed to surface water. |
| | | | | Industrial Worker | Adult | Ingestion<br>Dermal | None<br>None | Industrial workers are not exposed to surface water. |
| | | | | Trespassers | Adolescent | Ingestion<br>Dermal | Quant<br>Quant | Trespassers may be exposed to surface water while at the site. |
| | Sediment | Sediment | SWMU 22 | Construction Workers | Adult | Ingestion<br>Dermal | None<br>None | Construction workers are not exposed to sediment. |
| | | | | Industrial Worker | Adult | Ingestion<br>Dermal | None<br>None | Industrial workers are not exposed to sediment. |
| | | | | Trespassers | Adolescent | Ingestion<br>Dermal | Quant<br>Quant | Current trespassers may be exposed to sediment while at the site. |
| Future | Surface Soil | Surface Soil | SWMU 22 | Recreational Users | Child | Ingestion<br>Dermal | None<br>None | No COPCs were identified for surface soil. |
| | | | | | Adult | Ingestion<br>Dermal | None<br>None | |
| | | | | Residents | Child | Ingestion<br>Dermal | None<br>None | No COPCs were identified for surface soil. |
| | | | | | Adult | Ingestion<br>Dermal | None<br>None | |
| | | Air | SWMU 22 | Recreational Users | Child | Inhalation | None | No COPCs were identified for surface soil. |
| | | | | | Adult | Inhalation | None | |
| | | | | Residents | Child | Inhalation | None | No COPCs were identified for surface soil. |
| | | | | | Adult | Inhalation | None | |
| | Subsurface Soil | Subsurface Soil | SWMU 22 | Recreational Users | Child | Ingestion<br>Dermal | None<br>None | No COPCs were identified for subsurface soil. |
| | | | | | Adult | Ingestion<br>Dermal | None<br>None | |
| | | | | Residents | Child | Ingestion<br>Dermal | None<br>None | No COPCs were identified for subsurface soil. |
| | | | | | Adult | Ingestion<br>Dermal | None<br>None | |

## TABLE 7-13

## SELECTION OF EXPOSURE PATHWAYS
## SWMU 22 – LEAD AZIDE POND
## NSA CRANE, CRANE INDIANA


| Scenario Timeframe | Medium | Exposure Medium | Exposure Point | Receptor Population | Receptor Age | Exposure Route | Type of Analysis | Rationale for Selection or Exclusion of Exposure Pathway |
|---|---|---|---|---|---|---|---|---|
| Future | Subsurface Soil | Air | SWMU 22 | Recreational Users | Child | Inhalation | None | No COPCs were identified for subsurface soil. |
| | | | | | Adult | Inhalation | None | |
| | | | | Residents | Child | Inhalation | None | No COPCs were identified for subsurface soil. |
| | | | | | Adult | Inhalation | None | |
| | Groundwater | Groundwater | SWMU 22 | Recreational Users | Child | Ingestion<br>Dermal | None<br>None | Recreational users are not expected to be exposed to groundwater. |
| | | | | | Adult | Ingestion<br>Dermal | None<br>None | |
| | | | | Residents | Child | Ingestion<br>Dermal | Quant<br>Quant | Although a future residential scenario is considered unlikely at the site this scenario is included to aid in future risk management decisions. |
| | | | | | Adult | Ingestion<br>Dermal | Quant<br>Quant | |
| | | Air | SWMU 22 | Recreational Users | Child | Inhalation | None | Recreational users are not expected to be exposed to groundwater. |
| | | | | | Adult | Inhalation | None | |
| | | | | Residents | Child | Inhalation | None | No volatile COPCs were identified for groundwater. |
| | | | | | Adult | Inhalation | None | |
| | | | Vapor Intrusion | Residents | Child | Inhalation | None | No COPCs were identified for vapor intrusion. |
| | | | | | Adult | Inhalation | None | |
| | Surface Water | Surface Water | SWMU 22 | Recreational Users | Child | Ingestion<br>Dermal | Quant<br>Quant | Recreational users may be exposed to surface water while at the site. |
| | | | | | Adult | Ingestion<br>Dermal | Quant<br>Quant | |
| | | | | Residents | Child | Ingestion<br>Dermal | Quant<br>Quant | Although a future residential scenario is considered unlikely at the site this scenario is included to aid in future risk management decisions. |
| | | | | | Adult | Ingestion<br>Dermal | Quant<br>Quant | |

## TABLE 7-13

## SELECTION OF EXPOSURE PATHWAYS
## SWMU 22 – LEAD AZIDE POND
## NSA CRANE, CRANE INDIANA


| Scenario Timeframe | Medium | Exposure Medium | Exposure Point | Receptor Population | Receptor Age | Exposure Route | Type of Analysis | Rationale for Selection or Exclusion of Exposure Pathway |
|---|---|---|---|---|---|---|---|---|
| Future | Sediment | Sediment | SWMU 22 | Recreational Users | Child | Ingestion | Quant | Recreational users may be exposed to sediment while at the site. |
| | | | | | | Dermal | Quant | |
| | | | | | Adult | Ingestion | Quant | |
| | | | | | | Dermal | Quant | |
| | | | | Residents | Child | Ingestion | Quant | Although a future residential scenario is considered unlikely at the site this scenario is included to aid in future risk management decisions. |
| | | | | | | Dermal | Quant | |
| | | | | | Adult | Ingestion | Quant | |
| | | | | | | Dermal | Quant | |

**Notes:**
COPC - Chemical of potential concern.
Quant - Quantitative.

TABLE 7-14

RECEPTORS AND EXPOSURE ROUTES FOR QUANTITATIVE EVALUATION
SWMU 22 – LEAD AZIDE POND
NSA CRANE
CRANE INDIANA

| Receptors | Exposure Routes |
|---|---|
| Construction Workers<br>(current/future land use) | • Groundwater dermal contact (during excavation) |
| Adolescent Trespassers<br>(6 to 17 years)<br>(current/future land use) | • Surface water/sediment dermal contact<br>• Surface water/sediment incidental ingestion |
| Small Child (0 to 6 years) and<br>Adult Recreational Users<br>(future land use) | • Surface water/sediment dermal contact<br>• Surface water/sediment incidental ingestion |
| Residents (Adult/Children)<br>(future land use) | • Ingestion of groundwater<br>• Groundwater dermal contact (showering/bathing)<br>• Surface water/sediment dermal contact<br>• Surface water/sediment incidental ingestion |

**TABLE 7-15**

**EXPOSURE POINT CONCENTRATIONS**
**SWMU 22 - LEAD AZIDE POND**
**NSA CRANE**
**CRANE, INDIANA**

| Chemical | Groundwater (ug/L) | Surface Water (ug/L) | Sediment (mg/kg) |
|---|---|---|---|
| **Explosives** | | | |
| RDX | 15 | 0.85 | NA |
| **Metals** | | | |
| Arsenic | 5.5 | 0.64 | 6.2 |
| Cadmium | 4.7 | 0.58 | NA |
| Hexavalent Chromium | 0.046 | NA | NA |
| Lead | 13.8 | NA | NA |
| Perchlorate | 5.9 | NA | NA |

**Notes:**
The exposure point concentrations (EPCs) for surface water and sediment were calculated using USEPA's ProUCL software Version 4.1.01 (USEPA, 2010a).
The maximum detected concentration was used as the EPC for groundwater.
See the RAGS Part D Table 3s in Appendix E for details concerning the EPCs.
NA - Not applicable.  Not a COPC for this media.

## TABLE 7-16

## SUMMARY OF EXPOSURE INPUT PARAMETERS - REASONABLE MAXIMUM EXPOSURES
## SWMU 22 - LEAD AZIDE POND
## NSWC CRANE
## CRANE INDIANA


| Parameter Code | Exposure Parameter | Construction Worker | Adolescent Trespasser | Child Recreational User | Adult Recreational User | On-Site Child Resident | On-Site Adult Resident |
|---|---|---|---|---|---|---|---|
| **All Exposures** | | | | | | | |
| $C_{soil}$ | Exposure concentration for soil (mg/kg) | 95% UCL[1] | 95% UCL[1] | 95% UCL[1] | 95% UCL[1] | 95% UCL[1] | 95% UCL[1] |
| ED | Exposure Duration (years) | 1[2] | 10[3] | 6[4] | 24[4] | 6[4] | 24[4] |
| BW | Body Weight (kg) | 70[5] | 43[5] | 15[4] | 70[4] | 15[4] | 70[4] |
| AT-N | Averaging Time (Non-Cancer) (days) | 365[5] | 3,650[5] | 2,190[5] | 8,760[5] | 2,190[5] | 8,760[5] |
| AT-C | Averaging Time (Cancer) (days) | 25,550[5] | 25,550[5] | 25,550[5] | 25,550[5] | 25,550[5] | 25,550[5] |
| **Ingestion/Dermal Contact with Groundwater** | | | | | | | |
| $C_{gw}$ | Exposure concentration for groundwater (ug/L) | 95% UCL[1] | NA | NA | NA | 95% UCL[1] | 95% UCL[1] |
| IR | Ingestion Rate (L/day) | NA | NA | NA | NA | 1.5[6] | 2[5] |
| EF | Exposure Frequency (days/year) | 30[7] | NA | NA | NA | 350[4] | 350[4] |
| $ET/t_{event}$ | Exposure Time (hours/day)/ Event Duration (hours/event) | 4[7] | NA | NA | NA | 1[8] | 0.58[8] |
| EV | Event Frequency (events/day) | 1[7] | NA | NA | NA | 1[2] | 1[2] |
| SA | Skin Surface Available for Contact ($cm^2$) | 3,300[9] | NA | NA | NA | 6,600[8] | 18,000[8] |
| | Kp (cm/hour), t* (hour/event), □(hour), and B (unitless) | chemical-specific[8] | NA | NA | NA | chemical-specific[8] | chemical-specific[8] |
| **Ingestion/Dermal Contact with Surface Water** | | | | | | | |
| $C_{sw}$ | Exposure concentration for surface water (ug/L) | NA | 95% UCL[1] | 95% UCL[1] | 95% UCL[1] | 95% UCL[1] | 95% UCL[1] |
| CR | Contact Rate (L/hr) | NA | 0.01[10] | 0.01[10] | 0.01[10] | 0.01[10] | 0.01[10] |
| EF | Exposure Frequency (days/year) | NA | 26[11] | 52[12] | 52[12] | 52[12] | 52[12] |
| $ET/t_{event}$ | Exposure Time (hours/day)/ Event Duration (hours/event) | NA | 4[2] | 4[2] | 4[2] | 4[2] | 4[2] |
| EV | Event Frequency (events/day) | NA | 1[2] | 1[2] | 1[2] | 1[2] | 1[2] |
| SA | Skin Surface Available for Contact ($cm^2$) | NA | 3,280[13] | 2,800[8] | 5,700[8] | 2,800[8] | 5,700[8] |
| CF | Conversion Factor ($L/m^3$) | NA | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| | Kp (cm/hour), t* (hour/event), □(hour), and B (unitless) | NA | chemical-specific[8] | chemical-specific[8] | chemical-specific[8] | chemical-specific[8] | chemical-specific[8] |
| **Incidental Ingestion/Dermal Contact with Sediment** | | | | | | | |
| $C_{sed}$ | Exposure concentration for sediment (mg/kg) | NA | 95% UCL[1] | 95% UCL[1] | 95% UCL[1] | 95% UCL[1] | 95% UCL[1] |
| IR | Ingestion Rate (mg/day) | NA | 100[4] | 200[4] | 100[4] | 200[4] | 100[4] |
| EF | Exposure Frequency (days/year) | NA | 26[11] | 52[12] | 52[12] | 52[12] | 52[12] |
| FI | Fraction Ingested (unitless) | NA | 1[5] | 0.5[2] | 0.5[2] | 0.5[2] | 0.5[2] |
| SA | Skin Surface Available for Contact ($cm^2$) | NA | 3,280[13] | 2,800[8] | 5,700[8] | 2,800[8] | 5,700[8] |

**TABLE 7-16**

**SUMMARY OF EXPOSURE INPUT PARAMETERS - REASONABLE MAXIMUM EXPOSURES**
**SWMU 22 - LEAD AZIDE POND**
**NSWC CRANE**
**CRANE INDIANA**


| Parameter Code | Exposure Parameter | Construction Worker | Adolescent Trespasser | Child Recreational User | Adult Recreational User | On-Site Child Resident | On-Site Adult Resident |
|---|---|---|---|---|---|---|---|
| **Incidental Ingestion/Dermal Contact with Sediment (Continued)** | | | | | | | |
| AF | Soil to Skin Adherence Factor (mg/cm$^2$/event) | NA | 0.2[(8)] | 0.2[(8)] | 0.07[(8)] | 0.2[(8)] | 0.07[(8)] |
| ABS | Absorption Factor (unitless) | NA | chemical-specific[(8)] | chemical-specific[(8)] | chemical-specific[(8)] | chemical-specific[(8)] | chemical-specific[(8)] |
| CF | Conversion Factor (kg/mg) | NA | 1E-06 | 1E-06 | 1E-06 | 1E-06 | 1E-06 |

**Notes:**
1 - USEPA, 2002a. Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites. OSWER 9285.6-10.
2 - Professional judgment.
3 - Adolescents ages 7 to 16 years old.
4 - USEPA, 1991: Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. OSWER Directive 9285.6-03.
5 - USEPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A.
6 - USEPA, 1997b: Exposure Factors Handbook. EPA/600/P-95/002F a-c.
7 - Professional judgment.  Assumes construction workers are only exposed to groundwater water during part of the construction project.
8 - USEPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. PA/540/R/99/005.
9 - USEPA, 2002d: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9365.4-24.
10 - USEPA, 2011: Exposure Factors Handbook: 2011 Edition.  Table 3-93.  Value is upper confidence limit for fishing.
11 - Assume one day a week in warm weather months for reasonable maximum exposure and every other week for central tendency exposure.
12 - Assume two days a week in warm weather months for reasonable maximum exposure and one day a week for central tendency exposure.
13 - Assume 25 percent of total body surface area is exposed, USEPA, 1997: Exposure Factors Handbook. EPA/600/8-95/002F a-c.

**TABLE 7-17**

**SUMMARY OF EXPOSURE INPUT PARAMETERS - CENTRAL TENDENCY EXPOSURES**
**SWMU 22 - LEAD AZIDE POND**
**NSA CRANE**
**CRANE INDIANA**


| Parameter Code | Exposure Parameter | Construction Worker | Adolescent Trespasser | Child Recreational User | Adult Recreational User | On-Site Child Resident | On-Site Adult Resident |
|---|---|---|---|---|---|---|---|
| **All Exposures** | | | | | | | |
| $C_{soil}$ | Exposure concentration for soil (mg/kg) | 95% UCL[1] | 95% UCL[1] | 95% UCL[1] | 95% UCL[1] | 95% UCL[1] | 95% UCL[1] |
| ED | Exposure Duration (years) | 1[2] | 10[3] | 2[4] | 7[4] | 2[4] | 7[4] |
| BW | Body Weight (kg) | 70[5] | 43[4] | 15[4] | 70[4] | 15[4] | 70[4] |
| AT-N | Averaging Time (Non-Cancer) (days) | 365[5] | 3,650[5] | 730[5] | 2,555[5] | 730[5] | 2,555[5] |
| AT-C | Averaging Time (Cancer) (days) | 25,550[5] | 25,550[5] | 25,550[5] | 25,550[5] | 25,550[5] | 25,550[5] |
| **Ingestion/Dermal Contact with Groundwater** | | | | | | | |
| $C_{gw}$ | Exposure concentration for groundwater (ug/L) | 95% UCL[1] | NA | NA | NA | 95% UCL[1] | 95% UCL[1] |
| IR | Ingestion Rate (L/day) | NA | NA | NA | NA | 1.5[6] | 2[5] |
| EF | Exposure Frequency (days/year) | 15[7] | NA | NA | NA | 234[4] | 234[4] |
| $ET/t_{event}$ | Exposure Time (hours/day)/ Event Duration (hours/event) | 4[7] | NA | NA | NA | 0.33[8] | 0.25[8] |
| EV | Event Frequency (events/day) | 1[2] | NA | NA | NA | 1[2] | 1[2] |
| SA | Skin Surface Available for Contact ($cm^2$) | 3,300[9] | NA | NA | NA | 6,600[8] | 18,000[8] |
| | Kp (cm/hour), t* (hour/event), □(hour), and B (unitless) | chemical-specific[8] | NA | NA | NA | chemical-specific[8] | chemical-specific[8] |
| **Ingestion/Dermal Contact with Surface Water** | | | | | | | |
| $C_{sw}$ | Exposure concentration for surface water (ug/L) | NA | 95% UCL[1] | 95% UCL[1] | 95% UCL[1] | 95% UCL[1] | 95% UCL[1] |
| CR | Contact Rate (L/hr) | NA | 0.01[10] | 0.01[10] | 0.01[10] | 0.01[10] | 0.01[10] |
| EF | Exposure Frequency (days/year) | NA | 13[11] | 26[12] | 26[12] | 26[12] | 26[12] |
| $ET/t_{event}$ | Exposure Time (hours/day)/ Event Duration (hours/event) | NA | 2[7] | 2[7] | 2[7] | 2[7] | 2[7] |
| EV | Event Frequency (events/day) | NA | 1[2] | 1[2] | 1[2] | 1[2] | 1[2] |
| SA | Skin Surface Available for Contact ($cm^2$) | NA | 3,280[13] | 2,800[8] | 5,700[8] | 2,800[8] | 5,700[8] |
| CF | Conversion Factor ($L/m^3$) | NA | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| | Kp (cm/hour), t* (hour/event), □(hour), and B (unitless) | NA | chemical-specific[8] | chemical-specific[8] | chemical-specific[8] | chemical-specific[8] | chemical-specific[8] |
| **Incidental Ingestion/Dermal Contact with Sediment** | | | | | | | |
| $C_{sed}$ | Exposure concentration for sediment (mg/kg) | NA | 95% UCL[1] | 95% UCL[1] | 95% UCL[1] | 95% UCL[1] | 95% UCL[1] |
| IR | Ingestion Rate (mg/day) | NA | 50[4] | 100[4] | 50[4] | 100[4] | 50[4] |
| EF | Exposure Frequency (days/year) | NA | 13[11] | 26[12] | 26[12] | 26[12] | 26[12] |

## TABLE 7-17

## SUMMARY OF EXPOSURE INPUT PARAMETERS - CENTRAL TENDENCY EXPOSURES
## SWMU 22 - LEAD AZIDE POND
## NSA CRANE
## CRANE INDIANA


| Parameter Code | Exposure Parameter | Construction Worker | Adolescent Trespasser | Child Recreational User | Adult Recreational User | On-Site Child Resident | On-Site Adult Resident |
|---|---|---|---|---|---|---|---|
| **Incidental Ingestion/Dermal Contact with Sediment (Continued)** | | | | | | | |
| FI | Fraction Ingested (unitless) | NA | 1(5) | 0.5(2) | 0.5(2) | 0.5(2) | 0.5(2) |
| SA | Skin Surface Available for Contact ($cm^2$) | NA | 3,280(13) | 2,800(8) | 5,700(8) | 2,800(8) | 5,700(8) |
| AF | Soil to Skin Adherence Factor ($mg/cm^2$/event) | NA | 0.04(8) | 0.04(8) | 0.01(8) | 0.04(8) | 0.01(8) |
| ABS | Absorption Factor (unitless) | NA | chemical-specific(8) | chemical-specific(8) | chemical-specific(8) | chemical-specific(8) | chemical-specific(8) |
| CF | Conversion Factor (kg/mg) | NA | 1E-06 | 1E-06 | 1E-06 | 1E-06 | 1E-06 |

**Notes:**
1 - USEPA, 2002a. Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites. OSWER 9285.6-10.
2 - Professional judgment.
3 - Adolescents ages 7 to 16 years old.
4 - USEPA, 1993a: Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.
5 - USEPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A.
6 - Assume that head, arms, hands, lower legs, and feet are exposed (USEPA, 1997).
7 - Central tendency exposure is assumed to be one-half the reasonable maximum exposure value.
8 - USEPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. PA/540/R/99/005.
9 - USEPA, 2002d: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9365.4-24.
10 - Assume 50 percent of total body surface area is exposed, USEPA, 2004.
11 - Assume 1 day a week in warm weather months for RME and every other week for CTE.
12 - Assume 2 days a week in warm weather months for RME and one day a week for CTE.
13 - Assume 25 percent of total body surface area is exposed, U.S. EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002F a-c.

**TABLE 7-18**

**INTERMEDIATE VARIABLES FOR CALCULATING DA(EVENT)**
**SWMU 22 - LEAD AZIDE POND**
**NSA CRANE**
**CRANE, INDIANA**

| Chemical of Potential Concern | Media | Dermal Absorption Fraction (soil) | FA | Kp | | t(event) | | $\tau$ | | t* | | B |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Value | Value | Units | Value | Units | Value | Units | Value | Units | Value |
| **Explosives** | | | | | | | | | | | | |
| RDX | Groundwater, Surface Water | 0.015 | 1 | 3.4E-04 | cm/hr | (1) | hr | 1.8E+00 | hr | 4.4E+00 | hr | 1.9E-03 |
| **Metals** | | | | | | | | | | | | |
| Arsenic | Groundwater, Surface Water, Sediment | 0.03 | 1 | 1.0E-03 | cm/hr | (1) | hr | NA | NA | NA | NA | NA |
| Cadmium | Groundwater, Surface Water | 0.001 | 1 | 1.0E-03 | cm/hr | (1) | hr | NA | NA | NA | NA | NA |
| Hexavalent Chromium | Groundwater | 0 | 1 | 2.0E-03 | cm/hr | (1) | hr | NA | NA | NA | NA | NA |
| Lead | Groundwater | 0 | 1 | 1.0E-04 | cm/hr | (1) | hr | NA | NA | NA | NA | NA |
| **Miscellaneous Parameters** | | | | | | | | | | | | |
| Perchlorate | Groundwater | 0 | 1 | 1.0E-03 | cm/hr | (1) | hr | NA | NA | NA | NA | NA |

Notes:
All values from EPA's Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final, July 2004.
1 - See Tables 7-16 and 7-17 for values for T(event).
FA = Fraction Absorbed Water
Kp = Dermal Permeability Coefficient of Compound in Water
t(event) = Event Duration
$\tau$ = Lag Time
t* = Time to Reach Steady-State
B = Dimensionless Ratio of the Permeability Coefficient of a Compound Through the Stratum Corneum Relative to its Permeability Coefficient Across the Viable Epidermis
NA = Not applicable.

## TABLE 7-19

## NON-CANCER TOXICITY DATA -- ORAL/DERMAL
## SWMU 22 - LEAD AZIDE POND
## NSA CRANE
## CRANE, INDIANA

| 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(s) | Date(s) (MM/DD/YYYY) |
| **Explosives** | | | | | | | | | | |
| RDX | Subchronic | 1.0E-01 | mg/kg/day | 1 | 1.0E-01 | mg/kg/day | Central Nervous System | 30/1 | ATSDR | 1/2012 |
| | Chronic | 3.0E-03 | mg/kg/day | 1 | 3.0E-03 | mg/kg/day | Prostate | 100/1 | IRIS | 4/15/2013 |
| **Inorganics** | | | | | | | | | | |
| Arsenic | Chronic | 3.0E-04 | mg/kg/day | 1 | 3.0E-04 | mg/kg/day | Skin, Cardiovascular System | 3/1 | IRIS | 4/15/2013 |
| Cadmium | Chronic | 5.0E-04 | mg/kg/day | 0.05 | 2.5E-05 | mg/kg/day | Kidney | 10/1 | IRIS | 4/15/2013 |
| Hexavalent Chromium | Subchronic | 2.0E-02 | mg/kg/day | 0.025 | 5.0E-04 | mg/kg/day | None Reported | 100/3 | HEAST | 9/97 |
| | Chronic | 3.0E-03 | mg/kg/day | 0.025 | 7.5E-05 | mg/kg/day | None Reported | 300/3 | IRIS | 4/15/2013 |
| Lead | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **Miscellaneous Compounds** | | | | | | | | | | |
| Perchlorate | Chronic | 7.0E-04 | mg/kg/day | 1 | 7.0E-04 | mg/kg/day | Thyroid | 10/1 | IRIS | 4/15/2013 |

Notes:

1 - U.S. EPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. EPA/540/R/99/005.

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

Definitions:

ATSDR = Agency for Toxic Substances and Disease Registry

IRIS = Integrated Risk Information System

NA = Not Available.

PPRTV = Provisional Peer Reviewed Toxicity Value.

## TABLE 7-20

## NON-CANCER TOXICITY DATA -- INHALATION
## SWMU 22 - LEAD AZIDE POND
## NSA CRANE
## CRANE, INDIANA

| 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) (MM/DD/YYYY) |
| **Explosives** | | | | | | | | | |
| RDX | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **Inorganics** | | | | | | | | | |
| Arsenic | Chronic | 1.5E-05 | mg/m3 | 4.3E-06 | (mg/kg/day) | Skin, Cardiovascular System | NA | Cal EPA | 9/2009 |
| Cadmium | Chronic | 2.0E-05 | mg/m3 | 5.7E-06 | (mg/kg/day) | Kidney, Respiratory | NA | Cal EPA | 9/2009 |
| Hexavalent Chromium | Chronic | 1.0E-04 | mg/m3 | 2.9E-05 | (mg/kg/day) | Respiratory | 300/1 | IRIS | 4/15/2013 |
| Lead | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **Miscellaneous Compounds** | | | | | | | | | |
| Perchlorate | NA | NA | NA | NA | NA | NA | NA | NA | NA |

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

Definitions:
Cal EPA = California Environmental Protection Agency, Technical Support Document for Describing Available Cancer Slope Factors, September 2009.
NA = Not Applicable

## TABLE 7-21

## CANCER TOXICITY DATA -- ORAL/DERMAL
## SWMU 22 - LEAD AZIDE POND
## NSA CRANE
## CRANE, INDIANA

| 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 Description | Oral CSF | |
|---|---|---|---|---|---|---|---|---|
| | Value | Units | | Value | Units | | Source(s) | Date(s) (MM/DD/YYYY) |
| **Explosives** | | | | | | | | |
| RDX | 1.1E-01 | $(mg/kg/day)^{-1}$ | 1 | 1.1E-01 | $(mg/kg/day)^{-1}$ | C (Possible human carcinogen) | IRIS | 4/15/2013 |
| **Inorganics** | | | | | | | | |
| Arsenic | 1.5E+00 | $(mg/kg/day)^{-1}$ | 1 | 1.5E+00 | $(mg/kg/day)^{-1}$ | A / human carcinogen | IRIS | 4/15/2013 |
| Cadmium | NA | NA | NA | NA | NA | B1 /Known/likely human carcinogen. | IRIS | 4/15/2013 |
| Hexavalent Chromium | 5.0E-01 | $(mg/kg/day)^{-1}$ | 0.025 | 2.0E+01 | $(mg/kg/day)^{-1}$ | Carcinogenic potential cannot be determined (Oral route) | NJDEP | 4/8/2009 |
| Lead | NA | NA | NA | NA | NA | B2 / Probable human carcinogen | IRIS | 4/15/2013 |
| **Miscellaneous Compounds** | | | | | | | | |
| Perchlorate | NA | NA | NA | NA | NA | Not likely to be carcinogenic to humans | IRIS | 4/15/2013 |

Notes:

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

2 - Adjusted cancer slope factor for dermal = Oral cancer slope factor / Oral absorption efficiency for dermal.

IRIS = Integrated Risk Information System.

NA = Not Available.

NJDEP = New Jersey Department of Environmental Protection.

## TABLE 7-22

## CANCER TOXICITY DATA -- INHALATION
## SWMU 22 - LEAD AZIDE POND
## NSA CRANE
## CRANE, INDIANA

| Chemical of Potential Concern | Unit Risk | | Inhalation Cancer Slope Factor(1) | | Weight of Evidence/ Cancer Guideline Description | Unit Risk : Inhalation CSF | |
|---|---|---|---|---|---|---|---|
| | Value | Units | Value | Units | | Source(s) | Date(s) (MM/DD/YYYY) |
| **Explosives** | | | | | | | |
| RDX | NA | NA | NA | NA | C (Possible human carcinogen) | IRIS | 4/15/2013 |
| **Inorganics** | | | | | | | |
| Arsenic | 4.3E-03 | $(ug/m^3)^{-1}$ | 1.5E+01 | $(mg/kg/day)^{-1}$ | A / Known human carcinogen | IRIS | 4/15/2013 |
| Cadmium | 1.8E-03 | $(ug/m^3)^{-1}$ | 6.3E+00 | $(mg/kg/day)^{-1}$ | B1 /Known/likely human carcinogen. | IRIS | 4/15/2013 |
| Hexavalent Chromium | 8.4E-02 | $(ug/m^3)^{-1}$ | 2.9E+02 | $(mg/kg/day)^{-1}$ | Known/likely human carcinogen (Inhalation route) | IRIS | 4/15/2013 |
| Lead | NA | NA | NA | NA | B2 / Probable human carcinogen | IRIS | 4/15/2013 |
| **Miscellaneous Compounds** | | | | | | | |
| Perchlorate | NA | NA | NA | NA | Not likely to be carcinogenic to humans | IRIS | 4/15/2013 |

Notes:
1 - Inhalation CSF = Unit Risk * 70 kg / $20m^3$/day.

Definitions:
IRIS = Integrated Risk Information System.
NA = Not Available.

## TABLE 7-27

## SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - INDUSTRIAL EXPOSURES TO SETTLING BASIN - 22SD/SW011
## SWMU 22 - LEAD AZIDE POND
## NSA CRANE
## CRANE, INDIANA

| Chemical | Incremental Lifetime Carcinogenic Risk (ILCR) | | | Estimated Non-Carcinogenic Hazard Quotient (HQ) | | |
|---|---|---|---|---|---|---|
| | Exposure Point Concentration (mg/kg) | RSL[1] (mg/kg) | Estimated ILCR | Primary Target Organs | RSL[1] (mg/kg) | Estimated HQ |
| **Metals** | | | | | | |
| Arsenic | 12.3 | 1.6 | 8E-06 | Skin, Cardiovascular System | 260 | 0.05 |
| Barium | 38.3 | NA | NA | Kidney | 190,000 | 0.0002 |
| Cadmium | 0.26 | 9,300 | 3E-11 | Kidney | 800 | 0.0003 |
| Chromium[2] | 16 | NA | NA | None Specified | 1,500,000 | 0.00001 |
| Lead | 11 | NA | NA | NA | 800 | NA |
| Selenium | 0.19 | NA | NA | Skin, Central Nervous System | 5100 | 0.00004 |
| | | Total ILCR | **8E-06** | | Total HI | **0.05** |

1 - USEPA Regional Screening Level Table (November 2012a). Carcinogenic values correspond to a $1x10^{-6}$ cancer risk level. Noncarcinogenic values corresponds to a hazard index of 1.
2 - Values are for trivalent chromium.
NA - Not applicable. There are no cancer slope factors (CSF) and/or reference dose (RfD) available for this chemical.

## TABLE 7-28

### SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - RESIDENTIAL EXPOSURES TO SETTING BASIN - 22SD/SW011
### SWMU 22 - LEAD AZIDE POND
### NSA CRANE
### CRANE, INDIANA

| Chemical | Incremental Lifetime Carcinogenic Risk (ILCR) | | | Estimated Non-Carcinogenic Hazard Quotient (HQ) | | |
|---|---|---|---|---|---|---|
| | Exposure Point Concentration (mg/kg) | RSL[1] (mg/kg) | Estimated ILCR | Primary Target Organs | RSL[1] (mg/kg) | Estimated HQ |
| **Metals** | | | | | | |
| Arsenic | 12.3 | 0.39 | 3E-05 | Skin, Cardiovascular System | 22 | 0.6 |
| Barium | 38.3 | NA | NA | Kidney | 15,000 | 0.003 |
| Cadmium | 0.26 | 1,800 | 1E-10 | Kidney | 70 | 0.004 |
| Chromium[2] | 16 | NA | NA | None Specified | 120,000 | 0.0001 |
| Lead | 11 | NA | NA | NA | 400 | NA |
| Selenium | 0.19 | NA | NA | Skin, Central Nervous System | 390 | 0.0005 |
| | | Total ILCR | **3E-05** | Total HI (as trivalent chromium) | | **0.6** |

1 - USEPA Regional Screening Level Table (November 2012a). Carcinogenic values correspond to a $1x10^{-6}$ cancer risk level. Noncarcinogenic values corresponds to a hazard index of 1.
2 - Values are for trivalent chromium.
NA - Not applicable. There are no cancer slope factors (CSF) and/or reference dose (RfD) available for this chemical.

TABLE 7-29

**COMPARISON OF SETTLING BASIN SEDIMENTS TO MIGRATION CRITERIA**
**SWMU 22 - LEAD AZIDE POND**
**NSA CRANE**
**CRANE, INDIANA**

| LOCATION<br>SAMPLE ID<br>SAMPLE DATE<br>SAMPLE CODE<br>MATRIX<br>SAMPLE TYPE<br>SUBMATRIX<br>TOP DEPTH<br>BOTTOM DEPTH | **USEPA Protection of Groundwater SSLs[(1)]** | **IDEM Soil Migration to Groundwater[(2)]** | **22SD/SW011<br>22SD0110006<br>20110120<br>NORMAL<br>SD<br>NORMAL<br>SD<br>0<br>0.5** |
|---|---|---|---|
| **Metals (mg/kg)** | | | |
| Arsenic | 0.026 | 5.9 M | 12.3 J |
| Barium | 2,400 | 1,700 M | 38.3 J |
| Cadmium | 10.4 | 7.5 M | 0.26 J |
| Chromium | 560,000,000 (3) | 1,000,000 R | 16.2 J |
| Lead | 280 (4) | 270 M | 11.3 J |
| Selenium | 8 | 5.3 M | 0.19 J |

1 - USEPA Regional Screening Level (RSL), November 2012. Protection of groundwater values are risk-based SSLs and have been multiplied by 20 to represent a dilution attenuation factor of 20.
2 - IDEM Closure Guide, March 1,2013.
3 - Values are for trivalent chromium.
4 - Value is MCL based soil screening level.

C - Carcinogenic.
IDEM = Indiana Department of Environmental Management.
M - Maximum contaminant level.
mg/kg = Milligram per kilogram.
N - Noncarcinogenic.
R = Capped at 1,000,000.
SSL = Soil screening level.
USEPA = United States Environmental Protection Agency.

Exceeds USEPA SSL
Exceeds IDEM Screening Level
Exceeds Both USEPA SSL and IDEM Screening Level

# 8.0 ECOLOGICAL RISK ASSESSMENT

The goal of the SLERA for SWMU 22 was to evaluate the potential for adverse ecological impacts due to site-related contamination. This goal was accomplished by identifying COPCs detected at concentrations that exceed screening levels, identifying the locations of these exceedances, and concluding whether or not further investigation and/or remedial action at SWMU 22 at NSA Crane is warranted from an ecological perspective.

## 8.1 INTRODUCTION

The SLERA methodology used at NSA Crane is in accordance with the following guidance documents:

- Department of Navy Environmental Policy Memorandum 97-04: Use of Ecological Risk Assessments dated May 16, 1997.
- Navy Policy for Conducting Ecological Risk Assessments (1999).
- Final Guidelines for Ecological Risk Assessment (USEPA, 1998).
- Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (USEPA, 1997a).

This SLERA consists of Steps 1, 2, and 3a of the eight-step ecological risk evaluation process discussed in USEPA guidance (1997a and 1998) and the Navy Policy for Conducting ERAs (1999). The first two screening steps comprise the SLERA and correspond with Tier 1 of the Navy policy (1999), during which conservative exposure estimates are compared to screening-level and threshold toxicity values. Step 3a is the first step of a baseline ecological risk assessment (BERA) and consists of refining the Tier 1 assumptions following Steps 1 and 2 to further focus the ERA process on the chemicals of greatest concern at a site. Step 3a corresponds with the first part of Tier 2 of the Navy policy (1999). Steps 3b through 7 are conducted if additional evaluations or investigations are necessary. Aspects of Step 8, risk management, are addressed throughout the ERA process, in cooperation with Region 5 regulators.

A schematic diagram of the general risk assessment process is provided on Figure 8-1.

the EEQ. Rather, an EEQ greater than 1.0 simply indicates that the dose used to derive the TRV was exceeded.

Finally, there is uncertainty in how the predicted risks to a species at a site translate into risk to the population in the area as a whole.

## 8.6 ECOLOGICAL RISK SUMMARY AND CONCLUSIONS

This ERA evaluated surface soil, sediment, and surface water. Based on the initial screening of the chemical data, several chemicals were initially selected as COPCs in surface soil, sediment, and surface water because they were detected at concentrations that exceeded conservative screening levels, they had EEQs greater than 1.0 in the conservative food-chain model, or because they did not have screening levels.

These chemicals were then further evaluated to refine the list of COPCs, and to better characterize risks to ecological receptors. The following presents the results of the SLERA.

### 8.6.1 Soil Invertebrates and Terrestrial Plants

No chemicals were retained as COPCs for risks to terrestrial plants or soil invertebrates.

### 8.6.2 Sediment Invertebrates and Aquatic Organisms

No chemicals were retained as COPCs for risks to sediment invertebrates or aquatic organisms.

### 8.6.3 Mammals and Birds

No chemicals were retained as COPCs for herbivorous receptors, invertivorous receptors, or piscivorous receptors.

# 9.0 SUMMARY AND RECOMMENDATIONS

Several metals were detected in surface and subsurface soil at SWMU 22. Five metals (arsenic, cadmium, chromium, lead, and mercury) in soil exceeded either human health or ecological risk-based screening values. However, arsenic, cadmium, and chromium concentrations were within the applicable background soil concentration ranges. Metals concentrations in SWMU 22 subsurface soil samples did not exceed the background value. Perchlorate was not detected in soil at SWMU 22, and RDX was only detected in one surface soil sample (location 22SS025).

Several metals (arsenic, cadmium, chromium, lead, and selenium) and energetics-related compounds (HMX, RDX, perchlorate, TNT, and the TNT biotic degradation product 4ADNT) were detected in groundwater at concentrations greater than human health screening values. Perchlorate was detected in two wells (22MWT002 and 22MWT006); however, as it was detected in the upgradient well 22MWT006 its presence may not be site-related but rather an upgradient, off-SWMU source.

Four nitroaromatic compounds were detected in the settling basin located north of Building 138. Of these four compounds, only TNT and its degradation product 4ANDT were detected at concentrations exceeding risk-based screening values.

Concentrations of arsenic and mercury in samples collected at three stream sediment locations exceeded surface soil background values. Neither organic analytes nor perchlorate were not detected in any of the stream sediment samples.

All eight RCRA metals, HMX, and RDX were detected in at least one unfiltered surface water sample, and all eight metals and perchlorate were detected in at least one filtered surface water sample. Arsenic was detected in several surface water samples, one of which was the upstream sampling location 22SW011. There is no known source of arsenic contamination at SWMU 22, and the surface water arsenic concentrations are relatively uniform across and downstream of SWMU 22. Soil, sediment, and groundwater arsenic concentrations appear to be within naturally occurring arsenic concentration ranges. However, the upstream arsenic concentration at location 22SW011 was one-fourth of the maximum on-site total arsenic concentration, suggesting that arsenic at 22SW004 might be a site-related surface water contaminant. One dissolved cadmium result exceeded the ecological screening value, but the total metals concentration from the same sample did not. No other dissolved cadmium results exceeded ecological screening values. Total chromium concentrations exceeded the human health risk-based screening criterion in 13 surface water samples. RDX concentrations exceeded the human health risk-based screening criterion at seven surface water locations

A baseline HHRA was performed to characterize the potential risks to likely human receptors under current and potential future land use scenarios for SWMU 22. The HHRA identified no chemicals of potential concern (COPCs) were identified for direct contact to surface soil and subsurface soil. RDX in soil was the only chemical identified as exceeding the screening levels for migration from soil to groundwater. RDX was not considered to be a chemical of concern (COC) for migration from soil to groundwater even though RDX was detected in groundwater because risks from exposures RDX in groundwater were within acceptable levels. COPCs for direct contact to groundwater were RDX, arsenic, cadmium, hexavalent chromium, lead, and perchlorate; COPCs for direct contact to surface water were RDX, arsenic, and cadmium; and the COPC for direct contact to sediment was arsenic. The calculated cancer risks and hazard indices for these COPCs were within acceptable risk levels. Analysis of lead in groundwater did not exceed the USEPA goal regarding lead exposures.

Similarly, the SLERA, performed to characterize the potential risks to likely ecological receptors at SWMU 22 identified no chemicals of potential concern (COPC) in in surface soil, sediment, and surface water.

The purpose of this RFI was to identify possible contaminant releases that would require further investigation or pose a threat to human health or the environment. A site that does not require further investigation and does not pose an unacceptable risk to human health and the environment may be designated as requiring No Further Action (NFA) and may be removed from further consideration. Based on the results of the human health and ecological risk assessments, NFA is recommended for SWMU 22.

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# APPENDIX A

## FIELD DOCUMENTATION (BORING LOG, WELL CONSTRUCTION DIAGRAMS, GROUNDWATER LEVEL MEASUREMENT FORMS, SAMPLE LOG SHEETS, AND SLUG TEST DATA)

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# SURFACE WATER SAMPLE LOG SHEET



Project Site Name: NSA Crane, SWMU 22
Project No.: 112G02362

[X] Stream
[] Spring
[] Pond
[] Lake
[] Other:
[] QA Sample Type:

Sample ID No.: 22SW011
Sample Location: 22SW011
Sampled By: AEB/TE
C.O.C. No.:

Type of Sample:
[X] Low Concentration
[] High Concentration

**SAMPLING DATA:**

| Date: 1/20/11 | Color | pH | S.C. | Temp. | Turbidity | DO | ORP | Other |
|---|---|---|---|---|---|---|---|---|
| Time: 1345 | Visual | Standard | mS/cm | Degrees C | NTU | mg/l | mV | Salinity (ppt) |
| Depth: 6-8" / Method: Plastic bottle | Clear | 7.83 | 1.72 | -0.08 | 4.0 | 14.15 | 150 | 0.5 |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Preservative | Container Requirements | Collected |
|---|---|---|---|
| Explosives | 4°C | 3X 2 - 1 liter amber glass | ✓ |
| Perchlorate | 4°C | 3X 1 - 250 mL PE | ✓ |
| Total RCRA Metals | HNO3 - 4°C | 3X 1 - 500mL PE | ✓ |
| Dissolved RCRA Metals | HNO3 - 4°C | 3X 1 - 500mL PE, field filtered | ✓ |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

**OBSERVATIONS / NOTES:**

Creek width: 5-6'
creek depth: 6-8"
Flow rate: 15-20gpm
*Rocky creek bottom

**MAP:**

**Circle if Applicable:**

MS/MSD: yes
~~Duplicate ID No.:~~

**Signature(s):** Ellen Berklite

Tetra Tech NUS, Inc.

# SURFACE WATER SAMPLE LOG SHEET



| | | | |
|---|---|---|---|
| Project Site Name: | NSA CRANE SWMU 22 | Sample ID No.: | 22SW012 |
| Project No.: | 112G02362 | Sample Location: | 22SW012 |
| | | Sampled By: | Berklite/Losekamp |
| [X] Stream | | C.O.C. No.: | 2209 |
| [] Spring | | | |
| [] Pond | | Type of Sample: | |
| [] Lake | | [] Low Concentration | |
| [] Other: | | [] High Concentration | |
| [] QA Sample Type: | | | |

## SAMPLING DATA:

| | | Color (Visual) | pH (S.U.) | S.C. (mS/cm) | Temp. ($^0C$) | Turbidity (NTU) | DO (mg/l) | Salinity (%) | ORP |
|---|---|---|---|---|---|---|---|---|---|
| Date: | 4/9/2011 | | | | | | | | |
| Time: | 1830 | | | | | | | | |
| Depth: | Surface | Cloudy | 7.05 | 0.146 | 13.56 | 17.1 | 9.65 | - | 129 |
| Method: | Direct fill | | | | | | | | |

## SAMPLE COLLECTION INFORMATION:

| Analysis | Preservative | Container Requirements | Collected |
|---|---|---|---|
| Explosives (RDX / HMX) | $4^0C$ | (2) 1-liter ambers | Yes |
| Full Explosives | $4^0C$ | (2) 1-liter ambers | No |
| RCRA Total Metals | $4^0C$ / HN03 | (1) 500-ml plastic | No |
| RCRA Dissolved Metals | $4^0C$ / HN03 | (1) 500-ml plastic | No |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

## OBSERVATIONS / NOTES:

Flow rate = ~2 gpm.

Stream depth = 1.5 feet

GPS not utilized due to limited available satellites at time of sample collection

## MAP:

## Circle if Applicable:

| MS/MSD | Duplicate ID No.: |
|---|---|
| | |

## Signature(s):

Ellen Berklite

Tetra Tech NUS, Inc.

# SURFACE WATER SAMPLE LOG SHEET



| | | | |
|---|---|---|---|
| Project Site Name: | NSA CRANE SWMU 22 | Sample ID No.: | 22SW013 |
| Project No.: | 112G02362 | Sample Location: | 22SW013 |
| | | Sampled By: | Berklite/Losekamp |
| [X] Stream | | C.O.C. No.: | 2209 |
| [] Spring | | | |
| [] Pond | | Type of Sample: | |
| [] Lake | | [] Low Concentration | |
| [] Other: | | [] High Concentration | |
| [] QA Sample Type: | | | |

## SAMPLING DATA:

| | | Color (Visual) | pH (S.U.) | S.C. (mS/cm) | Temp. ($^0C$) | Turbidity (NTU) | DO (mg/l) | Salinity (%) | ORP |
|---|---|---|---|---|---|---|---|---|---|
| Date: | 4/9/2011 | | | | | | | | |
| Time: | 1805 | | | | | | | | |
| Depth: | Surface | Clear | 7.16 | 0.38 | 16.32 | 13 | 9.85 | - | 123 |
| Method: | Direct fill | | | | | | | | |

## SAMPLE COLLECTION INFORMATION:

| Analysis | Preservative | Container Requirements | Collected |
|---|---|---|---|
| Explosives (RDX / HMX) | $4^0C$ | (2) 1-liter ambers | Yes |
| Full Explosives | $4^0C$ | (2) 1-liter ambers | No |
| RCRA Total Metals | $4^0C$ / HN03 | (1) 500-ml plastic | No |
| RCRA Dissolved Metals | $4^0C$ / HN03 | (1) 500-ml plastic | No |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

## OBSERVATIONS / NOTES:

Flow rate = ~150 gpm.

Stream depth = 1.0 feet

GPS not utilized due to limited available satellites at time of sample collection

## MAP:

## Circle if Applicable:

**MS/MSD**

**Duplicate ID No.:**

## Signature(s):

Ellen Berklite

Tetra Tech NUS, Inc.

# SURFACE WATER SAMPLE LOG SHEET



Project Site Name: NSA CRANE SWMU 22

Project No.: 112G02362

Sample ID No.: 22SW014

Sample Location: 22SW014

Sampled By: Berklite/Losekamp

C.O.C. No.: 2209

[X] Stream
[] Spring
[] Pond
[] Lake
[] Other:
[] QA Sample Type:

Type of Sample:
[] Low Concentration
[] High Concentration

## SAMPLING DATA:

| | | Color (Visual) | pH (S.U.) | S.C. (mS/cm) | Temp. ($^0$C) | Turbidity (NTU) | DO (mg/l) | Salinity (%) | ORP |
|---|---|---|---|---|---|---|---|---|---|
| Date: | 4/9/2011 | | | | | | | | |
| Time: | 1815 | | | | | | | | |
| Depth: | Surface | Clear | 6.93 | 0.261 | 15.26 | 7.47 | 8.65 | - | 123 |
| Method: | Direct fill | | | | | | | | |

## SAMPLE COLLECTION INFORMATION:

| Analysis | Preservative | Container Requirements | Collected |
|---|---|---|---|
| Explosives (RDX / HMX) | $4^0$C | (2) 1-liter ambers | Yes |
| Full Explosives | $4^0$C | (2) 1-liter ambers | No |
| RCRA Total Metals | $4^0$C / HN03 | (1) 500-ml plastic | No |
| RCRA Dissolved Metals | $4^0$C / HN03 | (1) 500-ml plastic | No |
| | | | |
| | | | |
| | | | |

## OBSERVATIONS / NOTES:

Flow rate = ~75 gpm.

Stream depth = 1.0 feet

GPS not utilized due to limited available satellites at time of sample collection

## MAP:

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|
| | |

**Signature(s):** Ellen Berklite

Tetra Tech NUS, Inc.

# SURFACE WATER SAMPLE LOG SHEET



| | | | |
|---|---|---|---|
| Project Site Name: | NSA CRANE SWMU 22 | Sample ID No.: | 22SW015 |
| Project No.: | 112G02362 | Sample Location: | 22SW015 |
| | | Sampled By: | Berklite/Losekamp |
| [X] Stream | | C.O.C. No.: | 2209 |
| [] Spring | | | |
| [] Pond | | Type of Sample: | |
| [] Lake | | [] Low Concentration | |
| [] Other: | | [] High Concentration | |
| [] QA Sample Type: | | | |

## SAMPLING DATA:

| | | Color (Visual) | pH (S.U.) | S.C. (mS/cm) | Temp. ($^0$C) | Turbidity (NTU) | DO (mg/l) | Salinity (%) | ORP |
|---|---|---|---|---|---|---|---|---|---|
| Date: | 4/9/2011 | | | | | | | | |
| Time: | 1840 | | | | | | | | |
| Depth: | Surface | Clear | 5.22 | 0.102 | 13.12 | 10.35 | 9.52 | - | 255 |
| Method: | Direct fill | | | | | | | | |

## SAMPLE COLLECTION INFORMATION:

| Analysis | Preservative | Container Requirements | Collected |
|---|---|---|---|
| Explosives (RDX / HMX) | $4^0$C | (2) 1-liter ambers | Yes |
| Full Explosives | $4^0$C | (2) 1-liter ambers | No |
| RCRA Total Metals | $4^0$C / HN03 | (1) 500-ml plastic | No |
| RCRA Dissolved Metals | $4^0$C / HN03 | (1) 500-ml plastic | No |

## OBSERVATIONS / NOTES:

Flow rate = ~1 gpm.

Stream depth = 0.2 feet

GPS not utilized due to limited available satellites at time of sample collection

## MAP:

## Circle if Applicable:

| MS/MSD | Duplicate ID No.: |
|---|---|
| | |

**Signature(s):** Ellen Berklite

Tetra Tech NUS, Inc.

# SURFACE WATER SAMPLE LOG SHEET



| | | | |
|---|---|---|---|
| Project Site Name: | NSA CRANE SWMU 22 | Sample ID No.: | 22SW016 |
| Project No.: | 112G02362 | Sample Location: | 22SW016 |
| | | Sampled By: | Berklite/Losekamp |
| [X] Stream | | C.O.C. No.: | 2209 |
| [] Spring | | | |
| [] Pond | | Type of Sample: | |
| [] Lake | | [] Low Concentration | |
| [] Other: | | [] High Concentration | |
| [] QA Sample Type: | | | |

## SAMPLING DATA:

| | | Color (Visual) | pH (S.U.) | S.C. (mS/cm) | Temp. (°C) | Turbidity (NTU) | DO (mg/l) | Salinity (%) | ORP |
|---|---|---|---|---|---|---|---|---|---|
| Date: | 4/9/2011 | | | | | | | | |
| Time: | 1900 | | | | | | | | |
| Depth: | Surface | Lt. Brown | 6.5 | 0.156 | 14.81 | 17.9 | 10.3 | - | 158 |
| Method: | Direct fill | | | | | | | | |

## SAMPLE COLLECTION INFORMATION:

| Analysis | Preservative | Container Requirements | Collected |
|---|---|---|---|
| Explosives (RDX / HMX) | 4°C | (2) 1-liter ambers | Yes |
| Full Explosives | 4°C | (2) 1-liter ambers | No |
| RCRA Total Metals | 4°C / HN03 | (1) 500-ml plastic | No |
| RCRA Dissolved Metals | 4°C / HN03 | (1) 500-ml plastic | No |

## OBSERVATIONS / NOTES:

Flow rate = ~75 gpm.

Stream depth = 0.5 feet

Seep in sandstone. Outcrop above sample location

GPS not utilized due to limited available satellites at time of sample collection

## MAP:

## Circle if Applicable:

| MS/MSD | Duplicate ID No.: |
|---|---|
| | |

**Signature(s):** Allen Berklite

Tetra Tech NUS, Inc.

# SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSA Crane, SWMU 22
Project No.: 112G02362

[ ] Surface Soil
[ ] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: 22SD011
Sample Location: 22SD0110006
Sampled By: AEB/TE
C.O.C. No.:

Type of Sample:
[X] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 1/20/11<br>Time: 1410<br>Method: Stainless steel spoon<br>Monitor Reading (ppm): — | 0-6" | Brown | saturated, medium-coarse sand (SW) trace gravel, slight silt. |

**COMPOSITE SAMPLE DATA:** (crossed out)

| Date: | Time | Depth | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| Explosives & RCRA Metals | 2X 1- 8 oz w/m glass, 4°C | ✓ | |
| TOC | 2X 1- 8 oz w/m glass, 4°C | ✓ | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

MS/MSD: yes

~~Duplicate ID No.:~~

Signature(s): Ellen Berklite

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# APPENDIX B

## MISCELLANEOUS FIELD DOCUMENTATION [EQUIPMENT CALIBRATION FORMS, WORK PERMITS, FIELD TASK MODIFICATION REQUEST (FTMR) FORMS, AND SURVEY DATA]

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TETRA TECH

# FIELD TASK MODIFICATION REQUEST FORM

| Project/Installation Name | CTO & Project Number | Task Modification Number 002 |
|---|---|---|
| SWMU 22 – Lead Azide Pond, NSA Crane, IN | CTO F279; 112G02362 | |
| **Modification to**: Sampling and Analysis Plan, RCRA Facility Investigation, SWMU 22-Lead Azide Pond | **Site Location** SWMU 22 | **Date of Request** December 20, 2012 |

**Background.** Tetra Tech performed RCRA Facility Investigation (RFI) sampling at SWMU 22 in January and April 2011 and May 2012 that included the collection of surface and subsurface soil samples, surface water and sediment samples, and groundwater samples (Table 1 and Figure 1a and 1b). Analyses included energetics, metals, pH, and total organic carbon (Table 1). The distribution of constituents in the site media are illustrated on Figures 2 through 5. Water quality measurements for groundwater and surface water at SWMU 22 are summarized in Table 2a and 2b, respectively, and groundwater flow at SWMU 22 is presented on Figure 6.

Based on the human risk assessment, unacceptable risks from ingestion of groundwater contaminated with arsenic and RDX were estimated for hypothetical future residents. Table 3 summarizes the results of the risk assessment for SWMU 22 based on the data collected to date. To characterize the sources of RDX in groundwater at SWMU 22, additional activities are to be conducted. Historical discharges from the settling basin north of Building 138 may have contaminated soils along the drainages adjacent to it. These soils may be acting as secondary sources of contamination.

**Purpose of FTMR.** The purpose of this FTMR form is to present the supplemental RFI sampling activities to collect surface soil, surface water, sediment and groundwater samples to assess residual contamination in site media, which may be contributing to groundwater contamination in the area of 22MWT002.

**Proposed Supplemental Activities.** The supplemental sampling will be performed as described in this FTMR form and the approved September 2011 SAP. This FTMR form includes figures and tables and existing Standard Operating Procedure (SOP) to perform the proposed additional activities.

The approximate locations of the supplemental surface soil samples are shown on Figure 7; the supplemental sampling and analysis is presented on attached Table A-4 and described as follows:

- **Surface Soil:** Six surface soil samples will be collected in the area of Building 138 to characterize soil conditions for RDX to determine if residual contamination is present that may be acting as a source for groundwater contamination. Surface soil samples will be collected from one location (22SS003) adjacent to monitoring well 22MWT002 and from two locations (22SS004 and 22SS005) along the drainage north of well 22MWT002. One surface soil sample (22SS006) will be collected from the discharge of a corrugated metal pipe along the drainage. Two surface samples (22SS007 and 22SS007) will be collected from the drainage east of monitoring well 22MWT002 and south of the settling basin northwest of Building 138. The proposed surface soil sample locations are shown on Figure 7. The surface soil samples will be collected from 0 to 2 feet below ground surface (bgs) and in accordance with SOP-10 of the September 2011 SAP. The surface soil samples will be analyzed for RDX and TNT. (Analysis of TNT is to be performed due to detection of TNT in sediment in the settling basin north of Building 138.) In addition, the soil sample from the location of 22SS003 will also be analyzed for chromium speciation to confirm the presence of chromium as trivalent species at SWMU 22. The analysis method for the chromium speciation will be EPA Method 218.6.

- **Surface Water**: A surface water sample will be collected from location 22SD/SW025 (Figure 7). During the previous sampling events, no surface water was present. The surface water sample will be collected when sufficient water is present to collect a sample, which may be following a rain event or snow melt. The surface water sample will be collected according to SOP-05 and SOP-06 of the September 2011 SAP. The surface water sample will be analyzed for RDX and TNT.

- **Sediment**: A sediment sample will be collected from location 22SD017 to assess the sediment at that location for RDX and TNT. The sediment sample will be collected according to SOP-07 of the September 2011 SAP and analyzed for RDX and TNT.
- **Groundwater**: A groundwater sample will be collected from monitoring well 22MWT005 and analyzed for chromium speciation to confirm the presence of chromium as trivalent species at SWMU 22. Monitoring well 22MWT005 will be purged and sampled in accordance with SOP-18 and SOP-19 of the January 2011 SAP. The analysis method for the chromium speciation will be EPA Method 218.6.

Attachments to this FTMR include:

**Figures**
Figure 1a Sample Locations – January and April 2011 and May 2012
Figure 1b Sample Locations – January and April 2011
Figure 2 Soil Sample Results – January 2011 and May 2012
Figure 3 Surface Water Sample Results – January and April 2011 and May 2012
Figure 4 Sediment Sample Results – January 2011 and May 2012
Figure 5 Groundwater Sample Results – May 2012
Figure 6 Groundwater Potentiometric Surface Map
Figure 7 Proposed Sample Locations

**Table**
Table 1 Summary of Environmental Samples and Laboratory Analyses
Table 2a Groundwater Quality Data
Table 2b Surface Water Quality Data
Table 3 Summary of Receptor-Specific Human Risks and Hazards, Ecological Risks, and Recommendations
Table 4 Proposed Supplemental Sampling and Analysis

**Standard Operating Procedures (SOPs)**
SOP 05 – Surface Water Sampling
SOP 06 – Measurement of Water Quality Parameters
SOP 07 – Sediment Sampling
SOP 10 – Surface and Subsurface Soil Sampling
SOP 18 – Low-Flow Well Purging and Stabilization
SOP 19 – Groundwater Sampling

**Reason for Change/Modification:** Supplemental activities for characterization of nature and extent of constituents of concern, based on potential unacceptable risks.

**Person Requesting Change/Modification:**

[signature] 12/20/12

**Tim Evans, Project Manager / Date**

**Approvals:**

[signature] 12/20/12

**Ralph Basinski, Tetra Tech Activity Coordinator / Date**

**Modifications to the HASP required based on this change?** ☐ Yes ☒ No ☐ NA

N/A N/A

**Health Safety Manager** (Signature) **Date**

# FIGURES

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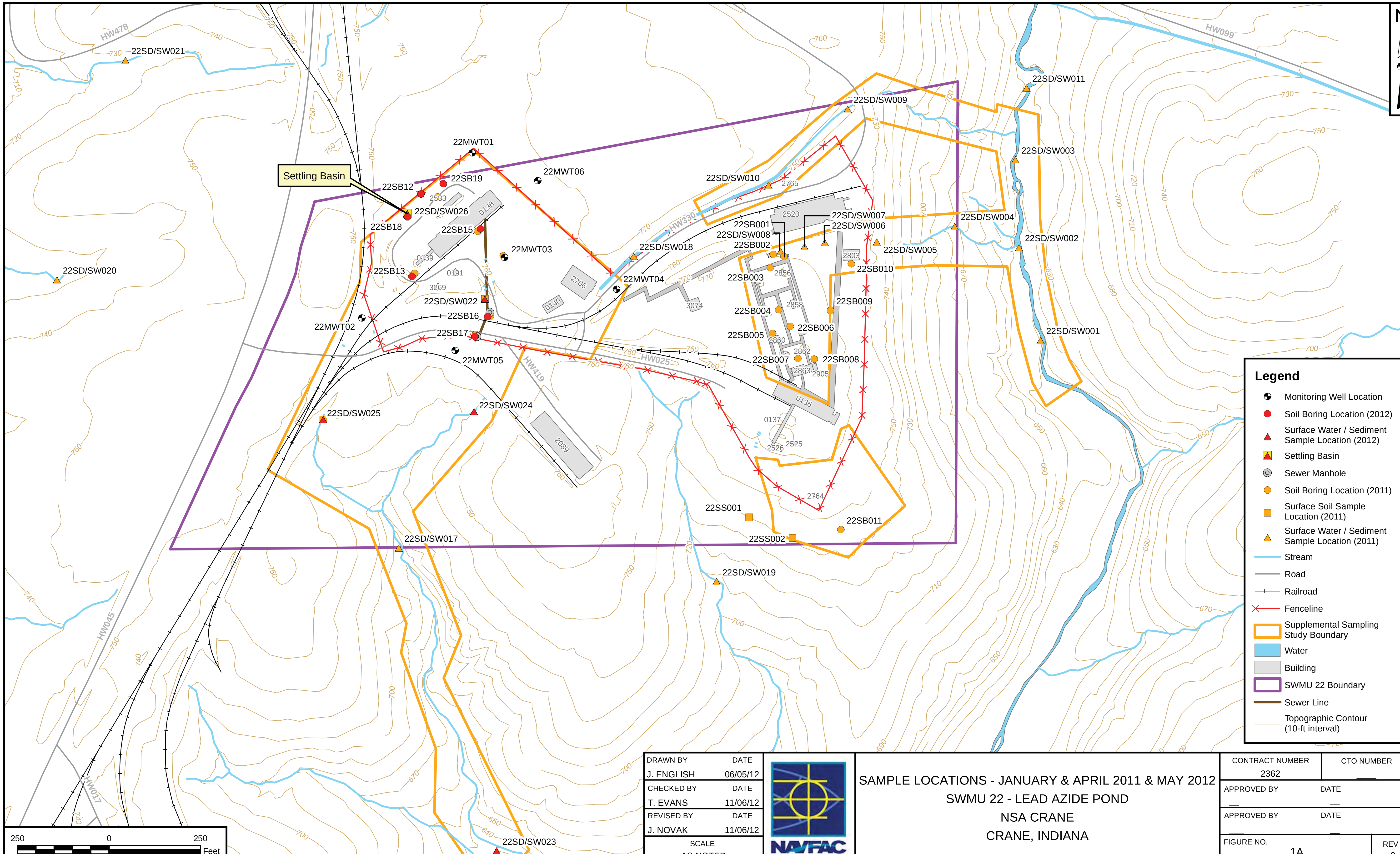


| DRAWN BY | DATE |
|---|---|
| J. ENGLISH | 06/05/12 |
| CHECKED BY | DATE |
| T. EVANS | 11/06/12 |
| REVISED BY | DATE |
| J. NOVAK | 11/06/12 |
| SCALE | |
| AS NOTED | |

NAVFAC

SAMPLE LOCATIONS - JANUARY & APRIL 2011 & MAY 2012
SWMU 22 - LEAD AZIDE POND
NSA CRANE
CRANE, INDIANA

| CONTRACT NUMBER | CTO NUMBER |
|---|---|
| 2362 | |
| APPROVED BY | DATE |
| APPROVED BY | DATE |
| FIGURE NO. 1A | REV 0 |

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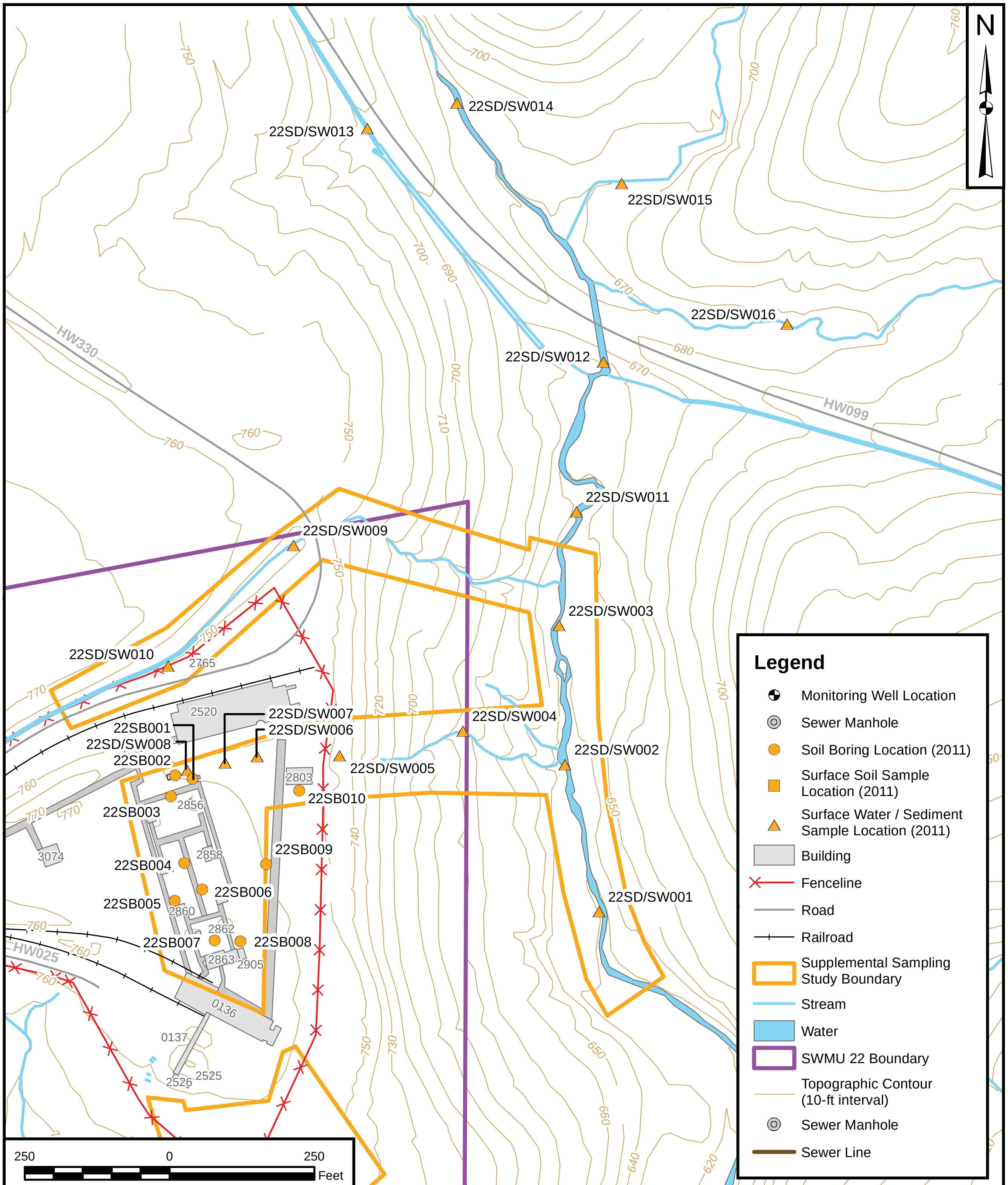


| | | | |
|---|---|---|---|
| DRAWN BY J. ENGLISH | DATE 06/06/12 | SAMPLE LOCATIONS<br>JANUARY & APRIL 2011<br>SWMU 22 - LEAD AZIDE POND<br>NSA CRANE<br>CRANE, INDIANA | CONTRACT NUMBER 2362 / CTO NUMBER ____ |
| CHECKED BY T. EVANS | DATE 11/02/12 | | APPROVED BY ____ DATE ____ |
| REVISED BY J. NOVAK | DATE 11/02/12 | | APPROVED BY ____ DATE ____ |
| SCALE AS NOTED | | | FIGURE NO. 1B / REV 0 |

NAVFAC

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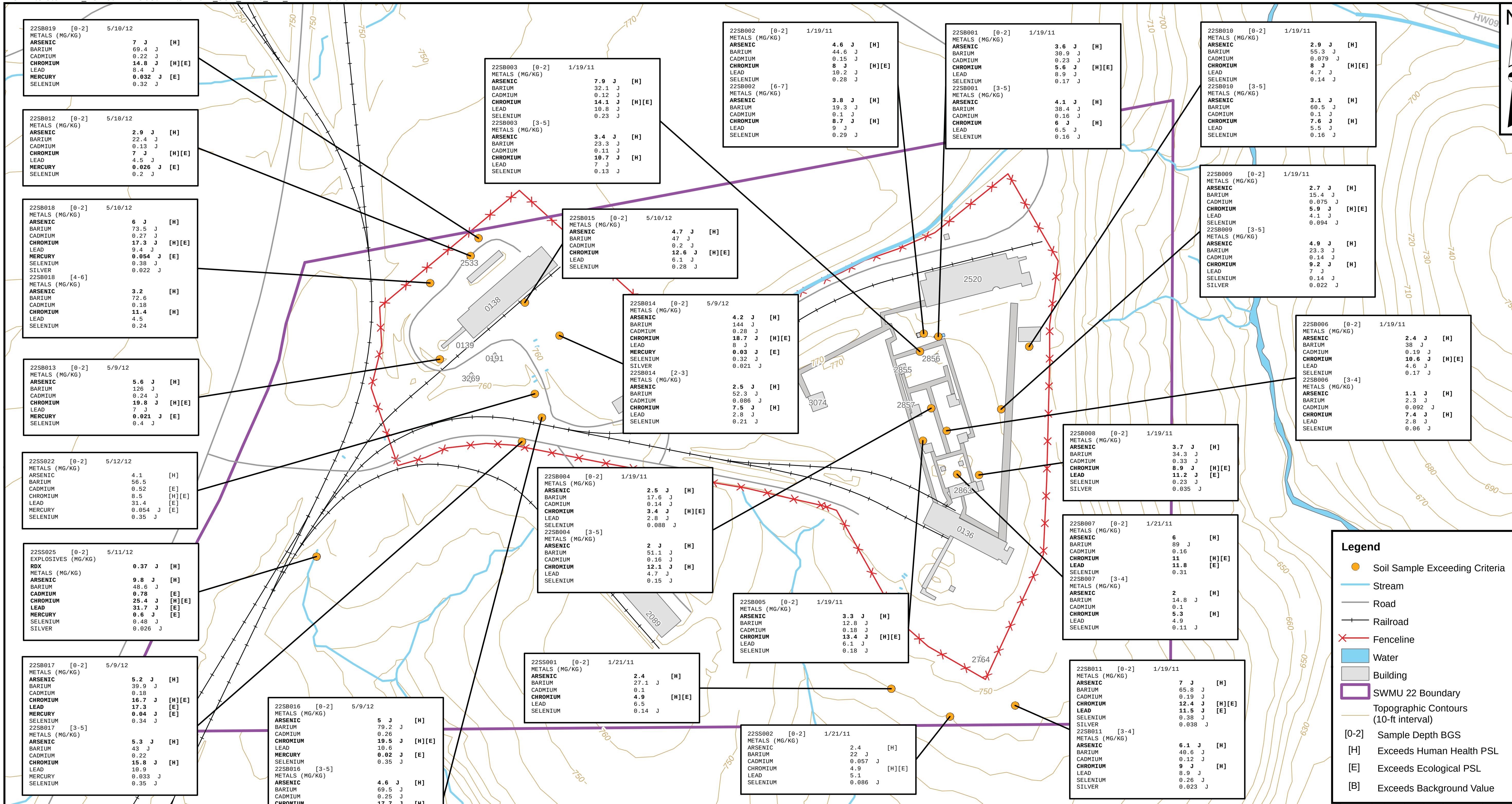


200 0 200 Feet

| DRAWN BY | DATE |
|---|---|
| J. ENGLISH | 10/10/11 |
| CHECKED BY | DATE |
| T. EVANS | 11/06/12 |
| REVISED BY | DATE |
| J. NOVAK | 11/06/12 |
| SCALE AS NOTED | |

NAVFAC

SOIL SAMPLE RESULTS
JANUARY 2011 AND MAY 2012
SWMU 22 - LEAD AZIDE POND
NAVAL SUPPORT ACTIVITY
CRANE, INDIANA

| CONTRACT NUMBER | CTO NUMBER |
|---|---|
| 02362 | F279 |
| APPROVED BY | DATE |
| — | — |
| APPROVED BY | DATE |
| — | — |
| FIGURE NO. 2 | REV 0 |

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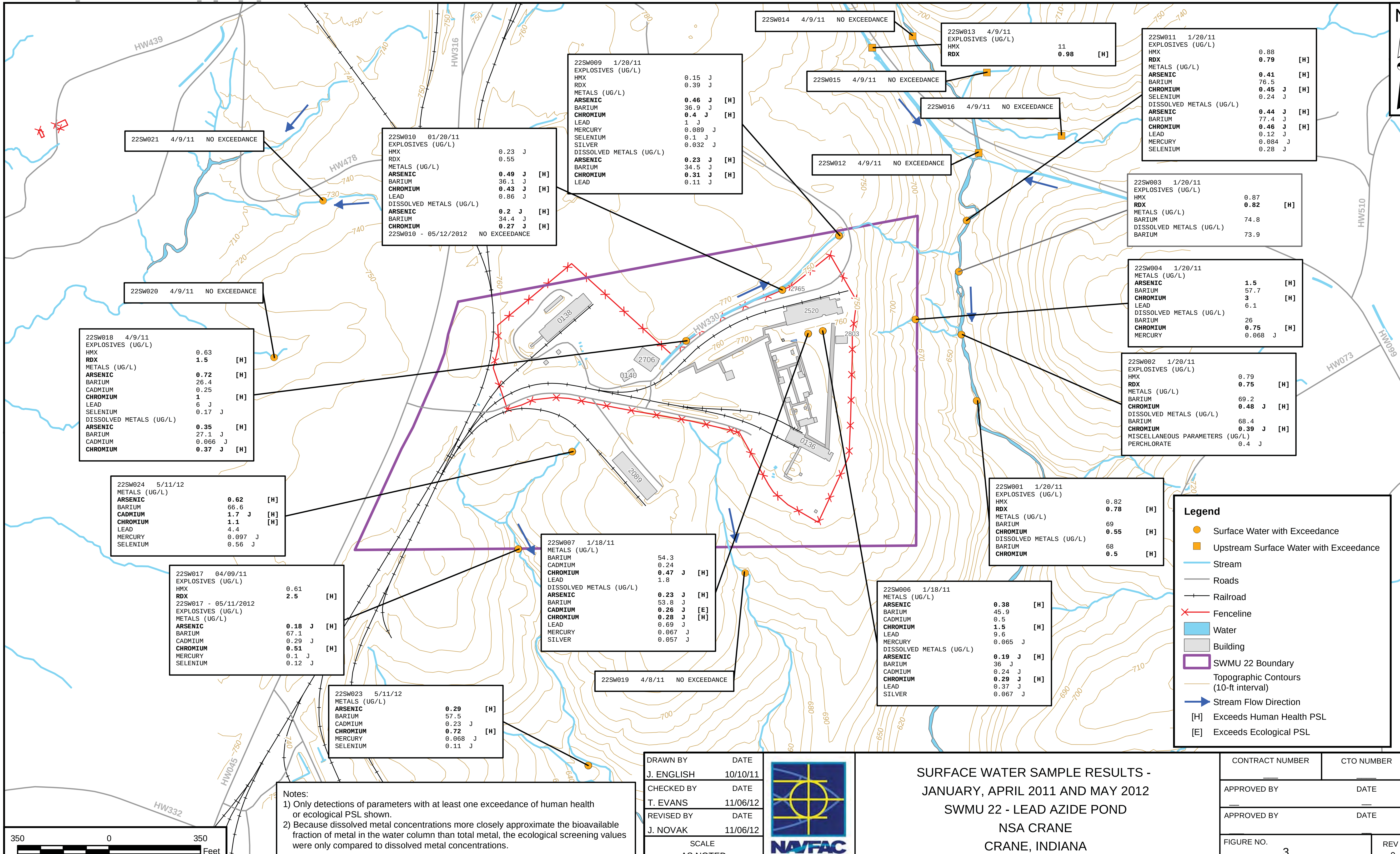


Notes:
1) Only detections of parameters with at least one exceedance of human health or ecological PSL shown.
2) Because dissolved metal concentrations more closely approximate the bioavailable fraction of metal in the water column than total metal, the ecological screening values were only compared to dissolved metal concentrations.

| DRAWN BY | DATE |
|---|---|
| J. ENGLISH | 10/10/11 |
| CHECKED BY | DATE |
| T. EVANS | 11/06/12 |
| REVISED BY | DATE |
| J. NOVAK | 11/06/12 |
| SCALE | |
| AS NOTED | |

NAVFAC

SURFACE WATER SAMPLE RESULTS -
JANUARY, APRIL 2011 AND MAY 2012
SWMU 22 - LEAD AZIDE POND
NSA CRANE
CRANE, INDIANA

| CONTRACT NUMBER | CTO NUMBER |
|---|---|
| __ | __ |
| APPROVED BY | DATE |
| __ | __ |
| APPROVED BY | DATE |
| | __ |
| FIGURE NO. 3 | REV 0 |

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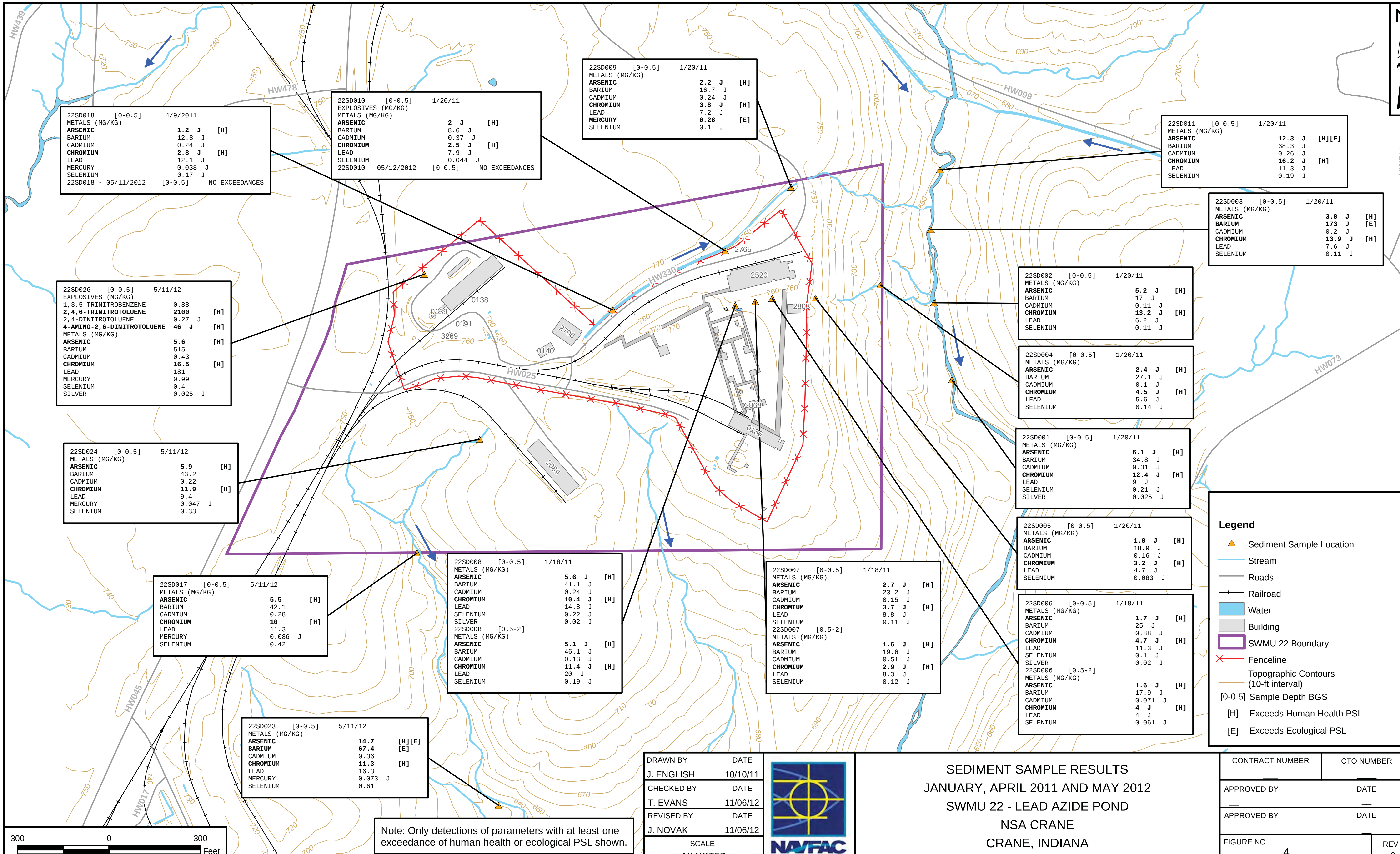


| DRAWN BY | DATE |
|---|---|
| J. ENGLISH | 10/10/11 |
| CHECKED BY | DATE |
| T. EVANS | 11/06/12 |
| REVISED BY | DATE |
| J. NOVAK | 11/06/12 |
| SCALE | |
| AS NOTED | |

NAVFAC

SEDIMENT SAMPLE RESULTS
JANUARY, APRIL 2011 AND MAY 2012
SWMU 22 - LEAD AZIDE POND
NSA CRANE
CRANE, INDIANA

| CONTRACT NUMBER | CTO NUMBER |
|---|---|
| APPROVED BY | DATE |
| APPROVED BY | DATE |
| FIGURE NO. 4 | REV 0 |

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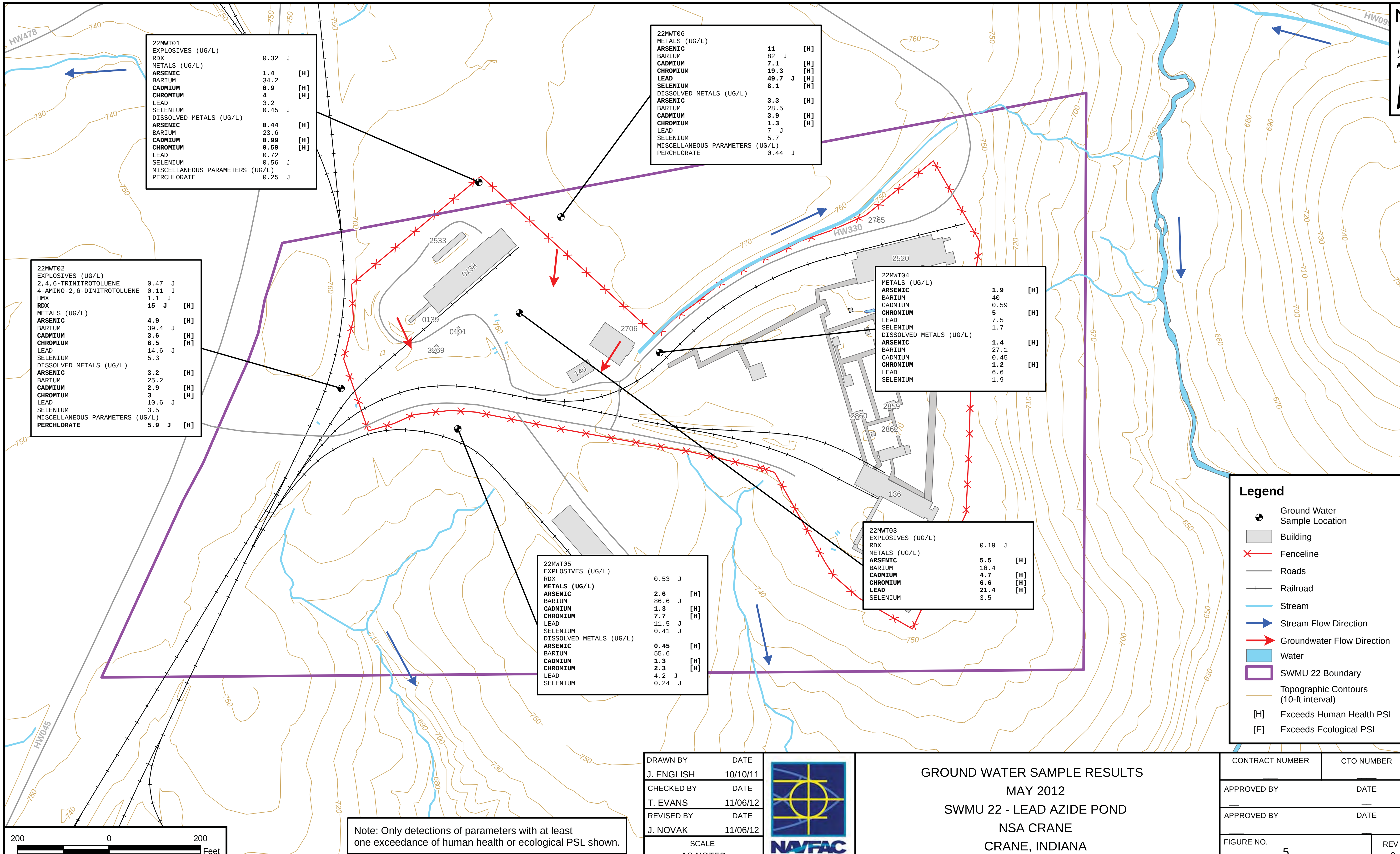

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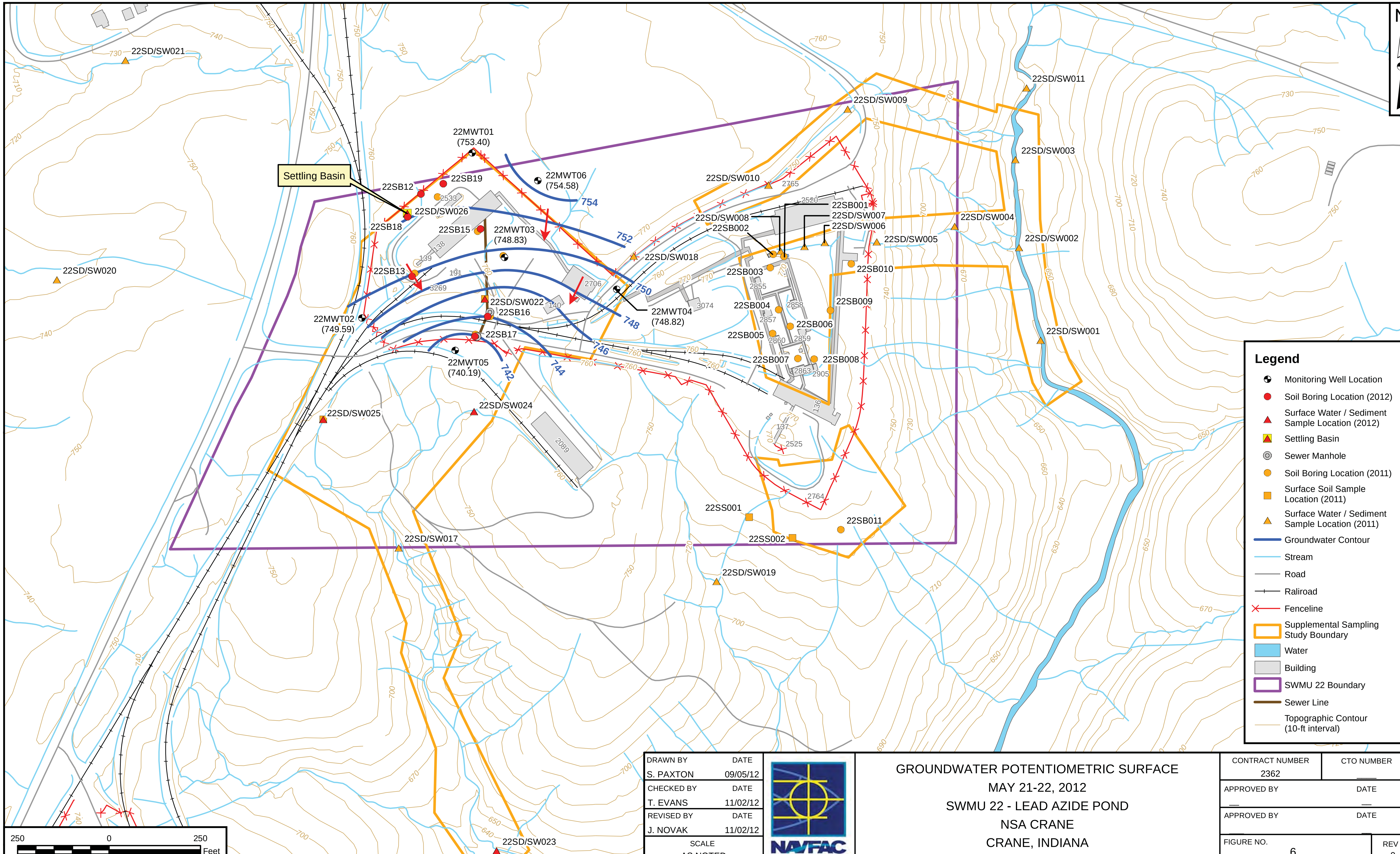


| DRAWN BY | DATE |
|---|---|
| S. PAXTON | 09/05/12 |
| CHECKED BY | DATE |
| T. EVANS | 11/02/12 |
| REVISED BY | DATE |
| J. NOVAK | 11/02/12 |
| SCALE | |
| AS NOTED | |

NAVFAC

GROUNDWATER POTENTIOMETRIC SURFACE
MAY 21-22, 2012
SWMU 22 - LEAD AZIDE POND
NSA CRANE
CRANE, INDIANA

| CONTRACT NUMBER | CTO NUMBER |
|---|---|
| 2362 | __ |
| APPROVED BY | DATE |
| __ | __ |
| APPROVED BY | DATE |
| __ | __ |
| FIGURE NO. | REV |
| 6 | 0 |

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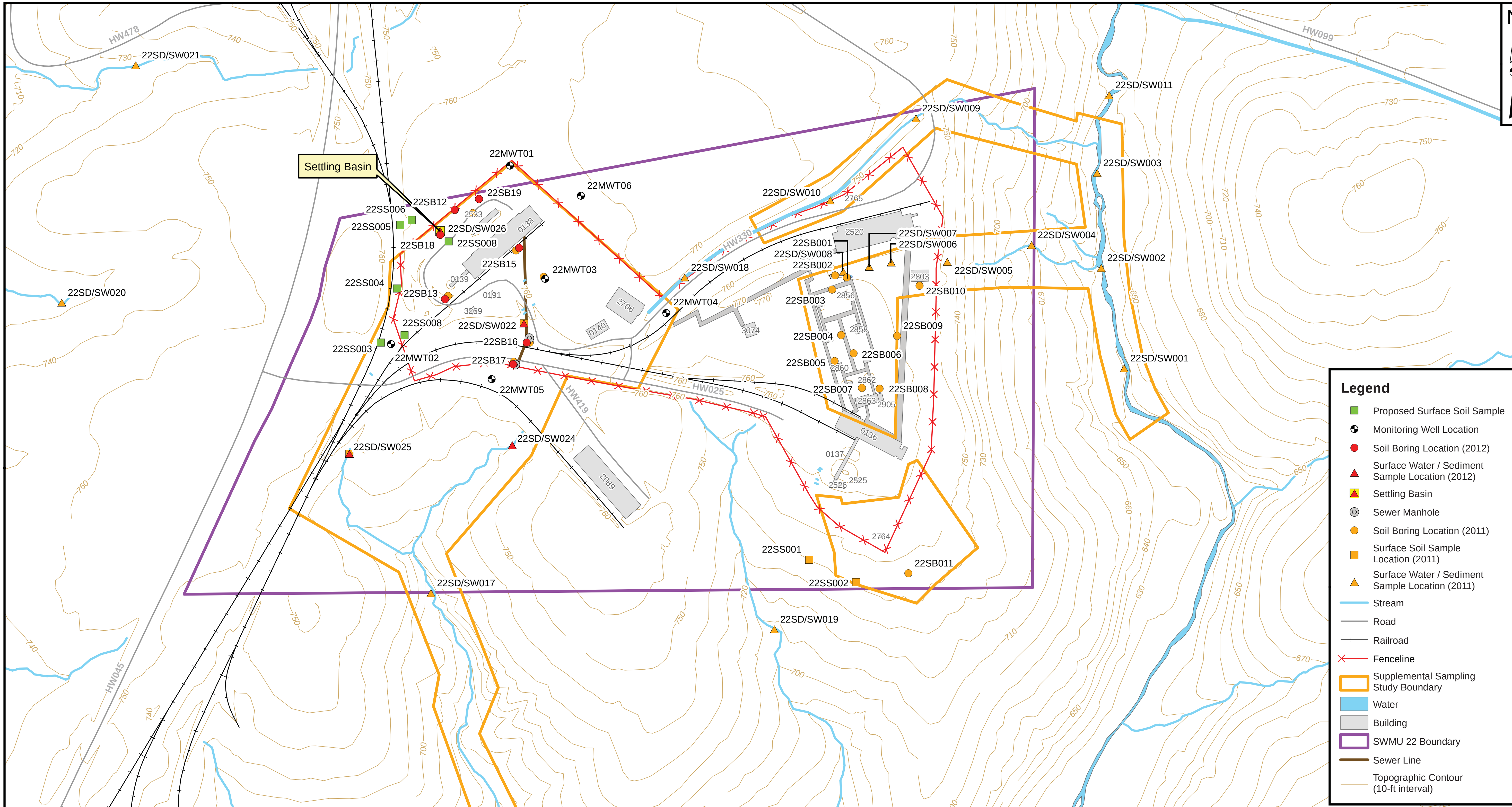


| | | | | |
|---|---|---|---|---|
| DRAWN BY J. ENGLISH | DATE 06/05/12 | NAVFAC | PROPOSED SAMPLE LOCATIONS<br>SWMU 22 - LEAD AZIDE POND<br>NSA CRANE<br>CRANE, INDIANA | CONTRACT NUMBER 2362 / CTO NUMBER F201 |
| CHECKED BY T. EVANS | DATE 12/14/12 | | | APPROVED BY __ / DATE __ |
| REVISED BY J. ENGLISH | DATE 12/14/12 | | | APPROVED BY __ / DATE __ |
| SCALE AS NOTED | | | | FIGURE NO. 7 / REV 0 |

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**TABLES**

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**TABLE 1**

**SUMMARY OF ENVIRONMENTAL SAMPLES AND LABORATORY ANALYSIS**
**SWMU 22 - LEAD AZIDE POND**
**NSWC CRANE**
**CRANE, INDIANA**


| Sample Location | Sample Identification | Sample Type | Date Sampled | Sample Depth Interval Sampled (feet bgs) | Energetics | | | | Metals | | Miscellaneous | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Nitroaromatics / Nitramines | RDX/HMX | NG/PETN | Perchlorate | RCRA Metals | RCRA Metals (dissolved) | pH | TOC | |
| 22SS001 | 22SS0010002 | Surface Soil | 21-Jan-11 | 0-2 | X | | | X | X | | | | Field Duplicate 22SSDUP01 |
| 22SS002 | 22SS0020002 | Surface Soil | 21-Jan-11 | 0-2 | X | | | X | X | | | | |
| 22SS022 | 22SS0220002 | Surface Soil | 12-May-12 | 0-2 | X | | X | | X | | | X | Listed as SD in SAP, no flow sampled as SS |
| 22SS025 | 22SS0250002 | Surface Soil | 11-May-12 | 0-2 | X | | X | | X | | | X | Field Duplicate 22SSDUP01. Listed as SD in SAP, no flow sampled as SS |
| 22SB001 | 22SB0010002 | Surface Soil | 19-Jan-11 | 0-2 | X | | | X | X | | X | | |
| | 22SB0010305 | Subsurface Soil | 19-Jan-11 | 3-5 | X | | | X | X | | X | | Field Duplicate 22SSDUP001 |
| | 22SB0010608 | Subsurface Soil | NA | NA | -- | | | -- | -- | | -- | | Sample not collected due to boring refusal before sample depth |
| 22SB002 | 22SB0020002 | Surface Soil | 19-Jan-11 | 0-2 | X | | | X | X | | | | |
| | 22SB0020607 | Subsurface Soil | 19-Jan-11 | 6-7 | X | | | X | X | | | | |
| 22SB003 | 22SB0030002 | Surface Soil | 19-Jan-11 | 0-2 | X | | | X | X | | | | |
| | 22SB0030305 | Subsurface Soil | 19-Jan-11 | 3-5 | X | | | X | X | | | | |
| 22SB004 | 22SB0040002 | Surface Soil | 19-Jan-11 | 0-2 | X | | | X | X | | | | |
| | 22SB0040305 | Subsurface Soil | 19-Jan-11 | 3-5 | X | | | X | X | | | | |
| 22SB005 | 22SB0050002 | Surface Soil | 19-Jan-11 | 0-2 | X | | | X | X | | | | |
| | 22SB005XXXX | Subsurface Soil | NA | NA | -- | | | -- | -- | | | | Sample not collected due to boring refusal before sample depth |
| 22SB006 | 22SB0060002 | Surface Soil | 19-Jan-11 | 0-2 | X | | | X | X | | | | |
| | 22SB0060304 | Subsurface Soil | 19-Jan-11 | 3-4 | X | | | X | X | | | | |
| 22SB007 | 22SB0070002 | Surface Soil | 21-Jan-11 | 0-2 | X | | | X | X | | | | |
| | 22SB0070304 | Subsurface Soil | 21-Jan-11 | 3-4 | X | | | X | X | | | | |
| 22SB008 | 22SB0080002 | Surface Soil | 19-Jan-11 | 0-2 | X | | | X | X | | X | | |
| | 22SB008XXXX | Subsurface Soil | NA | NA | -- | | | -- | -- | | -- | | Sample not collected due to boring refusal before sample depth |
| 22SB009 | 22SB0090002 | Surface Soil | 19-Jan-11 | 0-2 | X | | | X | X | | | | |
| | 22SB0090305 | Subsurface Soil | 19-Jan-11 | 3-5 | X | | | X | X | | | | |
| 22SB010 | 22SB0100002 | Surface Soil | 19-Jan-11 | 0-2 | X | | | X | X | | | | |
| | 22SB0100305 | Subsurface Soil | 19-Jan-11 | 3-5 | X | | | X | X | | | | |
| 22SB011 | 22SB0110002 | Surface Soil | 19-Jan-11 | 0-2 | X | | | X | X | | | | |
| | 22SB0110304 | Subsurface Soil | 19-Jan-11 | 3-4 | X | | | X | X | | | | |
| 22SB012 | 22SB0120002 | Surface Soil | 10-May-12 | 0-2 | X | | X | | X | | X | | Field Duplicate 22FD051212-01 |
| | 22SB012XXXX | Subsurface Soil | NA | NA | -- | | -- | | -- | | -- | | Sample not collected due to boring refusal before sample depth |
| 22SB013 | 22SB0130002 | Surface Soil | 9-May-12 | 0-2 | X | | X | | X | | | | |
| | 22SB013XXXX | Subsurface Soil | NA | NA | -- | | -- | | -- | | | | Sample not collected due to boring refusal before sample depth |

## TABLE 1

## SUMMARY OF ENVIRONMENTAL SAMPLES AND LABORATORY ANALYSIS
## SWMU 22 - LEAD AZIDE POND
## NSWC CRANE
## CRANE, INDIANA


| Sample Location | Sample Identification | Sample Type | Date Sampled | Sample Depth Interval Sampled (feet bgs) | Energetics | | | | Metals | | Miscellaneous | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Nitroaromatics / Nitramines | RDX/HMX | NG/PETN | Perchlorate | RCRA Metals | RCRA Metals (dissolved) | pH | TOC | |
| 22SB014 | 22SB0140002 | Surface Soil | 9-May-12 | 0-2 | X | | X | | X | | | | |
| | 22SB0140203 | Subsurface Soil | 10-May-12 | 2-3 | X | | X | | X | | | | |
| 22SB015 | 22SB0150002 | Surface Soil | 10-May-12 | 0-2 | X | | X | | X | | | | |
| | 22SB015XXXX | Subsurface Soil | NA | NA | -- | | -- | | -- | | | | Sample not collected due to boring refusal before sample depth |
| | 22SB015XXXX | Subsurface Soil | NA | NA | -- | | -- | | -- | | | | Sample not collected due to boring refusal before sample depth |
| 22SB016 | 22SB0160002 | Surface Soil | 9-May-12 | 0-2 | X | | X | | X | | | | |
| | 22SB0160305 | Subsurface Soil | 9-May-12 | 3-5 | X | | X | | X | | | | |
| | 22SB0160608 | Subsurface Soil | 9-May-12 | 6-8 | X | | X | | X | | | | |
| 22SB017 | 22SB0170002 | Surface Soil | 9-May-12 | 0-2 | X | | X | | X | | | | |
| | 22SB0170305 | Subsurface Soil | 9-May-12 | 3-5 | X | | X | | X | | | | |
| | 22SB017XXXX | Subsurface Soil | NA | NA | -- | | -- | | -- | | | | Sample not collected due to boring refusal before sample depth |
| 22SB018 | 22SB0180002 | Surface Soil | 10-May-12 | 0-2 | X | | X | | X | | | | |
| | 22SB0180406 | Subsurface Soil | 11-May-12 | 4-6 | | | | | | | | | |
| 22SB019 | 22SB0190002 | Surface Soil | 10-May-12 | 0-2 | X | | X | | X | | | | Sample added due to field observations |
| 22SD001 | 22SD0010006 | Sediment | 20-Jan-11 | 0-0.5 | X | | | | X | | | X | |
| 22SD002 | 22SD0020006 | Sediment | 20-Jan-11 | 0-0.5 | X | | | | X | | | X | |
| 22SD003 | 22SD0030006 | Sediment | 20-Jan-11 | 0-0.5 | X | | | | X | | | X | |
| 22SD004 | 22SD0040006 | Sediment | 20-Jan-11 | 0-0.5 | X | | | | X | | | X | |
| 22SD005 | 22SD0050006 | Sediment | 20-Jan-11 | 0-0.5 | X | | | | X | | | X | |
| 22SD006 | 22SD0060006 | Sediment | 18-Jan-11 | 0-0.5 | X | | | | X | | X | X | |
| | 22SD0060624 | Sediment | 18-Jan-11 | 0.5-2 | X | | | | X | | X | X | |
| 22SD007 | 22SD0070006 | Sediment | 18-Jan-11 | 0-0.5 | X | | | | X | | | X | |
| | 22SD0070624 | Sediment | 18-Jan-11 | 0.5-2 | X | | | | X | | | X | |
| 22SD008 | 22SD0080006 | Sediment | 18-Jan-11 | 0-0.5 | X | | | | X | | | X | |
| | 22SD0080624 | Sediment | 18-Jan-11 | 0.5-2 | X | | | | X | | | X | |
| 22SD009 | 22SD0090006 | Sediment | 20-Jan-11 | 0-0.5 | X | | | | X | | | X | Field Duplicate 22SDDUP01 |
| 22SD010 | 22SD0100006 | Sediment | 20-Jan-11 | 0-0.5 | X | | | | X | | | X | |
| 22SD010 | 22SD0100006 | Sediment | 12-May-12 | 0-0.5 | | | X | | | | | X | |
| 22SD011 | 22SD0110006 | Sediment | 20-Jan-11 | 0-0.5 | X | | | | X | | | X | |
| 22SD017 | 22SD0170006 | Sediment | 11-May-12 | 0-0.5 | | | X | | X | | | X | |
| 22SD018 | 22SD0180006 | Sediment | 9-Apr-11 | 0-0.5 | X | | | | X | | | X | Field Duplicate 22FD04091102 |
| 22SD018 | 22SD0180006 | Sediment | 12-May-12 | 0-0.5 | | | X | | | | | X | |
| 22SD022 | 22SD0220006 | Sediment | NA | NA | -- | | -- | | -- | | | -- | Listed as SD in SAP, no flow sampled as SS, see above 22SS022 |
| 22SD023 | 22SD0230006 | Sediment | 11-May-12 | 0-0.5 | X | | X | | X | | X | X | |
| 22SD024 | 22SD0240006 | Sediment | 11-May-12 | 0-0.5 | X | | X | | X | | | X | |

**TABLE 1**

**SUMMARY OF ENVIRONMENTAL SAMPLES AND LABORATORY ANALYSIS**
**SWMU 22 - LEAD AZIDE POND**
**NSWC CRANE**
**CRANE, INDIANA**


| Sample Location | Sample Identification | Sample Type | Date Sampled | Sample Depth Interval Sampled (feet bgs) | Energetics | | | | Metals | | Miscellaneous | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Nitroaromatics / Nitramines | RDX/HMX | NG/PETN | Perchlorate | RCRA Metals | RCRA Metals (dissolved) | pH | TOC | |
| 22SD025 | 22SD0250006 | Sediment | NA | NA | -- | | -- | | -- | | | -- | Listed as SD in SAP, no flow sampled as SS, see above 22SS022 |
| 22SD026 | 22SD0260006 | Sediment | 11-May-12 | 0-0.5 | X | | X | | X | | | X | Sample added due to field observations |
| 22SW001 | 22SW001 | Surface Water | 20-Jan-11 | -- | X | | | X | X | X | | | |
| 22SW002 | 22SW002 | Surface Water | 20-Jan-11 | -- | X | | | X | X | X | | | |
| 22SW003 | 22SW003 | Surface Water | 20-Jan-11 | -- | X | | | X | X | X | | | |
| 22SW004 | 22SW004 | Surface Water | 20-Jan-11 | -- | X | | | X | X | X | | | |
| 22SW005 | 22SW005 | Surface Water | 20-Jan-11 | NA | -- | | | -- | -- | -- | | | Dry, not sampled |
| 22SW006 | 22SW006 | Surface Water | 18-Jan-11 | -- | X | | | X | X | X | | | |
| 22SW007 | 22SW007 | Surface Water | 18-Jan-11 | -- | X | | | X | X | X | | | |
| 22SW008 | 22SW008 | Surface Water | 18-Jan-11 | -- | -- | | | -- | -- | -- | | | Dry, not sampled |
| 22SW009 | 22SW009 | Surface Water | 20-Jan-11 | -- | X | | | X | X | X | | | Field Duplicate 22SWDUP01 |
| 22SW010 | 22SW010 | Surface Water | 20-Jan-11 | -- | X | | | X | X | X | | | |
| 22SW010 | 22SW010 | Surface Water | 12-May-12 | -- | | | X | | | | | | |
| 22SW011 | 22SW011 | Surface Water | 20-Jan-11 | -- | X | | | X | X | X | | | |
| 22SW012 | 22SW012 | Surface Water | 9-Apr-11 | -- | | X | | | | | | | |
| 22SW013 | 22SW013 | Surface Water | 9-Apr-11 | -- | | X | | | | | | | |
| 22SW014 | 22SW014 | Surface Water | 9-Apr-11 | -- | | X | | | | | | | |
| 22SW015 | 22SW015 | Surface Water | 9-Apr-11 | -- | | X | | | | | | | |
| 22SW016 | 22SW016 | Surface Water | 9-Apr-11 | -- | | X | | | | | | | |
| 22SW017 | 22SW017 | Surface Water | 9-Apr-11 | -- | | X | | | | | | | |
| 22SW017 | 22SW017 | Surface Water | 11-May-12 | -- | | | X | | X | | | | |
| 22SW018 | 22SW018 | Surface Water | 9-Apr-11 | -- | X | | | | X | X | | | Field Duplicate 22FD04091101 |
| 22SW018 | 22SW018 | Surface Water | 12-May-12 | NA | | | -- | | | | | | Dry, not sampled |
| 22SW019 | 22SW019 | Surface Water | 9-Apr-11 | -- | | X | | | | | | | |
| 22SW020 | 22SW020 | Surface Water | 9-Apr-11 | -- | | X | | | | | | | |
| 22SW021 | 22SW021 | Surface Water | 9-Apr-11 | -- | | X | | | | | | | |
| 22SW022 | 22SW022 | Surface Water | 12-May-12 | NA | | | | | | | | | Dry, not sampled |
| 22SW023 | 22SW023 | Surface Water | 11-May-12 | -- | X | | X | | X | | X | | |
| 22SW024 | 22SW024 | Surface Water | 11-May-12 | -- | X | | X | | X | | | | Field Duplicate 22SWDUP01 |
| 22SW025 | 22SW025 | Surface Water | 11-May-12 | NA | | | | | | | | | Dry, not sampled |
| 22MWT001 | 22GWT001 | Groundwater | 22-May-12 | 15-25 | X | | X | X | X | X | | | |
| 22MWT002 | 22GWT002 | Groundwater | 22-May-12 | 11-21 | X | | X | X | X | X | | | Field Duplicate 22GWDUP01 |
| 22MWT003 | 22GWT003 | Groundwater | 23-May-12 | 13-23 | X | | X | X | X | | | | |
| 22MWT004 | 22GWT004 | Groundwater | 23-May-12 | 15-25 | X | | X | X | X | X | | | |
| 22MWT005 | 22GWT005 | Groundwater | 21-May-12 | 9-19 | X | | X | X | X | X | | | |
| 22MWT006 | 22GWT006 | Groundwater | 21-May-12 | 15-25 | X | | X | X | X | X | | | |

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## TABLE 2b

## SURFACE WATER QUALITY DATA
## SWMU 22 - LEAD AZIDE POND
## NSA CRANE, IN


| Location Number | Sample ID | Sample Date | pH | Spec Cond (mS/cm) | Temp (°C) | Turbidity (NTU) | DO (mg/L) | ORP (mV) |
|---|---|---|---|---|---|---|---|---|
| 22SW001 | 22SW001 | 1/20/2011 | 5.95 | 1.51 | -0.5 | 0.0 | 15.50 | 250 |
| 22SW002 | 22SW002 | 1/20/2011 | 6.96 | 1.51 | -0.23 | 0.8 | 14.82 | 189 |
| 22SW003 | 22SW003 | 1/20/2011 | 7.37 | 1.64 | 0.19 | 12.4 | 13.95 | 185 |
| 22SW004 | 22SW004 | 1/20/2011 | 7.39 | 0.233 | -0.19 | 683 | 13.82 | 132 |
| 22SW006 | 22SW006 | 1/18/2011 | 6.07 | 0.229 | 5.3 | 11 | 9.27 | 233 |
| 22SW007 | 22SW007 | 1/18/2011 | 6.71 | 0.232 | 5.25 | 2.4 | 6.35 | 207 |
| 22SW009 | 22SW009 | 1/20/2011 | 7.84 | 0.523 | -0.19 | 18.5 | 11.45 | 139 |
| 22SW010 | 22SW010 | 1/20/2011 | 7.66 | 0.555 | 0.57 | 25.6 | 13.21 | 23 |
| | | 5/12/2012 | 7.17 | 0.495 | 18.67 | 6.1 | 3.47 | 1 |
| 22SW011 | 22SW011 | 1/20/2011 | 7.83 | 1.720 | -0.08 | 8.0 | 14.15 | 150 |
| 22SW012 | 22SW012 | 4/9/2011 | 7.05 | 0.146 | 13.56 | 17.1 | 9.65 | 129 |
| 22SW013 | 22SW013 | 4/9/2011 | 7.16 | 0.38 | 16.32 | 13 | 9.85 | 123 |
| 22SW014 | 22SW014 | 4/9/2011 | 6.93 | 0.261 | 15.26 | 7.47 | 8.65 | 123 |
| 22SW015 | 22SW015 | 4/9/2011 | 5.22 | 0.102 | 13.12 | 10.35 | 9.52 | 255 |
| 22SW016 | 22SW016 | 4/9/2011 | 6.5 | 0.156 | 14.81 | 17.9 | 10.3 | 158 |
| 22SW017 | 22SW017 | 4/9/2011 | 6.19 | 0 | 14.6 | 14.50 | 13.23 | 146 |
| | | 5/11/2012 | 6.65 | 0.459 | 17.65 | 0.6 | 6.77 | 46 |
| 22SW018 | 22SW018 | 4/9/2011 | 7.03 | 0.000 | 21.84 | 9.20 | 9.36 | 236 |
| | | 5/12/2012 | -- DRY -- | | | | | |
| 22SW019 | 22SW019 | 4/9/2011 | 7.15 | 0.119 | 12.89 | 11.4 | 11.33 | 137 |
| 22SW020 | 22SW020 | 4/9/2011 | 6.84 | 0.526 | 15.92 | 17.7 | 11.92 | 124 |
| 22SW021 | 22SW021 | 4/9/2011 | 6.85 | 0.258 | 18.28 | 32.80 | 9.2 | 135 |

**TABLE 2b**

**SURFACE WATER QUALITY DATA**
**SWMU 22 - LEAD AZIDE POND**
**NSA CRANE, IN**


| Location Number | Sample ID | Sample Date | pH | Spec Cond (mS/cm) | Temp (°C) | Turbidity (NTU) | DO (mg/L) | ORP (mV) |
|---|---|---|---|---|---|---|---|---|
| 22SW023 | 22SW023 | 5/11/2012 | 7.06 | 0.296 | 17.64 | 3.20 | 4.79 | 113 |
| 22SW024 | 22SW024 | 5/11/2012 | 7.29 | 0.942 | 16.90 | 4.9 | 6.53 | 61 |

**Notes**
DO = dissolved oxygen
mg/L = milligram per liter
mS/cm = milliSiemens per centimeter
mV = millivolts
NTU = nephelometric turbidity units
ORP = oxidation-reduction potential
Spec Cond = spoecific conductance
Temp = temperature

**TABLE 2b**

**SURFACE WATER QUALITY DATA**
**SWMU 22 - LEAD AZIDE POND**
**NSA CRANE, IN**


| Location Number | Sample ID | Sample Date | pH | Spec Cond (mS/cm) | Temp (°C) | Turbidity (NTU) | DO (mg/L) | ORP (mV) |
|---|---|---|---|---|---|---|---|---|
| 22SW023 | 22SW023 | 5/11/2012 | 7.06 | 0.296 | 17.64 | 3.20 | 4.79 | 113 |
| 22SW024 | 22SW024 | 5/11/2012 | 7.29 | 0.942 | 16.90 | 4.9 | 6.53 | 61 |

**Notes**
DO = dissolved oxygen
mg/L = milligram per liter
mS/cm = milliSiemens per centimeter
mV = millivolts
NTU = nephelometric turbidity units
ORP = oxidation-reduction potential
Spec Cond = spoecific conductance
Temp = temperature

TABLE 3

SUMMARY OF RECEPTOR-SPECIFIC HUMAN RISKS AND HAZARDS AND ECOLOGICAL RISKS
SWMU 22 - LEAD AZIDE POND
NSA CRANE
CRANE, INDIANA


| Receptor Population | Environmental Media | Overall Carcinogenic Risk (Human) | Overall Hazard Index (Human) | Overall Risk (Ecological) | Critical Pathways & Chemicals of Concern |
|---|---|---|---|---|---|
| Current/Future Construction Worker (Adult) | Surface Soil | No carcinogenic COPCs | No noncarcinogenic COPCs | NA | NA |
| | Subsurface Soil | No carcinogenic COPCs | No noncarcinogenic COPCs | NA | NA |
| | Groundwater | 7E-08 | 0.002 | NA | NA |
| Current/Future Industrial Worker (Adult) | Surface Soil | No carcinogenic COPCs | No noncarcinogenic COPCs | NA | NA |
| | Subsurface Soil | No carcinogenic COPCs | No noncarcinogenic COPCs | NA | NA |
| Current/Future Trespassers (Adolescent) | Surface Soil | No carcinogenic COPCs | No noncarcinogenic COPCs | NA | NA |
| | Subsurface Soil | No carcinogenic COPCs | No noncarcinogenic COPCs | NA | NA |
| | Surface Water | 1E-06 | 3E-03 | NA | NA |
| | Sediment | 3E-07 | 3E-03 | NA | NA |
| Future Recreational User (Child) | Surface Soil | No carcinogenic COPCs | No noncarcinogenic COPCs | NA | NA |
| | Subsurface Soil | No carcinogenic COPCs | No noncarcinogenic COPCs | NA | NA |
| | Surface Water | 4E-06 | 0.008 | NA | NA |
| | Sediment | 4E-06 | 0.02 | NA | NA |
| Future Recreational User (Adult) | Surface Soil | No carcinogenic COPCs | No noncarcinogenic COPCs | NA | NA |
| | Subsurface Soil | No carcinogenic COPCs | No noncarcinogenic COPCs | NA | NA |
| | Surface Water | 2E-06 | 0.003 | NA | NA |
| | Sediment | 8E-07 | 0.004 | NA | NA |

**TABLE 3**

**SUMMARY OF RECEPTOR-SPECIFIC HUMAN RISKS AND HAZARDS AND ECOLOGICAL RISKS**
**SWMU 22 - LEAD AZIDE POND**
**NSA CRANE**
**CRANE, INDIANA**



| Receptor Population | Environmental Media | Overall Carcinogenic Risk (Human) | Overall Hazard Index (Human) | Overall Risk (Ecological) | Critical Pathways & Chemicals of Concern |
|---|---|---|---|---|---|
| Future Recreational User (Lifelong) | Surface Soil | No carcinogenic COPCs | No noncarcinogenic COPCs | NA | NA |
| | Subsurface Soil | No carcinogenic COPCs | No noncarcinogenic COPCs | NA | NA |
| | Surface Water | 6E-06 | NA | NA | NA |
| | Sediment | 4E-06 | NA | NA | NA |
| Hypothetical Resident (Child) | Surface Soil | No carcinogenic COPCs | No noncarcinogenic COPCs | NA | NA |
| | Subsurface Soil | No carcinogenic COPCs | No noncarcinogenic COPCs | NA | NA |
| | Groundwater | 3E-04<br>(7E-05)[(1)] | 3<br>(2)[(1)] | NA | Ingestion of groundwater (**arsenic**, chromium, RDX) |
| | Surface Water | 2E-06 | 0.005 | NA | NA |
| | Sediment | 2E-06 | 0.01 | NA | NA |
| Hypothetical Resident (Adult) | Surface Soil | No carcinogenic COPCs | No noncarcinogenic COPCs | NA | NA |
| | Subsurface Soil | No carcinogenic COPCs | No noncarcinogenic COPCs | NA | NA |
| | Groundwater | 2E-04<br>(1E-04)[(1)] | 1<br>(1)[(1)] | NA | Ingestion of groundwater (arsenic, chromium, RDX) |
| | Surface Water | 2E-06 | 0.003 | NA | NA |
| | Sediment | 8E-07 | 0.004 | NA | NA |

## TABLE 3

## SUMMARY OF RECEPTOR-SPECIFIC HUMAN RISKS AND HAZARDS AND ECOLOGICAL RISKS
## SWMU 22 - LEAD AZIDE POND
## NSA CRANE
## CRANE, INDIANA



| Receptor Population | Environmental Media | Overall Carcinogenic Risk (Human) | Overall Hazard Index (Human) | Overall Risk (Ecological) | Critical Pathways & Chemicals of Concern |
|---|---|---|---|---|---|
| Hypothetical Resident (Lifelong) | Surface Soil | No carcinogenic COPCs | No noncarcinogenic COPCs | NA | NA |
| | Subsurface Soil | No carcinogenic COPCs | No noncarcinogenic COPCs | NA | NA |
| | Groundwater | 5E-04 (2E-04)[(1)] | NA | NA | Ingestion of groundwater (**arsenic**, chromium, RDX) |
| | Surface Water | 4E-06 | NA | NA | NA |
| | Sediment | 2E-06 | NA | NA | NA |
| Mammals and Birds | Surface Soil | NA | NA | Acceptable | NA |
| Terrestrial Plants and Invertebrates | Surface Soil | NA | NA | Acceptable | NA |

**Notes**

CMS = Corrective Measures Study
LTM = Long-Term Monitoring
LUC = Land Use Control
NFA = No further action

Shaded cells have unacceptable risk or hazard.
Bolded parameters represent significant contributor to overall risk or hazard.

(1) Chromium was evaluated in the human health risk assessment as hexavalent chromium. Value in parenthesis is cancer risk or hazard index if chromium is evaluated as trivalent chromium

## TABLE 4

## SUPPLEMENTAL SAMPLING AND ANALYSIS
## SWMU 22 - LEAD AZIDE POND
## NAVAL SUPPORT ACTIVITY
## CRANE, INDIANA


| Sampling Location | ID Number | Matrix | Depth (feet or inches bgs) | Analysis | Number of Samples | Sampling SOP Reference[1] |
|---|---|---|---|---|---|---|
| 22SS003 | 22SS0030002 and 22FDXXXXXX01[2] | Soil | 0 - 2' | RDX, TNT Chromium (III +IV) | 1 + 1 FD | SOP-10 |
| 22SS004 | 22SS0040002 | Soil | 0 - 2' | RDX, TNT | 1 | SOP-10 |
| 22SS005 | 22SS0050002 | Soil | 0 - 2' | RDX, TNT | 1 | SOP-10 |
| 22SS006 | 22SS0060002 | Soil | 0 - 2' | RDX, TNT | 1 | SOP-10 |
| 22SS007 | 22SS0070002 | Soil | 0 - 2' | RDX, TNT | 1 | SOP-10 |
| 22SS008 | 22SS0080002 | Soil | 0 - 2' | RDX, TNT | 1 | SOP-10 |
| 22SD017 | 22SW0170006 | Sediment | 0-6" | RDX, TNT | 1 | SOP-07 |
| 22SW025 | 22SW025 22SW025-F[3] | Surface Water | At water surface | RDX, TNT | 1 + 1 FD | SOP-05, SOP-06 |
| 22MWT005 | 22GWT005 22GWT005-F[3] | Groundwater | NA | Chromium (III +IV) | 1 + 1 FD | SOP-18, SOP-19 |

**Notes:**

(1) Sampling SOP reference from SWMU 22 RFI UFP-SAP (Tetra Tech, January 2011) and SAP Addednum (Tetra Tech, May 2012)

(2) Field duplicate (FD) locations may change in the field based on visual observations and field conditions. "XXXXXX" represents date collected.

(3) For a filtered groundawter and surface water samples, "-F" will be added to the end of the ID number (e.g. 22SW025-F).

NA - not applicable

# SWMU 22 - LEAD AZIDE POND
# NAVAL SUPPORT ACTIVITY CRANE
# CRANE, INDIANA

## SAMPLE LOCATION SURVEY DATA

*HORIZONTAL DATUM: North American Datum 1983 (NAD83), INDIANA WEST ZONE, U.S. Survey Feet*

*VERTICAL DATUM: North American Vertical Datum 1988 (NAVD88)*

| Pt | N | E | Elev | Description | Sample Loc |
|---|---|---|---|---|---|
| 24 | 1315811.05 | 3027409.53 | 766.47 | GRD (Ground) | 22MWT01 |
| 25 | 1315811.30 | 3027409.16 | 768.94 | TC (Top of Casing) | |
| 26 | 1315811.32 | 3027409.14 | 768.74 | TP (Top of Pipe) | |
| 40 | 1315359.93 | 3027108.33 | 756.21 | GRD | 22MWT02 |
| 41 | 1315359.91 | 3027108.00 | 758.96 | TC | |
| 42 | 1315360.00 | 3027107.82 | 758.78 | TP | |
| 34 | 1315524.99 | 3027498.48 | 763.88 | GRD | 22MWT03 |
| 35 | 1315524.99 | 3027498.00 | 766.64 | TC | |
| 36 | 1315525.14 | 3027497.94 | 766.28 | TP | |
| 17 | 1315438.20 | 3027804.87 | 759.34 | GRD | 22MWT04 |
| 18 | 1315438.39 | 3027805.24 | 761.74 | TC | |
| 19 | 1315438.43 | 3027804.94 | 761.44 | TP | |
| 9 | 1315271.25 | 3027363.21 | 756.12 | GRD | 22MWT05 |
| 10 | 1315270.90 | 3027363.25 | 758.86 | TC | |
| 11 | 1315271.01 | 3027363.36 | 758.67 | TP | |
| 20 | 1315735.05 | 3027589.02 | 769.25 | GRD | 22MWT06 |
| 21 | 1315734.90 | 3027589.01 | 772.00 | TC | |
| 22 | 1315734.76 | 3027588.91 | 771.77 | TP | |
| 14 | 1315411.94 | 3027444.98 | 758.19 | 22SD/SW22 | |
| 6 | 1313902.38 | 3027476.97 | 628.99 | 22SD/SW23 | |
| 7 | 1315082.32 | 3027002.82 | 742.25 | 22SD/SW25 | |
| 8 | 1315103.96 | 3027415.43 | 738.68 | 22SD/SW24 | |
| 27 | 1315698.52 | 3027269.96 | 760.10 | 22SB12 | |
| 30 | 1315473.44 | 3027245.14 | 759.42 | 22SB13 | |
| 32 | 1315603.19 | 3027432.90 | 761.96 | 22SB15 | |
| 12 | 1315363.84 | 3027452.06 | 758.72 | 22SB16 | |
| 16 | 1315309.13 | 3027417.35 | 758.17 | 22SB17 | |
| 29 | 1315636.06 | 3027233.00 | 764.15 | 22SB18 | |
| 23 | 1315726.83 | 3027330.95 | 763.16 | 22SB19 | |
| 28 | 1315645.70 | 3027232.57 | 764.76 | SUMP 22SD26 | |
| 13 | 1315370.58 | 3027452.72 | 758.88 | SAMH 1 | |
| 15 | 1315301.44 | 3027420.52 | 758.19 | SAMH 2 | |
| 33 | 1315675.96 | 3027488.56 | 765.37 | BLD1 138 | |
| 31 | 1315527.96 | 3027318.88 | 761.22 | BLD1 138 | |
| 38 | 1315411.48 | 3027717.41 | 762.05 | BLD2 2706 | |
| 39 | 1315456.81 | 3027749.35 | 763.08 | BLD2 2706 | |

This survey was executed according to survey statement of work and technical specifications. I hereby certify that this survey was performed either by me or under my direct supervision and control and that all the information shown is true and correct to the best of my knowledge and belief.

Certified this 14th day of June, 2012.

Matthew L. Cooper L.S.
Indiana L.S. #20200079
Bledsoe Riggert & Guerrettaz, Inc

**PREPARED BY:**

**Bledsoe Riggert & Guerrettaz, Inc.**

**535 North Gospel Street**

**Paoli, IN 47454**

**812-723-2900**

**812-723-2933**

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# APPENDIX D

## ANALYTICAL DATA - FULL TABLES

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GROUNDWATER

| LOCATION<br>SAMPLE ID<br>SAMPLE DATE | 22MWT01<br>22GWT001<br>5/22/2012 | 22MWT02<br>22GWT002<br>5/22/2012 | 22MWT02<br>22GWT002-D<br>5/22/2012 | 22MWT03<br>22GWT003<br>5/23/2012 | 22MWT04<br>22GWT004<br>5/23/2012 |
|---|---|---|---|---|---|
| **EXPLOSIVES (UG/L)** | | | | | |
| 1,3,5-TRINITROBENZENE | 0.26 UJ | 0.26 UJ | 0.26 UJ | 0.26 UJ | 0.26 UJ |
| 1,3-DINITROBENZENE | 0.262 UJ | 0.262 UJ | 0.262 UJ | 0.262 UJ | 0.262 UJ |
| 2,4,6-TRINITROTOLUENE | 0.266 UJ | 0.47 J | 0.49 J | 0.266 UJ | 0.266 UJ |
| 2,4-DINITROTOLUENE | 0.250 UJ | 0.25 UJ | 0.25 UJ | 0.250 UJ | 0.250 UJ |
| 2,6-DINITROTOLUENE | 0.250 UJ | 0.25 UJ | 0.25 UJ | 0.250 UJ | 0.250 UJ |
| 2-AMINO-4,6-DINITROTOLUENE | 0.250 UJ | 0.25 UJ | 0.25 UJ | 0.250 UJ | 0.250 UJ |
| 2-NITROTOLUENE | 0.252 UJ | 0.252 UJ | 0.252 UJ | 0.252 UJ | 0.252 UJ |
| 3-NITROTOLUENE | 0.266 UJ | 0.266 UJ | 0.266 UJ | 0.266 UJ | 0.266 UJ |
| 4-AMINO-2,6-DINITROTOLUENE | 0.2 UJ | 0.11 J | 0.11 J | 0.2 UJ | 0.2 UJ |
| 4-NITROTOLUENE | 0.266 UJ | 0.266 UJ | 0.266 UJ | 0.266 UJ | 0.266 UJ |
| HMX | 0.230 UJ | 1.1 J | 1.2 J | 0.230 UJ | 0.230 UJ |
| NITROBENZENE | 0.252 UJ | 0.252 UJ | 0.252 UJ | 0.252 UJ | 0.252 UJ |
| NITROGLYCERIN | 0.26 UJ | 0.26 UJ | 0.26 UJ | 0.26 UJ | 0.26 UJ |
| PETN | 1.214 UJ | 1.214 UJ | 1.214 UJ | 1.214 UJ | 1.214 UJ |
| RDX | 0.32 J | 15 J | 15 J | 0.19 J | 0.246 UJ |
| TETRYL | 0.266 UJ | 0.266 UJ | 0.266 UJ | 0.266 UJ | 0.266 UJ |
| **METALS (UG/L)** | | | | | |
| ARSENIC | 1.4 | 4.9 | 4.8 | 5.5 | 1.9 |
| BARIUM | 34.2 | 39.4 J | 36.7 J | 16.4 | 40 |
| CADMIUM | 0.9 | 3.6 | 3.6 | 4.7 | 0.59 |
| CHROMIUM | 4 | 6.5 | 5.6 | 6.6 | 5 |
| LEAD | 3.2 | 14.6 J | 14.7 J | 21.4 | 7.5 |
| MERCURY | 0.18 U | 0.12 U | 0.2 U | 0.14 U | 0.19 U |
| SELENIUM | 0.45 J | 5.3 | 5.1 | 3.5 | 1.7 |
| SILVER | 0.06 U | 0.06 U | 0.06 U | 0.06 U | 0.06 U |
| **DISSOLVED METALS (UG/L)** | | | | | |
| ARSENIC | 0.44 | 3.2 | 3.1 | -- | 1.4 |
| BARIUM | 23.6 | 25.2 | 24.6 | -- | 27.1 |
| CADMIUM | 0.99 | 2.9 | 2.7 | -- | 0.45 |
| CHROMIUM | 0.59 | 3 | 2.8 | -- | 1.2 |
| LEAD | 0.72 | 10.6 J | 9.9 J | -- | 6.6 |
| MERCURY | 0.12 U | 0.12 U | 0.12 U | -- | 0.12 U |
| SELENIUM | 0.56 J | 3.5 | 3.3 | -- | 1.9 |
| SILVER | 0.06 U | 0.06 U | 0.06 U | -- | 0.06 U |
| **MISCELLANEOUS PARAMETERS** | | | | | |
| HEXAVALENT CHROMIUM (MG/L) | -- | -- | -- | -- | -- |
| OXIDATION REDUCTION POTENTIAL (MV) | -- | -- | -- | -- | -- |
| TURBIDITY (NTU) | -- | -- | -- | -- | -- |
| PH (S.U.) | -- | -- | -- | -- | -- |

## GROUNDWATER

| LOCATION<br>SAMPLE ID<br>SAMPLE DATE | 22MWT01<br>22GWT001<br>5/22/2012 | 22MWT02<br>22GWT002<br>5/22/2012 | 22MWT02<br>22GWT002-D<br>5/22/2012 | 22MWT03<br>22GWT003<br>5/23/2012 | 22MWT04<br>22GWT004<br>5/23/2012 |
|---|---|---|---|---|---|
| HEXAVALENT CHROMIUM (UG/L) | -- | -- | -- | -- | -- |
| PERCHLORATE (UG/L) | 0.25 J | 5.9 J | 6.1 J | 0.4 UJ | 0.4 UJ |
| **FILTERED MISCELLANEOUS** | | | | | |
| HEXAVALENT CHROMIUM (MG/L) | -- | -- | -- | -- | -- |
| OXIDATION REDUCTION POTENTIAL (MV) | -- | -- | -- | -- | -- |
| TURBIDITY (NTU) | -- | -- | -- | -- | -- |
| PH (S.U.) | -- | -- | -- | -- | -- |
| HEXAVALENT CHROMIUM (UG/L) | -- | -- | -- | -- | -- |

**GROUNDWATER Footnotes:**

-- = The chemical was not analyzed or no value was available.

Data Qualifiers:

Blank (i.e., no qualifier) = the chemical was detected.

J = The chemical was detected but the concentration reported is an estimated value.

U = The chemical was not detected.

UJ = The chemical was not detected but the value reported is estimated.

GROUNDWATER

| LOCATION<br>SAMPLE ID<br>SAMPLE DATE | 22MWT01<br>22GWT001<br>5/22/2012 | 22MWT02<br>22GWT002<br>5/22/2012 | 22MWT02<br>22GWT002-D<br>5/22/2012 | 22MWT03<br>22GWT003<br>5/23/2012 | 22MWT05<br>22GWT005<br>5/21/2012 |
|---|---|---|---|---|---|
| **EXPLOSIVES (UG/L)** | | | | | |
| 1,3,5-TRINITROBENZENE | 0.26 UJ | 0.26 UJ | 0.26 UJ | 0.26 UJ | 0.26 UJ |
| 1,3-DINITROBENZENE | 0.262 UJ | 0.262 UJ | 0.262 UJ | 0.262 UJ | 0.262 UJ |
| 2,4,6-TRINITROTOLUENE | 0.266 UJ | 0.47 J | 0.49 J | 0.266 UJ | 0.266 UJ |
| 2,4-DINITROTOLUENE | 0.250 UJ | 0.25 UJ | 0.25 UJ | 0.250 UJ | 0.25 UJ |
| 2,6-DINITROTOLUENE | 0.250 UJ | 0.25 UJ | 0.25 UJ | 0.250 UJ | 0.25 UJ |
| 2-AMINO-4,6-DINITROTOLUENE | 0.250 UJ | 0.25 UJ | 0.25 UJ | 0.250 UJ | 0.25 UJ |
| 2-NITROTOLUENE | 0.252 UJ | 0.252 UJ | 0.252 UJ | 0.252 UJ | 0.252 UJ |
| 3-NITROTOLUENE | 0.266 UJ | 0.266 UJ | 0.266 UJ | 0.266 UJ | 0.266 UJ |
| 4-AMINO-2,6-DINITROTOLUENE | 0.2 UJ | 0.11 J | 0.11 J | 0.2 UJ | 0.20 UJ |
| 4-NITROTOLUENE | 0.266 UJ | 0.266 UJ | 0.266 UJ | 0.266 UJ | 0.266 UJ |
| HMX | 0.230 UJ | 1.1 J | 1.2 J | 0.230 UJ | 0.23 UJ |
| NITROBENZENE | 0.252 UJ | 0.252 UJ | 0.252 UJ | 0.252 UJ | 0.252 UJ |
| NITROGLYCERIN | 0.26 UJ | 0.26 UJ | 0.26 UJ | 0.26 UJ | 0.26 UJ |
| PETN | 1.214 UJ | 1.214 UJ | 1.214 UJ | 1.214 UJ | 1.214 UJ |
| RDX | 0.32 J | 15 J | 15 J | 0.19 J | 0.53 J |
| TETRYL | 0.266 UJ | 0.266 UJ | 0.266 UJ | 0.266 UJ | 0.266 UJ |
| **METALS (UG/L)** | | | | | |
| ARSENIC | 1.4 | 4.9 | 4.8 | 5.5 | 2.6 |
| BARIUM | 34.2 | 39.4 J | 36.7 J | 16.4 | 86.6 J |
| CADMIUM | 0.9 | 3.6 | 3.6 | 4.7 | 1.3 |
| CHROMIUM | 4 | 6.5 | 5.6 | 6.6 | 7.7 |
| LEAD | 3.2 | 14.6 J | 14.7 J | 21.4 | 11.5 J |
| MERCURY | 0.18 U | 0.12 U | 0.2 U | 0.14 U | 0.29 U |
| SELENIUM | 0.45 J | 5.3 | 5.1 | 3.5 | 0.41 J |
| SILVER | 0.06 U | 0.06 U | 0.06 U | 0.06 U | 0.06 U |
| **DISSOLVED METALS (UG/L)** | | | | | |
| ARSENIC | 0.44 | 3.2 | 3.1 | -- | 0.45 |
| BARIUM | 23.6 | 25.2 | 24.6 | -- | 55.6 |
| CADMIUM | 0.99 | 2.9 | 2.7 | -- | 1.3 |
| CHROMIUM | 0.59 | 3 | 2.8 | -- | 2.3 |
| LEAD | 0.72 | 10.6 J | 9.9 J | -- | 4.2 J |
| MERCURY | 0.12 U | 0.12 U | 0.12 U | -- | 0.18 U |
| SELENIUM | 0.56 J | 3.5 | 3.3 | -- | 0.24 J |
| SILVER | 0.06 U | 0.06 U | 0.06 U | -- | 0.06 U |
| **MISCELLANEOUS PARAMETERS** | | | | | |
| HEXAVALENT CHROMIUM (MG/L) | -- | -- | -- | -- | -- |
| OXIDATION REDUCTION POTENTIAL (MV) | -- | -- | -- | -- | -- |
| TURBIDITY (NTU) | -- | -- | -- | -- | -- |
| PH (S.U.) | -- | -- | -- | -- | -- |

## GROUNDWATER

| LOCATION<br>SAMPLE ID<br>SAMPLE DATE | 22MWT01<br>22GWT001<br>5/22/2012 | 22MWT02<br>22GWT002<br>5/22/2012 | 22MWT02<br>22GWT002-D<br>5/22/2012 | 22MWT03<br>22GWT003<br>5/23/2012 | 22MWT05<br>22GWT005<br>5/21/2012 |
|---|---|---|---|---|---|
| HEXAVALENT CHROMIUM (UG/L) | -- | -- | -- | -- | -- |
| PERCHLORATE (UG/L) | 0.25 J | 5.9 J | 6.1 J | 0.4 UJ | 0.40 UJ |
| **FILTERED MISCELLANEOUS** | | | | | |
| HEXAVALENT CHROMIUM (MG/L) | -- | -- | -- | -- | -- |
| OXIDATION REDUCTION POTENTIAL (MV) | -- | -- | -- | -- | -- |
| TURBIDITY (NTU) | -- | -- | -- | -- | -- |
| PH (S.U.) | -- | -- | -- | -- | -- |
| HEXAVALENT CHROMIUM (UG/L) | -- | -- | -- | -- | -- |

**GROUNDWATER Footnotes:**

-- = The chemical was not analyzed or no value was available.

Data Qualifiers:

Blank (i.e., no qualifier) = the chemical was detected.

J = The chemical was detected but the concentration reported is an estimated value.

U = The chemical was not detected.

UJ = The chemical was not detected but the value reported is estimated.

GROUNDWATER

| LOCATION<br>SAMPLE ID<br>SAMPLE DATE | 22MWT01<br>22GWT001<br>5/22/2012 | 22MWT02<br>22GWT002<br>5/22/2012 | 22MWT02<br>22GWT002-D<br>5/22/2012 | 22MWT03<br>22GWT003<br>5/23/2012 | 22MWT05<br>22GWT005_20130123<br>1/23/2013 |
|---|---|---|---|---|---|
| **EXPLOSIVES (UG/L)** | | | | | |
| 1,3,5-TRINITROBENZENE | 0.26 UJ | 0.26 UJ | 0.26 UJ | 0.26 UJ | -- |
| 1,3-DINITROBENZENE | 0.262 UJ | 0.262 UJ | 0.262 UJ | 0.262 UJ | -- |
| 2,4,6-TRINITROTOLUENE | 0.266 UJ | 0.47 J | 0.49 J | 0.266 UJ | -- |
| 2,4-DINITROTOLUENE | 0.250 UJ | 0.25 UJ | 0.25 UJ | 0.250 UJ | -- |
| 2,6-DINITROTOLUENE | 0.250 UJ | 0.25 UJ | 0.25 UJ | 0.250 UJ | -- |
| 2-AMINO-4,6-DINITROTOLUENE | 0.250 UJ | 0.25 UJ | 0.25 UJ | 0.250 UJ | -- |
| 2-NITROTOLUENE | 0.252 UJ | 0.252 UJ | 0.252 UJ | 0.252 UJ | -- |
| 3-NITROTOLUENE | 0.266 UJ | 0.266 UJ | 0.266 UJ | 0.266 UJ | -- |
| 4-AMINO-2,6-DINITROTOLUENE | 0.2 UJ | 0.11 J | 0.11 J | 0.2 UJ | -- |
| 4-NITROTOLUENE | 0.266 UJ | 0.266 UJ | 0.266 UJ | 0.266 UJ | -- |
| HMX | 0.230 UJ | 1.1 J | 1.2 J | 0.230 UJ | -- |
| NITROBENZENE | 0.252 UJ | 0.252 UJ | 0.252 UJ | 0.252 UJ | -- |
| NITROGLYCERIN | 0.26 UJ | 0.26 UJ | 0.26 UJ | 0.26 UJ | -- |
| PETN | 1.214 UJ | 1.214 UJ | 1.214 UJ | 1.214 UJ | -- |
| RDX | 0.32 J | 15 J | 15 J | 0.19 J | -- |
| TETRYL | 0.266 UJ | 0.266 UJ | 0.266 UJ | 0.266 UJ | -- |
| **METALS (UG/L)** | | | | | |
| ARSENIC | 1.4 | 4.9 | 4.8 | 5.5 | -- |
| BARIUM | 34.2 | 39.4 J | 36.7 J | 16.4 | -- |
| CADMIUM | 0.9 | 3.6 | 3.6 | 4.7 | -- |
| CHROMIUM | 4 | 6.5 | 5.6 | 6.6 | 90.8 J |
| LEAD | 3.2 | 14.6 J | 14.7 J | 21.4 | -- |
| MERCURY | 0.18 U | 0.12 U | 0.2 U | 0.14 U | -- |
| SELENIUM | 0.45 J | 5.3 | 5.1 | 3.5 | -- |
| SILVER | 0.06 U | 0.06 U | 0.06 U | 0.06 U | -- |
| **DISSOLVED METALS (UG/L)** | | | | | |
| ARSENIC | 0.44 | 3.2 | 3.1 | -- | -- |
| BARIUM | 23.6 | 25.2 | 24.6 | -- | -- |
| CADMIUM | 0.99 | 2.9 | 2.7 | -- | -- |
| CHROMIUM | 0.59 | 3 | 2.8 | -- | 1.5 U |
| LEAD | 0.72 | 10.6 J | 9.9 J | -- | -- |
| MERCURY | 0.12 U | 0.12 U | 0.12 U | -- | -- |
| SELENIUM | 0.56 J | 3.5 | 3.3 | -- | -- |
| SILVER | 0.06 U | 0.06 U | 0.06 U | -- | -- |
| **MISCELLANEOUS PARAMETERS** | | | | | |
| HEXAVALENT CHROMIUM (MG/L) | -- | -- | -- | -- | 0.01 U |
| OXIDATION REDUCTION POTENTIAL (MV) | -- | -- | -- | -- | 641 |
| TURBIDITY (NTU) | -- | -- | -- | -- | -- |
| PH (S.U.) | -- | -- | -- | -- | 3.46 |

## GROUNDWATER

| LOCATION | 22MWT01 | 22MWT02 | 22MWT02 | 22MWT03 | 22MWT05 |
|---|---|---|---|---|---|
| **SAMPLE ID** | **22GWT001** | **22GWT002** | **22GWT002-D** | **22GWT003** | **22GWT005_20130123** |
| **SAMPLE DATE** | **5/22/2012** | **5/22/2012** | **5/22/2012** | **5/23/2012** | **1/23/2013** |
| HEXAVALENT CHROMIUM (UG/L) | -- | -- | -- | -- | -- |
| PERCHLORATE (UG/L) | 0.25 J | 5.9 J | 6.1 J | 0.4 UJ | -- |
| **FILTERED MISCELLANEOUS** | | | | | |
| HEXAVALENT CHROMIUM (MG/L) | -- | -- | -- | -- | 0.01 U |
| OXIDATION REDUCTION POTENTIAL (MV) | -- | -- | -- | -- | 635 |
| TURBIDITY (NTU) | -- | -- | -- | -- | -- |
| PH (S.U.) | -- | -- | -- | -- | 3.46 |
| HEXAVALENT CHROMIUM (UG/L) | -- | -- | -- | -- | -- |

**GROUNDWATER Footnotes:**

-- = The chemical was not analyzed or no value was available.

Data Qualifiers:

Blank (i.e., no qualifier) = the chemical was detected.

J = The chemical was detected but the concentration reported is an estimated value.

U = The chemical was not detected.

UJ = The chemical was not detected but the value reported is estimated.

GROUNDWATER

| LOCATION | 22MWT01 | 22MWT02 | 22MWT02 | 22MWT03 | 22MWT05 |
|---|---|---|---|---|---|
| SAMPLE ID | 22GWT001 | 22GWT002 | 22GWT002-D | 22GWT003 | 22GWT005_20130123-D |
| SAMPLE DATE | 5/22/2012 | 5/22/2012 | 5/22/2012 | 5/23/2012 | 1/23/2013 |
| **EXPLOSIVES (UG/L)** | | | | | |
| 1,3,5-TRINITROBENZENE | 0.26 UJ | 0.26 UJ | 0.26 UJ | 0.26 UJ | -- |
| 1,3-DINITROBENZENE | 0.262 UJ | 0.262 UJ | 0.262 UJ | 0.262 UJ | -- |
| 2,4,6-TRINITROTOLUENE | 0.266 UJ | 0.47 J | 0.49 J | 0.266 UJ | -- |
| 2,4-DINITROTOLUENE | 0.250 UJ | 0.25 UJ | 0.25 UJ | 0.250 UJ | -- |
| 2,6-DINITROTOLUENE | 0.250 UJ | 0.25 UJ | 0.25 UJ | 0.250 UJ | -- |
| 2-AMINO-4,6-DINITROTOLUENE | 0.250 UJ | 0.25 UJ | 0.25 UJ | 0.250 UJ | -- |
| 2-NITROTOLUENE | 0.252 UJ | 0.252 UJ | 0.252 UJ | 0.252 UJ | -- |
| 3-NITROTOLUENE | 0.266 UJ | 0.266 UJ | 0.266 UJ | 0.266 UJ | -- |
| 4-AMINO-2,6-DINITROTOLUENE | 0.2 UJ | 0.11 J | 0.11 J | 0.2 UJ | -- |
| 4-NITROTOLUENE | 0.266 UJ | 0.266 UJ | 0.266 UJ | 0.266 UJ | -- |
| HMX | 0.230 UJ | 1.1 J | 1.2 J | 0.230 UJ | -- |
| NITROBENZENE | 0.252 UJ | 0.252 UJ | 0.252 UJ | 0.252 UJ | -- |
| NITROGLYCERIN | 0.26 UJ | 0.26 UJ | 0.26 UJ | 0.26 UJ | -- |
| PETN | 1.214 UJ | 1.214 UJ | 1.214 UJ | 1.214 UJ | -- |
| RDX | 0.32 J | 15 J | 15 J | 0.19 J | -- |
| TETRYL | 0.266 UJ | 0.266 UJ | 0.266 UJ | 0.266 UJ | -- |
| **METALS (UG/L)** | | | | | |
| ARSENIC | 1.4 | 4.9 | 4.8 | 5.5 | -- |
| BARIUM | 34.2 | 39.4 J | 36.7 J | 16.4 | -- |
| CADMIUM | 0.9 | 3.6 | 3.6 | 4.7 | -- |
| CHROMIUM | 4 | 6.5 | 5.6 | 6.6 | 19.8 J |
| LEAD | 3.2 | 14.6 J | 14.7 J | 21.4 | -- |
| MERCURY | 0.18 U | 0.12 U | 0.2 U | 0.14 U | -- |
| SELENIUM | 0.45 J | 5.3 | 5.1 | 3.5 | -- |
| SILVER | 0.06 U | 0.06 U | 0.06 U | 0.06 U | -- |
| **DISSOLVED METALS (UG/L)** | | | | | |
| ARSENIC | 0.44 | 3.2 | 3.1 | -- | -- |
| BARIUM | 23.6 | 25.2 | 24.6 | -- | -- |
| CADMIUM | 0.99 | 2.9 | 2.7 | -- | -- |
| CHROMIUM | 0.59 | 3 | 2.8 | -- | 1.6 U |
| LEAD | 0.72 | 10.6 J | 9.9 J | -- | -- |
| MERCURY | 0.12 U | 0.12 U | 0.12 U | -- | -- |
| SELENIUM | 0.56 J | 3.5 | 3.3 | -- | -- |
| SILVER | 0.06 U | 0.06 U | 0.06 U | -- | -- |
| **MISCELLANEOUS PARAMETERS** | | | | | |
| HEXAVALENT CHROMIUM (MG/L) | -- | -- | -- | -- | 0.01 U |
| OXIDATION REDUCTION POTENTIAL (MV) | -- | -- | -- | -- | 662 |
| TURBIDITY (NTU) | -- | -- | -- | -- | -- |
| PH (S.U.) | -- | -- | -- | -- | 3.52 |

## GROUNDWATER

| LOCATION<br>SAMPLE ID<br>SAMPLE DATE | 22MWT01<br>22GWT001<br>5/22/2012 | 22MWT02<br>22GWT002<br>5/22/2012 | 22MWT02<br>22GWT002-D<br>5/22/2012 | 22MWT03<br>22GWT003<br>5/23/2012 | 22MWT05<br>22GWT005_20130123-D<br>1/23/2013 |
|---|---|---|---|---|---|
| HEXAVALENT CHROMIUM (UG/L) | -- | -- | -- | -- | -- |
| PERCHLORATE (UG/L) | 0.25 J | 5.9 J | 6.1 J | 0.4 UJ | -- |
| **FILTERED MISCELLANEOUS** | | | | | |
| HEXAVALENT CHROMIUM (MG/L) | -- | -- | -- | -- | 0.01 U |
| OXIDATION REDUCTION POTENTIAL (MV) | -- | -- | -- | -- | 639 |
| TURBIDITY (NTU) | -- | -- | -- | -- | -- |
| PH (S.U.) | -- | -- | -- | -- | 3.48 |
| HEXAVALENT CHROMIUM (UG/L) | -- | -- | -- | -- | -- |

**GROUNDWATER Footnotes:**

-- = The chemical was not analyzed or no value was available.

Data Qualifiers:

Blank (i.e., no qualifier) = the chemical was detected.

J = The chemical was detected but the concentration reported is an estimated value.

U = The chemical was not detected.

UJ = The chemical was not detected but the value reported is estimated.

GROUNDWATER

| LOCATION<br>SAMPLE ID<br>SAMPLE DATE | 22MWT01<br>22GWT001<br>5/22/2012 | 22MWT02<br>22GWT002<br>5/22/2012 | 22MWT02<br>22GWT002-D<br>5/22/2012 | 22MWT03<br>22GWT003<br>5/23/2012 | 22MWT05<br>22GWT005_20130416<br>4/16/2013 |
|---|---|---|---|---|---|
| **EXPLOSIVES (UG/L)** | | | | | |
| 1,3,5-TRINITROBENZENE | 0.26 UJ | 0.26 UJ | 0.26 UJ | 0.26 UJ | -- |
| 1,3-DINITROBENZENE | 0.262 UJ | 0.262 UJ | 0.262 UJ | 0.262 UJ | -- |
| 2,4,6-TRINITROTOLUENE | 0.266 UJ | 0.47 J | 0.49 J | 0.266 UJ | -- |
| 2,4-DINITROTOLUENE | 0.250 UJ | 0.25 UJ | 0.25 UJ | 0.250 UJ | -- |
| 2,6-DINITROTOLUENE | 0.250 UJ | 0.25 UJ | 0.25 UJ | 0.250 UJ | -- |
| 2-AMINO-4,6-DINITROTOLUENE | 0.250 UJ | 0.25 UJ | 0.25 UJ | 0.250 UJ | -- |
| 2-NITROTOLUENE | 0.252 UJ | 0.252 UJ | 0.252 UJ | 0.252 UJ | -- |
| 3-NITROTOLUENE | 0.266 UJ | 0.266 UJ | 0.266 UJ | 0.266 UJ | -- |
| 4-AMINO-2,6-DINITROTOLUENE | 0.2 UJ | 0.11 J | 0.11 J | 0.2 UJ | -- |
| 4-NITROTOLUENE | 0.266 UJ | 0.266 UJ | 0.266 UJ | 0.266 UJ | -- |
| HMX | 0.230 UJ | 1.1 J | 1.2 J | 0.230 UJ | -- |
| NITROBENZENE | 0.252 UJ | 0.252 UJ | 0.252 UJ | 0.252 UJ | -- |
| NITROGLYCERIN | 0.26 UJ | 0.26 UJ | 0.26 UJ | 0.26 UJ | -- |
| PETN | 1.214 UJ | 1.214 UJ | 1.214 UJ | 1.214 UJ | -- |
| RDX | 0.32 J | 15 J | 15 J | 0.19 J | -- |
| TETRYL | 0.266 UJ | 0.266 UJ | 0.266 UJ | 0.266 UJ | -- |
| **METALS (UG/L)** | | | | | |
| ARSENIC | 1.4 | 4.9 | 4.8 | 5.5 | -- |
| BARIUM | 34.2 | 39.4 J | 36.7 J | 16.4 | -- |
| CADMIUM | 0.9 | 3.6 | 3.6 | 4.7 | -- |
| CHROMIUM | 4 | 6.5 | 5.6 | 6.6 | 1 U |
| LEAD | 3.2 | 14.6 J | 14.7 J | 21.4 | -- |
| MERCURY | 0.18 U | 0.12 U | 0.2 U | 0.14 U | -- |
| SELENIUM | 0.45 J | 5.3 | 5.1 | 3.5 | -- |
| SILVER | 0.06 U | 0.06 U | 0.06 U | 0.06 U | -- |
| **DISSOLVED METALS (UG/L)** | | | | | |
| ARSENIC | 0.44 | 3.2 | 3.1 | -- | -- |
| BARIUM | 23.6 | 25.2 | 24.6 | -- | -- |
| CADMIUM | 0.99 | 2.9 | 2.7 | -- | -- |
| CHROMIUM | 0.59 | 3 | 2.8 | -- | 1 U |
| LEAD | 0.72 | 10.6 J | 9.9 J | -- | -- |
| MERCURY | 0.12 U | 0.12 U | 0.12 U | -- | -- |
| SELENIUM | 0.56 J | 3.5 | 3.3 | -- | -- |
| SILVER | 0.06 U | 0.06 U | 0.06 U | -- | -- |
| **MISCELLANEOUS PARAMETERS** | | | | | |
| HEXAVALENT CHROMIUM (MG/L) | -- | -- | -- | -- | -- |
| OXIDATION REDUCTION POTENTIAL (MV) | -- | -- | -- | -- | 623 |
| TURBIDITY (NTU) | -- | -- | -- | -- | 1.8 |
| PH (S.U.) | -- | -- | -- | -- | 3.79 |

## GROUNDWATER

| LOCATION<br>SAMPLE ID<br>SAMPLE DATE | 22MWT01<br>22GWT001<br>5/22/2012 | 22MWT02<br>22GWT002<br>5/22/2012 | 22MWT02<br>22GWT002-D<br>5/22/2012 | 22MWT03<br>22GWT003<br>5/23/2012 | 22MWT05<br>22GWT005_20130416<br>4/16/2013 |
|---|---|---|---|---|---|
| HEXAVALENT CHROMIUM (UG/L) | -- | -- | -- | -- | 0.046 |
| PERCHLORATE (UG/L) | 0.25 J | 5.9 J | 6.1 J | 0.4 UJ | -- |
| **FILTERED MISCELLANEOUS** | | | | | |
| HEXAVALENT CHROMIUM (MG/L) | -- | -- | -- | -- | -- |
| OXIDATION REDUCTION POTENTIAL (MV) | -- | -- | -- | -- | 616 |
| TURBIDITY (NTU) | -- | -- | -- | -- | 1 U |
| PH (S.U.) | -- | -- | -- | -- | 3.61 |
| HEXAVALENT CHROMIUM (UG/L) | -- | -- | -- | -- | 0.034 |

**GROUNDWATER Footnotes:**

-- = The chemical was not analyzed or no value was available.

Data Qualifiers:

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J = The chemical was detected but the concentration reported is an estimated value.

U = The chemical was not detected.

UJ = The chemical was not detected but the value reported is estimated.

**GROUNDWATER**

| LOCATION | 22MWT01 | 22MWT02 | 22MWT02 | 22MWT03 | 22MWT06 |
|---|---|---|---|---|---|
| SAMPLE ID | 22GWT001 | 22GWT002 | 22GWT002-D | 22GWT003 | 22GWT006 |
| SAMPLE DATE | 5/22/2012 | 5/22/2012 | 5/22/2012 | 5/23/2012 | 5/21/2012 |
| **EXPLOSIVES (UG/L)** | | | | | |
| 1,3,5-TRINITROBENZENE | 0.26 UJ | 0.26 UJ | 0.26 UJ | 0.26 UJ | 0.26 UJ |
| 1,3-DINITROBENZENE | 0.262 UJ | 0.262 UJ | 0.262 UJ | 0.262 UJ | 0.262 UJ |
| 2,4,6-TRINITROTOLUENE | 0.266 UJ | 0.47 J | 0.49 J | 0.266 UJ | 0.266 UJ |
| 2,4-DINITROTOLUENE | 0.250 UJ | 0.25 UJ | 0.25 UJ | 0.250 UJ | 0.25 UJ |
| 2,6-DINITROTOLUENE | 0.250 UJ | 0.25 UJ | 0.25 UJ | 0.250 UJ | 0.25 UJ |
| 2-AMINO-4,6-DINITROTOLUENE | 0.250 UJ | 0.25 UJ | 0.25 UJ | 0.250 UJ | 0.25 UJ |
| 2-NITROTOLUENE | 0.252 UJ | 0.252 UJ | 0.252 UJ | 0.252 UJ | 0.252 UJ |
| 3-NITROTOLUENE | 0.266 UJ | 0.266 UJ | 0.266 UJ | 0.266 UJ | 0.266 UJ |
| 4-AMINO-2,6-DINITROTOLUENE | 0.2 UJ | 0.11 J | 0.11 J | 0.2 UJ | 0.20 UJ |
| 4-NITROTOLUENE | 0.266 UJ | 0.266 UJ | 0.266 UJ | 0.266 UJ | 0.266 UJ |
| HMX | 0.230 UJ | 1.1 J | 1.2 J | 0.230 UJ | 0.23 UJ |
| NITROBENZENE | 0.252 UJ | 0.252 UJ | 0.252 UJ | 0.252 UJ | 0.252 UJ |
| NITROGLYCERIN | 0.26 UJ | 0.26 UJ | 0.26 UJ | 0.26 UJ | 0.26 UJ |
| PETN | 1.214 UJ | 1.214 UJ | 1.214 UJ | 1.214 UJ | 1.214 UJ |
| RDX | 0.32 J | 15 J | 15 J | 0.19 J | 0.246 UJ |
| TETRYL | 0.266 UJ | 0.266 UJ | 0.266 UJ | 0.266 UJ | 0.266 UJ |
| **METALS (UG/L)** | | | | | |
| ARSENIC | 1.4 | 4.9 | 4.8 | 5.5 | 11 |
| BARIUM | 34.2 | 39.4 J | 36.7 J | 16.4 | 82 J |
| CADMIUM | 0.9 | 3.6 | 3.6 | 4.7 | 7.1 |
| CHROMIUM | 4 | 6.5 | 5.6 | 6.6 | 19.3 |
| LEAD | 3.2 | 14.6 J | 14.7 J | 21.4 | 49.7 J |
| MERCURY | 0.18 U | 0.12 U | 0.2 U | 0.14 U | 0.14 U |
| SELENIUM | 0.45 J | 5.3 | 5.1 | 3.5 | 8.1 |
| SILVER | 0.06 U | 0.06 U | 0.06 U | 0.06 U | 0.06 U |
| **DISSOLVED METALS (UG/L)** | | | | | |
| ARSENIC | 0.44 | 3.2 | 3.1 | -- | 3.3 |
| BARIUM | 23.6 | 25.2 | 24.6 | -- | 28.5 |
| CADMIUM | 0.99 | 2.9 | 2.7 | -- | 3.9 |
| CHROMIUM | 0.59 | 3 | 2.8 | -- | 1.3 |
| LEAD | 0.72 | 10.6 J | 9.9 J | -- | 7 J |
| MERCURY | 0.12 U | 0.12 U | 0.12 U | -- | 0.12 U |
| SELENIUM | 0.56 J | 3.5 | 3.3 | -- | 5.7 |
| SILVER | 0.06 U | 0.06 U | 0.06 U | -- | 0.06 U |
| **MISCELLANEOUS PARAMETERS** | | | | | |
| HEXAVALENT CHROMIUM (MG/L) | -- | -- | -- | -- | -- |
| OXIDATION REDUCTION POTENTIAL (MV) | -- | -- | -- | -- | -- |
| TURBIDITY (NTU) | -- | -- | -- | -- | -- |
| PH (S.U.) | -- | -- | -- | -- | -- |

## GROUNDWATER

| LOCATION<br>SAMPLE ID<br>SAMPLE DATE | 22MWT01<br>22GWT001<br>5/22/2012 | 22MWT02<br>22GWT002<br>5/22/2012 | 22MWT02<br>22GWT002-D<br>5/22/2012 | 22MWT03<br>22GWT003<br>5/23/2012 | 22MWT06<br>22GWT006<br>5/21/2012 |
|---|---|---|---|---|---|
| HEXAVALENT CHROMIUM (UG/L) | -- | -- | -- | -- | -- |
| PERCHLORATE (UG/L) | 0.25 J | 5.9 J | 6.1 J | 0.4 UJ | 0.44 J |
| **FILTERED MISCELLANEOUS** | | | | | |
| HEXAVALENT CHROMIUM (MG/L) | -- | -- | -- | -- | -- |
| OXIDATION REDUCTION POTENTIAL (MV) | -- | -- | -- | -- | -- |
| TURBIDITY (NTU) | -- | -- | -- | -- | -- |
| PH (S.U.) | -- | -- | -- | -- | -- |
| HEXAVALENT CHROMIUM (UG/L) | -- | -- | -- | -- | -- |

**GROUNDWATER Footnotes:**

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UJ = The chemical was not detected but the value reported is estimated.

## SEDIMENT

| LOCATION<br>SAMPLE ID<br>SAMPLE DATE | 22SD/SW001<br>22SD0010006<br>1/20/2011 | 22SD/SW002<br>22SD0020006<br>1/20/2011 | 22SD/SW003<br>22SD0030006<br>1/20/2011 | 22SD/SW004<br>22SD0040006<br>1/20/2011 | 22SD/SW005<br>22SD0050006<br>1/20/2011 |
|---|---|---|---|---|---|
| **EXPLOSIVES (MG/KG)** | | | | | |
| 1,3,5-TRINITROBENZENE | 0.158 U | 0.158 U | 0.158 U | 0.158 U | 0.158 U |
| 1,3-DINITROBENZENE | 0.126 U | 0.126 U | 0.126 U | 0.126 U | 0.126 U |
| 2,4,6-TRINITROTOLUENE | 0.166 U | 0.166 U | 0.166 U | 0.166 U | 0.166 U |
| 2,4-DINITROTOLUENE | 0.166 U | 0.166 U | 0.166 U | 0.166 U | 0.166 U |
| 2,6-DINITROTOLUENE | 0.166 U | 0.166 U | 0.166 U | 0.166 U | 0.166 U |
| 2-AMINO-4,6-DINITROTOLUENE | 0.15 U | 0.15 U | 0.15 U | 0.15 U | 0.15 U |
| 2-NITROTOLUENE | 0.132 U | 0.132 U | 0.132 U | 0.132 U | 0.132 U |
| 3-NITROTOLUENE | 0.142 U | 0.142 U | 0.142 U | 0.142 U | 0.142 U |
| 4-AMINO-2,6-DINITROTOLUENE | 0.15 U | 0.15 U | 0.15 U | 0.15 U | 0.15 U |
| 4-NITROTOLUENE | 0.16 U | 0.16 U | 0.16 U | 0.16 U | 0.16 U |
| HMX | 0.16 U | 0.16 U | 0.16 U | 0.16 U | 0.16 U |
| NITROBENZENE | 0.15 U | 0.15 U | 0.15 U | 0.15 U | 0.15 U |
| NITROGLYCERIN | -- | -- | -- | -- | -- |
| PETN | -- | -- | -- | -- | -- |
| RDX | 0.16 U | 0.16 U | 0.16 U | 0.16 U | 0.16 U |
| TETRYL | 0.182 U | 0.182 U | 0.182 U | 0.182 U | 0.182 U |
| **METALS (MG/KG)** | | | | | |
| ARSENIC | 6.1 J | 5.2 J | 3.8 J | 2.4 J | 1.8 J |
| BARIUM | 34.8 J | 17 J | 173 J | 27.1 J | 18.9 J |
| CADMIUM | 0.31 J | 0.11 J | 0.2 J | 0.1 J | 0.16 J |
| CHROMIUM | 12.4 J | 13.2 J | 13.9 J | 4.5 J | 3.2 J |
| LEAD | 9 J | 6.2 J | 7.6 J | 5.6 J | 4.7 J |
| MERCURY | 0.03 U | 0.033 U | 0.037 U | 0.054 U | 0.045 U |
| SELENIUM | 0.21 J | 0.11 J | 0.11 J | 0.14 J | 0.083 J |
| SILVER | 0.025 J | 0.04 UJ | 0.04 UJ | 0.04 UJ | 0.04 UJ |
| **MISCELLANEOUS PARAMETERS** | | | | | |
| PERCENT MOISTURE (%) | -- | -- | -- | -- | -- |
| TOTAL ORGANIC CARBON (MG/KG) | 11000 | 1200 | 2900 | 13000 | 31000 |
| PH (S.U.) | -- | -- | -- | -- | -- |

**SEDIMENT** **Footnotes:**

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J = The chemical was detected but the concentration reported is an estimated value.

U = The chemical was not detected.

UJ = The chemical was not detected but the value reported is an estimated.

R = The value is rejected.

## SEDIMENT

| LOCATION<br>SAMPLE ID<br>SAMPLE DATE | 22SD/SW006<br>22SD0060006<br>1/18/2011 | 22SD/SW006<br>22SD0060624<br>1/18/2011 | 22SD/SW007<br>22SD0070006<br>1/18/2011 | 22SD/SW007<br>22SD0070624<br>1/18/2011 | 22SD/SW008<br>22SD0080006<br>1/18/2011 |
|---|---|---|---|---|---|
| **EXPLOSIVES (MG/KG)** | | | | | |
| 1,3,5-TRINITROBENZENE | 0.158 U | 0.158 U | 0.158 U | 0.158 U | 0.158 U |
| 1,3-DINITROBENZENE | 0.126 U | 0.126 U | 0.126 U | 0.126 U | 0.126 U |
| 2,4,6-TRINITROTOLUENE | 0.166 U | 0.166 U | 0.166 U | 0.166 U | 0.166 U |
| 2,4-DINITROTOLUENE | 0.166 U | 0.166 U | 0.166 U | 0.166 U | 0.166 U |
| 2,6-DINITROTOLUENE | 0.166 U | 0.166 U | 0.166 U | 0.166 U | 0.166 U |
| 2-AMINO-4,6-DINITROTOLUENE | 0.15 U | 0.15 U | 0.15 U | 0.15 U | 0.15 U |
| 2-NITROTOLUENE | 0.132 U | 0.132 U | 0.132 U | 0.132 U | 0.132 U |
| 3-NITROTOLUENE | 0.142 U | 0.142 U | 0.142 U | 0.142 U | 0.142 U |
| 4-AMINO-2,6-DINITROTOLUENE | 0.15 U | 0.15 U | 0.15 U | 0.15 U | 0.15 U |
| 4-NITROTOLUENE | 0.16 U | 0.16 U | 0.16 U | 0.16 U | 0.16 U |
| HMX | 0.16 U | 0.16 U | 0.16 U | 0.16 U | 0.16 U |
| NITROBENZENE | 0.15 U | 0.15 U | 0.15 U | 0.15 U | 0.15 U |
| NITROGLYCERIN | -- | -- | -- | -- | -- |
| PETN | -- | -- | -- | -- | -- |
| RDX | 0.16 U | 0.16 U | 0.16 U | 0.16 U | 0.16 U |
| TETRYL | 0.182 U | 0.182 U | 0.182 U | 0.182 U | 0.182 U |
| **METALS (MG/KG)** | | | | | |
| ARSENIC | 1.7 J | 1.6 J | 2.7 J | 1.6 J | 5.6 J |
| BARIUM | 25 J | 17.9 J | 23.2 J | 19.6 J | 41.1 J |
| CADMIUM | 0.88 J | 0.071 J | 0.15 J | 0.51 J | 0.24 J |
| CHROMIUM | 4.7 J | 4 J | 3.7 J | 2.9 J | 10.4 J |
| LEAD | 11.3 J | 4 J | 8.8 J | 8.3 J | 14.8 J |
| MERCURY | 0.041 U | 0.04 U | 0.034 U | 0.039 U | 0.045 U |
| SELENIUM | 0.1 J | 0.061 J | 0.11 J | 0.12 J | 0.22 J |
| SILVER | 0.02 J | 0.04 UJ | 0.04 UJ | 0.04 UJ | 0.02 J |
| **MISCELLANEOUS PARAMETERS** | | | | | |
| PERCENT MOISTURE (%) | -- | -- | -- | -- | -- |
| TOTAL ORGANIC CARBON (MG/KG) | 10000 | 2000 | 8300 | 5500 | 18000 |
| PH (S.U.) | 6.6 | 7.3 | -- | -- | -- |

**SEDIMENT** **Footnotes:**

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J = The chemical was detected but the concentration reported is an e

U = The chemical was not detected.

UJ = The chemical was not detected but the value reported is an esti

R = The value is rejected.

**SEDIMENT**

| LOCATION<br>SAMPLE ID<br>SAMPLE DATE | 22SD/SW008<br>22SD0080624<br>1/18/2011 | 22SD/SW009<br>22SD0090006<br>1/20/2011 | 22SD/SW009<br>22SD0090006-D<br>1/20/2011 | 22SD/SW010<br>22SD0100006<br>1/20/2011 | 22SD/SW010<br>22SD0100006_20120512<br>5/12/2012 |
|---|---|---|---|---|---|
| **EXPLOSIVES (MG/KG)** | | | | | |
| 1,3,5-TRINITROBENZENE | 0.158 U | 0.158 U | 0.158 U | 0.158 U | -- |
| 1,3-DINITROBENZENE | 0.126 U | 0.126 U | 0.126 U | 0.126 U | -- |
| 2,4,6-TRINITROTOLUENE | 0.166 U | 0.166 U | 0.166 U | 0.166 U | -- |
| 2,4-DINITROTOLUENE | 0.166 U | 0.166 U | 0.166 U | 0.166 U | -- |
| 2,6-DINITROTOLUENE | 0.166 U | 0.166 U | 0.166 U | 0.166 U | -- |
| 2-AMINO-4,6-DINITROTOLUENE | 0.15 U | 0.15 U | 0.15 U | 0.15 U | -- |
| 2-NITROTOLUENE | 0.132 U | 0.132 U | 0.132 U | 0.132 U | -- |
| 3-NITROTOLUENE | 0.142 U | 0.142 U | 0.142 U | 0.142 U | -- |
| 4-AMINO-2,6-DINITROTOLUENE | 0.15 U | 0.15 U | 0.15 U | 0.15 U | -- |
| 4-NITROTOLUENE | 0.16 U | 0.16 U | 0.16 U | 0.16 U | -- |
| HMX | 0.16 U | 0.16 U | 0.16 U | 0.16 U | -- |
| NITROBENZENE | 0.15 U | 0.15 U | 0.15 U | 0.15 U | -- |
| NITROGLYCERIN | -- | -- | -- | -- | 0.17 U |
| PETN | -- | -- | -- | -- | 1.158 U |
| RDX | 0.16 U | 0.16 U | 0.16 U | 0.16 U | -- |
| TETRYL | 0.182 U | 0.182 U | 0.182 U | 0.182 U | -- |
| **METALS (MG/KG)** | | | | | |
| ARSENIC | 5.1 J | 2.2 J | 5.2 J | 2 J | -- |
| BARIUM | 46.1 J | 16.7 J | 35.1 J | 8.6 J | -- |
| CADMIUM | 0.13 J | 0.24 J | 1.5 J | 0.37 J | -- |
| CHROMIUM | 11.4 J | 3.8 J | 38.6 J | 2.5 J | -- |
| LEAD | 20 J | 7.2 J | 53 J | 7.9 J | -- |
| MERCURY | 0.056 U | 0.26 | 0.052 U | 0.051 U | -- |
| SELENIUM | 0.19 J | 0.1 J | 0.14 J | 0.044 J | -- |
| SILVER | 0.04 UJ | 0.04 UJ | 0.073 U | 0.04 UJ | -- |
| **MISCELLANEOUS PARAMETERS** | | | | | |
| PERCENT MOISTURE (%) | -- | -- | -- | -- | 44.1 |
| TOTAL ORGANIC CARBON (MG/KG) | 2100 | 18000 | 22000 | 8800 | 29000 |
| PH (S.U.) | -- | -- | -- | -- | -- |

**SEDIMENT** **Footnotes:**

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U = The chemical was not detected.

UJ = The chemical was not detected but the value reported is an esti

R = The value is rejected.

SEDIMENT

| LOCATION<br>SAMPLE ID<br>SAMPLE DATE | 22SD/SW011<br>22SD0110006<br>1/20/2011 | 22SD/SW017<br>22SD0170006<br>5/11/2012 | 22SD/SW017<br>22SD0170006_20130123<br>1/23/2013 | 22SD/SW018<br>22SD0180006<br>4/9/2011 | 22SD/SW018<br>22SD0180006-D<br>4/9/2011 |
|---|---|---|---|---|---|
| **EXPLOSIVES (MG/KG)** | | | | | |
| 1,3,5-TRINITROBENZENE | 0.158 U | -- | -- | 0.158 U | 0.158 U |
| 1,3-DINITROBENZENE | 0.126 U | -- | -- | 0.126 U | 0.126 U |
| 2,4,6-TRINITROTOLUENE | 0.166 U | -- | 0.2 U | 0.166 U | 0.166 U |
| 2,4-DINITROTOLUENE | 0.166 U | -- | -- | 0.166 U | 0.166 U |
| 2,6-DINITROTOLUENE | 0.166 U | -- | -- | 0.166 U | 0.166 U |
| 2-AMINO-4,6-DINITROTOLUENE | 0.15 U | -- | -- | 0.15 U | 0.15 U |
| 2-NITROTOLUENE | 0.132 U | -- | -- | 0.132 U | 0.132 U |
| 3-NITROTOLUENE | 0.142 U | -- | -- | 0.142 U | 0.142 U |
| 4-AMINO-2,6-DINITROTOLUENE | 0.15 U | -- | -- | 0.15 U | 0.15 U |
| 4-NITROTOLUENE | 0.16 U | -- | -- | 0.16 U | 0.16 U |
| HMX | 0.16 U | -- | -- | 0.16 U | 0.16 U |
| NITROBENZENE | 0.15 U | -- | -- | 0.15 U | 0.15 U |
| NITROGLYCERIN | -- | 0.17 U | -- | -- | -- |
| PETN | -- | 1.158 U | -- | -- | -- |
| RDX | 0.16 U | -- | 0.2 U | 0.16 U | 0.16 U |
| TETRYL | 0.182 U | -- | -- | 0.182 U | 0.182 U |
| **METALS (MG/KG)** | | | | | |
| ARSENIC | 12.3 J | 5.5 | -- | 1.2 J | 1.5 J |
| BARIUM | 38.3 J | 42.1 | -- | 12.8 J | 18.5 J |
| CADMIUM | 0.26 J | 0.28 | -- | 0.24 J | 0.15 J |
| CHROMIUM | 16.2 J | 10 | -- | 2.8 J | 5 J |
| LEAD | 11.3 J | 11.3 | -- | 12.1 J | 10.3 J |
| MERCURY | 0.049 U | 0.086 J | -- | 0.038 J | 0.04 U |
| SELENIUM | 0.19 J | 0.42 | -- | 0.17 J | 0.15 J |
| SILVER | 0.04 UJ | 0.04 U | -- | 0.04 UJ | 0.04 UJ |
| **MISCELLANEOUS PARAMETERS** | | | | | |
| PERCENT MOISTURE (%) | -- | 31.1 | -- | -- | -- |
| TOTAL ORGANIC CARBON (MG/KG) | 2800 | 670 | -- | 6900 J | 13000 J |
| PH (S.U.) | -- | -- | -- | -- | -- |

**SEDIMENT** **Footnotes:**

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U = The chemical was not detected.

UJ = The chemical was not detected but the value reported is an esti

R = The value is rejected.

## SEDIMENT

| LOCATION | 22SD/SW018 | 22SD/SW023 | 22SD/SW024 | 22SD/SW026 |
|---|---|---|---|---|
| SAMPLE ID | 22SD0180006_20120512 | 22SD0230006 | 22SD0240006 | 22SD0260006 |
| SAMPLE DATE | 5/12/2012 | 5/11/2012 | 5/11/2012 | 5/11/2012 |
| **EXPLOSIVES (MG/KG)** | | | | |
| 1,3,5-TRINITROBENZENE | -- | 0.158 U | 0.158 U | 0.88 |
| 1,3-DINITROBENZENE | -- | 0.126 U | 0.126 U | 0.126 U |
| 2,4,6-TRINITROTOLUENE | -- | 0.166 U | 0.166 U | 2100 |
| 2,4-DINITROTOLUENE | -- | 0.166 U | 0.166 U | 0.27 J |
| 2,6-DINITROTOLUENE | -- | 0.166 U | 0.166 U | 0.166 U |
| 2-AMINO-4,6-DINITROTOLUENE | -- | 0.15 U | 0.15 U | 0.15 U |
| 2-NITROTOLUENE | -- | 0.132 U | 0.132 U | 0.132 U |
| 3-NITROTOLUENE | -- | 0.142 U | 0.142 U | 0.142 U |
| 4-AMINO-2,6-DINITROTOLUENE | -- | 0.15 U | 0.15 U | 46 J |
| 4-NITROTOLUENE | -- | 0.16 U | 0.16 U | 0.16 U |
| HMX | -- | 0.16 U | 0.16 U | 0.16 U |
| NITROBENZENE | -- | 0.15 U | 0.15 U | 0.15 U |
| NITROGLYCERIN | 0.17 U | 0.17 U | 0.17 U | 0.17 U |
| PETN | 1.158 U | 1.158 U | 1.158 U | 1.158 U |
| RDX | -- | 0.16 U | 0.16 U | 0.16 U |
| TETRYL | -- | 0.182 U | 0.182 U | 0.182 U |
| **METALS (MG/KG)** | | | | |
| ARSENIC | -- | 14.7 | 5.9 | 5.6 |
| BARIUM | -- | 67.4 | 43.2 | 515 |
| CADMIUM | -- | 0.36 | 0.22 | 0.43 |
| CHROMIUM | -- | 11.3 | 11.9 | 16.5 |
| LEAD | -- | 16.3 | 9.4 | 181 |
| MERCURY | -- | 0.073 J | 0.047 J | 0.99 |
| SELENIUM | -- | 0.61 | 0.33 | 0.4 |
| SILVER | -- | 0.04 U | 0.04 U | 0.025 J |
| **MISCELLANEOUS PARAMETERS** | | | | |
| PERCENT MOISTURE (%) | 21.4 | 25.7 | 21.6 | 19.3 |
| TOTAL ORGANIC CARBON (MG/KG) | 39000 | 14000 | 6400 | -- |
| PH (S.U.) | -- | 6.1 | -- | -- |

**SEDIMENT** **Footnotes:**

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Data Qualifiers:

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J = The chemical was detected but the concentration reported is an e

U = The chemical was not detected.

UJ = The chemical was not detected but the value reported is an esti

R = The value is rejected.

SOIL

| LOCATION<br>SAMPLE ID<br>SAMPLE DATE | 22SB001<br>22SB0010002<br>1/19/2011 | 22SB001<br>22SB0010305<br>1/19/2011 | 22SB001<br>22SB0010305-D<br>1/19/2011 | 22SB002<br>22SB0020002<br>1/19/2011 | 22SB002<br>22SB0020607<br>1/19/2011 |
|---|---|---|---|---|---|
| **EXPLOSIVES (MG/KG)** | | | | | |
| 1,3,5-TRINITROBENZENE | 0.158 U | 0.158 U | 0.158 U | 0.158 U | 0.158 U |
| 1,3-DINITROBENZENE | 0.126 U | 0.126 U | 0.126 U | 0.126 U | 0.126 U |
| 2,4,6-TRINITROTOLUENE | 0.166 U | 0.166 U | 0.166 U | 0.166 U | 0.166 U |
| 2,4-DINITROTOLUENE | 0.166 U | 0.166 U | 0.166 U | 0.166 U | 0.166 U |
| 2,6-DINITROTOLUENE | 0.166 U | 0.166 U | 0.166 U | 0.166 U | 0.166 U |
| 2-AMINO-4,6-DINITROTOLUENE | 0.15 U | 0.15 U | 0.15 U | 0.15 U | 0.15 U |
| 2-NITROTOLUENE | 0.132 U | 0.132 U | 0.132 U | 0.132 U | 0.132 U |
| 3-NITROTOLUENE | 0.142 U | 0.142 U | 0.142 U | 0.142 U | 0.142 U |
| 4-AMINO-2,6-DINITROTOLUENE | 0.15 U | 0.15 U | 0.15 U | 0.15 U | 0.15 U |
| 4-NITROTOLUENE | 0.16 U | 0.16 U | 0.16 U | 0.16 U | 0.16 U |
| HMX | 0.16 U | 0.16 U | 0.16 U | 0.16 U | 0.16 U |
| NITROBENZENE | 0.15 U | 0.15 U | 0.15 U | 0.15 U | 0.15 U |
| NITROGLYCERIN | -- | -- | -- | -- | -- |
| PETN | -- | -- | -- | -- | -- |
| RDX | 0.16 U | 0.16 U | 0.16 U | 0.16 U | 0.16 U |
| TETRYL | 0.182 U | 0.182 U | 0.182 U | 0.182 U | 0.182 U |
| **METALS (MG/KG)** | | | | | |
| ARSENIC | 3.6 J | 4.1 J | 4.7 J | 4.6 J | 3.8 J |
| BARIUM | 30.9 J | 38.4 J | 85.5 J | 44.6 J | 19.3 J |
| CADMIUM | 0.23 J | 0.16 J | 0.26 J | 0.15 J | 0.1 J |
| CHROMIUM | 5.6 J | 6 J | 14 J | 8 J | 8.7 J |
| LEAD | 8.9 J | 6.5 J | 144 J | 10.2 J | 9 J |
| MERCURY | 0.04 U | 0.044 U | 0.043 U | 0.026 U | 0.032 U |
| SELENIUM | 0.17 J | 0.16 J | 0.39 J | 0.28 J | 0.29 J |
| SILVER | 0.04 UJ | 0.04 UJ | 0.027 J | 0.04 UJ | 0.04 UJ |
| **MISCELLANEOUS PARAMETERS** | | | | | |
| PERCENT MOISTURE (%) | -- | -- | -- | -- | -- |
| TOTAL SOLIDS (%) | -- | -- | -- | -- | -- |
| HEXAVALENT CHROMIUM (MG/KG) | -- | -- | -- | -- | -- |
| PERCHLORATE (MG/KG) | 0.004 U | 0.004 U | 0.004 U | 0.004 U | 0.004 U |
| TOTAL ORGANIC CARBON (MG/KG) | -- | -- | -- | -- | -- |
| OXIDATION REDUCTION POTENTIAL (MV) | -- | -- | -- | -- | -- |
| PH (S.U.) | 7.3 | 7.9 | 7.7 | -- | -- |

**SOIL Footnotes:**

-- = The chemical was not analyzed or no value was available.

Data Qualifiers:

Blank (i.e., no qualifier) = the chemical was detected.

J = The chemical was detected but the concentration reported is an estimated value.

U = The chemical was not detected.

UJ = The chemical was not detected but the value reported is an estimated.

SOIL

| LOCATION<br>SAMPLE ID<br>SAMPLE DATE | 22SB003<br>22SB0030002<br>1/19/2011 | 22SB003<br>22SB0030305<br>1/19/2011 | 22SB004<br>22SB0040002<br>1/19/2011 | 22SB004<br>22SB0040305<br>1/19/2011 | 22SB005<br>22SB0050002<br>1/19/2011 |
|---|---|---|---|---|---|
| **EXPLOSIVES (MG/KG)** | | | | | |
| 1,3,5-TRINITROBENZENE | 0.158 U | 0.158 U | 0.158 U | 0.158 U | 0.158 U |
| 1,3-DINITROBENZENE | 0.126 U | 0.126 U | 0.126 U | 0.126 U | 0.126 U |
| 2,4,6-TRINITROTOLUENE | 0.166 U | 0.166 U | 0.166 U | 0.166 U | 0.166 U |
| 2,4-DINITROTOLUENE | 0.166 U | 0.166 U | 0.166 U | 0.166 U | 0.166 U |
| 2,6-DINITROTOLUENE | 0.166 U | 0.166 U | 0.166 U | 0.166 U | 0.166 U |
| 2-AMINO-4,6-DINITROTOLUENE | 0.15 U | 0.15 U | 0.15 U | 0.15 U | 0.15 U |
| 2-NITROTOLUENE | 0.132 U | 0.132 U | 0.132 U | 0.132 U | 0.132 U |
| 3-NITROTOLUENE | 0.142 U | 0.142 U | 0.142 U | 0.142 U | 0.142 U |
| 4-AMINO-2,6-DINITROTOLUENE | 0.15 U | 0.15 U | 0.15 U | 0.15 U | 0.15 U |
| 4-NITROTOLUENE | 0.16 U | 0.16 U | 0.16 U | 0.16 U | 0.16 U |
| HMX | 0.16 U | 0.16 U | 0.16 U | 0.16 U | 0.16 U |
| NITROBENZENE | 0.15 U | 0.15 U | 0.15 U | 0.15 U | 0.15 U |
| NITROGLYCERIN | -- | -- | -- | -- | -- |
| PETN | -- | -- | -- | -- | -- |
| RDX | 0.16 U | 0.16 U | 0.16 U | 0.16 U | 0.16 U |
| TETRYL | 0.182 U | 0.182 U | 0.182 U | 0.182 U | 0.182 U |
| **METALS (MG/KG)** | | | | | |
| ARSENIC | 7.9 J | 3.4 J | 2.5 J | 2 J | 3.3 J |
| BARIUM | 32.1 J | 23.3 J | 17.6 J | 51.1 J | 12.8 J |
| CADMIUM | 0.12 J | 0.11 J | 0.14 J | 0.16 J | 0.18 J |
| CHROMIUM | 14.1 J | 10.7 J | 3.4 J | 12.1 J | 13.4 J |
| LEAD | 10.8 J | 7 J | 2.8 J | 4.7 J | 6.1 J |
| MERCURY | 0.046 U | 0.04 U | 0.02 U | 0.086 U | 0.028 U |
| SELENIUM | 0.23 J | 0.13 J | 0.088 J | 0.15 J | 0.18 J |
| SILVER | 0.04 UJ | 0.04 UJ | 0.04 UJ | 0.04 UJ | 0.04 UJ |
| **MISCELLANEOUS PARAMETERS** | | | | | |
| PERCENT MOISTURE (%) | -- | -- | -- | -- | -- |
| TOTAL SOLIDS (%) | -- | -- | -- | -- | -- |
| HEXAVALENT CHROMIUM (MG/KG) | -- | -- | -- | -- | -- |
| PERCHLORATE (MG/KG) | 0.004 U | 0.004 U | 0.004 U | 0.004 U | 0.004 U |
| TOTAL ORGANIC CARBON (MG/KG) | -- | -- | -- | -- | -- |
| OXIDATION REDUCTION POTENTIAL (MV) | -- | -- | -- | -- | -- |
| PH (S.U.) | -- | -- | -- | -- | -- |

**SOIL Footnotes:**

-- = The chemical was not analyzed or no value was available.

Data Qualifiers:

Blank (i.e., no qualifier) = the chemical was detected.

J = The chemical was detected but the concentration reported is an e

U = The chemical was not detected.

UJ = The chemical was not detected but the value reported is an esti

SOIL

| LOCATION<br>SAMPLE ID<br>SAMPLE DATE | 22SB006<br>22SB0060002<br>1/19/2011 | 22SB006<br>22SB0060304<br>1/19/2011 | 22SB007<br>22SB0070002<br>1/21/2011 | 22SB007<br>22SB0070304<br>1/21/2011 | 22SB008<br>22SB0080002<br>1/19/2011 |
|---|---|---|---|---|---|
| **EXPLOSIVES (MG/KG)** | | | | | |
| 1,3,5-TRINITROBENZENE | 0.158 U | 0.158 U | 0.158 U | 0.158 U | 0.158 U |
| 1,3-DINITROBENZENE | 0.126 U | 0.126 U | 0.126 U | 0.126 U | 0.126 U |
| 2,4,6-TRINITROTOLUENE | 0.166 U | 0.166 U | 0.166 U | 0.166 U | 0.166 U |
| 2,4-DINITROTOLUENE | 0.166 U | 0.166 U | 0.166 U | 0.166 U | 0.166 U |
| 2,6-DINITROTOLUENE | 0.166 U | 0.166 U | 0.166 U | 0.166 U | 0.166 U |
| 2-AMINO-4,6-DINITROTOLUENE | 0.15 U | 0.15 U | 0.15 U | 0.15 U | 0.15 U |
| 2-NITROTOLUENE | 0.132 U | 0.132 U | 0.132 U | 0.132 U | 0.132 U |
| 3-NITROTOLUENE | 0.142 U | 0.142 U | 0.142 U | 0.142 U | 0.142 U |
| 4-AMINO-2,6-DINITROTOLUENE | 0.15 U | 0.15 U | 0.15 U | 0.15 U | 0.15 U |
| 4-NITROTOLUENE | 0.16 U | 0.16 U | 0.16 U | 0.16 U | 0.16 U |
| HMX | 0.16 U | 0.16 U | 0.16 U | 0.16 U | 0.16 U |
| NITROBENZENE | 0.15 U | 0.15 U | 0.15 U | 0.15 U | 0.15 U |
| NITROGLYCERIN | -- | -- | -- | -- | -- |
| PETN | -- | -- | -- | -- | -- |
| RDX | 0.16 U | 0.16 U | 0.16 U | 0.16 U | 0.16 U |
| TETRYL | 0.182 U | 0.182 U | 0.182 U | 0.182 U | 0.182 U |
| **METALS (MG/KG)** | | | | | |
| ARSENIC | 2.4 J | 1.1 J | 6 | 2 | 3.7 J |
| BARIUM | 38 J | 2.3 J | 89 J | 14.8 J | 34.3 J |
| CADMIUM | 0.19 J | 0.092 J | 0.16 | 0.1 | 0.33 J |
| CHROMIUM | 10.6 J | 7.4 J | 11 | 5.3 | 8.9 J |
| LEAD | 4.6 J | 2.8 J | 11.8 | 4.9 | 11.2 J |
| MERCURY | 0.021 U | 0.025 U | 0.079 U | 0.046 U | 0.035 U |
| SELENIUM | 0.17 J | 0.06 J | 0.31 | 0.11 J | 0.23 J |
| SILVER | 0.04 UJ | 0.04 UJ | 0.04 U | 0.04 U | 0.035 J |
| **MISCELLANEOUS PARAMETERS** | | | | | |
| PERCENT MOISTURE (%) | -- | -- | -- | -- | -- |
| TOTAL SOLIDS (%) | -- | -- | -- | -- | -- |
| HEXAVALENT CHROMIUM (MG/KG) | -- | -- | -- | -- | -- |
| PERCHLORATE (MG/KG) | 0.004 U | 0.004 U | 0.004 U | 0.004 U | 0.004 U |
| TOTAL ORGANIC CARBON (MG/KG) | -- | -- | -- | -- | -- |
| OXIDATION REDUCTION POTENTIAL (MV) | -- | -- | -- | -- | -- |
| PH (S.U.) | -- | -- | -- | -- | 8.2 |

**SOIL Footnotes:**

-- = The chemical was not analyzed or no value was available.

Data Qualifiers:

Blank (i.e., no qualifier) = the chemical was detected.

J = The chemical was detected but the concentration reported is an e

U = The chemical was not detected.

UJ = The chemical was not detected but the value reported is an esti

## SOIL

| LOCATION<br>SAMPLE ID<br>SAMPLE DATE | 22SB009<br>22SB0090002<br>1/19/2011 | 22SB009<br>22SB0090305<br>1/19/2011 | 22SB010<br>22SB0100002<br>1/19/2011 | 22SB010<br>22SB0100305<br>1/19/2011 | 22SB011<br>22SB0110002<br>1/19/2011 |
|---|---|---|---|---|---|
| **EXPLOSIVES (MG/KG)** | | | | | |
| 1,3,5-TRINITROBENZENE | 0.158 U | 0.158 U | 0.158 U | 0.158 U | 0.158 U |
| 1,3-DINITROBENZENE | 0.126 U | 0.126 U | 0.126 U | 0.126 U | 0.126 U |
| 2,4,6-TRINITROTOLUENE | 0.166 U | 0.166 U | 0.166 U | 0.166 U | 0.166 U |
| 2,4-DINITROTOLUENE | 0.166 U | 0.166 U | 0.166 U | 0.166 U | 0.166 U |
| 2,6-DINITROTOLUENE | 0.166 U | 0.166 U | 0.166 U | 0.166 U | 0.166 U |
| 2-AMINO-4,6-DINITROTOLUENE | 0.15 U | 0.15 U | 0.15 U | 0.15 U | 0.15 U |
| 2-NITROTOLUENE | 0.132 U | 0.132 U | 0.132 U | 0.132 U | 0.132 U |
| 3-NITROTOLUENE | 0.142 U | 0.142 U | 0.142 U | 0.142 U | 0.142 U |
| 4-AMINO-2,6-DINITROTOLUENE | 0.15 U | 0.15 U | 0.15 U | 0.15 U | 0.15 U |
| 4-NITROTOLUENE | 0.16 U | 0.16 U | 0.16 U | 0.16 U | 0.16 U |
| HMX | 0.16 U | 0.16 U | 0.16 U | 0.16 U | 0.16 U |
| NITROBENZENE | 0.15 U | 0.15 U | 0.15 U | 0.15 U | 0.15 U |
| NITROGLYCERIN | -- | -- | -- | -- | -- |
| PETN | -- | -- | -- | -- | -- |
| RDX | 0.16 U | 0.16 U | 0.16 U | 0.16 U | 0.16 U |
| TETRYL | 0.182 U | 0.182 U | 0.182 U | 0.182 U | 0.182 U |
| **METALS (MG/KG)** | | | | | |
| ARSENIC | 2.7 J | 4.9 J | 2.9 J | 3.1 J | 7 J |
| BARIUM | 15.4 J | 23.3 J | 55.3 J | 60.5 J | 65.8 J |
| CADMIUM | 0.075 J | 0.14 J | 0.079 J | 0.1 J | 0.19 J |
| CHROMIUM | 5.9 J | 9.2 J | 8 J | 7.6 J | 12.4 J |
| LEAD | 4.1 J | 7 J | 4.7 J | 5.5 J | 11.5 J |
| MERCURY | 0.042 U | 0.04 U | 0.031 U | 0.025 U | 0.038 U |
| SELENIUM | 0.094 J | 0.14 J | 0.14 J | 0.16 J | 0.38 J |
| SILVER | 0.04 UJ | 0.022 J | 0.04 UJ | 0.04 UJ | 0.038 J |
| **MISCELLANEOUS PARAMETERS** | | | | | |
| PERCENT MOISTURE (%) | -- | -- | -- | -- | -- |
| TOTAL SOLIDS (%) | -- | -- | -- | -- | -- |
| HEXAVALENT CHROMIUM (MG/KG) | -- | -- | -- | -- | -- |
| PERCHLORATE (MG/KG) | 0.004 U | 0.004 U | 0.004 U | 0.004 U | 0.004 U |
| TOTAL ORGANIC CARBON (MG/KG) | -- | -- | -- | -- | -- |
| OXIDATION REDUCTION POTENTIAL (MV) | -- | -- | -- | -- | -- |
| PH (S.U.) | -- | -- | -- | -- | -- |

**SOIL Footnotes:**

-- = The chemical was not analyzed or no value was available.

Data Qualifiers:

Blank (i.e., no qualifier) = the chemical was detected.

J = The chemical was detected but the concentration reported is an e

U = The chemical was not detected.

UJ = The chemical was not detected but the value reported is an esti

## SOIL

| LOCATION<br>SAMPLE ID<br>SAMPLE DATE | 22SB011<br>22SB0110304<br>1/19/2011 | 22SB012<br>22SB0120002<br>5/10/2012 | 22SB012<br>22SB0120002-D<br>5/10/2012 | 22SB013<br>22SB0130002<br>5/9/2012 | 22SB014<br>22SB0140002<br>5/9/2012 |
|---|---|---|---|---|---|
| **EXPLOSIVES (MG/KG)** | | | | | |
| 1,3,5-TRINITROBENZENE | 0.158 U | 0.158 UJ | 0.158 UJ | 0.158 UJ | 0.158 UJ |
| 1,3-DINITROBENZENE | 0.126 U | 0.126 UJ | 0.126 UJ | 0.126 UJ | 0.126 UJ |
| 2,4,6-TRINITROTOLUENE | 0.166 U | 0.166 UJ | 0.166 UJ | 0.166 UJ | 0.166 UJ |
| 2,4-DINITROTOLUENE | 0.166 U | 0.166 UJ | 0.166 UJ | 0.166 UJ | 0.166 UJ |
| 2,6-DINITROTOLUENE | 0.166 U | 0.166 UJ | 0.166 UJ | 0.166 UJ | 0.166 UJ |
| 2-AMINO-4,6-DINITROTOLUENE | 0.15 U | 0.15 UJ | 0.15 UJ | 0.15 UJ | 0.15 UJ |
| 2-NITROTOLUENE | 0.132 U | 0.132 UJ | 0.132 UJ | 0.132 UJ | 0.132 UJ |
| 3-NITROTOLUENE | 0.142 U | 0.142 UJ | 0.142 UJ | 0.142 UJ | 0.142 UJ |
| 4-AMINO-2,6-DINITROTOLUENE | 0.15 U | 0.15 UJ | 0.15 UJ | 0.15 UJ | 0.15 UJ |
| 4-NITROTOLUENE | 0.16 U | 0.16 UJ | 0.16 UJ | 0.16 UJ | 0.16 UJ |
| HMX | 0.16 U | 0.16 UJ | 0.16 UJ | 0.16 UJ | 0.16 UJ |
| NITROBENZENE | 0.15 U | 0.15 UJ | 0.15 UJ | 0.15 UJ | 0.15 UJ |
| NITROGLYCERIN | -- | 0.17 UJ | 0.17 UJ | 0.17 UJ | 0.17 UJ |
| PETN | -- | 1.158 UJ | 1.158 UJ | 1.158 UJ | 1.158 UJ |
| RDX | 0.16 U | 0.16 UJ | 0.16 UJ | 0.16 UJ | 0.16 UJ |
| TETRYL | 0.182 U | 0.182 UJ | 0.182 UJ | 0.182 UJ | 0.182 UJ |
| **METALS (MG/KG)** | | | | | |
| ARSENIC | 6.1 J | 2.9 J | 3.6 J | 5.6 J | 4.2 J |
| BARIUM | 40.6 J | 22.4 J | 108 J | 126 J | 144 J |
| CADMIUM | 0.12 J | 0.13 J | 0.23 J | 0.24 J | 0.28 J |
| CHROMIUM | 9 J | 7 J | 19.1 J | 19.8 J | 18.7 J |
| LEAD | 8.9 J | 4.5 J | 7.4 J | 7 J | 8 J |
| MERCURY | 0.067 U | 0.026 J | 0.025 J | 0.021 J | 0.03 J |
| SELENIUM | 0.26 J | 0.2 J | 0.31 J | 0.4 J | 0.32 J |
| SILVER | 0.023 J | 0.04 UJ | 0.04 UJ | 0.04 UJ | 0.021 J |
| **MISCELLANEOUS PARAMETERS** | | | | | |
| PERCENT MOISTURE (%) | -- | 16 | 18.5 | 13 | 18.9 |
| TOTAL SOLIDS (%) | -- | -- | -- | -- | -- |
| HEXAVALENT CHROMIUM (MG/KG) | -- | -- | -- | -- | -- |
| PERCHLORATE (MG/KG) | 0.004 U | -- | -- | -- | -- |
| TOTAL ORGANIC CARBON (MG/KG) | -- | -- | -- | -- | -- |
| OXIDATION REDUCTION POTENTIAL (MV) | -- | -- | -- | -- | -- |
| PH (S.U.) | -- | 7.7 | 7.6 | -- | -- |

**SOIL Footnotes:**

-- = The chemical was not analyzed or no value was available.

Data Qualifiers:

Blank (i.e., no qualifier) = the chemical was detected.

J = The chemical was detected but the concentration reported is an e

U = The chemical was not detected.

UJ = The chemical was not detected but the value reported is an esti

## SOIL

| LOCATION<br>SAMPLE ID<br>SAMPLE DATE | 22SB014<br>22SB0140203<br>5/10/2012 | 22SB015<br>22SB0150002<br>5/10/2012 | 22SB016<br>22SB0160002<br>5/9/2012 | 22SB016<br>22SB0160305<br>5/9/2012 | 22SB016<br>22SB0160608<br>5/9/2012 |
|---|---|---|---|---|---|
| **EXPLOSIVES (MG/KG)** | | | | | |
| 1,3,5-TRINITROBENZENE | 0.158 UJ | 0.158 UJ | 0.158 UJ | 0.158 UJ | 0.158 UJ |
| 1,3-DINITROBENZENE | 0.126 UJ | 0.126 UJ | 0.126 UJ | 0.126 UJ | 0.126 UJ |
| 2,4,6-TRINITROTOLUENE | 0.166 UJ | 0.166 UJ | 0.166 UJ | 0.166 UJ | 0.166 UJ |
| 2,4-DINITROTOLUENE | 0.166 UJ | 0.166 UJ | 0.166 UJ | 0.166 UJ | 0.166 UJ |
| 2,6-DINITROTOLUENE | 0.166 UJ | 0.166 UJ | 0.166 UJ | 0.166 UJ | 0.166 UJ |
| 2-AMINO-4,6-DINITROTOLUENE | 0.15 UJ | 0.15 UJ | 0.15 UJ | 0.15 UJ | 0.15 UJ |
| 2-NITROTOLUENE | 0.132 UJ | 0.132 UJ | 0.132 UJ | 0.132 UJ | 0.132 UJ |
| 3-NITROTOLUENE | 0.142 UJ | 0.142 UJ | 0.142 UJ | 0.142 UJ | 0.142 UJ |
| 4-AMINO-2,6-DINITROTOLUENE | 0.15 UJ | 0.15 UJ | 0.15 UJ | 0.15 UJ | 0.15 UJ |
| 4-NITROTOLUENE | 0.16 UJ | 0.16 UJ | 0.16 UJ | 0.16 UJ | 0.16 UJ |
| HMX | 0.16 UJ | 0.16 UJ | 0.16 UJ | 0.16 UJ | 0.16 UJ |
| NITROBENZENE | 0.15 UJ | 0.15 UJ | 0.15 UJ | 0.15 UJ | 0.15 UJ |
| NITROGLYCERIN | 0.17 UJ | 0.17 UJ | 0.17 UJ | 0.17 UJ | 0.17 UJ |
| PETN | 1.158 UJ | 1.158 UJ | 1.158 UJ | 1.158 UJ | 1.158 UJ |
| RDX | 0.16 UJ | 0.16 UJ | 0.16 UJ | 0.16 UJ | 0.16 UJ |
| TETRYL | 0.182 UJ | 0.182 UJ | 0.182 UJ | 0.182 UJ | 0.182 UJ |
| **METALS (MG/KG)** | | | | | |
| ARSENIC | 2.5 J | 4.7 J | 5 J | 4.6 J | 3.4 J |
| BARIUM | 52.3 J | 47 J | 79.2 J | 69.5 J | 54 J |
| CADMIUM | 0.086 J | 0.2 J | 0.26 | 0.25 J | 0.19 J |
| CHROMIUM | 7.5 J | 12.6 J | 19.5 J | 17.7 J | 8.7 J |
| LEAD | 2.8 J | 6.1 J | 10.6 | 10.6 J | 8.7 J |
| MERCURY | 0.04 U | 0.04 U | 0.02 J | 0.021 J | 0.027 J |
| SELENIUM | 0.21 J | 0.28 J | 0.35 J | 0.46 J | 0.29 J |
| SILVER | 0.04 UJ | 0.04 UJ | 0.04 U | 0.04 UJ | 0.04 UJ |
| **MISCELLANEOUS PARAMETERS** | | | | | |
| PERCENT MOISTURE (%) | 8.1 | 14.3 | 9.1 | 13.4 | 15 |
| TOTAL SOLIDS (%) | -- | -- | -- | -- | -- |
| HEXAVALENT CHROMIUM (MG/KG) | -- | -- | -- | -- | -- |
| PERCHLORATE (MG/KG) | -- | -- | -- | -- | -- |
| TOTAL ORGANIC CARBON (MG/KG) | -- | -- | -- | -- | -- |
| OXIDATION REDUCTION POTENTIAL (MV) | -- | -- | -- | -- | -- |
| PH (S.U.) | -- | -- | -- | -- | -- |

**SOIL Footnotes:**

-- = The chemical was not analyzed or no value was available.

Data Qualifiers:

Blank (i.e., no qualifier) = the chemical was detected.

J = The chemical was detected but the concentration reported is an e

U = The chemical was not detected.

UJ = The chemical was not detected but the value reported is an esti

**SOIL**

| LOCATION<br>SAMPLE ID<br>SAMPLE DATE | 22SB017<br>22SB0170002<br>5/9/2012 | 22SB017<br>22SB0170305<br>5/9/2012 | 22SB018<br>22SB0180002<br>5/10/2012 | 22SB018<br>22SB0180406<br>5/11/2012 | 22SB019<br>22SB0190002<br>5/10/2012 |
|---|---|---|---|---|---|
| **EXPLOSIVES (MG/KG)** | | | | | |
| 1,3,5-TRINITROBENZENE | 0.158 UJ | 0.158 UJ | 0.158 UJ | 0.158 U | 0.158 UJ |
| 1,3-DINITROBENZENE | 0.126 UJ | 0.126 UJ | 0.126 UJ | 0.126 U | 0.126 UJ |
| 2,4,6-TRINITROTOLUENE | 0.166 UJ | 0.166 UJ | 0.166 UJ | 0.166 U | 0.166 UJ |
| 2,4-DINITROTOLUENE | 0.166 UJ | 0.166 UJ | 0.166 UJ | 0.166 U | 0.166 UJ |
| 2,6-DINITROTOLUENE | 0.166 UJ | 0.166 UJ | 0.166 UJ | 0.166 U | 0.166 UJ |
| 2-AMINO-4,6-DINITROTOLUENE | 0.15 UJ | 0.15 UJ | 0.15 UJ | 0.15 U | 0.15 UJ |
| 2-NITROTOLUENE | 0.132 UJ | 0.132 UJ | 0.132 UJ | 0.132 U | 0.132 UJ |
| 3-NITROTOLUENE | 0.142 UJ | 0.142 UJ | 0.142 UJ | 0.142 U | 0.142 UJ |
| 4-AMINO-2,6-DINITROTOLUENE | 0.15 UJ | 0.15 UJ | 0.15 UJ | 0.15 U | 0.15 UJ |
| 4-NITROTOLUENE | 0.16 UJ | 0.16 UJ | 0.16 UJ | 0.16 U | 0.16 UJ |
| HMX | 0.16 UJ | 0.16 UJ | 0.16 UJ | 0.16 U | 0.16 UJ |
| NITROBENZENE | 0.15 UJ | 0.15 UJ | 0.15 UJ | 0.15 U | 0.15 UJ |
| NITROGLYCERIN | 0.17 UJ | 0.17 UJ | 0.17 UJ | 0.17 U | 0.17 UJ |
| PETN | 1.158 UJ | 1.158 UJ | 1.158 UJ | 1.158 U | 1.158 UJ |
| RDX | 0.16 UJ | 0.16 UJ | 0.16 UJ | 0.16 U | 0.16 UJ |
| TETRYL | 0.182 UJ | 0.182 UJ | 0.182 UJ | 0.182 U | 0.182 UJ |
| **METALS (MG/KG)** | | | | | |
| ARSENIC | 5.2 J | 5.3 J | 6 J | 3.2 | 7 J |
| BARIUM | 39.9 J | 43 J | 73.5 J | 72.6 | 69.4 J |
| CADMIUM | 0.18 | 0.22 | 0.27 J | 0.18 | 0.22 J |
| CHROMIUM | 16.7 J | 15.8 J | 17.3 J | 11.4 | 14.8 J |
| LEAD | 17.3 | 10.9 | 9.4 J | 4.5 | 8.4 J |
| MERCURY | 0.04 J | 0.033 J | 0.054 J | 0.04 U | 0.032 J |
| SELENIUM | 0.34 J | 0.35 J | 0.38 J | 0.24 | 0.32 J |
| SILVER | 0.04 U | 0.04 U | 0.022 J | 0.04 U | 0.04 UJ |
| **MISCELLANEOUS PARAMETERS** | | | | | |
| PERCENT MOISTURE (%) | 12.2 | 9.4 | 16.3 | 15 | 15.4 |
| TOTAL SOLIDS (%) | -- | -- | -- | -- | -- |
| HEXAVALENT CHROMIUM (MG/KG) | -- | -- | -- | -- | -- |
| PERCHLORATE (MG/KG) | -- | -- | -- | -- | -- |
| TOTAL ORGANIC CARBON (MG/KG) | -- | -- | -- | -- | -- |
| OXIDATION REDUCTION POTENTIAL (MV) | -- | -- | -- | -- | -- |
| PH (S.U.) | -- | -- | -- | -- | -- |

**SOIL Footnotes:**

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## SOIL

| LOCATION<br>SAMPLE ID<br>SAMPLE DATE | 22SB020<br>22SB0200002<br>1/23/2013 | 22SB020<br>22SB0200002-D<br>1/23/2013 | 22SB020<br>22SB0200203<br>1/23/2013 | 22SS001<br>22SS0010002<br>1/21/2011 | 22SS001<br>22SS0010002-D<br>1/21/2011 |
|---|---|---|---|---|---|
| **EXPLOSIVES (MG/KG)** | | | | | |
| 1,3,5-TRINITROBENZENE | -- | -- | -- | 0.158 U | 0.158 U |
| 1,3-DINITROBENZENE | -- | -- | -- | 0.126 U | 0.126 U |
| 2,4,6-TRINITROTOLUENE | 0.2 U | 0.2 U | 0.2 U | 0.166 U | 0.166 U |
| 2,4-DINITROTOLUENE | -- | -- | -- | 0.166 U | 0.166 U |
| 2,6-DINITROTOLUENE | -- | -- | -- | 0.166 U | 0.166 U |
| 2-AMINO-4,6-DINITROTOLUENE | -- | -- | -- | 0.15 U | 0.15 U |
| 2-NITROTOLUENE | -- | -- | -- | 0.132 U | 0.132 U |
| 3-NITROTOLUENE | -- | -- | -- | 0.142 U | 0.142 U |
| 4-AMINO-2,6-DINITROTOLUENE | -- | -- | -- | 0.15 U | 0.15 U |
| 4-NITROTOLUENE | -- | -- | -- | 0.16 U | 0.16 U |
| HMX | -- | -- | -- | 0.16 U | 0.16 U |
| NITROBENZENE | -- | -- | -- | 0.15 U | 0.15 U |
| NITROGLYCERIN | -- | -- | -- | -- | -- |
| PETN | -- | -- | -- | -- | -- |
| RDX | 0.2 U | 0.2 U | 0.2 U | 0.16 U | 0.16 U |
| TETRYL | -- | -- | -- | 0.182 U | 0.182 U |
| **METALS (MG/KG)** | | | | | |
| ARSENIC | -- | -- | -- | 2.4 | 3.1 |
| BARIUM | -- | -- | -- | 27.1 J | 48.9 J |
| CADMIUM | -- | -- | -- | 0.1 | 0.099 J |
| CHROMIUM | 16.5 | 17.3 | -- | 4.9 | 7.1 |
| LEAD | -- | -- | -- | 6.5 | 7.3 |
| MERCURY | -- | -- | -- | 0.068 U | 0.063 U |
| SELENIUM | -- | -- | -- | 0.14 J | 0.18 J |
| SILVER | -- | -- | -- | 0.04 U | 0.04 U |
| **MISCELLANEOUS PARAMETERS** | | | | | |
| PERCENT MOISTURE (%) | -- | -- | -- | -- | -- |
| TOTAL SOLIDS (%) | 83.9 | 86 | -- | -- | -- |
| HEXAVALENT CHROMIUM (MG/KG) | 1.31 | 1.12 | -- | -- | -- |
| PERCHLORATE (MG/KG) | -- | -- | -- | 0.004 U | 0.004 U |
| TOTAL ORGANIC CARBON (MG/KG) | -- | -- | -- | -- | -- |
| OXIDATION REDUCTION POTENTIAL (MV) | 605 | 623 | -- | -- | -- |
| PH (S.U.) | 5.36 | 5.26 | -- | -- | -- |

**SOIL Footnotes:**

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## SOIL

| LOCATION<br>SAMPLE ID<br>SAMPLE DATE | 22SS002<br>22SS0020002<br>1/21/2011 | 22SS004<br>22SS0040002<br>1/23/2013 | 22SS005<br>22SS0050002<br>1/23/2013 | 22SS006<br>22SS0060002<br>1/23/2013 | 22SS007<br>22SS0070002<br>1/23/2013 |
|---|---|---|---|---|---|
| **EXPLOSIVES (MG/KG)** | | | | | |
| 1,3,5-TRINITROBENZENE | 0.158 U | -- | -- | -- | -- |
| 1,3-DINITROBENZENE | 0.126 U | -- | -- | -- | -- |
| 2,4,6-TRINITROTOLUENE | 0.166 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U |
| 2,4-DINITROTOLUENE | 0.166 U | -- | -- | -- | -- |
| 2,6-DINITROTOLUENE | 0.166 U | -- | -- | -- | -- |
| 2-AMINO-4,6-DINITROTOLUENE | 0.15 U | -- | -- | -- | -- |
| 2-NITROTOLUENE | 0.132 U | -- | -- | -- | -- |
| 3-NITROTOLUENE | 0.142 U | -- | -- | -- | -- |
| 4-AMINO-2,6-DINITROTOLUENE | 0.15 U | -- | -- | -- | -- |
| 4-NITROTOLUENE | 0.16 U | -- | -- | -- | -- |
| HMX | 0.16 U | -- | -- | -- | -- |
| NITROBENZENE | 0.15 U | -- | -- | -- | -- |
| NITROGLYCERIN | -- | -- | -- | -- | -- |
| PETN | -- | -- | -- | -- | -- |
| RDX | 0.16 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U |
| TETRYL | 0.182 U | -- | -- | -- | -- |
| **METALS (MG/KG)** | | | | | |
| ARSENIC | 2.4 | -- | -- | -- | -- |
| BARIUM | 22 J | -- | -- | -- | -- |
| CADMIUM | 0.057 J | -- | -- | -- | -- |
| CHROMIUM | 4.9 | -- | -- | -- | -- |
| LEAD | 5.1 | -- | -- | -- | -- |
| MERCURY | 0.056 U | -- | -- | -- | -- |
| SELENIUM | 0.086 J | -- | -- | -- | -- |
| SILVER | 0.04 U | -- | -- | -- | -- |
| **MISCELLANEOUS PARAMETERS** | | | | | |
| PERCENT MOISTURE (%) | -- | -- | -- | -- | -- |
| TOTAL SOLIDS (%) | -- | -- | -- | -- | -- |
| HEXAVALENT CHROMIUM (MG/KG) | -- | -- | -- | -- | -- |
| PERCHLORATE (MG/KG) | 0.004 U | -- | -- | -- | -- |
| TOTAL ORGANIC CARBON (MG/KG) | -- | -- | -- | -- | -- |
| OXIDATION REDUCTION POTENTIAL (MV) | -- | -- | -- | -- | -- |
| PH (S.U.) | -- | -- | -- | -- | -- |

**SOIL Footnotes:**

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J = The chemical was detected but the concentration reported is an e

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UJ = The chemical was not detected but the value reported is an esti

SOIL

| LOCATION<br>SAMPLE ID<br>SAMPLE DATE | 22SS008<br>22SS0080002<br>1/23/2013 | 22SS022<br>22SS0220002<br>5/12/2012 | 22SS025<br>22SS0250002<br>5/11/2012 | 22SS025<br>22SS0250002-D<br>5/11/2012 |
|---|---|---|---|---|
| **EXPLOSIVES (MG/KG)** | | | | |
| 1,3,5-TRINITROBENZENE | -- | 0.158 U | 0.158 U | 0.158 U |
| 1,3-DINITROBENZENE | -- | 0.126 U | 0.126 U | 0.126 U |
| 2,4,6-TRINITROTOLUENE | 0.2 U | 0.166 U | 0.166 U | 0.166 U |
| 2,4-DINITROTOLUENE | -- | 0.166 U | 0.166 U | 0.166 U |
| 2,6-DINITROTOLUENE | -- | 0.166 U | 0.166 U | 0.166 U |
| 2-AMINO-4,6-DINITROTOLUENE | -- | 0.15 U | 0.15 U | 0.15 U |
| 2-NITROTOLUENE | -- | 0.132 U | 0.132 U | 0.132 U |
| 3-NITROTOLUENE | -- | 0.142 U | 0.142 U | 0.142 U |
| 4-AMINO-2,6-DINITROTOLUENE | -- | 0.15 U | 0.15 U | 0.15 U |
| 4-NITROTOLUENE | -- | 0.16 U | 0.16 U | 0.16 U |
| HMX | -- | 0.16 U | 0.16 U | 0.16 U |
| NITROBENZENE | -- | 0.15 U | 0.15 U | 0.15 U |
| NITROGLYCERIN | -- | 0.17 U | 0.17 U | 0.17 U |
| PETN | -- | 1.158 U | 1.158 U | 1.158 U |
| RDX | 0.2 U | 0.16 U | 0.37 J | 0.27 J |
| TETRYL | -- | 0.182 U | 0.182 U | 0.182 U |
| **METALS (MG/KG)** | | | | |
| ARSENIC | -- | 4.1 | 9.8 J | 9.4 |
| BARIUM | -- | 56.5 | 48.6 J | 83.5 |
| CADMIUM | -- | 0.52 | 0.78 | 0.87 |
| CHROMIUM | -- | 8.5 | 25.4 J | 23.3 |
| LEAD | -- | 31.4 | 31.7 J | 26.3 |
| MERCURY | -- | 0.054 J | 0.6 J | 0.29 |
| SELENIUM | -- | 0.35 J | 0.48 J | 0.56 |
| SILVER | -- | 0.04 U | 0.026 J | 0.025 J |
| **MISCELLANEOUS PARAMETERS** | | | | |
| PERCENT MOISTURE (%) | -- | 14.9 | 22.8 | 19.3 |
| TOTAL SOLIDS (%) | -- | -- | -- | -- |
| HEXAVALENT CHROMIUM (MG/KG) | -- | -- | -- | -- |
| PERCHLORATE (MG/KG) | -- | -- | -- | -- |
| TOTAL ORGANIC CARBON (MG/KG) | -- | 11000 | 4100 | 3900 |
| OXIDATION REDUCTION POTENTIAL (MV) | -- | -- | -- | -- |
| PH (S.U.) | -- | -- | -- | -- |

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Data Qualifiers:

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SURFACE WATER

| LOCATION | 22SD/SW001 | 22SD/SW002 | 22SD/SW003 | 22SD/SW004 | 22SD/SW006 |
|---|---|---|---|---|---|
| SAMPLE ID | 22SW001 | 22SW002 | 22SW003 | 22SW004 | 22SW006 |
| SAMPLE DATE | 1/20/2011 | 1/20/2011 | 1/20/2011 | 1/20/2011 | 1/18/2011 |
| **EXPLOSIVES (UG/L)** | | | | | |
| 1,3,5-TRINITROBENZENE | 0.26 U | 0.26 U | 0.26 U | 0.26 U | 0.52 U |
| 1,3-DINITROBENZENE | 0.262 U | 0.262 U | 0.262 U | 0.262 U | 0.52 U |
| 2,4,6-TRINITROTOLUENE | 0.266 U | 0.266 U | 0.266 U | 0.266 U | 0.52 U |
| 2,4-DINITROTOLUENE | 0.25 U | 0.25 U | 0.25 U | 0.25 U | 0.52 U |
| 2,6-DINITROTOLUENE | 0.25 U | 0.25 U | 0.25 U | 0.25 U | 0.52 U |
| 2-AMINO-4,6-DINITROTOLUENE | 0.25 U | 0.25 U | 0.25 U | 0.25 U | 0.52 U |
| 2-NITROTOLUENE | 0.252 U | 0.252 U | 0.252 U | 0.252 U | 0.52 U |
| 3-NITROTOLUENE | 0.266 U | 0.266 U | 0.266 U | 0.266 U | 0.52 U |
| 4-AMINO-2,6-DINITROTOLUENE | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.40 U |
| 4-NITROTOLUENE | 0.266 U | 0.266 U | 0.266 U | 0.266 U | 0.52 U |
| HMX | 0.82 | 0.79 | 0.87 | 0.23 U | 0.48 U |
| NITROBENZENE | 0.252 U | 0.252 U | 0.252 U | 0.252 U | 0.52 U |
| NITROGLYCERIN | -- | -- | -- | -- | -- |
| PETN | -- | -- | -- | -- | -- |
| RDX | 0.78 | 0.75 | 0.82 | 0.246 U | 0.48 U |
| TETRYL | 0.266 U | 0.266 U | 0.266 U | 0.266 U | 0.52 U |
| **METALS (UG/L)** | | | | | |
| ARSENIC | 0.18 U | 0.18 U | 0.18 U | 1.5 | 0.38 |
| BARIUM | 69 | 69.2 | 74.8 | 57.7 | 45.9 |
| CADMIUM | 0.04 U | 0.04 U | 0.04 U | 0.04 U | 0.5 |
| CHROMIUM | 0.55 | 0.48 J | 0.43 R | 3 | 1.5 |
| LEAD | 0.22 U | 0.22 U | 0.11 R | 6.1 | 9.6 |
| MERCURY | 0.12 U | 0.12 U | 0.12 U | 0.12 U | 0.065 J |
| SELENIUM | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| SILVER | 0.06 UJ | 0.06 UJ | 0.06 UJ | 0.06 UJ | 0.06 UJ |
| **DISSOLVED METALS (UG/L)** | | | | | |
| ARSENIC | 0.18 U | 0.18 U | 0.18 U | 0.18 U | 0.19 J |
| BARIUM | 68 | 68.4 | 73.9 | 26 | 36 J |
| CADMIUM | 0.04 U | 0.04 U | 0.04 U | 0.04 U | 0.24 J |
| CHROMIUM | 0.5 | 0.39 J | 0.92 R | 0.75 | 0.29 J |
| LEAD | 0.22 U | 0.22 U | 2.2 R | 0.22 U | 0.37 J |
| MERCURY | 0.12 U | 0.12 U | 0.12 U | 0.068 J | 0.12 U |
| SELENIUM | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 UJ |
| SILVER | 0.06 UJ | 0.06 UJ | 0.06 UJ | 0.06 UJ | 0.067 J |
| **MISCELLANEOUS PARAMETERS** | | | | | |
| PH (S.U.) | -- | -- | -- | -- | -- |
| PERCHLORATE (UG/L) | 0.40 U | 0.4 J | 0.40 U | 0.40 U | 0.40 U |

**SURFACE WATER Footnotes:**

SURFACE WATER

| LOCATION<br>SAMPLE ID<br>SAMPLE DATE | 22SD/SW007<br>22SW007<br>1/18/2011 | 22SD/SW009<br>22SW009<br>1/20/2011 | 22SD/SW009<br>22SW009-D<br>1/20/2011 | 22SD/SW010<br>22SW010<br>1/20/2011 | 22SD/SW010<br>22SW010_20120512<br>5/12/2012 |
|---|---|---|---|---|---|
| **EXPLOSIVES (UG/L)** | | | | | |
| 1,3,5-TRINITROBENZENE | 0.52 U | 0.26 U | 0.26 U | 0.26 U | -- |
| 1,3-DINITROBENZENE | 0.52 U | 0.262 U | 0.262 U | 0.262 U | -- |
| 2,4,6-TRINITROTOLUENE | 0.52 U | 0.266 U | 0.266 U | 0.266 U | -- |
| 2,4-DINITROTOLUENE | 0.52 U | 0.25 U | 0.25 U | 0.25 U | -- |
| 2,6-DINITROTOLUENE | 0.52 U | 0.25 U | 0.25 U | 0.25 U | -- |
| 2-AMINO-4,6-DINITROTOLUENE | 0.52 U | 0.25 U | 0.25 U | 0.25 U | -- |
| 2-NITROTOLUENE | 0.52 U | 0.252 U | 0.252 U | 0.252 U | -- |
| 3-NITROTOLUENE | 0.52 U | 0.266 U | 0.266 U | 0.266 U | -- |
| 4-AMINO-2,6-DINITROTOLUENE | 0.40 U | 0.20 U | 0.20 U | 0.20 U | -- |
| 4-NITROTOLUENE | 0.52 U | 0.266 U | 0.266 U | 0.266 U | -- |
| HMX | 0.48 U | 0.15 J | 0.23 U | 0.23 J | -- |
| NITROBENZENE | 0.52 U | 0.252 U | 0.252 U | 0.252 U | -- |
| NITROGLYCERIN | -- | -- | -- | -- | 0.26 U |
| PETN | -- | -- | -- | -- | 1.214 U |
| RDX | 0.48 U | 0.39 J | 0.38 J | 0.55 | -- |
| TETRYL | 0.52 U | 0.266 U | 0.266 U | 0.266 U | -- |
| **METALS (UG/L)** | | | | | |
| ARSENIC | 0.18 U | 0.46 J | 0.3 J | 0.49 J | -- |
| BARIUM | 54.3 | 36.9 J | 36.3 J | 36.1 J | -- |
| CADMIUM | 0.24 | 0.073 U | 0.064 U | 0.083 U | -- |
| CHROMIUM | 0.47 J | 0.4 J | 0.49 J | 0.43 J | -- |
| LEAD | 1.8 | 1 J | 0.78 J | 0.86 J | -- |
| MERCURY | 0.12 U | 0.089 J | 0.12 U | 0.12 U | -- |
| SELENIUM | 0.20 U | 0.1 J | 0.20 UJ | 0.20 UJ | -- |
| SILVER | 0.06 UJ | 0.032 J | 0.06 UJ | 0.06 UJ | -- |
| **DISSOLVED METALS (UG/L)** | | | | | |
| ARSENIC | 0.23 J | 0.23 J | 0.18 J | 0.2 J | -- |
| BARIUM | 53.8 J | 34.5 J | 33.8 J | 34.4 J | -- |
| CADMIUM | 0.26 J | 0.04 U | 0.04 U | 0.043 U | -- |
| CHROMIUM | 0.28 J | 0.31 J | 0.31 J | 0.27 J | -- |
| LEAD | 0.69 J | 0.11 J | 0.12 J | 0.22 UJ | -- |
| MERCURY | 0.067 J | 0.12 U | 0.12 U | 0.12 U | -- |
| SELENIUM | 0.20 UJ | 0.20 UJ | 0.20 UJ | 0.20 UJ | -- |
| SILVER | 0.057 J | 0.06 UJ | 0.06 UJ | 0.06 UJ | -- |
| **MISCELLANEOUS PARAMETERS** | | | | | |
| PH (S.U.) | -- | -- | -- | -- | -- |
| PERCHLORATE (UG/L) | 0.40 U | 0.40 U | 0.40 U | 0.40 U | -- |

**SURFACE WATER Footnotes:**

## SURFACE WATER

| LOCATION<br>SAMPLE ID<br>SAMPLE DATE | 22SD/SW011<br>22SW011<br>1/20/2011 | 22SD/SW012<br>22SW012<br>4/9/2011 | 22SD/SW013<br>22SW013<br>4/9/2011 | 22SD/SW014<br>22SW014<br>4/9/2011 | 22SD/SW015<br>22SW015<br>4/9/2011 |
|---|---|---|---|---|---|
| **EXPLOSIVES (UG/L)** | | | | | |
| 1,3,5-TRINITROBENZENE | 0.26 U | -- | -- | -- | -- |
| 1,3-DINITROBENZENE | 0.262 U | -- | -- | -- | -- |
| 2,4,6-TRINITROTOLUENE | 0.266 U | -- | -- | -- | -- |
| 2,4-DINITROTOLUENE | 0.25 U | -- | -- | -- | -- |
| 2,6-DINITROTOLUENE | 0.25 U | -- | -- | -- | -- |
| 2-AMINO-4,6-DINITROTOLUENE | 0.25 U | -- | -- | -- | -- |
| 2-NITROTOLUENE | 0.252 U | -- | -- | -- | -- |
| 3-NITROTOLUENE | 0.266 U | -- | -- | -- | -- |
| 4-AMINO-2,6-DINITROTOLUENE | 0.20 U | -- | -- | -- | -- |
| 4-NITROTOLUENE | 0.266 U | -- | -- | -- | -- |
| HMX | 0.88 | 0.23 U | 11 | 0.23 U | 0.23 U |
| NITROBENZENE | 0.252 U | -- | -- | -- | -- |
| NITROGLYCERIN | -- | -- | -- | -- | -- |
| PETN | -- | -- | -- | -- | -- |
| RDX | 0.79 | 0.246 U | 0.98 | 0.246 U | 0.246 U |
| TETRYL | 0.266 U | -- | -- | -- | -- |
| **METALS (UG/L)** | | | | | |
| ARSENIC | 0.41 | -- | -- | -- | -- |
| BARIUM | 76.5 | -- | -- | -- | -- |
| CADMIUM | 0.04 U | -- | -- | -- | -- |
| CHROMIUM | 0.45 J | -- | -- | -- | -- |
| LEAD | 0.22 U | -- | -- | -- | -- |
| MERCURY | 0.12 U | -- | -- | -- | -- |
| SELENIUM | 0.24 J | -- | -- | -- | -- |
| SILVER | 0.06 UJ | -- | -- | -- | -- |
| **DISSOLVED METALS (UG/L)** | | | | | |
| ARSENIC | 0.44 J | -- | -- | -- | -- |
| BARIUM | 77.4 J | -- | -- | -- | -- |
| CADMIUM | 0.04 UJ | -- | -- | -- | -- |
| CHROMIUM | 0.46 J | -- | -- | -- | -- |
| LEAD | 0.12 J | -- | -- | -- | -- |
| MERCURY | 0.084 J | -- | -- | -- | -- |
| SELENIUM | 0.28 J | -- | -- | -- | -- |
| SILVER | 0.06 UJ | -- | -- | -- | -- |
| **MISCELLANEOUS PARAMETERS** | | | | | |
| PH (S.U.) | -- | -- | -- | -- | -- |
| PERCHLORATE (UG/L) | 0.40 U | -- | -- | -- | -- |

**SURFACE WATER Footnotes:**

## SURFACE WATER

| LOCATION<br>SAMPLE ID<br>SAMPLE DATE | 22SD/SW016<br>22SW016<br>4/9/2011 | 22SD/SW017<br>22SW017<br>4/9/2011 | 22SD/SW017<br>22SW017_20120511<br>5/11/2012 | 22SD/SW018<br>22SW018<br>4/9/2011 | 22SD/SW018<br>22SW018-D<br>4/9/2011 |
|---|---|---|---|---|---|
| **EXPLOSIVES (UG/L)** | | | | | |
| 1,3,5-TRINITROBENZENE | -- | -- | -- | 0.26 U | 0.26 U |
| 1,3-DINITROBENZENE | -- | -- | -- | 0.262 U | 0.262 U |
| 2,4,6-TRINITROTOLUENE | -- | -- | -- | 0.266 U | 0.266 U |
| 2,4-DINITROTOLUENE | -- | -- | -- | 0.25 U | 0.25 U |
| 2,6-DINITROTOLUENE | -- | -- | -- | 0.25 U | 0.25 U |
| 2-AMINO-4,6-DINITROTOLUENE | -- | -- | -- | 0.25 U | 0.25 U |
| 2-NITROTOLUENE | -- | -- | -- | 0.252 U | 0.252 U |
| 3-NITROTOLUENE | -- | -- | -- | 0.266 U | 0.266 U |
| 4-AMINO-2,6-DINITROTOLUENE | -- | -- | -- | 0.20 U | 0.20 U |
| 4-NITROTOLUENE | -- | -- | -- | 0.266 U | 0.266 U |
| HMX | 0.23 U | 0.61 | -- | 0.63 | 0.43 J |
| NITROBENZENE | -- | -- | -- | 0.252 U | 0.252 U |
| NITROGLYCERIN | -- | -- | 0.26 U | -- | -- |
| PETN | -- | -- | 1.214 U | -- | -- |
| RDX | 0.246 U | 2.5 | -- | 1.5 | 1.1 |
| TETRYL | -- | -- | -- | 0.266 U | 0.266 U |
| **METALS (UG/L)** | | | | | |
| ARSENIC | -- | -- | 0.18 J | 0.72 | 0.64 J |
| BARIUM | -- | -- | 67.1 | 26.4 | 24.4 |
| CADMIUM | -- | -- | 0.29 J | 0.25 | 0.19 J |
| CHROMIUM | -- | -- | 0.51 | 1 | 1.1 J |
| LEAD | -- | -- | 0.22 U | 6 J | 3.9 J |
| MERCURY | -- | -- | 0.1 J | 0.12 U | 0.12 U |
| SELENIUM | -- | -- | 0.12 J | 0.17 J | 0.15 J |
| SILVER | -- | -- | 0.06 U | 0.06 U | 0.06 U |
| **DISSOLVED METALS (UG/L)** | | | | | |
| ARSENIC | -- | -- | -- | 0.35 | 0.34 |
| BARIUM | -- | -- | -- | 27.1 J | 20.1 J |
| CADMIUM | -- | -- | -- | 0.066 J | 0.048 J |
| CHROMIUM | -- | -- | -- | 0.37 J | 0.55 J |
| LEAD | -- | -- | -- | 0.22 U | 0.22 U |
| MERCURY | -- | -- | -- | 0.12 U | 0.12 U |
| SELENIUM | -- | -- | -- | 0.20 UJ | 1 UJ |
| SILVER | -- | -- | -- | 0.06 U | 0.06 U |
| **MISCELLANEOUS PARAMETERS** | | | | | |
| PH (S.U.) | -- | -- | -- | -- | -- |
| PERCHLORATE (UG/L) | -- | -- | -- | -- | -- |

**SURFACE WATER Footnotes:**

## SURFACE WATER

| LOCATION | 22SD/SW019 | 22SD/SW020 | 22SD/SW021 | 22SD/SW023 | 22SD/SW024 |
|---|---|---|---|---|---|
| SAMPLE ID | 22SW019 | 22SW020 | 22SW021 | 22SW023 | 22SW024 |
| SAMPLE DATE | 4/9/2011 | 4/9/2011 | 4/9/2011 | 5/11/2012 | 5/11/2012 |
| **EXPLOSIVES (UG/L)** | | | | | |
| 1,3,5-TRINITROBENZENE | -- | -- | -- | 0.26 U | 0.26 U |
| 1,3-DINITROBENZENE | -- | -- | -- | 0.262 U | 0.262 U |
| 2,4,6-TRINITROTOLUENE | -- | -- | -- | 0.266 U | 0.266 U |
| 2,4-DINITROTOLUENE | -- | -- | -- | 0.25 U | 0.25 U |
| 2,6-DINITROTOLUENE | -- | -- | -- | 0.25 U | 0.25 U |
| 2-AMINO-4,6-DINITROTOLUENE | -- | -- | -- | 0.25 U | 0.25 U |
| 2-NITROTOLUENE | -- | -- | -- | 0.252 U | 0.252 U |
| 3-NITROTOLUENE | -- | -- | -- | 0.266 U | 0.266 U |
| 4-AMINO-2,6-DINITROTOLUENE | -- | -- | -- | 0.2 U | 0.2 U |
| 4-NITROTOLUENE | -- | -- | -- | 0.266 U | 0.266 U |
| HMX | 0.23 U | 0.23 U | 0.23 U | 0.23 U | 0.23 U |
| NITROBENZENE | -- | -- | -- | 0.252 U | 0.252 U |
| NITROGLYCERIN | -- | -- | -- | 0.26 U | 0.26 U |
| PETN | -- | -- | -- | 1.214 U | 1.214 U |
| RDX | 0.246 U | 0.246 U | 0.246 U | 0.246 U | 0.246 U |
| TETRYL | -- | -- | -- | 0.266 U | 0.266 U |
| **METALS (UG/L)** | | | | | |
| ARSENIC | -- | -- | -- | 0.29 | 0.62 |
| BARIUM | -- | -- | -- | 57.5 | 66.6 |
| CADMIUM | -- | -- | -- | 0.23 J | 1.7 J |
| CHROMIUM | -- | -- | -- | 0.72 | 1.1 |
| LEAD | -- | -- | -- | 0.22 U | 4.4 |
| MERCURY | -- | -- | -- | 0.068 J | 0.097 J |
| SELENIUM | -- | -- | -- | 0.11 J | 0.56 J |
| SILVER | -- | -- | -- | 0.19 U | 0.06 U |
| **DISSOLVED METALS (UG/L)** | | | | | |
| ARSENIC | -- | -- | -- | -- | -- |
| BARIUM | -- | -- | -- | -- | -- |
| CADMIUM | -- | -- | -- | -- | -- |
| CHROMIUM | -- | -- | -- | -- | -- |
| LEAD | -- | -- | -- | -- | -- |
| MERCURY | -- | -- | -- | -- | -- |
| SELENIUM | -- | -- | -- | -- | -- |
| SILVER | -- | -- | -- | -- | -- |
| **MISCELLANEOUS PARAMETERS** | | | | | |
| PH (S.U.) | -- | -- | -- | 6.3 | -- |
| PERCHLORATE (UG/L) | -- | -- | -- | -- | -- |

**SURFACE WATER Footnotes:**

SURFACE WATER

| LOCATION | 22SD/SW024 |
|---|---|
| SAMPLE ID | 22SW024-D |
| SAMPLE DATE | 5/11/2012 |
| **EXPLOSIVES (UG/L)** | |
| 1,3,5-TRINITROBENZENE | 0.26 U |
| 1,3-DINITROBENZENE | 0.262 U |
| 2,4,6-TRINITROTOLUENE | 0.266 U |
| 2,4-DINITROTOLUENE | 0.25 U |
| 2,6-DINITROTOLUENE | 0.25 U |
| 2-AMINO-4,6-DINITROTOLUENE | 0.25 U |
| 2-NITROTOLUENE | 0.252 U |
| 3-NITROTOLUENE | 0.266 U |
| 4-AMINO-2,6-DINITROTOLUENE | 0.2 U |
| 4-NITROTOLUENE | 0.266 U |
| HMX | 0.23 U |
| NITROBENZENE | 0.252 U |
| NITROGLYCERIN | 0.26 U |
| PETN | 1.214 U |
| RDX | 0.246 U |
| TETRYL | 0.266 U |
| **METALS (UG/L)** | |
| ARSENIC | 0.71 |
| BARIUM | 67.2 |
| CADMIUM | 0.64 J |
| CHROMIUM | 1.2 |
| LEAD | 1.6 |
| MERCURY | 0.082 J |
| SELENIUM | 0.54 J |
| SILVER | 0.15 U |
| **DISSOLVED METALS (UG/L)** | |
| ARSENIC | -- |
| BARIUM | -- |
| CADMIUM | -- |
| CHROMIUM | -- |
| LEAD | -- |
| MERCURY | -- |
| SELENIUM | -- |
| SILVER | -- |
| **MISCELLANEOUS PARAMETERS** | |
| PH (S.U.) | -- |
| PERCHLORATE (UG/L) | -- |

**SURFACE WATER Footnotes:**

## Appendix B
## Interviewee Supplied Documents and Figures

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Notes on Brunswick II-F-2

Vic Willis - Deputy Director of Ordnance

Tom Floyd - ~~1336~~ 1652

a. Rockeye or 3 inch - Stan Armstrong, Ext 1564.

<u>Cast Loaded</u>

Pouring room - Waste water from the tray washer goes to the sump, which is periodically pumped out and the bottoms sent to the burning ground. By January all this will go to a charcoal filter pollution system.

Drill building - Bomblet washer uses steam and hot water to remove explosive from outside of bomblets. This goes to the sump now, but will soon be sent to the charcoal filter. Drills are water-cooled with recirculating water. Slush from this operation is gathered daily and put into the sump. This will not change. It is cleaned every other week and the residue sent to the burning ground. This amounts to about 100 pounds per day.

Polystyrene bomblet trays - Those from Honeywell are reused, while Marguardt's are sent to the landfill.

Small amounts of explosive scrap on templates are reused. Spills on the floor are sent to the burning ground. Wash-up water from the floor goes to the sump.

Com B -

<u>L.A.P.</u>

100 plus to operate per shift.

150/200 parts per million TNT in pink water samples.

1301-07c - Indus(Manuf) Oper/Products/Quantity (Crane)

filed: cfo 6/27/78

c. Explosives Actuated Devices - Ralph Bechtel. 30-40 personnel

Booster Area  Bldgs 136 and 138

Each building in the area has a sump. All screening and washing rinse waters go to the sump and the overflow to a holding basin with an earthen dam (which once broke). The sumps are treated with caustic, ferric ammonium nitrate or an acid. Nothing goes to the sewer from the assembly rooms. It is the tubing/screening/blending cells, the backline operations that have wet washes. Vacuum jug catchings go to the burning ground, as do spills and rejects.

---

Lead Stephanate - Not produced

Lead Azides

d. Mine Fill A - Bldg 160 - Morris Roberts - 1439

120-mm rounds loaded with Comp B were steamed out in 160 as recently as 6 months ago. The system is set up and ready to go again and will be in use as soon as money is received. This process is used on all cast explosives -- anything that will melt -- Comp B, TNT, HBX, tritanol, but not on anything soluble like amatol and ammonium picrate.

Some TNT from demil operations has been reused here, but most comps have either been sold or sent to the burning ground.

Clarence Gilliam has taken red water samples from 160.

Mine fill A has a new pollution abatement system for the pouring room. The equipment has never been tested.

B.R. Hubble

May 1983

# INITIAL ASSESSMENT STUDY OF NAVAL WEAPONS SUPPORT CENTER CRANE, INDIANA

NEESA 13-003

**NAVAL ENERGY AND ENVIRONMENTAL SUPPORT ACTIVITY**

**Port Hueneme, California 93043**

RELEASE OF THIS DOCUMENT REQUIRES PRIOR NOTIFICATION OF THE CHIEF OFFICIAL OF THE STUDIED ACTIVITY.

In Building 122, the flare assembly building, 5"/54 parachute flares were placed in the projectiles. The asbestos lines were cut to length and tied to the parachute rig. Excess asbestos line was discarded in the regular trash since it is not the fiber type that is a health hazard. One section of Building 122 is used for the recovery of magnesium and sodium nitrate from the MK45 and MK24 flare candles. The plant operated in 1974 and 1975 and used 2,000 gallons of a mixed methylene chloride and methanol, which was recovered. Building 122 also houses a paint booth and a polyurethane foam machine for the MK58 marine marker. Prior to 1979, out-of-specification foam was sent to the burning grounds. About six 55-gallon drums per year were dumped. Prior to the mid-1970s, paint sludge was sent to the ordnance burning ground. Building 133, the phosphorus pressing house, uses a composition of red phosphorous, manganese dioxide, magnesium, zinc oxide, and linseed oil. This is a wet operation, requiring wet floors, wet walls, etc. A sump behind Building 133 is operated the same as others in the area. Building 2697 in the pyro area is operated the same as others in the area. Building 2698 in the pyro area is operated by the Applied Science Department. Building 2698 houses a foam machine and other process equipment. Oxalic acid is used here. The TMAE (tetrakis diaminoethylene) is chemilumninescent compound which is used in Building 2698.

Figure 6.1-5 is an aerial view, looking north, of the Pyro Plant taken on 29 April 1981. In the lower left are the ready magazines, Buildings 134 and 135; in the lower center are Buildings 1885 and 1886, the phosphorus mixing buildings. The larger building in the right foreground is the flare assembly Building, 122. A general discussion of Pyrotechnics used at NWSC is presented in Appendix H.

#### 6.1.1.2 Pyrotechnics Testing

Compositions manufactured were tested for luminous intensity, color production, obscuring power, and burning rate. The test areas, including Pond 330, also known as Pond 333 in some cases, were used to test flares. These ponds are not currently used for testing.

#### 6.1.1.3 Explosive-Actuated Devices

Explosive-actuated devices (EADs) include detonators, squibs, boosters, cartridge-actuated devices (CADs), primers leads, relays, and delays. These are initiated electrically, or by friction. EADs usually are loaded with explosives such as lead azide, lead styphinate, tetryl, RDX and black powder pressed into an item directly or made into a pellet and merely assembled, being held in place by a bonding agent, by press fitting, or by compression pads. The initiating materials are manufactured elsewhere and are shipped water-or alcohol-wet. In the Booster area (EAD area), the raw materials are received in Building 2855 and stored in the wet magazine, Building 2856. They are dried in Buildings 2857 and 2858 and screened in Buildings 2859 and 2860. They are stored in dry magazines, Buildings 2861 and 2862. Building 2863 has the final weighing and blending operation before the actual loading into the ordnance item in Building 136. There it may be press loaded, or poured into the item.

In Building 138, booster pellets are pressed. In the 1950s about 1,200 pounds of black powder per day were used in the preparation of color burst charges.

The 5"/54 illuminating round has replaced the assembly of finished items, such as the MK95 detonators or boosters, which took place in Building 2520, the explosives assembly building, in earlier years. Building 2803 was used to test rocket components in live firing tests. These were small EAD items. In figure 6.2-3, looking northwest, the EAD area may be seen, with Building 2520 on the right and Building 136 in the left foreground. Building 138 is at the top.

The wastewaters from leads azide and lead styphinate operations in Building 136 were poured into a pond to render the materials safe (or killed) from an explosive standpoint. The pond was pumped periodically, and the material was taken to the burning grounds for disposal. A new sump was built to intercept the effluent before it reached the site. That sump is 7 foot by 8 foot 6 inches, with connections to the sanitary sewer. The sump was plugged to isolate it, and the flow has continued to the original pond, which is a 15 foot by 8 foot by 3 foot deep unlined earthen pit. The flow rate is about 2,300 gallons per week. Sludge samples have shown the presence of lead, varying from 0.03 parts per million (ppm) to 17 ppm, barium from less than 0.1 to 1.0 ppm, antimony from 0.5 t0 2.0 ppm, and chromium from less than 1.0 to about 1,300 ppm.

In 1981, after the liquid and sediment in the pond was analyzed, the contaminated material was removed and hauled off station to an approved landfill site by a state certified waste hauler. The pond is no longer in existence. A treatment facility completed in 1982, now treats the waste generated from Building 136.

### 6.1.2 Black Powder Operations

Quilting black powder operations were conducted in Building 103 during World War II. The ignition ends of bag charges contain some 360 grams of black powder to facilitate the ignition of smokeless powder in bag charge. As much as 40,000 charges were manufactured in July 1945 when production peaked. Service magazines in Buildings 110 and 111 provided storage for these operations. Documentation indicates that sewing machine operators in quilting black powder operations wore asbestos aprons, but the impact of this practice could not be determined, because personnel interviewed had little or no knowledge of the use of asbestos aprons.

Saluting charges were loaded in Building 101. These charges contain black powder and are used when firing guns to pay honor. No projectiles are involved. Burster charges of mix fill were loaded into 5"/51 and 4"/50 projectiles in Building 104. Mix fill consists of charges of black powder and TNT.

During the Southeast Asia conflict, Building 103 was active in repacking of black powder (as much as 58,000 units in 1965) and fabricating 2-ounce expelling charges (50,000 in 1967). Sixteen-inch bag charges were also manufactured. About 77,000 charges were filled in 1968. Miscellaneous projectiles such as non-fragmenting, illuminating, and window projectiles contain pellets or charges of black powder for expelling and/or igniting color burst units or other types of loads. These projectiles were loaded in various areas, including Buildings 104, 145, and 123.

IIA,

DEPARTMENT OF THE NAVY
NAVAL WEAPONS SUPPORT CENTER
CRANE, INDIANA 47522

IN REPLY REFER TO:
122H-JJF:bar
6260
8 September 1977

MEMORANDUM

From: 122H
To: 053D

Subj: Report of possible sources of contamination for chemical demilitarization and facilities restoration study

Encl: (1) General Development Map, set
(2) Listing of chemical storage sites

1. This report addresses identifying the possible sources of chemical contamination at the Naval Weapons Support Center, Crane, Indiana which might be of significant magnitude as to have an impact on the health and well being of persons either employed at this Center or living at the periphery of the Center.

2. Twenty-eight areas on the Center have been identified as being possible sources of significant contamination. These areas have been circled in red on enclosure (1) and each will be discussed in detail. The areas are as follows:

A. Production Areas

a. Three Inch, or Rockeye, Explosives Loading Complex
b. 40 Millimeter Loading Complex
c. Booster Area
d. Mine Filling Area A
e. Mine Filling Area B
f. Loading and Filling Area
g. Pyrotechnic or Pyro Area
h. Ordnance Demolition Area
i. Rifle Range and Ordnance Burning Area
j. Ordnance Burning Pit
k. Pyrotechnic Test Area
l. Old Pyrotechnic Test Area
m. Chemical Burial Ground
n. Clothing Change House Area (Chemical Warfare)
o. Rocket Range
p. Old Sixteen Inch Loading and Demilitarization Facility
q. Truck Washing Facility, Building 600

B. Production Support Areas

r. Quality Evaluation Laboratory Complex
s. Applied Sciences Complex
t. Small Arms and Packing and Preservation Complex
u. Old Open Burning Pit
v. Sanitary Land Fill Area
w. McComish Gorge Landfill Area
x. Pest Control Storage and Office Area

Process Decon/Demil Oper

Filed 27 Sep 77

y. Metal Scrapyard
z. Firefighting Practice Area
aa. Laundry
bb. Roads and Grounds Area

3. Description of Operations/Areas

a. Three Inch, or Rockeye, Loading Complex

The Three Inch Area is located at map coordinates K-42. The complex is an explosives, cast loading area. Trinitrotoluene, (TNT), RDX, HBX are explosives which have been utilized in this area. Significant surface contamination by these explosives occurs principally associated with waste water from the operation. Currently, a milcon project to control this contamination is under construction.

b. 40 Millimeter Loading Complex

The 40 millimeter area is located at map coordinates Q-31. The complex has been used for cast loading of explosives, TNT, RDX, and HBX. These operations have been confined to Building 146 which also contains three demilitarization furnaces and high pressure water demilitarization facilities, steam demilitarization facilities and explosive drilling facilities. Control equipment to control airborne emissions from the demilitarization furnaces and from the high pressure water demilitarization equipment has been installed. Extensive prior use has contaminated the area with explosives from the steam demilitarization facility and with residual contamination from the demilitarization furnaces.

c. Booster Area

The Booster Area is located at map coordinates W-26. This facility loads initiating devices with tetryl, lead azide and lead styphnate primarily. In the past, booster devices were loaded extensively which utilized tetryl and TNT mostly. Due to the extremely sensitive nature of the explosives loaded in this area, little contamination is permitted. Spillage and scrap are treated in pits in the area to neutralize the materials.

d. Mine Filling Area A

The Mine Filling Area A is located at map coordinates Z-24. This is a high volume cast loading area which has been used extensively in the past 12 years and has heavily contaminated the area with TNT, RDX, and aluminum powder. (The aluminum should have no significant impact). The sources of contamination have been from exhaust ventilation equipment emissions and from waste water. The extent of contamination from exhaust ventilation has been measured at approximately 40,000 pounds per year total during peak production periods. The area also has a hot water-steam demilitarization facility which contributes some explosives contamination at Building 160 from process waste water. Control equipment has been installed in Mine Filling Area A to control contamination from waste water and exhaust ventilation emissions. The plant has not operated since the installation of the control equipment, however.

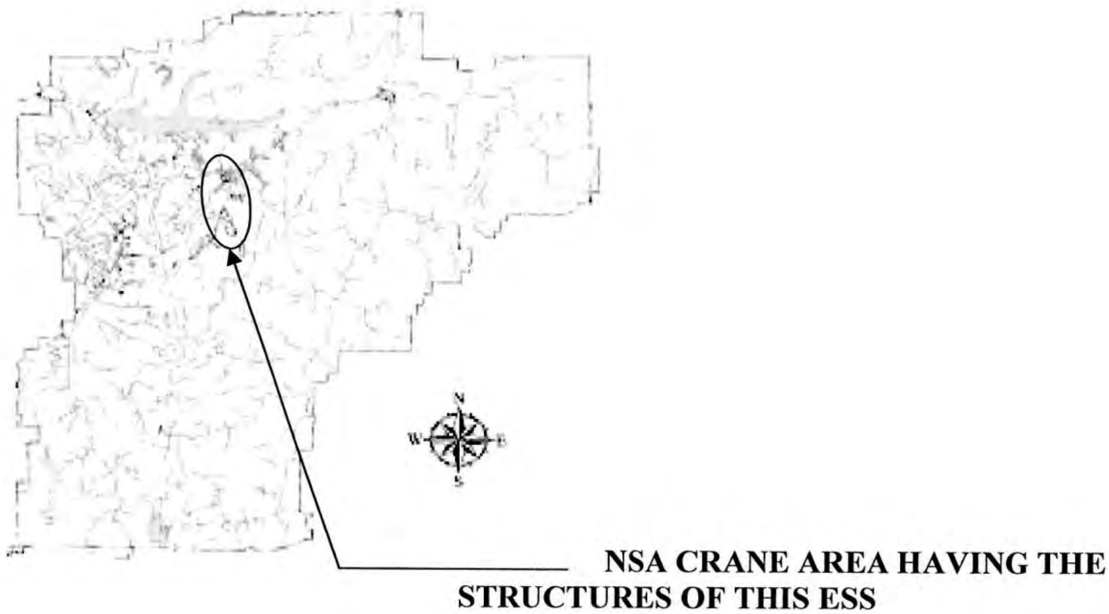



**Figure 3: General Map of the Locations of the Backline, Buildings 1885/1886 and Mine Fill "A" Structures**

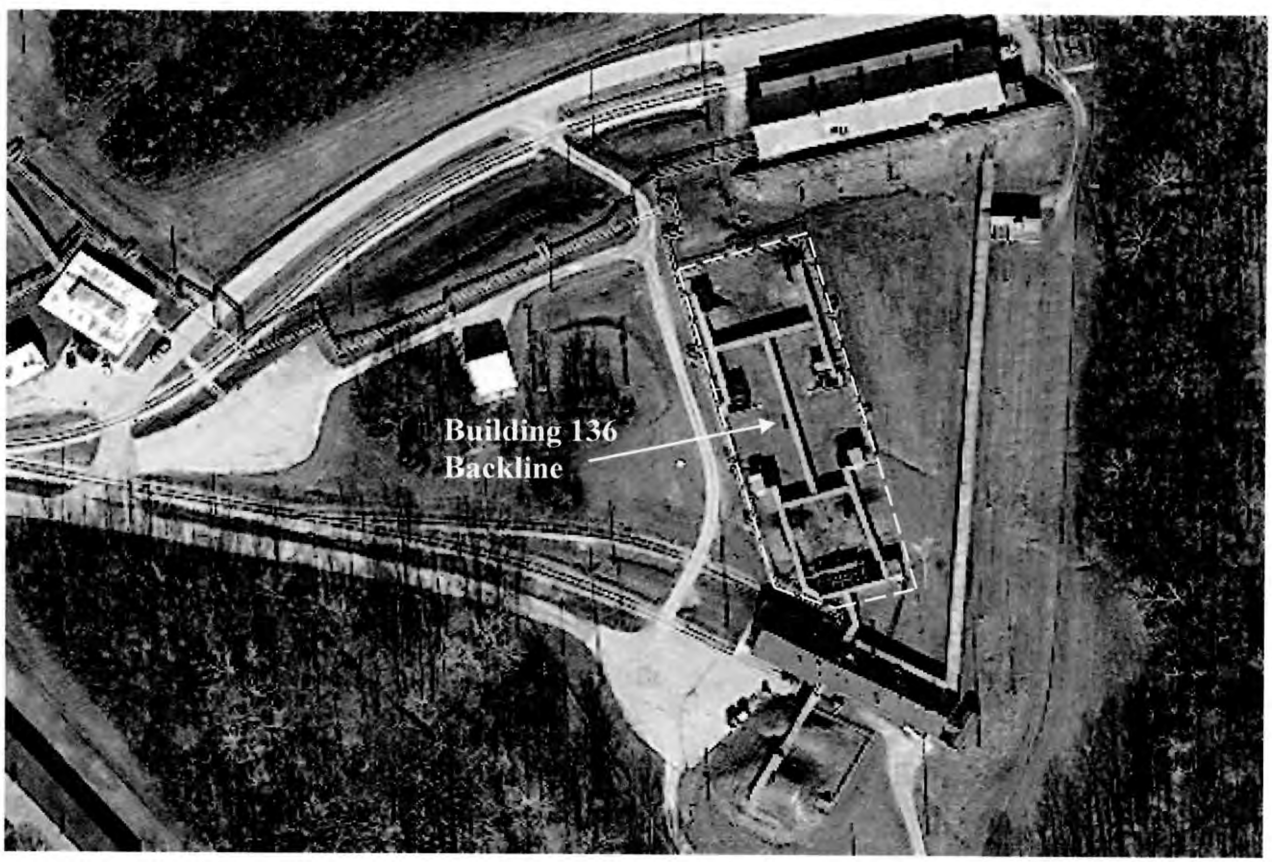



**Figure 4: Overhead View of the Backline and Surrounding Area**

**Figure 5: General Elevation View of the Backline**

## 2.2 Additional Information

### 2.2.1 Areas Containing or Suspected to Contain MPPEH

The three areas scheduled for demolition are suspected of containing MPPEH and are described below by Area and Building Number.

#### 2.2.1.1 Building 136 Backline

**a. Building 2855, Receiving Building.** This structure was used to receive initiating types of explosives in storage containers where the explosive was packed in a combination of water and alcohol (60/40 mix to prevent freezing). The explosive was removed from the container (drum) in jute bags over a stainless steel sink (existing) washed of sawdust on the outside of the bag and then the bag was placed in a stainless steel crock for temporary storage. Contamination should be minimal from this process with only alcohol and water (with some sawdust) entering the external sumps by open drain. The building has sealed lead floors (for static electricity protection) that also drained to the sumps. The stainless steel handling sink and worktable remain in the building. The total interior of the building is covered with paint chips from the walls.


**Building 2855 Viewed from the East.**

The building was constructed of reinforced concrete walls on three sides with a wood and transite fourth wall. The roof is slightly sloped wood with a rubber membrane covering. The floor is a concrete slab overlaid with ¼" lead that extends up a raised curb. There are no drains in the building except for the opening that leads to the two sumps. There is an earth barricade with concrete revetment walls between the building and the other buildings of the Backline. The earth barricade should not illustrate any type of contamination.


**Sink and Tables Inside of Building**

**b. Building 2855, Filling of Drying Tubes.** Building 2855 had another mission beyond that of receiving explosives. It was used to fill glass drying tubes with the explosive being stored in the stainless steel crocks in Magazine 2856. The SOP for the operation described emptying a bag of explosive into an aluminum filter tub and then a process for transferring the explosive in increments to cloth lined glass drying tubes. At different points in the process, water and alcohol washing of parts and equipment to remove trace explosive and this would have been flushed into the open drain to the two sumps outside. The tubes were not ready to be moved to the drying buildings.

**c. Building 2856, Wet Storage Magazine.** This two chamber heated earth covered structure temporarily stored the initiating explosive in stainless steel crocks. The structure is reinforced concrete with two feet of earth cover. The interior was painted and currently the paint is peeling from the walls. There are no drains in the structure but an open drain is located at the end of the surface tunnel in front of the magazine and it connects to two external sumps. No open explosives were processed in this structure. Only a spilled container would be the reason for any explosive contamination. The standard operating procedure was specific on how important cleaning up after a spill was to continued safety of personnel.


**Wet Storage Magazine 2856 Viewed from the Front**

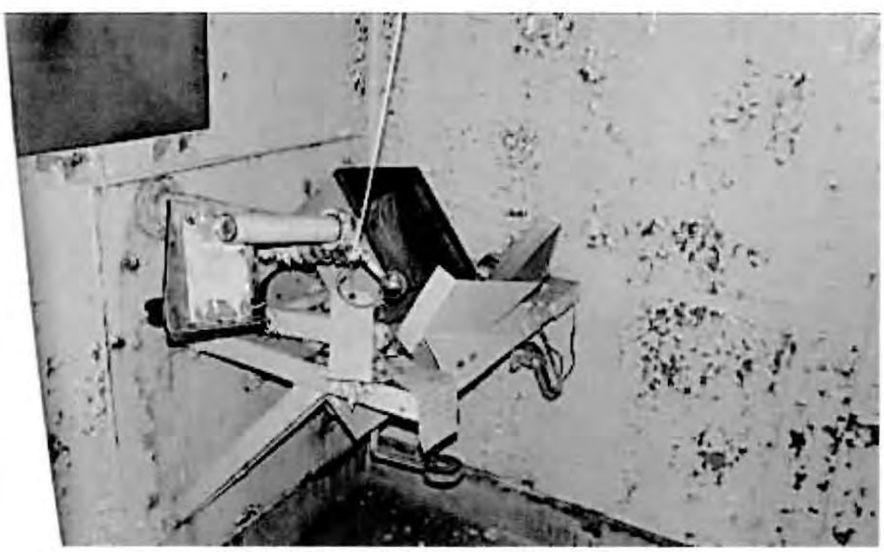
**Wet Storage Magazine 2856 Viewed from Rear**

**One of Two Dry Storage Magazines Shown from the Rear**


**Interior of one of the Dry Storage Magazines**

**g. Building 2863, Bowling/Rebowling & Blending Building.** This was the final processing building of the Backline and was used to transfer the dry initiating explosive from the bulk condition after screening into measured containers for use in Building 136. Explosives were blended in one area, and weighed and placed in bowls in another. All operations within this building were conducted by remote control. The building is of reinforced concrete with several steel shields installed for specialized work. Very small amounts of explosives were associated with the various dry processes conducted within the building. The potential for explosive contamination is low due to the nature of the work required and the discipline of the personnel to clean up any spilled explosive before restarting any process step. The building has a concrete slab floor and a flat rubber membrane roof. There are no floor drains with the washdown water handled by above ground pipes to an external set of two sumps.


**Exterior of the Bowling/Rebowling and Blending Building**
**(Access Tunnel Behind Building is Illustrated)**



**Blending Equipment in Cell**

**Adjacent Blending Process Cell**

**Exterior of Bowling/Rebowling Station Shield**

**Interior of the Same Station**

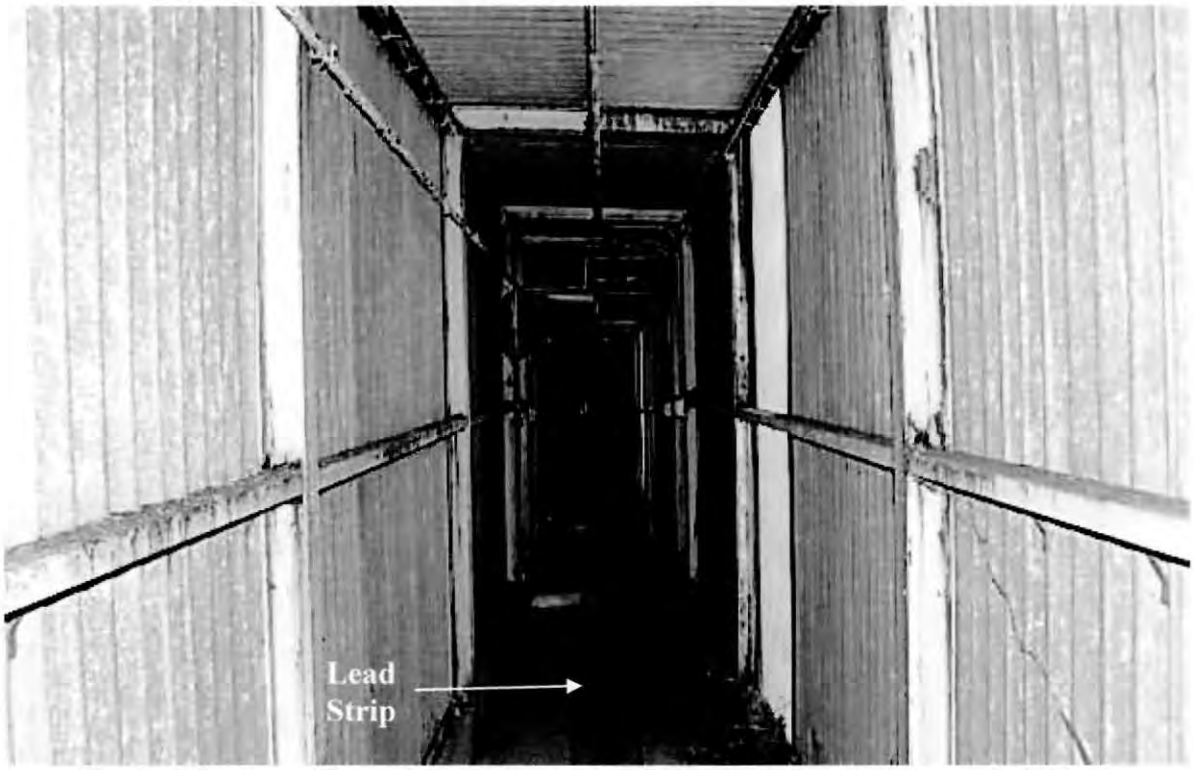
**h. Building 2905, Bottle Washing Building.** This building was added several years after the Backline was established for the purpose of cleaning the various apparatus used throughout the process. It is located to the east of Building 2863 and is constructed of masonry on a concrete slab with a flat rubber membrane roof.

**Building 2905 Viewed from the Northeast Corner**

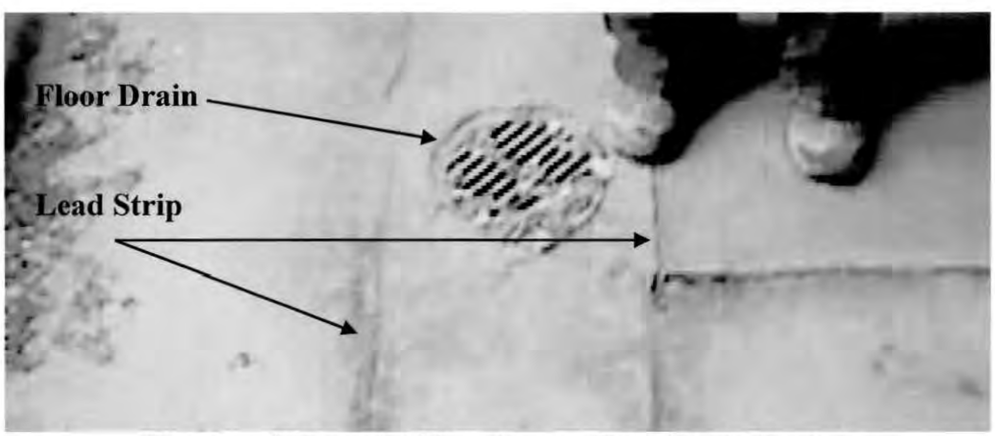
**Interior of Building 2905 Illustrating Sink and Table**

Like the other buildings, this building has no floor drains with the waste water drained to external sumps by an open trench.

**i. Personnel Tunnels.** All of the buildings and magazines previously discussed are connected by a series of personnel tunnels. The tunnels were used to transport explosives by manual powered four wheel cars through the various stages of processing. The tunnels consist of a concrete base that has a 12" wide lead center strip embedded in the concrete for the purpose of bleeding static electricity from the card via a drag chain.




**Typical Runway Tunnel that Connects all Magazines and Process Buildings**



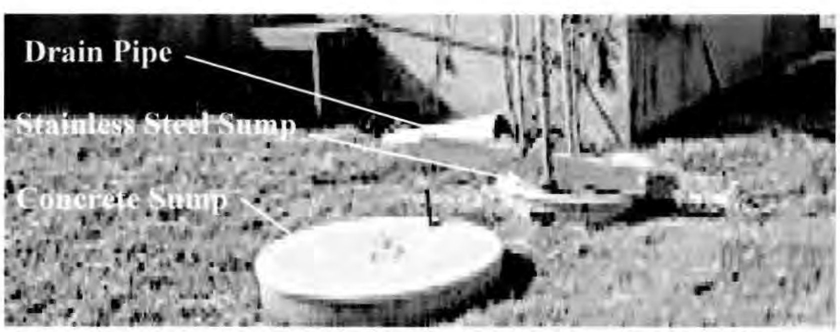

**Personnel Tunnel with only one Floor Drain Found**

The tunnels are free of floor drains except for one found at an intersection between Buildings 2855 and 2857. It connects to the waste water line that will be described later. The walls and roof of the tunnels are corrugated transite attached to a steel frame. One area of the tunnel, adjacent to Building 2863 does have a drain that is open and leads to the sumps behind the building. The need for the two drains described above in an otherwise drain free set of tunnels is not clear.

**Open Drain in Tunnel near Building 2863**

**j. Sumps and Drain Lines.** The seven processing buildings and three places of the personnel tunnels are connected to a drainage system consisting of two different sumps at each building and a buried 6" vitreous clay pipe that originally drained in two places to an open sump or pond but later was altered to drain into a collection tank that connected to the domestic sewer system.

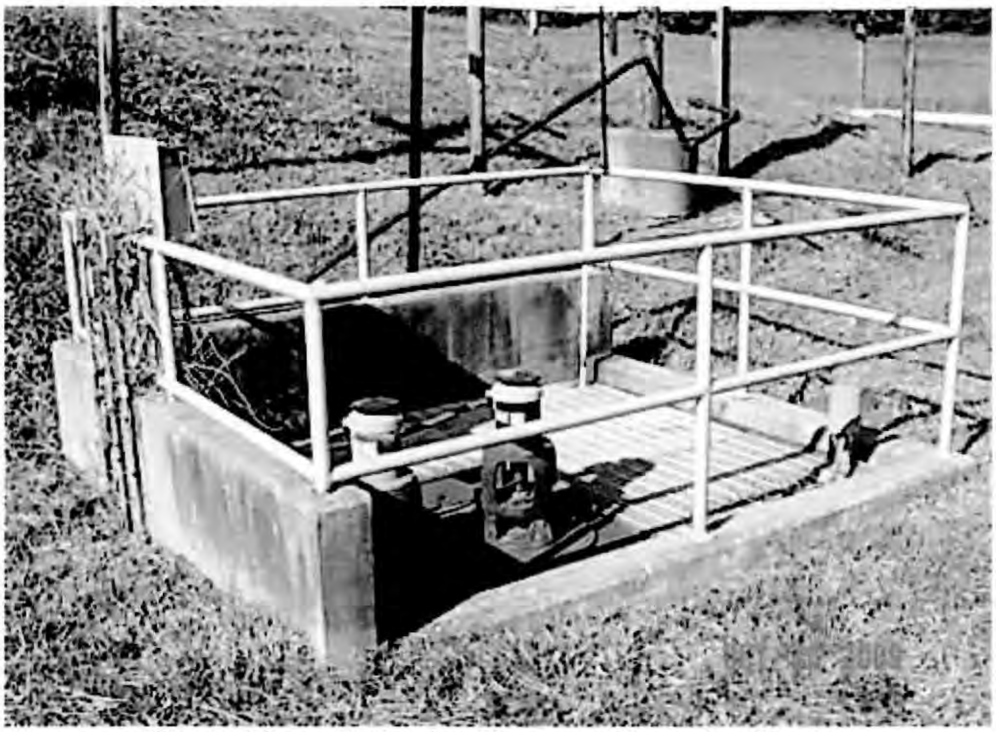
**(1) Sump System.** Each processing building has its own open drain pipe to a round and covered stainless steel sump that then overflowed into a round and covered concrete sump before being connected to the drainage line. A review of the historical information available revealed that a process existed to treat the waste water in the




**Two Sump System is Typical for the Processing Buildings**

stainless steel sump prior to it entering the second settling sump for discharge to the drainage line. The SOP for process, however, could not be retrieved. However, because an SOP existed, there is evidence that the waste explosive did not flow unaltered into the drainage system and to the central pond or later the collection tank.

**(2) Collection Tank.** The first use of the tank was to connect the two segments of underground drainage line to the domestic waste sewer near Building 2520. In the early 1980's the collection tank was altered to a pumping station that fed an explosive waste water treatment system installed in a new building near the Backline site.



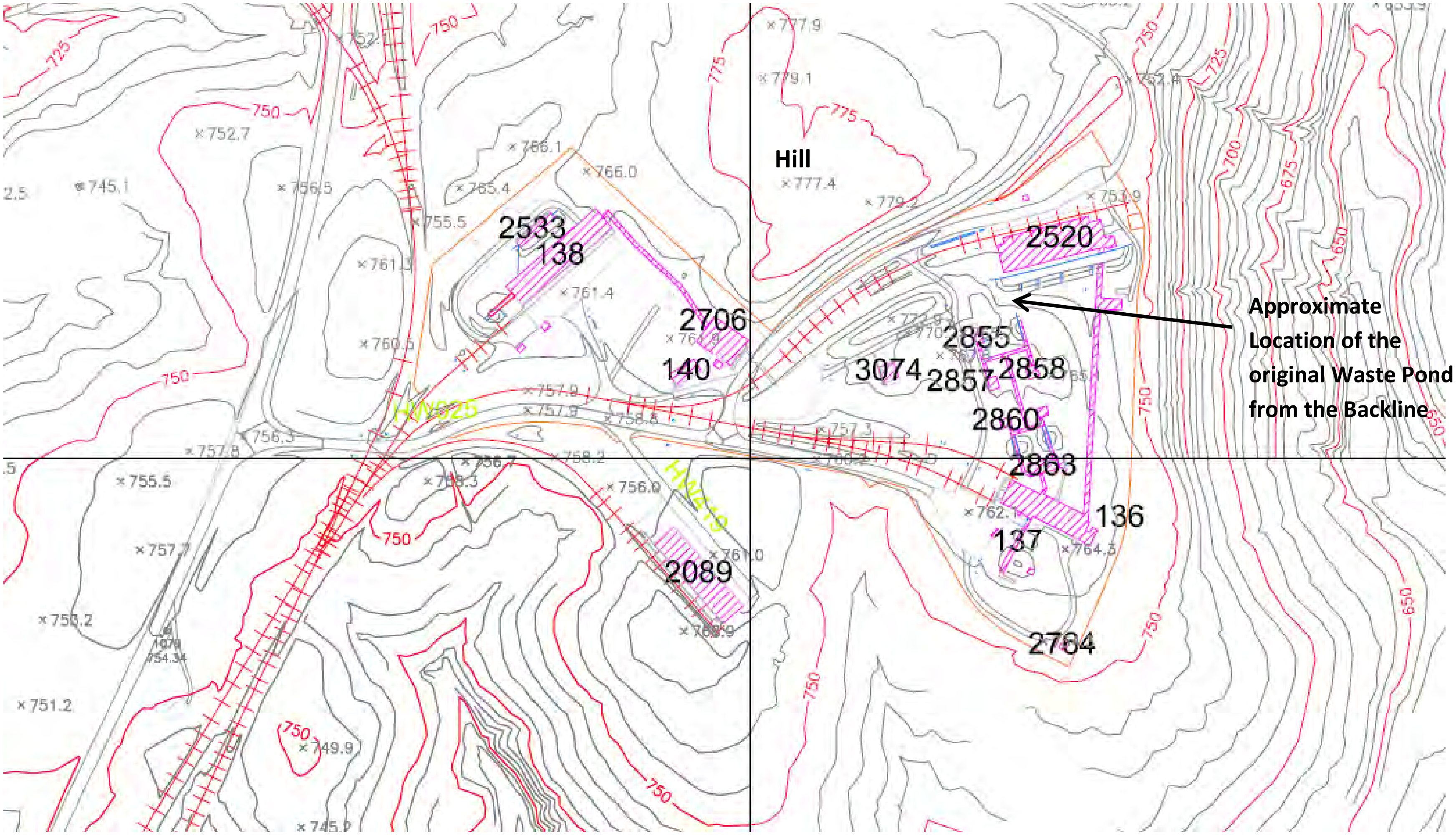
**Waste Water Collection Tank and Pumping Station**

The waste water system was never used due to the shutting down of the Backline that was no longer needed for local production of detonators.

### 2.2.1.2 Buildings 1885 and 1886, Red Phosphorus Composition Mixing

These two buildings are located in the Pyrotechnic Production Area. The two buildings share a common roof with open area between and a wall on one side. The building is constructed of a concrete slab with each building having two cells separated from a control room area by a reinforced concrete wall. The remainder of the building is wood with transite panels inside and asbestos cement shingles on the exterior. The roof is sloped rubber membrane over a wood support structure.

# TOPOGRAPHICAL MAP OF THE BUILDING 136/138/2520 AREA




**The above layout illustrates the area prior to the main structures of the Backline being demolished.**

# UNITED STATES ARMY ENVIRONMENTAL HYGIENE AGENCY

## ABERDEEN PROVING GROUND, MD 21010

AEHA

WATER QUALITY ENGINEERING SPECIAL STUDY NO. 81-24-8806-80 AND
WATER QUALITY BIOLOGICAL STUDY NO. 81-24-8807-80
CRANE ARMY AMMUNITION ACTIVITY
CRANE, INDIANA
4-14 JUNE 1979

Distribution limited to US Government agencies only; protection of privileged information evaluating another command; Apr 80. Other requests for this document must be referred to Commander, Crane Army Ammunition Activity, Crane, IN 47522.

discharges to sumps where it is collected and recycled. Sumps are pumped out as necessary to prevent overflows.

(2) Samples of runoff and sediment were collected from surface drainage ditches, as shown in Figure A-2, on 9 April 1979. Data are reported in Table D-2, Appendix D, this Annex. Sample No. 1 showed a trace of munitions in the aqueous portion; however, the sediment was high in TNT (109 µg/g), RDX (31 µg/g) and HMX (7 µg/g). Sample no. 2 was less than detectable for munitions in both water and sediment. Sample point no. 1 was resampled on 8 June 1979. Traces of TNT in the water and high concentrations in the sediment were confirmed. This drainage channel is apparently contaminated with munitions, although no actual sump overflows were observed during the USAEHA sampling.

c. Booster Area (Explosive Actuating Device Facility). This complex, shown in Figure A-3, is presently used to load military explosive actuating devices such as detonators, boosters and other initiators. Munitions used include tetryl, lead azide, lead styphnate, TNT, RDX or PETN and therefore, may be present as contaminants in wastewaters. Wastewaters are generated during the manufacture of devices as well as equipment and area washdown. The contaminated wastewaters are collected in a number of sumps where munitions are chemically destructed (killed). The overflows are then dumped to a gravel filled earthen pit (Figure A-3).

(1) The USAEHA personnel collected a sample of runoff and sediment from the drainage ditch below the earthen pit on 9 April 1979. The instantaneous flow rate was estimated at less than 0.06 L/s (1 gal/min). There was no evidence of lead or TNT in the aqueous fraction, nor lead concentration greater than typical background levels in the sediment (Table D-3, Appendix D, this Annex). It was learned that this operation was to be studied for corrective action by a contractor, and therefore was omitted from further investigation by this Agency.

(2) Mason and Hanger - Silas Mason Co., Inc., (MHSM) conducted a study (reference 6, Appendix A, this Annex), under contract to the US Navy Northern Division, Naval Facilities Engineering Command, of the operations at this complex which produce wastewaters. This study included characterization of the contents of the earthen pit and surface drainage from the area. They concluded that:

(a) Up to 8700 L (2,300 gal) per week of wastewater are generated by the complex on a 1 shift (8 hr/5 day) operation. Wastewater characteristics are described in Table E-1, Appendix E, this Annex. Significant concentrations of lead (0.22-4.9 mg/L) and RDX (0.19-4.4 mg/L) were measured.

(b) The wastewater seeps from the earthen pit to the adjacent surface drainage ditch. At instantaneous flow rates of 0.05 L/s (0.8

gal/min) they encountered concentrations of lead of 0.19-1.19 mg/L and RDX of 0.02-4.4 mg/L (Table E-2, Appendix E, this Annex). A sediment sample from the drainage ditch was found to contain 2.86 percent lead on a dry weight basis (Table E-3, Appendix E, this Annex).

(c) Adjustment of wastewater pH to 8.5 and filtration was effective in lead removal, indicating that chemical treatment of the wastewater to produce a satisfactory effluent is feasible.

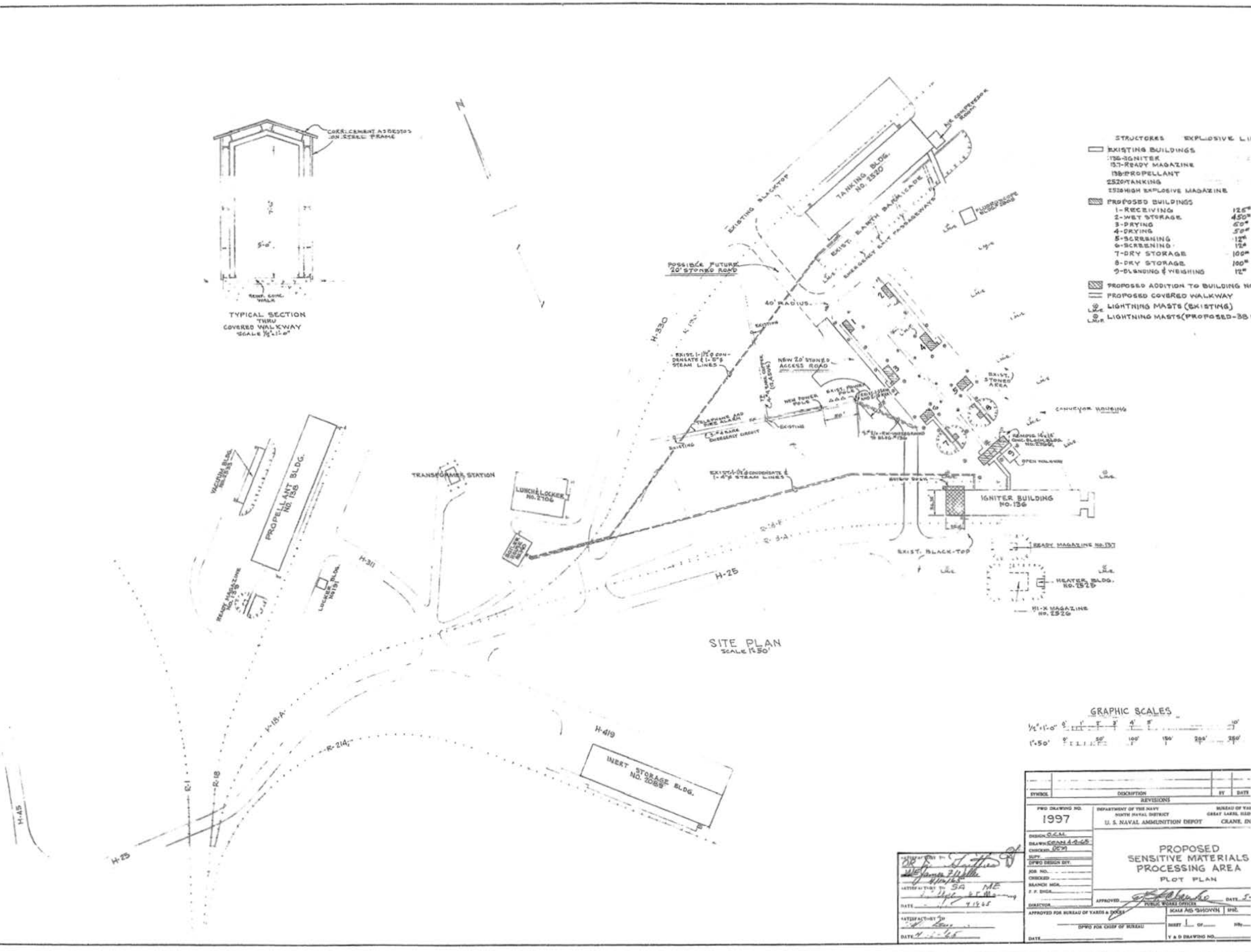
(d) The existing wastewater disposal system (earthen pit) should be abandoned and removed. Two alternative substitutes are: batch chemical treatment with discharge to sanitary sewers or surface drainage; and lagoon storage with forced evaporation to effect a zero discharge. The MHSM recommends the former approach.

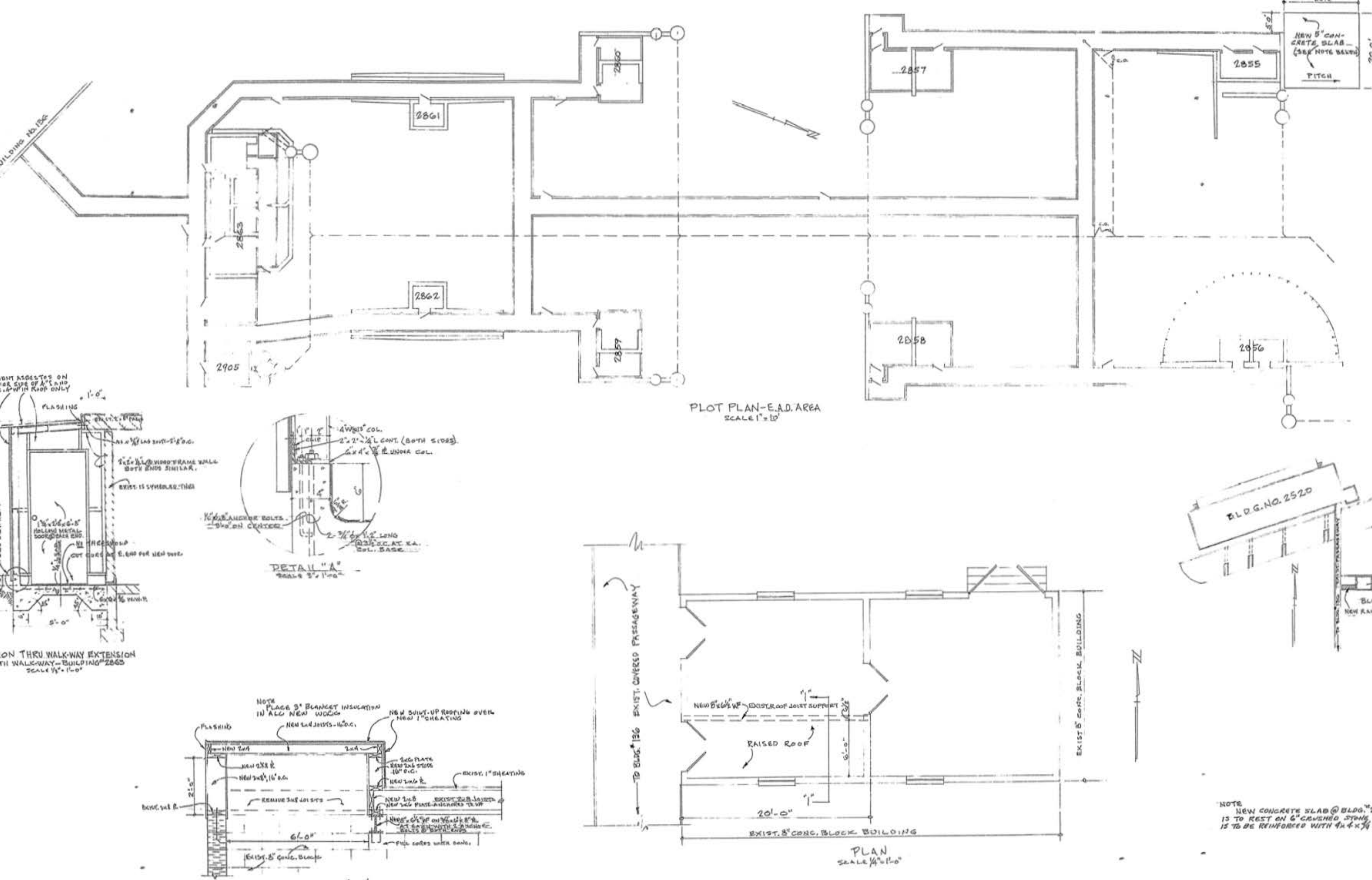
(e) This Agency concurs with the MHSM conclusions and recommendations. However, additional laboratory testing to verify the effectiveness of chemical treatment is necessary. Treatment must be effective not only for lead removal but also for other wastewater constituents which may be of concern (RDX, cerium, etc). The treatment process should produce a nontoxic effluent for discharge. Sludge from the treatment process will likely be environmentally hazardous and must be managed as per hazardous waste guidelines. These comments have been made in formal design reviews prior to publication of this report (reference 12, Appendix A, this Annex).

d. <u>Mine Fill A</u>. This munitions production line was used extensively in the past for cast loading of bombs and mines with composition B, TNT, HBX etc. However, it is presently inactive except for heat treating of Rockeye bomb casings and other miscellaneous operations which do not generate contaminated wastewaters. A new exhaust ventilation wet scrubber collection system, a contaminated wastewater collection system, and a wastewater filtration and recirculation system have been installed but have not been needed or used. The general layout and relationship to surface drainage is shown in Figure A-4.

(1) During the preliminary visit, on 9 April 1979, water and sediment samples were collected from the two major drainage channels which carry runoff form the area leading to Turkey Creek. Sample points are located on Figure A-4. A sample was also taken from the new (unused) contaminated wastewater collection basin. None of the samples contained any munitions. No other measured substances were present in significant concentrations above normal background levels. Data are contained in Table D-4. Therefore, no further data were collected.

(2) Building 160 is located at the northern end of the Mine Fill A complex, Figure A-5. This is a demilitarization facility using hot water and


CORR. CEMENT ASBESTOS ON STEEL FRAME
TYPICAL SECTION THRU COVERED WALKWAY
SCALE ½"=1'-0"
STRUCTURES
EXPLOSIVE LI
EXISTING BUILDINGS
136-IGNITER
137-READY MAGAZINE
138-PROPELLANT
2520-TANKING
2526-HIGH EXPLOSIVE MAGAZINE
PROPOSED BUILDINGS
1-RECEIVING 125#
2-WET STORAGE 450#
3-DRYING 50#
4-DRYING 50#
5-SCREENING 12#
6-SCREENING 12#
7-DRY STORAGE 100#
8-DRY STORAGE 100#
9-BLENDING & WEIGHING 12#
PROPOSED ADDITION TO BUILDING NO
PROPOSED COVERED WALKWAY
LIGHTNING MASTS (EXISTING)
LIGHTNING MASTS (PROPOSED-38
TANKING BLDG. NO. 2520
EXISTING BLACKTOP
EXIST. EARTH BARRICADE
EMERGENCY EXIT PASSAGEWAYS
AIR COMPRESSOR ROOM
POSSIBLE FUTURE 20' STONED ROAD
40' RADIUS
NEW 20' STONED ACCESS ROAD
EXIST. STONED AREA
CONVEYOR HOUSING
OPEN WALKWAY
IGNITER BUILDING NO. 136
READY MAGAZINE NO. 137
HEATER BLDG. NO. 2525
HI-X MAGAZINE NO. 2526
EXIST. BLACK-TOP
TRANSFORMER STATION
LUNCH & LOCKER NO. 2706
PROPELLANT BLDG. NO. 138
VACUUM BLDG.
READY MAGAZINE NO. 139
LOCKER BLDG.
INERT STORAGE BLDG. NO. 2089
H-330
H-311
H-25
H-419
H-45
R-18
R-214
SITE PLAN
SCALE 1"=50'
GRAPHIC SCALES
½"=1'-0"
1"=50'
SYMBOL
DESCRIPTION
BY
DATE
REVISIONS
PWO DRAWING NO.
1997
DEPARTMENT OF THE NAVY
NINTH NAVAL DISTRICT
U. S. NAVAL AMMUNITION DEPOT
CRANE, IN
PROPOSED
SENSITIVE MATERIALS
PROCESSING AREA
PLOT PLAN
APPROVED
PUBLIC WORKS OFFICER
APPROVED FOR BUREAU OF YARDS & DOCKS
DPWO FOR CHIEF OF BUREAU
SCALE AS SHOWN
SHEET 1 OF
Y & D DRAWING NO.




**DESIGN APPROVED**
BY
WEAPONS PRODUCTION ENGINEERING CENTER (WPEC) CRANE INDIANA
J. R. ROACH
DATE 25 FEB 69 NO. A-110

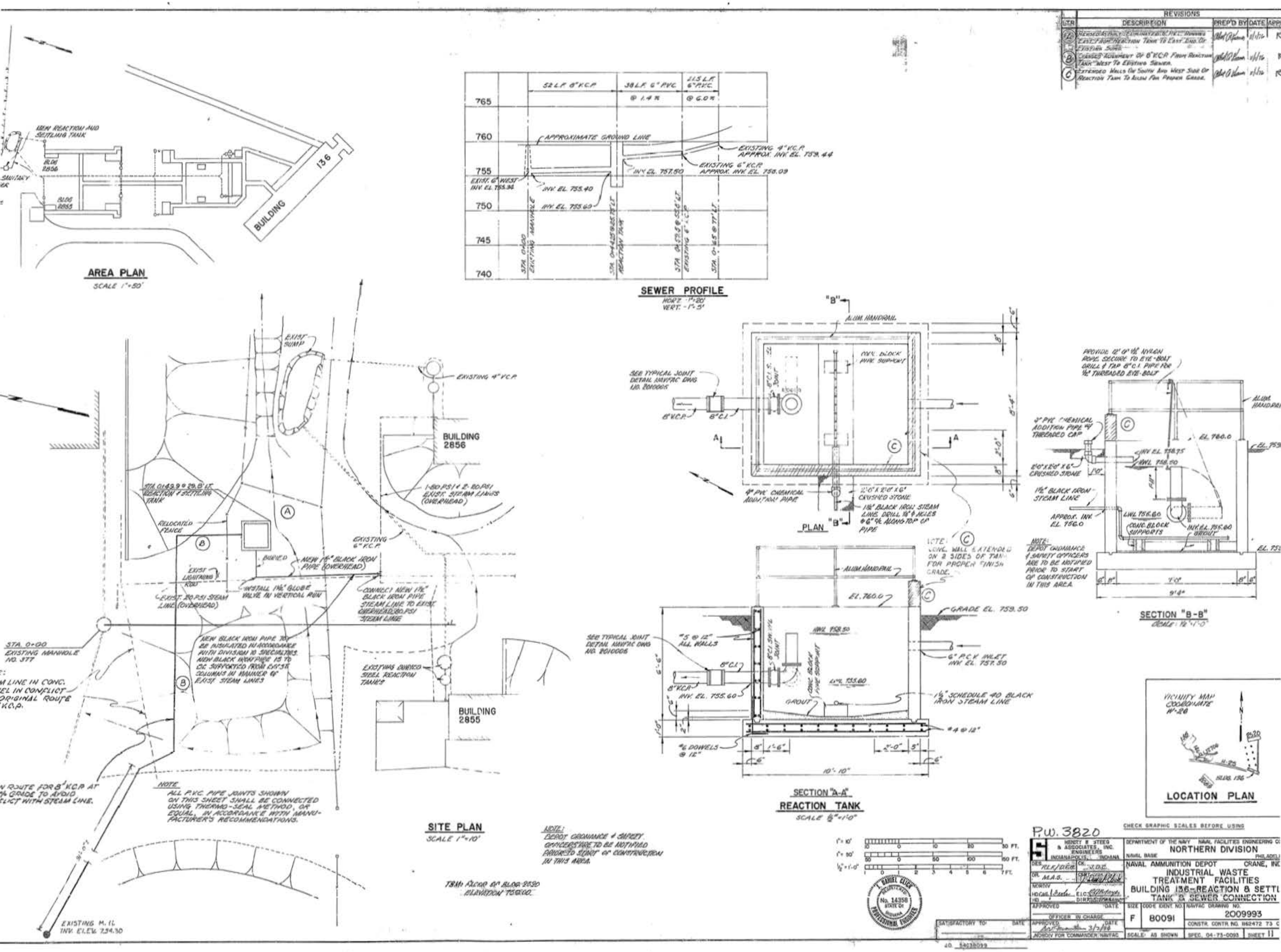
| | | |
|---|---|---|
| SATISFACTORY TO | DATE 2/25/69 | |
| SATISFACTORY TO | DATE 2/25/69 | |
| SATISFACTORY TO OR | DATE 2/25/69 | |

PWD DWG REF
PWD DRAWING NO. 2455
DESIGN O.C.M. TEC & SPC
DRAWN COAN 2/11/69
CHECKED
SUPV.
APPROVED — PUBLIC WORKS OFFICER — DATE
APPROVED — FOR COMMANDER NAVFAC — DATE

DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND
MIDWEST DIVISION — GREAT LAKES, ILLINOIS
NAVAL AMMUNITION DEPOT — CRANE, INDIANA

WALKWAY EXTENSION & RAISED ROOF CHANGES @ E.A.D. AREA
BUILDINGS 2863 & 2805

SIZE F — CODE IDENT. NO. 80091 — NAVFAC DRAWING NO.
CONSTR. CONTR. NO.
SCALE AS NOTED — SPEC. NO. — SHEET 1



REVISIONS
LTR
DESCRIPTION
PREP'D BY
DATE
APPR
52 L.F. 8" V.C.P.
38 L.F. 6" P.V.C. @ 1.4 %
11.5 L.F. 6" P.V.C. @ 6.0 %
APPROXIMATE GROUND LINE
EXISTING 4" V.C.P. APPROX. INV. EL. 759.44
EXISTING 6" V.C.P. APPROX. INV. EL. 755.09
INV. EL. 757.50
EXIST. 6" WEST INV. EL. 755.34
INV. EL. 755.40
INV. EL. 755.60
765
760
755
750
745
740
STA. 0+00 EXISTING MANHOLE
REACTION TANK
EXISTING 6" V.C.P.
SEWER PROFILE
HORZ. - 1"=20'
VERT. - 1"=5'
NEW REACTION AND SETTLING TANK
BLDG 2856
BLDG 2855
SANITARY
BUILDING 136
AREA PLAN
SCALE 1"=50'
EXIST. SUMP
EXISTING 4" V.C.P.
BUILDING 2856
BUILDING 2855
1-80 PSI & 2-20 PSI EXIST. STEAM LINES (OVERHEAD)
RELOCATED FENCE
BURIED
EXISTING 6" V.C.P.
NEW 1½" BLACK IRON PIPE (OVERHEAD)
EXIST. LIGHTNING ROD
INSTALL 1½" GLOBE VALVE IN VERTICAL RUN
CONNECT NEW 1½" BLACK IRON PIPE STEAM LINE TO EXIST. OVERHEAD 80 PSI STEAM LINE
EXIST. 20 PSI STEAM LINE (OVERHEAD)
STA. 0+00 EXISTING MANHOLE NO. 377
EXISTING CONCRETE STEEL REACTION TANKS
EXISTING M.H. INV. ELEV. 734.30
NOTE
ALL P.V.C. PIPE JOINTS SHOWN ON THIS SHEET SHALL BE CONNECTED USING THERMO-SEAL METHOD, OR EQUAL, IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS.
SITE PLAN
SCALE 1"=10'
NOTE:
DEPOT ORDNANCE & SAFETY OFFICERS ARE TO BE NOTIFIED PRIOR TO START OF CONSTRUCTION IN THIS AREA.
TBM: FLOOR OF BLDG. 2530 ELEVATION 756.00
"B"
ALUM. HANDRAIL
CONC. BLOCK PIPE SUPPORT
SEE TYPICAL JOINT DETAIL NAVFAC DWG NO. 2010005
8" V.C.P.
8" C.I.
4" PVC CHEMICAL ADDITION PIPE
2'-0" X 2'-0" X 6" CRUSHED STONE
1½" BLACK IRON STEAM LINE. DRILL ⅛" Ø HOLES @ 6" ⅊ ALONG TOP OF PIPE
PLAN
NOTE: CONC. WALL EXTENDED ON 2 SIDES OF TANK FOR PROPER FINISH GRADE.
EL. 760.0
GRADE EL. 759.50
HWL 758.50
LWL 755.60
"5 @ 12" ALL WALLS
6" P.C.V. INLET INV. EL. 757.50
8" V.C.P. INV. EL. 755.60
GROUT
1½" SCHEDULE 40 BLACK IRON STEAM LINE
#4 @ 12"
#6 DOWELS @ 12"
10'-10"
SECTION "A-A"
REACTION TANK
SCALE ½"=1'-0"
PROVIDE 12' 0" ½" NYLON ROPE. SECURE TO EYE-BOLT. DRILL & TAP 8" C.I. PIPE FOR ½" THREADED EYE-BOLT
4" PVC CHEMICAL ADDITION PIPE W/ THREADED CAP
EL. 760.0
INV. EL. 758.75
HWL 758.50
2'-0" X 2'-0" X 6" CRUSHED STONE
1½" BLACK IRON STEAM LINE
APPROX. INV. EL. 756.0
LWL 756.60
CONC. BLOCK SUPPORTS
INV. EL. 755.60
GROUT
NOTE: DEPOT ORDNANCE & SAFETY OFFICERS ARE TO BE NOTIFIED PRIOR TO START OF CONSTRUCTION IN THIS AREA.
7'-0"
9'-4"
SECTION "B-B"
SCALE ½"=1'-0"
VICINITY MAP COORDINATE H-26
LOCATION PLAN
CHECK GRAPHIC SCALES BEFORE USING
P.W. 3820
HENRY B. STEEG & ASSOCIATES, INC. ENGINEERS INDIANAPOLIS, INDIANA
DEPARTMENT OF THE NAVY NAVAL FACILITIES ENGINEERING COMMAND
NORTHERN DIVISION
NAVAL AMMUNITION DEPOT CRANE, IND.
INDUSTRIAL WASTE TREATMENT FACILITIES
BUILDING 136-REACTION & SETTLING TANK & SEWER CONNECTION
SIZE F
CODE IDENT. NO. 80091
NAVFAC DRAWING NO. 2009993
SPEC. 04-73-0093
SHEET 11
SCALE: AS SHOWN
APPROVED
OFFICER IN CHARGE
SATISFACTORY TO
No. 14358 STATE OF INDIANA PROFESSIONAL ENGINEER

## Appendix C
## Site Interview Aerial Photos

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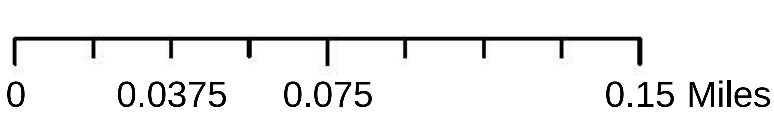
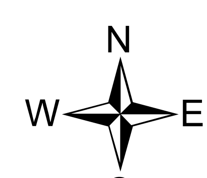
# UXO 9 - 1966 Aerial Photo



# UXO 9 - 2012 Aerial Photo

0 0.0375 0.075 0.15 Miles

N
W E
S

# Appendix D
# Visual Site Inspection Photos

***Photo 1:*** Approximate location of sample 22SW013 at Solid Waste Management Unit 22. Picture is looking to the southwest.

***Photo 2:*** Another view of sample location 22SW013, looking to the southeast.

***Photo 3:*** Large drainage channel upslope from sample location 22SW013.

***Photo 4:*** Smaller drainage channel upslope of sample location 22SW013.

*Photo 5:* Concrete lined drainage channel adjacent to Highway 99 and downstream from sample location 22SW013. Picture is looking to the southwest.

*Photo 6:* View of typical heavily wooded slopes in the area of UXO 0009.

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