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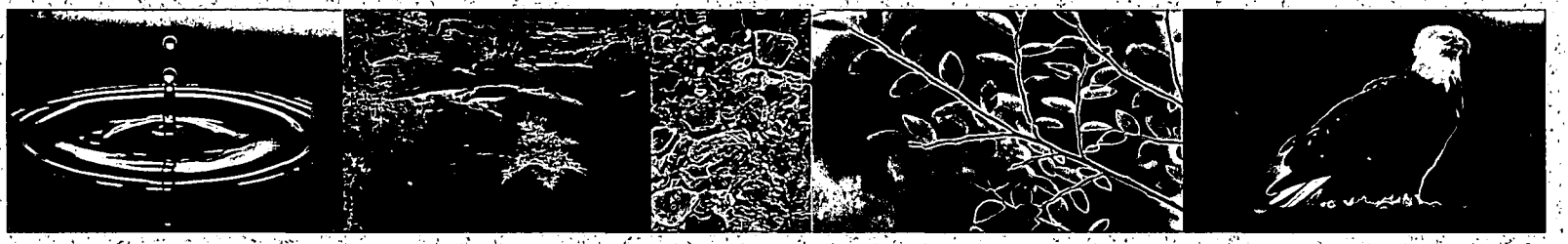

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CORRECTIVE MEASURES STUDY
for
SOLID WASTE MANAGEMENT UNIT 3 (AMMUNITION BURNING GROUNDS)

VOLUME I - TEXT

Naval Surface Warfare Center
Crane, Indiana

Contract Task Order 0311

November 2005

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ACRONYMS

°F	degrees Fahrenheit
2A-DNT	2-amino-4,6-dinitrotoluene
4A-DNT	4-amino-2,6-dinitrotoluene
ABG	Ammunition Burning Grounds
AET	Apparent Effects Threshold
AHPA	Archaeological and Historic Preservation Act
ARAR	Applicable or Relevant and Appropriate Requirement
AUF	area use factor
B&R Environmental	Brown and Root Environmental
BC/BC	Big Clifty Sandstone/Beech Creek
BCF	bioconcentration factor
BGEPA	Bald and Gold Eagle Protection Act
CAAA	Crane Army Ammunition Activity
CAC	chronic aquatic criteria
CAO	Corrective Action Objective
CCCRA	Current Contamination Conditions Risk Assessment
CEC	cation exchange capacity
CFR	Code of Federal Regulations
CLEAN 3	Comprehensive Long-Term Environmental Action Navy
CMA	Corrective Measures Alternative
CMS	Corrective Measures Study
COCs	chemicals of concern
COPCs	contaminants of potential concern
CTO	Contract Task Order
CWA	Clean Water Act
DCE	cis-1,2-dichloroethene
DNT	dinitrotoluene
DOT	Department of Transportation
EDQLs	Ecological Data Quality Levels
EEQs	Ecological Effects Quotient
EMR	Environmental Monitoring Report
EO	Executive Order
EPT	Ephemeroptera, Plecoptera, Trichoptera

ERA	Environmental Risk Assessment
ft^3/s	cubic feet per second
G-H	Golconda-Haney
gpm	gallons per minute
HEAST	Health Effects Assessment Summary Table
HHRA	human health risk assessment
HHRE	human health risk evaluation
HI	Hazardous Index
HLSC	human life cycle safe concentration
HMX	Hexahydro-1,3,5-trinitro-1,3,5-trizine
IAC	Indiana Administrative Code
IAS	Initial Assessment Study
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
IERA	Indiana Environmental Remediation Act
IESA	Indiana Non-game and Endangered Species Conservation Act
ILCR	Incremental Lifetime Cancer Risk
in/yr	inches per year
IR	Installation Restoration
IRIS	Integrated Risk Information System
ISWMB	Indiana Solid Waste Management Board
IWR	Indiana Wildlife Regulation
kg	kilograms
kg/day	kilograms per day
Kow	partition coefficient
L	liters
LDR	Land Disposal Restriction
LOAEL	lowest-observed-adverse effect level
LSC	Little Sulfur Creek
LUCs	land use controls
MCL	Maximum Concentration Level
MCS	media cleanup standard
MF	modifying factor
mg/day	milligrams per day
mg/kg	milligram per kilogram
mg/kg/day	milligrams per kilogram per day

mph	miles per hour
msl	mean sea level
MTA	Main Treatment Area
NAD	Naval Ammunition Depot
NAVFAC	Navy Southern Division Naval Facilities Engineering Command
NCEA	National Center for Environmental Assessment
NEESA	Naval Energy and Environmental Support Activity
NOAA	National Oceanic and Atmospheric Administration
NOAEL	No-Observable-Adverse-Effects-Level
NPDES	National Pollution Discharge Elimination System
NSWC	Naval Surface Warfare Center
NTUs	nephelometric turbidity units
NWSC	Naval Weapons Support Center
OJT	Old Jeep Trail
PBT	persistent, bioaccumulative, and toxic
PRG	Preliminary Remediation Goal
QAPP	Quality Assurance Project Plan
RBC	Risk-Based Concentration
RBTL	risk based target level
RCRA	Resource Conservation and Recovery Act
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RFA	RCRA Facility Assessment
RfD	Reference Dose
RFI	RCRA Facility Investigation
Secretary	United States Secretary of the Interior
SSLs	Soil Screening Levels
SVOCs	semivolatile organic compounds
SWMU 2	Dye Burial Grounds
SWMU 3	Ammunition Burning Grounds/Old Jeep Trail/Little Sulfur Creek
SWMU	solid waste management unit
TAL	target analyte list
TBC	To Be Considered
TCA	tetrachloroethane
TCE	trichloroethylene
TLSC	terrestrial life cycle safe concentration
TNT	2,4,6-trinitrotoluene

TOC	total organic carbon
TtNUS	Tetra Tech NUS, Incorporated
U.S. EPA	United States Environmental Protection Agency
U.S.	United States
UF	uncertainty factor
USACE	U.S. Army Corps of Engineers
USGS	United States Geological Survey
UST	underground storage tank
VOC	Volatile Organic Compound
WES	Waterways Experimental Station
WQBEL	water quality-based effluent limitations
WQS	water quality standards
yd^3	cubic yards
µg/L	microgram per liter

1.0 INTRODUCTION

1.1 SCOPE AND OBJECTIVES

This Corrective Measures Study (CMS) Report was prepared for the solid waste management unit (SWMU), 3 [Ammunition Burning Grounds (ABG)] Main Treatment Area (MTA), Old Jeep Trail (OJT), and Little Sulfur Creek (LSC) at the Naval Surface Warfare Center (NSWC) facility located in Crane, Indiana for the United States (U.S.) Navy Naval Facilities Engineering Command, Engineering Field Division South (NAVFAC EFD SOUTH) under Contract Task Order (CTO) 0311, of the Comprehensive Long-Term Environmental Action Navy (CLEAN) 3, Contract Number N62467-94-D-0888. SWMU 3 consists of the MTA, the OJT, and LSC.

This work is part of the Navy's Installation Restoration (IR) Program, which is designed to identify contamination of Navy and Marine Corps lands/facilities resulting from past operations and to institute corrective measures, as needed. There are typically four distinct phases. Phase 1 is the Preliminary Assessment [formerly known as the Initial Assessment Study (IAS)]. Phase 2 is a Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA), which augments the information collected in the Preliminary Assessment. Phase 3 is the RCRA Facility Investigation (RFI)/CMS, which characterizes the contamination at a facility and develops options for remediation of the site. Phase 4 is the Corrective Measures Implementation, which results in the control or cleanup of contamination at the sites. This report has been prepared under Phase 3. The Indiana Department of Environmental Management (IDEM) is the lead oversight agency. However, under a work-sharing agreement, U.S. Environmental Protection Agency (U.S. EPA) Region 5 is responsible for the FRI/CMS phases at SWMU 3.

This work was conducted in accordance with the requirements of the Indiana State RCRA Hazardous Waste Permit for the facility (IN5170023498), which went into effect on January 13, 2000.

The corrective measures action and objectives of the CMS are as follows:

- Identify Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) criteria.
- Identify risk-based action levels that are protective of human health and the environment.

- Develop Corrective Action Objectives (CAOs), which identify chemicals of concern (COCs), potential receptors, pathways, and media cleanup standards (MCSs). The MCSs are based on chemical-specific ARARs, TBC criteria, and risk-based action levels. The receptors are based on appropriate regulatory requirements.

- Identify and screen corrective measures technologies.

- Develop Corrective Measures Alternatives (CMAs).

- Conduct detailed analysis of CMAs.

The MTA is permitted by U.S. EPA Region 5 as a treatment facility for hazardous waste munitions, explosives, and pyrotechnics and is subject to the groundwater monitoring and corrective action requirements of 40 Code of Federal Regulations (CFR) 264 Subpart F (i.e., the MTA is an active RCRA-permitted hazardous waste treatment facility). These regulations require corrective actions for any groundwater contamination resulting from the treatment operations. Additionally, all RCRA-permitted facilities are subject to RCRA closure requirements; therefore, at the end of the active life of the MTA, the MTA is required to either be clean closed or closed as a RCRA landfill. Thus, for the MTA, the CMS will deal with risks to current receptors (i.e., site worker, construction worker, and trespasser).

RFI studies had been conducted by the US Army Corps of Engineers (USACE) for groundwater, soils, and surface waters at the MTA. These studies recommended that corrective measures be considered to address explosives, chlorinated solvent, and metals contamination in soils, groundwater, and surface waters (Murphy, 1994; Murphy and Wade, 1998; Albertson et al., 1998).

The OJT portion of SWMU 3 is currently inactive. The RFI Report for the OJT and LSC recommended that a CMS be conducted to address explosives, chlorinated solvent, and metals contamination in groundwater and soils at the OJT (TtNUS, 2005a).

A draft Conceptual Site Model and Fieldwork Report was developed for SWMU 3 (TtNUS, 2005b). The Field Report portion of the Conceptual Site Model and Fieldwork Report describes and documents the site investigation activities conducted in April 2004 and presents the results and interpretation thereof for SWMU 3. The Conceptual Site Model portion of the draft Conceptual Site Model and Fieldwork Report describes the geology, hydrology, groundwater contamination sources, fate and transport of contamination and is the basis for developing, evaluating, and choosing the corrective measures presented in this CMS.

1.2 ORGANIZATION OF THE CMS

This CMS Report consists of six sections and supporting appendices. Section 1.0 is an introduction. Section 2.0 provides a description of current conditions of the MTA, OJT, and LSC. This section also includes the follow-on human health and ecological risk assessments that further develop the risk assessments presented in the RFI Report (TtNUS, 2005a) as well as a summary of the draft Conceptual Site Model and Fieldwork Report (TtNUS, 2005b). Since the development of the draft Conceptual Site Model and Fieldwork Report, a further understanding of the site geology, hydrology, groundwater contamination sources, contamination fate and transport, and regulatory applicability for SWMU 3 has been developed; therefore, the Conceptual Site Model discussed in Section 2.0 has been updated to include these understandings. Section 3.0 identifies the ARARs, TBCs, COCs, and MCSs; provides volumes of contaminated media; and identifies CAOs for the MTA, OJT, and LSC. Section 4.0 provides the identification and screening of corrective measure technologies for each medium (soil, groundwater, etc.) at the MTA, OJT, and LSC. Sections 5.0 and 6.0 present the development/evaluation and comparative analysis and recommendation of corrective measures alternatives, respectively.

1.3 ACTIVITY BACKGROUND INFORMATION

1.3.1 Location

1.3.1.1 Facility

SWMU 3 is located in the eastern portion of NSWC Crane along LSC. NSWC Crane is located in a rural, sparsely populated region of south-central Indiana, approximately 75 miles southwest of Indianapolis and 71 miles northwest of Louisville, Kentucky (Figure 1-1) immediately east of Crane Village and Burns City. NSWC Crane encompasses 62,463 acres (approximately 98 square miles), most of which is located in the northern portion of Martin County. Smaller portions are located in Greene, Daviess, and Lawrence Counties. Most of NSWC Crane is forested, and the surrounding area is wooded or farmed land.

1.3.1.1 MTA, OJT, and LSC

The MTA portion of the SWMU 3 is located at the headwaters of LSC (Figure 1-2). The OJT area is located in the valley of LSC, approximately one-half mile south-southeast of the MTA on Jeep Trail 25 (Figure 1-2).

1.3.2 Facility History

This section provides general information on the history of NSWC Crane and its activities.

1.3.2.1 History of Ownership and Operation

The NSWC Crane facility was commissioned on December 1, 1941 as the Naval Ammunition Depot (NAD), Burns City. Its initial mission was to prepare, load, renovate, receive, store, and issue all types of ammunition, including pyrotechnics and illuminating projectiles, and act as a principal supply source at a critical time during the early days of World War II. In May 1943, the depot was renamed the Naval Ammunition Depot Crane, in honor of Commodore William Montgomery Crane, the Navy's first chief of the Bureau of Ordnance. The name changed again in 1975 to the Naval Weapons Support Center (NWSC) Crane to reflect the facility's growing involvement in high-technology weapons systems. In 1977, the Secretary of Defense combined all conventional ammunition acquisition under the responsibility of a single service. The ammunition production and storage function was given to the Army, and the Crane Army Ammunition Activity (CAAA) was established as a Crane tenant to accomplish this task for Naval ammunition. In 1992, the facility name was changed to NSWC Crane. The Army has assumed ordnance production, storage, and related responsibilities under the single-service management directive. All environmental activities on the installation, including permitting activities, remain the responsibility of the Navy. Information regarding operations conducted at the ABG MTA and the OJT is provided in Sections 1.3.1.2 and 1.3.1.3.

1.3.1.2 MTA Operations

1.3.1.2.1 Historical and Present Day Operations

surface impoundment

The MTA portion of SWMU 3 is used extensively to destroy unwanted materials contaminated with explosives and related materials. Several separate treatment units are located within the site (Figure 1-3). The largest quantities of materials were treated at the MTA from 1956 to 1960, when 15,000 pounds per day of smokeless powder were flashed. In the same period, about 46,000 pounds per day of high explosives were burned.

Prior to the construction and use of lined and unlined steel pans for open burning operations, explosives and propellants and materials contaminated with explosives and propellants were spread and ignited on pads or in pits at the MTA. Many of these burn pads and pits were reportedly located in the area now occupied by the clay-lined steel burn pans (see Unit No. 3 on Figure 1-3). However, others were located throughout the MTA.

Three unlined surface impoundments were used to remove liquids from otherwise combustible sludges resulting from the blending and loading of munitions. In 1982, each impoundment was modified to include a liner and leachate collection system. Each of the impoundments was approximately 40 feet in diameter. Two impoundments held 2,4,6-trinitrotoluene (TNT), hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), and breakdown compounds in water from a facility munitions plant (Rockeye) and other locations within NSWC Crane. A third impoundment held phosphorus compounds. The three impoundments have been replaced by (no longer present) dewatering units (see Units 10 and 11 on Figure 1-3). The impoundments are now empty and are scheduled for closure.

Two empty underground storage tanks (USTs) were used to store runoff and leachate from the three former impoundments. One tank was located immediately east of the phosphorus impoundment. The other tank contained runoff from the two adjacent TNT and RDX impoundments. The tanks were removed in 1994, and these two areas are currently undergoing closure pursuant to a RCRA closure plan.

The "ash pile" area (Figure 1-3) was the site of a former stockpile of burn residue. The pile, which consisted of approximately 12,290 pounds of burn residue, was removed between July 1986 and February 1987, pursuant to a RCRA closure plan.

Prior to approximately 1985, pink water sludge was placed and burned in an unlined pit in the location of the pink water tanks (see Nos. Unit 14 on Figure 1-3). This flashing process was relocated to the burn pads in approximately 1985. The pink color of the water and sludge was caused by the presence of explosives and related chemicals.

The former primer burn box was used for thermal treatment of ammunition components (for example, small impact-sensitive primers) and pyrotechnic munitions. The burn box has been decommissioned, and these activities are now performed at the primer pits and the incendiary cage (see Nos. Units 12 and 13, respectively, on Figure 1-3).

No treatment operations have taken place on the ground surface since the 1980s; all current treatment operations take place in containment facilities. The following operations currently occur at the ABG. The locations of many of these ABG activities are shown on Figure 1-3 as noted below.

- Solid bulk propellant and explosives are open burned in 18 clay-lined steel pans at the ABG Main Burn Pan Grid (Unit No. 3).

- The primer pit operation (Unit No. 12) involves treatment of small explosive components such as hand grenade fuses and cartridge primers.

- Solvents contaminated with propellants, explosives, and pyrotechnics are burned in one unlined steel pan (Unit No. 5).

- Waste scrap pyrotechnics, which have been desensitized in No. 2 fuel oil, are burned in a second unlined steel pan (Unit No. 7).

- A third pan is used to burn scrap black powder desensitized with water (Unit No. 8).

- Two sets of four pans each are used at Unit No. 6 for the treatment of a waste mixture containing red phosphorus and No. 2 fuel oil.

- The incendiary cage (Unit No. 13) is set up primarily to allow the open burning of pyrotechnic devices and components.

- The flashing and thermal treatment of suspect explosives-contaminated materials is carried out at three concrete-lined burn pads (Unit No. 9).

- Explosives- and pyrotechnic-contaminated sludges from production operations are treated at three sludge burning pans (Unit Nos. 10 and 11). Hexahydro-1,3,5-trinitro-1,3,5-trizine (HMX)-contaminated sludge and phosphorus-contaminated sludge are currently burned at this unit.

1.3.1.2.2 Regulatory Status

In November 1988, the MTA was granted RCRA interim status. On January 13, 2000, the MTA RCRA interim status was terminated because the MTA RCRA operating permit sent into effect.

The RCRA operating permit includes the following:

- Strict operating conditions including that treatment can take place only in containment containers.
- Procedural requirements for inspection of the surrounding area as well as removal of any material generated during the open burning operations.
- Strict groundwater monitoring requirements.
- Upon suspension of operations, the MTA must undergo RCRA closure requirements.

The MTA RCRA operating permit closure requirements state that all hazardous wastes and hazardous constituents must be either:

- "Clean closed" (i.e., shipped off site to a permitted RCRA treatment, storage, and/or disposal facility) or

- "Closure in place" (i.e., the on-site containment of all the hazardous wastes in a RCRA landfill with ongoing groundwater monitoring of the site).

1.3.1.3 OJT

The OJT is an inactive area that is adjacent to and downstream in the LSC valley (south-southeast) of the MTA. Former operations at the OJT were directly associated with operations at SWMU 3. The OJT area was used to burn out bombs and flash powder from the mid-1970s through 1983. The area was also used to flash the residue from bombs and projectiles after they had been subject to melt-out or drill-out operations to remove the bulk of the explosives (Murphy, 1994). Materials were treated at two separate regions (the burn area and the burn pit) of the Old Jeep Trail area (also known as the OJT). The approximate locations pf these two areas are shown on Figure 1-4. At the burn area, bomb casings from which the bulk explosives had been removed were filled with initiating powder, tilted on-end toward a hillside east of the OJT, and flashed to complete the demilitarization process. Some munitions are thought to have been lashed to a horizontally positioned utility pole (that may have been creosote treated) prior to flashing.

The burn pit was a trench or natural depression, approximately 100 feet long, 30 feet wide, and 10 to 12 feet deep, located just south-southeast of the burn area (Figure 1-4). The term "pit" may be a misnomer because it may have been more of a natural topographic depression than an excavated pit. Powder was flashed and explosives-contaminated materials were burned in this pit. The contaminated material may have included cardboard, paper, wood, and metal packaging that may have come into contact with explosives, solvent-contaminated rags, and/or any other material that may have been contaminated with explosives. Some of the wooden packaging material may have contained

pentachlorophenol. Small munitions items and components were also reportedly treated in the burn pits. The area has not been used for any operations since 1983 when it was filled with clean fill material and revegetated. The area is now overgrown with brush, trees, and grasses.

The exact sizes, shapes, and locations of the burn pit and the burn area are not known. Their approximate locations are indicated on Figure 1-4. However, descriptions of the treatment areas in previous reports (Dunbar, 1982; Murphy, 1996) and interviews with base personnel during the OJT and LSC RFI (TtNUS, 2002) indicate that the treatment areas may have covered a larger area than just the burn area and the burn pit, extending from OJT westward to the LSC stream channel and southward as far as well 03-07 (see Figure 4-1). However, contaminants were not detected during sampling along the length of the OJT in areas where treatment reportedly took place. Although inactive as a treatment area, OJT is still actively used as a vehicle route.

1.3.1.4 Groundwater Contamination Sources

Based on the above discussion of operations and the results of previous investigations at the MTA and OJT, the key operations and potential sources of groundwater contamination at the MTA and the OJT are identified in Section 2.0.

1.4 PHYSICAL CHARACTERISTICS OF SWMU 3 STUDY AREA

The MTA is approximately 20 acres in size; the OJT is approximately 6 acres in size. The MTA, OJT area, and LSC are located in the central-east portion of the facility. The site maps for the MTA and the OJT are presented as Figures 1-3 and 1-4, respectively.

1.4.1 Climate and Meteorology

The climate in the region of NSWC Crane can be described as temperate (NOAA, 1988). Precipitation is distributed evenly throughout the year, and there is no pronounced wet or dry season for this region. Rainfall in the spring and summer is produced mostly from showers and thunderstorms. A peak rainfall of about 2½ inches in a 24-hour period can be expected about once a year. Snowfalls of 3 inches or more occur on an average of two or three times per winter season. The annual mean monthly distribution of rain and snow for the area is shown in Table 1-1. Annual rainfall total is about 40 inches per year (in/yr), with the highest mean monthly totals occurring in the late spring and in the early summer period of May through July. Snowfall averages about 23 in/yr, with most occurring in the winter months of December through February.

Mean monthly air temperatures for the region are shown in Table 1-2. Temperatures range from a minimum of 27.9 degrees Fahrenheit (°F) in January to a maximum of 75.7°F in July. The mean annual temperature for the area is 52.6°F.

Relative humidity for the local area is generally highest in the early morning hours in June through September and generally ranges between 80 to 88 percent on average. The lowest values of relative humidity have historically occurred between March through October during the afternoon and evening hours when values average between 54 and 58 percent.

Long-term climatological records (NOAA, 1988) for the area indicate that the monthly prevailing wind direction is southwest during the months of April through December, then shifts to the northwest during the months of January through March. The annual prevailing wind direction for the region is from the southwest. The annual average wind speed for the area is about 9.6 miles per hour (mph).

1.4.2 Topography and Physical Features

1.4.2.1 NSWC Crane

NSWC Crane is in the unglaciated area of the Crawford Uplands Physiographic Province. This province is a rugged, highly vegetated, dissected plateau bounded by the Mitchell Plain Physiographic Province to the east and the Wabash Lowland Physiographic Province to the west (Murphy and Wade, 1988). The Mitchell Plain is a low dissected limestone plateau characterized by sinkholes and karst topographic features. The boundary between the Crawford Upland and the Mitchell Plain is marked by the highly irregular, eastern-facing Chester Escarpment. Springs, caverns, caves, and other solution weathering features can be found along this escarpment and on the eastern edge of the NSWC Crane facility. The boundary between the Crawford Upland and the Mitchell Plain near the western boundary of NSWC Crane is gradual (Murphy and Wade, 1988).

The terrain is predominantly rolling with moderately incised stream valleys throughout and occasional flat areas in the central and northern portions at NSWC Crane. The elevations across NSWC Crane range from about 500 feet above mean sea level (msl) at the southern drainageway to about 850 feet msl on the ridge in the west-central portion of the site. V-shaped drainageways in the north progress to 2,000-foot-wide floodplains in the south and rise to approximately 150 to 200 feet at the ridgelines (NEESA, 1983).

1.4.2.2 SWMU 3

The LSC watershed, which contains the MTA and OJT, is characterized by rugged relief, with ground surface elevations ranging from about 600 to 800 feet above msl in the headwaters. At the OJT, ground surface elevations range from approximately 550 to 800 feet above msl. The surface elevation is approximately 500 feet above msl where LSC exits the southern border of the installation.

The MTA is relatively flat and is within the northern headwater area of LSC. The MTA was formerly kept devoid of vegetation to minimize the potential for fires during open burning treatments. However, since the early 1990s, areas along LSC within SWMU 3 have been seeded with grass to minimize erosion of soil into LSC.

The OJT site is located in a gravel-covered area on the western side of the gravel access road (Jeep Trail 25), where the road widens in excess of 50 feet. The OJT and the remainder of the LSC valley are surrounded by wooded areas along the hillsides to the east and west, with miscellaneous natural ground vegetation under the tree canopy and along the creek banks.

1.4.3 Geology

Bedrock underlying the Crane facility consists of sedimentary rocks from the Lower Pennsylvanian age Mansfield Formation (Raccoon Creek Group) and the Upper Mississippian age Stephensport and West Baden Groups. Due to erosion and the moderate relief in the area, the Lower Pennsylvanian and Upper Mississippian rock units crop out on the ridgetops and along the stream valleys.

The USACE Water Experiment Station (WES), the Indiana Geological Survey, and Indiana University have been investigating the geology and hydrogeology of the LSC watershed since the early 1980s. The USACE WES understanding of the geologic units in the LSC watershed based on boring logs drilled to various depths throughout the LSC watershed, is presented in Appendix A of the draft Conceptual Site Model and Fieldwork Report.

1.4.4 Surface Water Hydrology

The surface drainage at NSWC Crane has formed a dense, dendritic pattern throughout the installation. Most of the major streams flow in a general southward or southwestward direction. Seven primary creeks in five drainage basins carry surface water off the installation, where they eventually drain into the East Fork White River and then to the Wabash River to the southwest. Figure 1-2 shows the main drainage basins of NSWC Crane. SWMU 3 which includes the MTA and the OJT area lie within the Sulphur Creek

drainage basin. LSC is a small stream whose headwaters originate in channels on the north, west, and south of the ABG. These ephemeral channels run through SWMU 3 and converge on the eastern side of the SWMU. From the MTA, a single channel meanders south-southeastward a distance of approximately 0.5 mile to the OJT area and then continues another 0.6 mile until it reaches the installation boundary. The Sulphur Creek basin drains approximately 30 percent of NWSC Crane.

LSC is approximately 4.6 miles long from its northernmost headwaters to its intersection with Sulphur Creek south of the installation. Several intermittent tributaries discharge into LSC from both sides of the stream, including the Johnson Hollow tributary, which intersects with LSC near the NSWC Crane boundary. The Dye Burial Grounds (SWMU 2) are located north of the OJT, and surface drainage from this site enters several ephemeral gullies that drain into LSC between MTA and OJT.

The LSC channel is usually dry north (upstream) of Spring C (see Figure 1-2). During dry periods of summer and fall, the flow rate in the creek between Springs A and C is typically less than about 50 gallons per minute (gpm). Downstream of where the discharge from Spring A enters LSC, the dry weather flow in LSC is typically greater than 100 gpm. Flow rates in LSC were visually estimated on June 19, 2001 to be about 20 gpm. Downstream of Spring A, the flow rate in LSC can increase by two to three orders of magnitude, due in large part to the rapid increases in the flow rates of the springs along the creek.

From the installation boundary, LSC flows southward about 2 miles before it enters Sulphur Creek. Sulphur Creek then flows southward and empties into Indian Creek, which drains into the East Fork White River and then flows southwestward into the Wabash River.

1.4.5 Hydrogeology

1.4.5.1 NSWC Crane

USACE WES discussed regional groundwater trends pertaining to the unglaciated southwestern portion of Indiana. In general, groundwater is contained in joint openings of limestone and sandstone aquifers. Surficial unconsolidated aquifers are thin and have limited potential as water supplies.

Aquifers beneath NSWC Crane are considered to be vertically isolated from each other by interlayered shale beds that act as aquitards. Groundwater recharge in the unconsolidated surficial materials occurs through rainfall infiltration at the ground surface. Groundwater recharge in the underlying bedrock units

can occur where aquifer units crop out or from vertical downward migration through joint openings from overlying units.

Local variations in bedding thickness and composition, dip, aquifer and aquitard thicknesses, presence or absence of fractures, incision by surface drainage, and karstic conditions cause local groundwater movement at NSWC Crane to differ from regional trends. Where erosion resulting from surface drainage has cut through aquifer units, groundwater discharge occurs as springs and seeps. Springs and seeps are prevalent at contacts between aquitards and overlying aquifers. Groundwater flowing from springs and seeps into surface water can potentially re-enter the groundwater system as recharge to a lower aquifer outcropping downstream below aquitards.

In the eastern portion of NSWC Crane, the karstic conditions are present primarily in major drainage valleys where erosion has cut into permeable sandstones overlying easily dissolved limestone units (USACE WES, 1998). Rapid infiltration in the Big Clifty Sandstone has caused dissolution and weathering of the underlying Beech Creek Limestone. The result of this occurrence has been the creation of karst and collapse conditions along some of the major drainageways within the eastern part of NSWC Crane.

The upper soil materials on the tops and sides of ridges are generally unsaturated. The uppermost bedrock is composed of the Lower Pennsylvanian age Mansfield Formation consisting of irregular beds and lenses of sandstone, siltstone, and shale. Because of the irregularities in the extent and thickness of each lithologic unit and the variability in the permeability and yield of groundwater for each well, it is difficult to divide the Pennsylvanian age rocks into distinct aquifers or water-bearing units. In general, groundwater is likely moving along fractures, joints, and bedding planes and not through a porous matrix as is commonly the case with unconsolidated deposits.

1.4.5.2 SWMU 3

The complex hydrology associated with SWMU 3 is discussed in Appendix A of the draft Conceptual Site Model and Fieldwork Report, which includes the following sections:

- Aquifers and Aquitards including the Karst Systems
- Groundwater Flow Directions
- Dye Tracer Studies
- Groundwater Discharge and Springs

The following presents a brief summary of the hydrology from draft Conceptual Site Model and Fieldwork Report.

1.4.5.2.1 Aquifers and Aquitards

Groundwater in the nonglaciated southwestern portion of Indiana is generally contained in fractures and joint openings of limestone and sandstone aquifers. Aquifers are generally isolated from one another vertically by less permeable shale and siltstone units. Groundwater enters the aquifers as infiltration in outcrop areas and flows by gravity down the dip of the strata or locally in directions controlled by the potentiometric gradients, which are in most cases influenced by topography and locations of stream channels (i.e., groundwater discharge areas).

Four primary aquifers in the LSC watershed have been identified in the Pennsylvanian and Upper Mississippian strata:

- Pennsylvanian sandstones
- Haney Limestone [also referred to as the Golconda-Haney (G-H) aquifer]
- Big Clifty Sandstone/Beech Creek (BC/BC) Limestone aquifer
- Beaver Bend Limestone

The Pennsylvanian sandstone aquifer is the uppermost aquifer and is present only along the tops of ridges at elevations above 615 feet above msl. The Glen Dean Limestone is present beneath the Pennsylvanian aquifer in isolated areas of the watershed. The Hardinsburg Shale is up to 50 feet thick and contains mostly shale with some low-permeability sandstone in the middle. This formation forms a nearly continuous, relatively impermeable barrier to groundwater flow between the Pennsylvanian sandstones above and the G-H Limestone below.

The G-H Limestone aquifer crops out on the sides of LSC and Johnson Hollow. This limestone aquifer is up to 20 feet thick. The Indian Springs Shale aquitard (the 20-foot-thick upper member of the Big Clifty Formation) underlies the G-H aquifer and minimizes vertical movement of groundwater downward into the Big Clifty Sandstone through most of the watershed. In places where the Indian Springs Shale and higher strata have been removed by post-Pennsylvanian erosion, surface recharge into the Big Clifty Sandstone is relatively rapid.

The Big Clifty Sandstone and the underlying Beech Creek Limestone are both permeable rock units and are in direct hydraulic communication with one another. Together, they form the most important aquifer

unit in the watershed. The porosity and permeability of the Big Clifty Sandstone are due to intergranular pore spaces and to fractures (i.e., it has both primary and secondary permeability). The Beech Creek Limestone is very dense and well cemented; all of its permeability and porosity are due to vertical fractures, bedding-plane fractures, and solution openings along the fractures. The lithology, fracture patterns, and permeability characteristics of the Big Clifty Sandstone and the Beech Creek Limestone are detailed in reports by the USACE (Hunt, 1988; Murphy and Ciocco, 1990; Murphy, 1994) and the Indiana Geological Survey (Barnhill and Ambers, 1994). The BC/BC aquifer is exposed near the ground surface in the eastern half of SWMU 3, along the LSC valley, and in the lower elevation of Johnson Hollow. Beneath the ridges, the aquifer is approximately 60 feet thick and fracture flow is dominant in the limestone. Solution openings and cavities become larger and hydraulically more significant close to the stream valleys where conduit systems in the limestone have developed. Starting in the eastern half of SWMU 3 and continuing down the LSC valley to the facility property line, the dissolution of the Beech Creek Limestone was so extensive that, sometime in the geologic past, the overlying limestone collapsed; the Big Clifty Sandstone has also collapsed with the Beech Creek Limestone. The collapsed zones extend along the centers of the LSC valley and Johnson Hollow, are permeable, and form a hydraulic continuum within the BC/BC aquifer on both sides of the valleys.

The Elwren, Sample, and Reelsville Formations lie beneath the BC/BC aquifer and have a combined thickness of approximately 75 feet. The permeability of the shales in these formations is so low that a significant hydraulic head difference of about 46 feet exists between the BC/BC aquifer and the Beaver Bend Limestone aquifer below (Baedke, 1998). The Beaver Bend Limestone is about 12 feet thick and forms an important aquifer below the Elwren-Sample-Reelsville aquiclude.

Karst System Monitoring

The MTA and OJT are underlain by two separate karst systems. Several studies of these karst systems have been conducted by the USACE WES and the Indiana University Department of Geological Sciences.

The karst systems show both temporal and spatial variation between diffuse-type and conduit-type groundwater flow. From highest to lowest, the three aquifer systems present at SWMU 3 are the G-H aquifer, the Beech Creek aquifer, and the Beaver Bend aquifer.

The solution openings and cavities (the karst system) in the Beech Creek Limestone have formed groundwater conduits that roughly trend north to south on both sides of the LSC valley. Based on the results of dye tracer studies, groundwater enters these karst conduits, which allow for rapid groundwater

flow southward and roughly parallel to LSC to conduit outlets (i.e., springs). These conduits and springs along the valley walls south of the OJT area are discussed below.

1.4.5.2.2 Groundwater Flow Directions

In general, the shallow groundwater flow patterns mimic topography; highest groundwater elevations are typically found along ridge crests, and groundwater flow is toward the major stream or tributary valleys. Recharge to the shallow groundwater system generally occurs over most of the uplands and sideslopes. Groundwater moves downward and then laterally, where it discharges to the deeper stream valleys as springs, seeps, and baseflow.

The aquifers present in the LSC watershed consist primarily of sandstone and limestone. In the MTA area, groundwater in the G-H aquifer generally flows toward the MTA from the northern, western, and southern sides (Hunt, 1988; Murphy, 1994; Duwelius et al., 1995). When the groundwater reaches the cropline of this aquifer, the groundwater is apparently seeping near the ground surface through residual soils and weathered shale until it reaches the cropline of the Big Clifty Sandstone. There, it infiltrates into the Big Clifty Sandstone. No visible surface seeps or springs have been reported emanating from the G-H aquifer in the vicinity of the MTA.

The next lower aquifer, the BC/BC aquifer, has been more extensively studied than any of the other three aquifers. In general, the highest groundwater elevations (560 to 565 feet above msl) in this aquifer were found at the northern end of the LSC watershed (north of the MTA and in the vicinity of the DBG). Groundwater generally flows from north to south in the watershed, and also inward toward LSC (i.e., from the perimeter of the watershed toward the creek and Johnson Hollow). The elevation where groundwater discharges from Spring C was about 530 feet above msl (see Figure 1-2). The lowest groundwater elevations (about 510 to 515 feet above msl) were recorded at the southern end of the watershed at Spring A and well 03B10.

LSC is a losing stream between ABG and OJT and probably southward toward Spring C. In this section of the watershed, the streambed is usually dry, and groundwater flows either through the breccia zone materials parallel to the stream (i.e., underflow) or flows back into the bedrock valley wall. These localized flow directions (i.e., away from the Creek toward the northeast and southwest) are in contrast to the overall watershed flow directions, which are toward the stream valley. The apparent contradiction in flow directions can be explained by the presence of karst conduits that run in a north-south direction on both sides of the stream valley. The majority of groundwater in the OJT area is likely flowing toward the karst conduits.

Groundwater in the BC-BC aquifer and the conduits eventually discharges back into the LSC at Springs A, A', B, and C, smaller unnamed springs, and diffuse seepage through the streambed. All this discharge occurs at Spring C and south of Spring C, where the top of the Elwren Shale intersects the streambed and LSC becomes a gaining stream (i.e., flow of water is from the ground into the stream). LSC becomes a perennial stream at Spring C, where the flow of groundwater to the stream is sufficient to maintain flow in the stream continuously.

The Beaver Bend limestone is 10 to 12 feet thick and comprises the lowest aquifer that has been investigated in this watershed. Based on data from monitoring wells, the Beaver Bend is fully saturated and flowing southward at a very gentle gradient (Murphy, 1994). The Beaver Bend is considered to be isolated hydraulically from the BC-BC aquifer above.

1.4.5.2.3 Overview of Dye Trace Study

During early groundwater investigations in the LSC watershed, investigators (Hunt, 1988; Murphy and Ciocco, 1990) surmised that springs at the southern end of the watershed were linked to karst conduits originating to the north. Several dye tracer studies were performed to evaluate the pathways in these conduits and to estimate the velocity of travel. The first dye tracer investigation was performed by Murphy and Ciocco (1990). The stream flow and spring flows were above average during the testing. The fluorescein dye persisted in these Springs A and A' for at least 5 days following injection. Based on a mean travel time of 16 hours and assuming a sinuous travel distance of about 8,000 feet, Murphy and Ciocco (1990) estimated a groundwater velocity of approximately 500 feet per hour through the conduit system. They detected a weak but inconclusive presence of dye in Springs B and C and in springs located north of ABG in another watershed. They attributed these weak detections possibly to background coloration of the water. Based on these results, it was clear that the ABG was directly linked to a karst conduit system that transfers water from the ABG south to Springs A and A' through the Beech Creek Limestone.

Indiana University initiated a second tracer test on the western side of LSC on May 3, 1997 (Baedke, 1998). Rhodamine WT dye and bromide ion were added to well 03C02P2 (see Figure 1-3). Eosin dye was injected into well 03C10. The springs and the stream were at relatively high flow rates because 2.5 inches of rain fell the previous day. Rhodamine WT dye was visually detected at Springs A and A' after injection at ABG. The bromide tracer appeared at the same time as the Rhodamine WT. Baedke (1998) calculated a travel velocity of 938 feet per hour between well 03C02P2 and Spring A, which is faster than the velocity calculated by Murphy and Ciocco (1990). Although the Rhodamine WT was

detected at these two springs up to 4 days after injection, the bromide tracer dissipated quickly, presumably because the bromide ion does not sorb and is therefore flushed from the conduit system more quickly. Rhodamine WT was not detected during the entire test period in any other springs that were monitored. Eosin was not detected at all, even in Springs A and A'. Therefore, it does not appear that the portion of the BC/BC aquifer located near well 03C10 is directly connected to the conduit system feeding Springs A and A'.

On October 11, 2000, Rhodamine WT dye was again injected into well 03C02P2, but the flow rates in the stream and the springs were relatively low during this test (Krothe, 2002). Monitoring showed that the dye traveled from the well to Springs A and A'. This study concluded that the travel velocity was slower during dry weather conditions.

Previous dye tracer tests all showed that the ABG area does not seem to be hydraulically connected to Spring C, which is a major spring located on the eastern side of the creek, downstream of the OJT area. Groundwater elevations indicate a flow direction from the OJT burn pits to the east-northeast toward well 03-24 (see Figure 1-4). It was hypothesized that these solution channels might be linked to a conduit system that leads southward to Spring C, which is separate from but analogous to the conduit system investigated previously on the western side of the creek. Two dye tracer tests have been performed recently on the eastern side of LSC to determine whether there is a link between the OJT area and Spring C (Jock and Krothe, 2002 and Hydrogeology, Inc., 2005). Fluorescein dye was injected into well 03-24 on May 24, 2002. The dye was first detected in Spring C 17 hours after injection. The dye concentration peaked 28 to 38 hours after injection. A second dye tracer test was conducted on December 2, 2004, using monitoring well 03-24 as the injection point and Springs A and C as monitoring points. This test resulted in 108 percent of the dye being recovered at Spring C. No dye was recovered at Spring A. Thus, the OJT area is linked to the Spring C conduit system in the vicinity of well 03-24. However, this conduit system does not seem to be as well developed, and travel velocities are not as fast as the conduit system on the western side of the creek feeding Springs A and A'.

1.4.5.2.4 Overview of Groundwater Discharge and Springs

The BC/BC aquifer discharges to the ground surface from both sides of the valley via numerous springs and baseflow in LSC downstream of Spring C. These springs and baseflow are forced to the ground surface because, at this point in the watershed, the stream has incised down to the underlying Elwren Shale. Springs A, A', B, and C are the largest in this area of the watershed. Springs A, A', and B are located on the western side of the valley, approximately 6,000 to 6,800 feet south of the MTA. Spring C is located on the eastern side of the creek, about 2,000 feet south of the OJT area. Presumably, Springs

A, A', and B are draining the portion of the BC/BC aquifer west of the creek, and Spring C is draining the aquifer on the eastern side of the creek. These springs flow year round; however, flow rates fluctuate rapidly due to rainstorm or large snowmelt events.

In March and April 1996, continuous flow measurements were conducted for Springs A and C. During these measurements, the flow rates of the two springs rose rapidly in response to rain events and declined fairly rapidly within a few days. The peak flows in these two springs during the 2-month time period were approximately 10,000 gpm, or 22.3 cubic feet per second (ft^3/s). This is consistent with previous reports (e.g., Hunt, 1988; Murphy and Ciocco, 1990) that springs become turbid during high flow events and then clear up and return to normal flow within a day or two after a storm event. The flashiness of the spring flows and the fact that the discharge becomes turbid during a storm indicate that the springs are linked to conduit systems that take surface recharge and transfer it through the conduit systems quickly. The suspended solids contained in the discharge waters likely come from the areas of recharge and gradually move through the conduit system, primarily during storm events.

1.4.6 Water Supply

1.4.6.1 NSWC Crane

Seven primary creeks carry surface water off the installation and eventually drain into the East Fork of the While River, and then to the Wabash River to the southwest. The seven creeks that drain NSWC Crane are Furst Creek, Sulphur Creek, LSC, Boggs Creek, Turkey Creek, Indian Creek, and Seed Tick Creek (Figure 1-2). Also located within the installation are several small ponds and Lake Greenwood, an 800-acre, man-made, spring-fed lake in the northwestern portion of the installation. Lake Greenwood is the main source of drinking water at NSWC Crane, and it is also used for recreation.

1.4.6.2 SWMU 3

Groundwater at the MTA and OJT is not currently and is not anticipated to be used in the future as a potable drinking water source.

1.4.6.3 LSC

Groundwater in the BC/BC aquifer within the MTA flows southeast and into a karst conduit system and is then conveyed at a rapid velocity southeastward to Springs A and A'. Groundwater within the OJT area flows east-southeastward within collapse breccia material and discharges at Spring C into LSC. During most times of the year, the flow in LSC consists entirely of flow from Springs A, A', and C. LSC first

becomes a perennial stream at Spring C. All surface water, sediments, and groundwater leaving the MTA and OJT areas eventually enter LSC.

Based on information from the United States Geological Survey (USGS), the closest public water intake is Shoals, which is located on the East Fork White River (see Figure 1-2).

1.4.7 Surrounding Land Use

NSWC Crane is situated in a rural area of south-central Indiana. The surrounding communities that form the region are in a period of transition from an economic base of agriculture, mining, and quarrying to an economy built on manufacturing and service industries. The patterns of settlement, population statistics, and median income are similar throughout the region.

There is no State or local planning within the vicinity of NSWC Crane. The only zoning and land use regulations are found in the municipalities within the region. None of these municipalities are close enough to have an impact on NSWC Crane. None of the areas adjacent to NSWC Crane are zoned, and zoning is not anticipated in the near future. The MTA of SWMU 3 is approximately 1 mile east of the nearest NSWC Crane property boundary. There are no known current or likely future land use or community actions under consideration or proposed at this time for the off-base land in the vicinity of SWMU 3; however, LSC flows into Sulfur Creek which flows off base. SWMU 3 is contained completely within NSWC Crane and likely future land use at areas surrounding the SWMU is expected to be limited to industrial uses.

1.4.8 Ecological Setting

1.4.8.1 Facility Location

A biological characterization of NSWC Crane, including a listing of plants and animals found at the facility, was presented in the Installation Assessment (Army, 1978) and the IAS (NEESA, 1983), and is summarized in the Environmental Monitoring Reports (EMRs) (Halliburton NUS, 1992a and 1992b). A list of the species that may inhabit NSWC Crane and are protected under the U.S. Endangered Species Act, Indiana Department of Natural Resources Heritage Data Center, or the U.S. Fish and Wildlife Service is summarized in the RCRA Facility Permit (U.S. EPA, 1995). The following paragraphs briefly summarize the environmental setting at the installation.

Eighty percent of NSWC Crane's 63,000 acres are classified as Central Hardwoods Forest of the United States (NEESA, 1983). In addition, some agricultural fields are in various stages of succession.

Openings on dry upland sites contain almost pure stands of grasses with some clumps of woody plants such as persimmon, sassafras, and sumac. Wetter sites have river birch, willow, sycamore, and cottonwood. Hillside communities have mostly hickory, white and black oak, red maple, sugar maple, tulip poplar, ash, and beech (NEESA, 1983).

The great variety of habitats at NSWC Crane (i.e., many stages of forest succession, streams, ponds, Lake Greenwood, grassy open spaces) has lead to a high diversity of animal species (NEESA, 1983). Some of these species include (but are not limited to) mammals such as white-tailed deer, beaver, coyote, hawks, red fox, rabbits, raccoons, mice; birds such as ducks, geese, wild turkey, bobwhite quail, red-tailed hawks, and American robins; and various amphibians, reptiles, fish, and invertebrates.

The bird population includes a number of State or federal threatened, endangered, or species of special concern that use the installation as their home range. These species include the bald eagle, osprey, sharp-shinned hawk, red-shouldered hawk, broad-winged hawk, black and white warbler, hooded warbler, and the worm-eating warbler (B&R Environmental, 1997). Also, the Indiana bat, a federal endangered species, is known to forage at NSWC Crane. Because of the bat and its potential habitat, the cutting of trees is restricted to certain times during the year, and the cutting of shagbark hickory trees is prohibited.

1.4.8.2.1 SWMU 3

Terrestrial Habitats: The most frequent tree species at SWMU 3 are mockernut hickory (*Carya tomentosa*), shagbark hickory (*Carya ovata*), sugar maple (*Acer saccharum*), tulip poplar (*Liriodendron tulipifera*), sassafras (*Sassafras albidum*), red oak (*Quercus rubra*), white oak (*Quercus alba*), and American beech (*Fagus grandifolia*). Common understory plants include flowering dogwood (*Cornus florida*) and sugar maple. Various tree seedlings, clubmosses, grasses, rushes, and forbs occur as groundcover at the site.

A total of 25 bird species were observed in the area of the SWMU during the 1995 biological survey. Commonly observed species included wild turkey (*Meleagris galopava*), whippoorwill (*Caprimulgus vociferus*), common crow (*Corvus brachyrhynchos*), common flicker (*Colaptes auratus*), American gold finch (*Spinus tristis*), chipping sparrow (*Spizella passerina*), and blue jay (*Cyanocitta crigtata*).

Aquatic Habitats: The channel of LSC has a riffle-and-pool structure, and standing water is limited to pooled areas during low-flow conditions such as during the 1995 biological survey. The 1995 survey included identification of fish and benthic macroinvertebrates in pools near two springs that flow into the

creek. Spring A is located in the southern (most downstream) portion of SWMU 3. The water depth in the pool near Spring A was 6½ feet at the time of the 1995 survey. Spring C is located approximately 2,500 feet upstream of Spring A. The water level in the Spring C pool was 1½ feet during the survey. The LSC channel upstream of Spring C is generally dry except after rain events, resulting in the absence of permanent aquatic communities in most portions of the creek within SWMU 3.

Fish were captured for identification using an electrofishing backpack unit. In the pool near Spring A, the bluntnose minnow (*Pimenthales notatus*) was abundant, the gizzard shad (*Dorosoma cepedianum*) and creek chub (*Semotilis atromaculatus*) were common, and the largemouth bass (*Micropterus salmoides*) was uncommon. In the Spring C pool, the gizzard shad, silverjaw minnow (*Ericymba buccata*), and bluntnose minnow (*Pimenthales notatus*) were common, and the ribbon shiner (*Notropus fumeus*) and blacknose dace (*Rhinichthys atratulus*) were uncommon.

Benthic macroinvertebrates were collected using a D-frame kick net and preserved using 70-percent isopropanol. At the Spring A pool, 71 individuals in seven taxa were observed. The Ephemeroptera, Plecoptera, Trichoptera (EPT) Index was calculated to be 0.429, which is indicative of a relatively unpolluted stream. At the Spring C pool, 81 individuals in eight taxa were observed. The EPT Index was 0.375, indicative of a relatively unpolluted stream. For a riffle in LSC adjoining the Spring C pool, 40 individuals in four taxa were observed, and the EPT Index was 0.500, which is also indicative of a relatively unpolluted stream.

The waterbodies at SMWU 3 discharge directly to LSC. The designated State water uses for the Sulphur Creek-LSC waterbody segment are aquatic life support, fish consumption, and primary contact. This waterbody segment was assessed as part of the 2004 Indiana Integrated Water Quality Monitoring and Assessment Report to determine if the waterbody was supporting those uses (IDEM, 2004). The Sulphur Creek-LSC waterbody segment is fully supporting the aquatic life support and primary contact water uses; it was not assessed for the fish consumption water use (IDEM, 2004).

Threatened and Endangered Species: The Endangered Species Management Plan for NSWC Crane lists the federal and State threatened and endangered species and species of special concern potentially present at NSWC Crane. The Indiana bat and bald eagle are the only federally threatened or endangered species at NSWC Crane. Although the Indiana bat may be present at SWMU 3, the bald eagle is not likely present at SWMU 3 due to a lack of vast expanses of open water (i.e., the preferred hunting habitat for the Bald Eagle). In addition, a number of State endangered and federal and State species of concern have been listed.

LSC flows southward for about 2 miles before it enters Sulphur Creek. Sulphur Creek discharges off site to the East Fork White River. River otters, a State endangered species, are being reintroduced to Indiana. The otters are expanding from their original release sites into other watersheds including the East Fork White River (IDNR, 2000). Also, the East Fork White River is the site for an ongoing study of lake sturgeon populations, another State endangered species (IDNR, 2000). Finally, spotted darters, a State endangered species, has been found in the East Fork White River (IDNR, 2000). Other threatened, endangered, or special concern species also may be present in the water bodies just off site of Crane.

1.4.8.2.1.1 MTA

The MTA consists of an active treatment facility that is mostly clear of vegetation. Most terrestrial areas within the site support deciduous forest vegetation in varying stages of natural succession. Aquatic habitats within the site consist of the surface waters and sediments of LSC. Terrestrial and aquatic habitats in areas surrounding the ABG, including the OJT, were characterized in detail in August and September 1995 as part of an Environmental Risk Assessment (ERA) completed in February 1999 (TtNUS, 1999). The following site description is based on information in that ERA.

Terrestrial Habitats: The authors of the 1995 biological survey noted that the noise, smoke, and other human activity at the MTA portion of the SWMU, as well as predation, may have reduced the diversity of wildlife in the surrounding area.

Aquatic Habitats: Springs A, A', and C, where aquatic habitats were observed during the 1995 biological survey, are located south (i.e., downstream) of the MTA.

The Sulphur Creek and LSC waterbody segment, which run through the MTA, is fully supporting the State-designated aquatic life support and primary contact water uses; it was not assessed for the fish consumption water use (IDEM, 2004).

1.4.8.2.2.2 OJT

The OJT consists of a portion of a narrow, forested stream valley centered on LSC. Most terrestrial areas within the site support deciduous forest vegetation in varying stages of natural succession. Aquatic habitats within the site consist of the surface waters and sediments of LSC. Terrestrial and aquatic habitats in areas surrounding the OJT were characterized in detail in August and September 1995 as part of an ERA completed in February 1999 (TtNUS, 1999).

Terrestrial Habitats: The forested habitats within and surrounding the OJT support numerous bird species (i.e., 25 bird species observed during the 1995 biological survey).

Aquatic Habitats: The OJT is upstream of Springs A and C, which are generally dry except after rain events, resulting in the absence of permanent aquatic communities in most portions of the creek within the OJT.

Threatened and Endangered Species: Although the Indiana bat may be present at the OJT, the bald eagle is not likely present due to a lack of vast expanses of open water (i.e., the preferred hunting habitat for the Bald Eagle).

TABLE 1-1

CLIMATOLOGICAL MEAN MONTHLY RAINFALL AND SNOWFALL AMOUNTS[1]
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GGROUNDS
NSWC CRANE
CRANE, INDIANA

Month	Mean Monthly Rainfall (inches)	Mean Monthly Snowfall (inches)
January	2.89	6.3
February	2.52	5.9
March	3.78	3.5
April	3.66	0.5
May	3.93	T[2]
June	4.06	0
July	3.89	0
August	3.28	0
September	3.11	0
October	2.68	T[2]
November	3.21	1.9
December	2.95	4.8
Annual	**39.98**	**23.0**

1 - Reference: National Oceanic and Atmospheric Administration (NOAA), 1988.
2 - Snowfall amounts less than 0.01 inch.

TABLE 1-2

CLIMATOLOGICAL
MEAN MONTHLY TEMPERATURES[1]
CMS REPORT FOR SWMU 3 – AMMUNITION BURNING GROUNDS
NSWC CRANE,
CRANE, INDIANA

Month	Mean Monthly Temperature (°F)
January	27.9
February	30.6
March	40.3
April	52.0
May	62.5
June	71.7
July	75.7
August	73.6
September	66.8
October	55.3
November	42.0
December	31.8
Annual	**52.6**

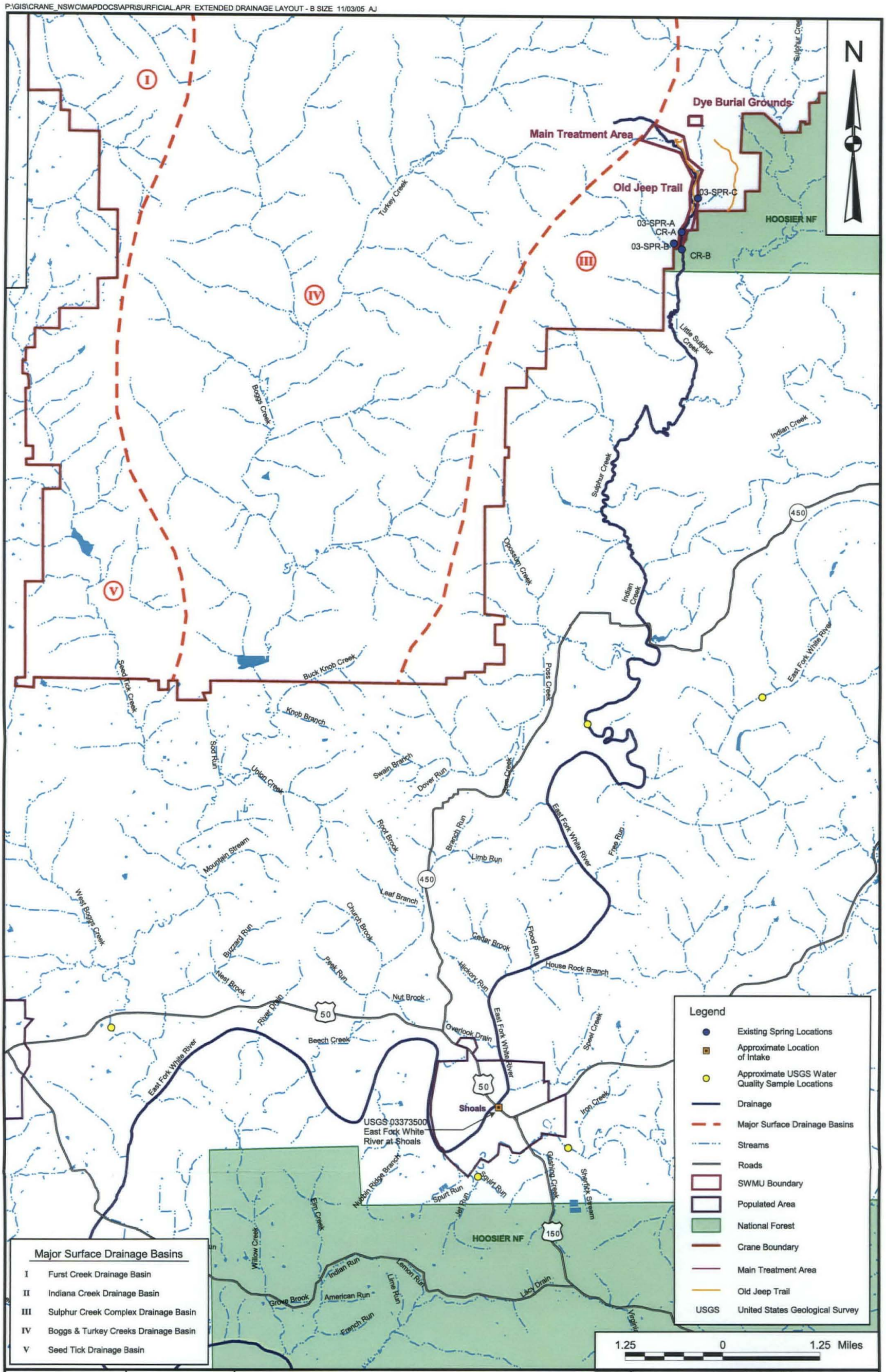
1 - Reference: National Oceanic and Atmospheric Administration (NOAA), 1988.

°F - degrees Fahrenheit.

DRAWN BY J. LAMEY	DATE 3/9/00	NAVFAC	LOCATION OF NSWC CRANE CMS REPORT FOR SWMU 03 - AMMUNITION BURNING GROUNDS NSWC CRANE CRANE, INDIANA	CONTRACT NUMBER CTO 0311
CHECKED BY V. PLACHY	DATE 10/20/05			APPROVED BY — DATE —
COST/SCHEDULE-AREA				APPROVED BY — DATE —
SCALE AS NOTED				DRAWING NO. FIGURE 1 - 1 / REV 0

P:\GIS\NSWC_CRANE\APR\0087.APR GENERAL LOCATION MAP 10/20/05 AJ

P:\GIS\CRANE_NSWC\MAPDOCS\APR\SURFICIAL.APR EXTENDED DRAINAGE LAYOUT - B SIZE 11/03/05 AJ



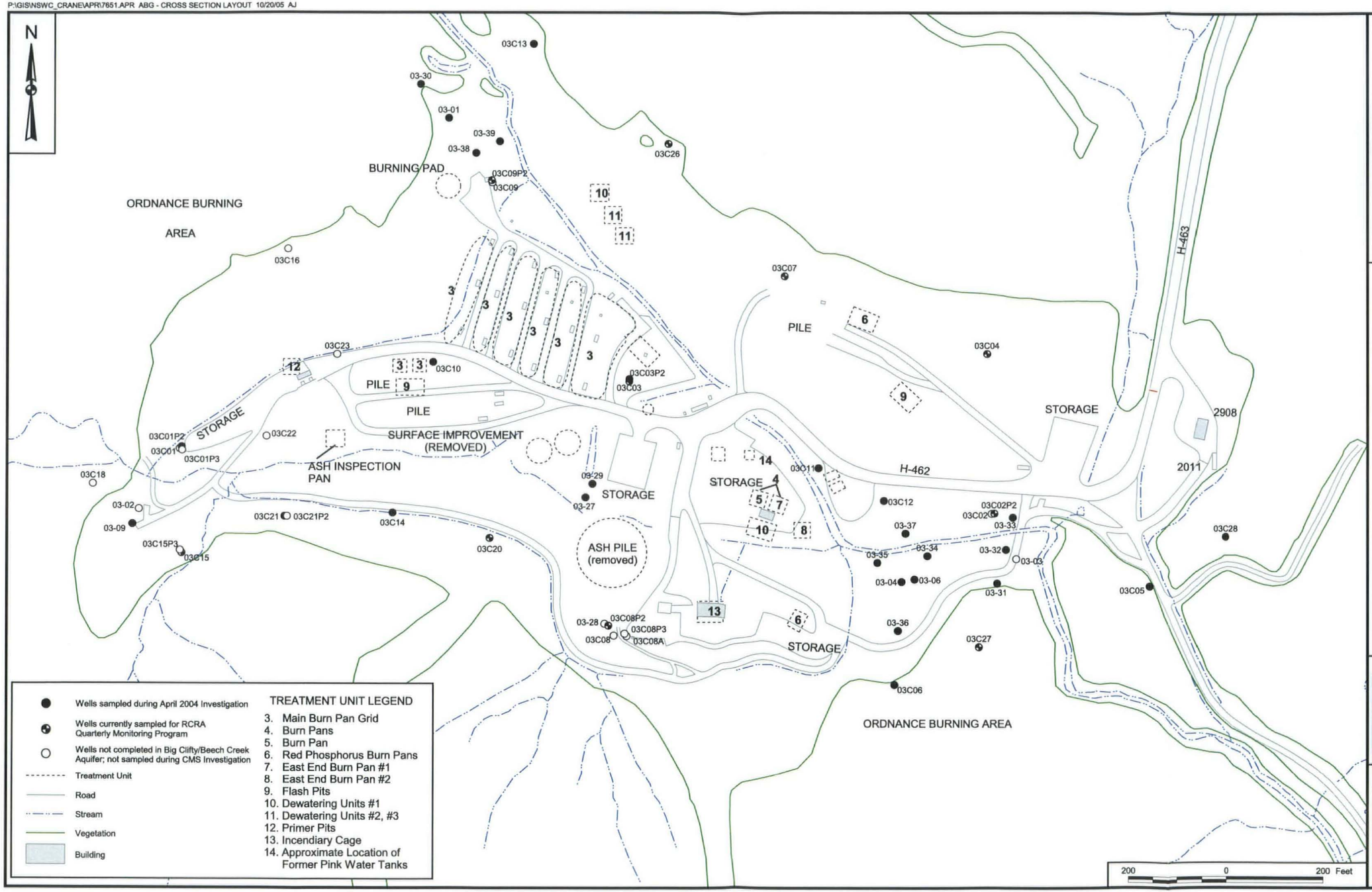
DRAWN BY	DATE
C. FOSTER	6/08/05
CHECKED BY	DATE
V. PLACHY	11/03/05
COST/SCHEDULE-AREA	
SCALE	
AS NOTED	

NAVFAC

SURFACE WATER FEATURES ASSOCIATED
WITH LITTLE SULPHUR CREEK
CMS REPORT FOR
SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

CONTRACT NUMBER CTO 0311	
APPROVED BY —	DATE —
APPROVED BY —	DATE —
DRAWING NO. FIGURE 1 - 2	REV 0

P:\GIS\NSWC_CRANE\APR\7651.APR ABG - CROSS SECTION LAYOUT 10/20/05 AJ



Wells sampled during April 2004 Investigation

Wells currently sampled for RCRA Quarterly Monitoring Program

Wells not completed in Big Clifty/Beech Creek Aquifer; not sampled during CMS Investigation

Treatment Unit

Road

Stream

Vegetation

Building

TREATMENT UNIT LEGEND

3. Main Burn Pan Grid
4. Burn Pans
5. Burn Pan
6. Red Phosphorus Burn Pans
7. East End Burn Pan #1
8. East End Burn Pan #2
9. Flash Pits
10. Dewatering Units #1
11. Dewatering Units #2, #3
12. Primer Pits
13. Incendiary Cage
14. Approximate Location of Former Pink Water Tanks

CONTRACT NO.
CTO 0311

APPROVED BY — DATE

APPROVED BY — DATE

DRAWING NO. — REV 0

FIGURE 1 - 3

PHYSICAL FEATURES OF
AMMUNITION BURNING GROUNDS
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

NAVFAC

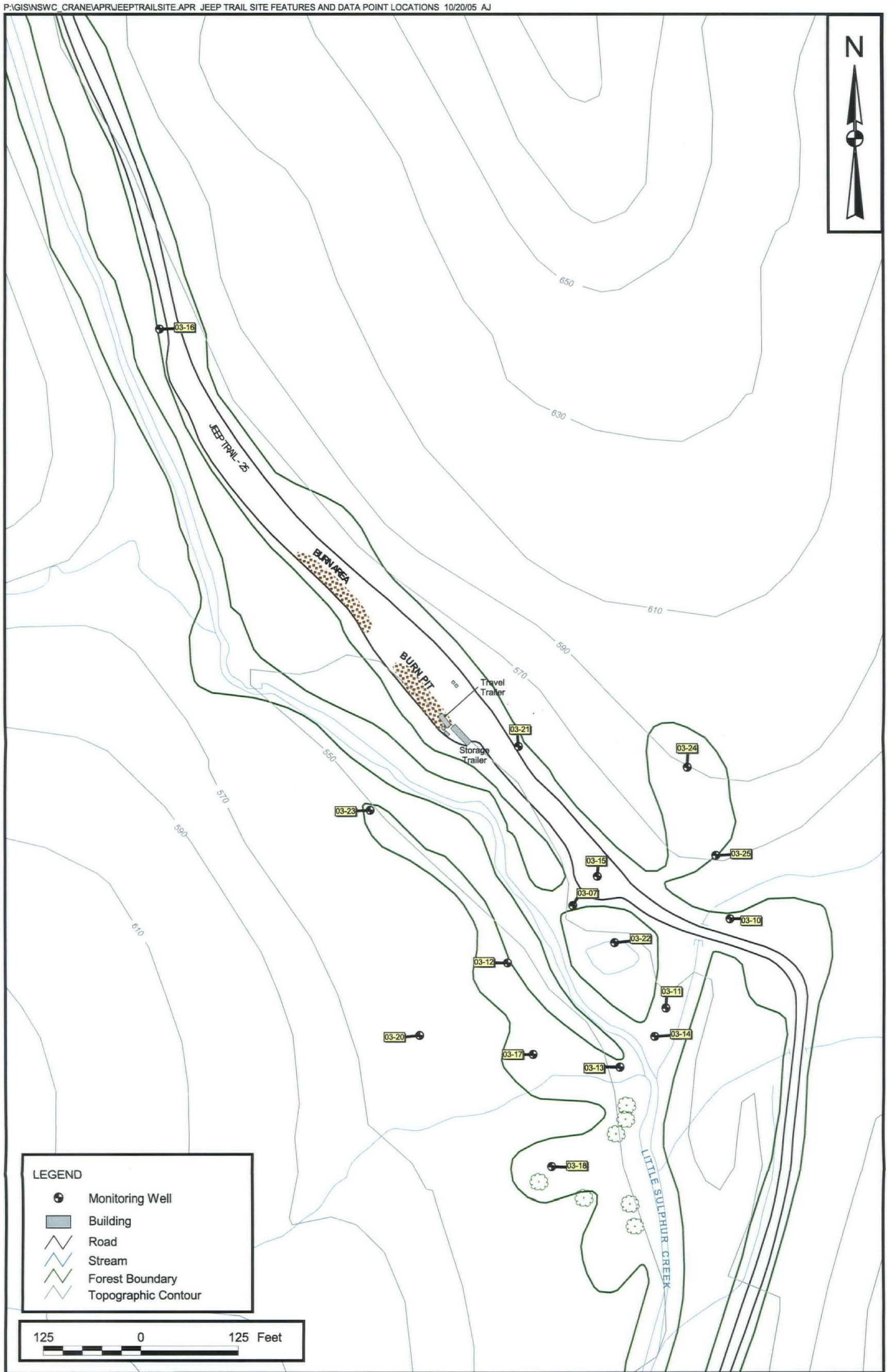
DRAWN BY A. JANOCHA — DATE 3/03/04

CHECKED BY V. PLACHY — DATE 10/20/05

COST/SCHED-AREA

SCALE AS NOTED

P:\GIS\NSWC_CRANE\APR\JEEPTRAILSITE.APR JEEP TRAIL SITE FEATURES AND DATA POINT LOCATIONS 10/20/05 AJ



DRAWN BY J. LAMEY	DATE 5/20/02	OLD JEEP TRAIL AREA CMS REPORT FOR SWMU 03 - AMMUNITION BURNING GROUNDS NSWC CRANE CRANE, INDIANA	CONTRACT NUMBER CTO 0311
CHECKED BY V. PLACHY	DATE 10/20/05		APPROVED BY — DATE —
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED	NAVFAC		DRAWING NO. FIGURE 1 - 4 REV 0

2.0 DESCRIPTION OF CURRENT CONDITIONS AT SWMU 3

Various historical investigations and risk assessments have been conducted at SWMU 3. As a result of these studies, the following have been identified as contaminants of potential concern (COPCs) for human health and ecological risk:

MTA

Soils (human health):

- Explosives (RDX)
- Volatile organic compounds (VOCs) [trichloroethylene (TCE)]
- Metals (barium, lead, manganese)

Groundwater (human health):

- Explosives (RDX)
- VOCs (TCE)
- Metals (barium)

Sediments (ecological):

- Metals (barium, lead, and zinc)

OJT

Soils (human health):

- Explosives (RDX)
- Metals (lead)

Groundwater (human health):

- Explosives [RDX and degradation product (2A-DNT)]
- VOCs (TCE and degradation product)

LSC

Surface Water (human health/ecological):

- Explosives [RDX and degradation products 2A-DNT and 4-amino-2,6-dinitrotoluene (4A-DNT)]
- Metals (barium)

Sediments (ecological):

- Metals (barium, lead, and zinc)

Section 2.1 describes the historical investigations that have resulted in identification of these COPCs. Section 2.2 summarizes the results of the follow-on human health screening evaluation (HHSE) at the MTA that was conducted to determine whether risk exists for current human MTA receptors. Section 2.3 summarizes the follow-on MTA ERA. Section 2.4 summarizes the OJT human health risk assessment (HHRA) from the RFI Report (TtNUS, 2005a). Section 2.5 summarizes the OJT ERA from the RFI Report. Section 2.6 summarizes the follow-on human health risk screening evaluation (HHSRE) and follow-on ERA for LSC. Section 2.7 describes the conceptual site model for SWMU 5. Section 2.8 contains recommendations for the CMS.

AWQS

2.1 HISTORICAL INVESTIGATIONS

2.1.1 Surface/Subsurface Soil

2.1.1.1 MTA

2.1.1.1.1 USACE Phase III Study

Surface/Subsurface Soil

In 1993, the USACE collected surface soil grab samples (from depths of 1 to 30 inches) and subsurface soil samples (from depths of 30 to 60 inches and 60 to 90 inches) from locations across the ABG (Albertson et al., 1998). The soil samples were analyzed for explosive compounds, VOCs, semivolatile organic compounds (SVOCs), and metals.

The results of the soil analyses showed that VOCs were present in only a few locations and only minor concentrations were typically detected (Albertson et al., 1998), with the maximum concentrations of TCE, cis-1,2-dichloroethene (DCE), and trans-1,2-DCE detected in boring 03/10-17.

HMX, RDX, trinitrobenzene, TNT, 2,4-dinitrotoluene (DNT), 2,6-DNT, 2A-DNT, and 4A-DNT were detected in surface and subsurface ABG soils. Locations where the highest concentrations of energetic compounds were detected included surface grab sample 03/10-61 and boring 03/10-35.

2.1.1.1.2 Current Contamination Conditions Risk Assessment

2.1.1.1.3 TtNUS CMS Field Investigation

A field investigation was conducted at the ABG by Tetra Tech NUS, Inc. (TtNUS) in April 2004 in an effort to fill data gaps identified during the early stage of CMS development. Groundwater underlying the MTA and OJT is contaminated with explosives (RDX) and chlorinated solvents (TCE) at concentrations greater than risk threshold levels and by metals (barium) at concentrations greater than screening levels. It was known that these contaminants were released to groundwater as the result of historical treatment practices, which occurred directly on the ground surface, releasing contaminants to the soils. In order to develop and estimate costs for effective remedial measures for soils, it was necessary to determine the locations and depths of soil contamination. Also it was necessary to evaluate the relative ratios of contamination in soils versus contamination in bedrock to determine whether soil remediation would effectively reduce the contaminant sources. The historical data were inadequate to make these determinations.

To fill these data gaps, an additional investigation of MTA soils and groundwater was conducted during April 2004. A total of 223 soil samples were collected at 67 locations. All soil samples were analyzed for explosives and selected soil samples were analyzed also analyzed for VOCs, RDX degradation products, Target Analyte List (TAL) metals, total organic carbon (TOC), pH, and cation exchange capacity (CEC). Sample depths were generally from 0 to 2 feet, 2 to 6 feet, 6 to 10 feet, and 10 to 14 feet or until refusal. Analytical results showing positive hits in surface and subsurface soil are provided in Appendix A of the draft Draft Conceptual Site Model and Fieldwork Report (TtNUS, 2005b). Figure 2-1 summarizes the results for the most frequently detected explosives (RDX, HMX, and TNT) and the most frequently detected organic (TCE). Figure 2-2 summarizes the results for barium, the primary metal of concern.

All target explosives were detected in at least once in all surface soil samples. However, the most frequently detected explosives were RDX, HMX, and TNT. Most detections of explosives were less than 1.0 milligrams per kilogram (mg/kg), with maximum explosive concentrations detected at 03SB120, which is the location of the former pink water tanks (see Figures 1-3 and 2-1).

Surface Soil

Three HMX detections in surface soil (03SS088, 03SS119, and 03SS120) were greater than the soil-to-groundwater HMX soil screening level (SSL) level of 52.6 mg/kg. Five RDX detections in surface soil (03SS080, 03SS107, 03SS109, 03SS119, and 03SS120) were greater than the RDX SSL of 0.004 mg/kg. Seven detections for TNT in surface soil (03SS050, 03SS075, 03SS079, 03SS088, 03SS108, 03SS119, and 03SS120) were greater than the TNT SSL of 0.011 mg/kg. Surface soils were not analyzed for TCE.

Subsurface Soil

Six (HMX, RDX, TNT, 1,3,5-trinitrotoluene, 2A-DNT, and 4A-DNT) of the 11 target explosives were detected in subsurface soil. The maximum concentrations of HMX, RDX, and TNT were detected in soil borings 03SB119, 03SB120, and 03SB079, respectively.

None of the HMX detections in subsurface soil were greater than the HMX SSL of 52.6 mg/kg. Four of the RDX detections in subsurface soil (03SB061, 03SB080, 03SB119, and 03SB120) exceeded the RDX SSL of 0.004 mg/kg. Two of the TNT detections in subsurface soil (03SB079 and 03SB088) exceeded the TNT SSL of 0.011 mg/kg. Five of the TCE detections (03SB061 at two depths, 03SB102, 03SB103, and 03SB112) exceeded the TCE SSL of 0.057 mg/kg.

Based on these results, it was concluded that it is not possible to identify soil sources of COPCs

2.1.1.2 Groundwater

2.1.1.2.1 <u>USACE Phase III Groundwater Release Study and NSWC Crane Quarterly Monitoring</u>

A Phase III RFI characterization for groundwater was conducted by the USACE WES (Murphy, 1994) at the ABG. A total of 98 borings and wells were drilled for this study. Seventy-two wells were sampled quarterly starting in 1987. Springs were also sampled. The RFI Report concluded that several wells within the ABG proper were contaminated. Contaminants included RDX, TCE, and the trace metal barium. Other trace metals were detected less frequently. The occurrence of RDX in groundwater was confined to wells within the ABG proper (MTA) and the mouth of Spring A.

The RFI recommended that a risk assessment be conducted to establish action levels and thence to proceed to the CMS.

2.1.1.2.2 RCRA Part B Permit Monitoring

The MTA is a RCRA-permitted treatment unit for the open burning of explosive materials in containment devices. The RCRA Part B Operating Permit requires quarterly groundwater monitoring of upgradient and downgradient wells in the BC/BC and Beaver Bend aquifers, the Spring A discharge point for contaminated MTA surface waters, and in LSC. As part of RCRA quarterly monitoring at selected ABG wells, 12 Beech Creek aquifer monitoring wells have been sampled between 8 and 20 times since the fall of 1998. The samples have been analyzed for inorganics, VOCs, and explosives. Annually, Appendix IX monitoring is conducted in selected wells. Nine rounds of monitoring were conducted to determine whether explosives and chlorinated solvents may be naturally degrading. Analytical results are presented in annual monitoring reports, which also include statistical comparisons of downgradient wells to the upgradient well. Following is a summary of the conclusions regarding contaminants that have been detected in statistically significant concentrations and that also exceed risk-based target levels (RBTLs) established in the Operating Permit. Appendix A contains summary tables and conclusions from the annual monitoring reports for the calendar years 2000, 2001, 2002, and 2003 (SAIC, 2002a; SAIC, 2002b; SAIC, 2003a; SAIC, 2003b, respectively)

Explosives: RDX is the primary explosive that has been detected in downgradient wells, Spring A, and in LSC. 1,3,5-Tritnitrobenzene has been sporadically detected in in two downgradient wells.

Metals: Barium (total and dissolved) is the primary metal that has been detected in downgradient wells and Springs A and C. Sporadically, exceedances have been observed for selenium, manganese, and zinc in one well (03C11).

VOCs: TCE and TCE degradation products have been consistently observed in several downgradient wells. Carbon tetrachloride has been consistently detected in two wells (03C09P2 and 03C10). Chloroform has been consistently detected in four wells (03C09P2, 03C10, 03C11, and 03C20). VOCs have been rarely detected in Springs A and C and LSC.

2.1.1.2.3 TtNUS CMS Field Investigation

The field investigation conducted by TtNUS at the MTA in April 2004 included the collection of groundwater samples from 26 monitoring wells. All groundwater samples were analyzed for explosives, VOCs, and metals. Selected samples were also analyzed for perchlorates. In the case of metals, unfiltered samples were analyzed for total metals. If the turbidity of a sample was greater than 10 nephelometric turbidity units (NTUs), a filtered sample was collected and analyzed for dissolved

metals. Analytical results showing positive hits in groundwater are provided in Appendix A of the Draft Conceptual Site Model and Fieldwork Report (TtNUS, 2005b).

The most frequently detected explosives in groundwater at the MTA were HMX and RDX. More than 80 percent of the detections were greater than 1 microgram per liter (µg/L), with concentrations at 11 locations (03-01, 03-31, 03-33, 03-38, 03-39, 03C03P2, 03C14, 03TW01, 03TW02, 03TW04, and 03TW05) exceeding the U.S. EPA Region 9 RDX Preliminary Remediation Goal (PRG) screening criterion value of 0.61 µg/L. None of the HMX detections in groundwater exceeded the HMX PRG screening criterion of 1,800 µg/L.

In addition to RDX and HMX, one TNT detection (03-21) exceeded the TNT screening criterion of 2.2 µg/L, three 4A-DNT detections (03TW05, 03-21, and 03C03P2) were greater than the 4A-DNT PRG screening criterion of 2.2 µg/L, and one 2A-DNT detection (03C03P2) exceeded the 2A-DNT PRG screening criterion of 2.2 µg/L.

There were 14 detections of TCE in groundwater at the MTA. Eleven TCE detections (03C03P2, 03C06, 03TW02, 03TW05, 03-38, 03-39, 03-01, 03-07, 03-12, 03-15, and 03-24) exceeded the PRG screening criterion of 1.6 µg/L.

2.1.2.2 OJT

2.1.2.2.1 <u>2001 OJT/LSC RFI</u>

Surface/Subsurface Soil

Forty-eight surface soil and 62 subsurface soil samples were collected from 48 soil borings ranging from 1 to 15 feet below ground surface (bgs) at the OJT during the 2001 OJT/LSC RFI. The maximum RDX soil concentration was 4.4 mg/kg in soil boring 03SB24 on the western side of the burn pit. This and other soil RDX concentrations might account for the high RDX concentration detected in well 03-21. The burn pit was identified as the potential source area of energetics (i.e., RDX) and TCE contamination in groundwater. However, the levels of TCE detected in soil were not high enough to account for the TCE concentrations detected in well 03-07. Summaries of the analytical data for surface and subsurface soil samples collected during the 2001 OJT/LSC RFI are presented in Appendix A of the Draft Conceptual Site Model and Fieldwork Report (TtNUS, 2005b).

2.1.2.2.2 TtNUS CMS Field Investigation

Subsurface Soil

Four soil borings (03SB049, 03SB50, 03SB51, and 03SB52) were completed at the OJT during the April 2004 field investigation. All OJT surface and subsurface samples were analyzed for explosives and TAL metals. Selected sample depths were analyzed also for VOCs, RDX degradation products, and perchlorates. Analytical results showing positive hits in groundwater are provided in Appendix A of the Draft Conceptual Site Model and Fieldwork Report (TtNUS, 2005b).

TNT and HMX were the only two explosives detections (both at 03SS050) in surface soil at the OJT. Only the TNT concentration exceeded the TNT soil-to-groundwater SSL of 0.011 mg/kg. There were no detections of explosives in subsurface soil.

There were no detections of TCE in OJT surface or subsurface soil samples.

2.1.2.2.3 USACE Ground Water Study – 1981 to 1983 and 1994

Groundwater

The USACE installed 17 monitoring wells in the OJT area between 1981 and 1983 (Murphy, 1996). TCE concentrations in one well (03-07) exceeded 1,000 µg/L on several occasions, and reached as high as 19,000 µg/L in 1982.

In 1994, TCE and cis-1,2-DCE concentrations were 4,000 and 1,000 µg/L, respectively, in well 03-07 (Murphy, 1996); TCE contamination was also detected at lower concentrations in two wells to the northeast (03-15 and 03-24) and two wells to the southwest (03-12 and 03-20) of well 03-07, and the highest RDX concentration (365 µg/L) was detected in well 03-21, located north of well 03-07 and southeast of the burn pit.

2.1.2.2.4 2001 OJT/LSC RFI

Groundwater

The OJT monitoring wells were resampled in 2001 during the OJT/LSC RFI. The TCE concentration in well 03-07 and the RDX concentration in well 03-21 decreased significantly compared to the 1994 concentrations. Analytical results for this study are provided in Appendix A of the Draft Conceptual Site Model and Fieldwork Report (TtNUS, 2005b).

2.1.2.2.5 TtNUS CMS Field Investigation

Groundwater

A total of six groundwater wells (03-07, 03-12, 03-15, 03-16, 03-21, and 03-24) were sampled during the field investigation conducted in April 2004. All samples were analyzed for VOCs, explosives, and metals, with the samples at locations 03-07 and 03-15 also being analyzed for perchlorates. Analytical results showing positive hits in groundwater are provided in Appendix A of the Draft Conceptual Site Model and Fieldwork Report (TtNUS, 2005b).

Five explosives (2A-DNT, 4A-DNT, HMX, RDX, and TNT) were detected in all wells sampled during the investigation.

The maximum detected concentrations of RDX and HMX were in samples from wells 03-21 and 03-12. One TNT detection (03-21) exceeded the PRG of 2.2 µg/L. All six wells had positive RDX detections that exceeded the PRG of 0.61 µg/L. None of the detected HMX concentrations exceeded the PRG of 1,800 µg/L.

2.2 FOLLOW-ON HUMAN HEALTH RISK SCREENING EVALUATION

The MTA is an active operating RCRA-permitted hazardous waste treatment facility. NSWC Crane intends to conduct hazardous waste treatment operations at the MTA until the year 2050. All RCRA-permitted facilities are subject to RCRA closure requirements for permitted facilities. At the end of the active life of the MTA, it will either be clean closed or closed as a RCRA landfill in accordance with RCRA closure regulations for hazardous waste treatment facilities. Therefore, human receptors and pathways of exposure for this CMS are limited to the existing land use scenario because future land use scenarios will be addressed in the closure plan. A follow-on HHRSE was conducted to determine whether risks exist to current receptors, that must be addressed in the CMS. Appendix B contains the detailed HHRSE. Following is a summary of potential receptors, exposures under current land use, and exposure pathways that were considered in the HHRSE:

On-Site Residents: Prohibited as long as the MTA is operated as a RCRA hazardous waste treatment facility (i.e., on-site residents are not a viable pathway under the current land use scenario).

Site Worker: Exposure occurs under current use of MTA as RCRA hazardous waste treatment facility. Exposure is limited to surface soils because contaminated groundwater from the BC/BC aquifer is not

withdrawn for drinking water (i.e., site worker exposure to surface soils is a viable pathway under the current land use scenario).

Construction Worker: Exposure may occur under current use of MTA as hazardous waste treatment facility (i.e., construction worker exposure to surface soils is a potential pathway under the current land use scenario).

Trespasser: Exposure may occur under current use of MTA as RCRA hazardous waste treatment facility. Exposure is limited to surface soils because contaminated groundwater from the BC/BC aquifer is not withdrawn for drinking water (i.e., trespasser exposure to surface soils is a viable pathway under the current land use scenario).

LSC Surface Waters for Recreational Use: LSC becomes a perennial stream downstream from Spring C (discharge point for contaminated OJT groundwater) and Springs A and A' (discharge points for contaminated MTA groundwater) (i.e., LSC recreational use exposure for the recreational user is a viable pathway under the current land use scenario).

LSC Surface Waters as Drinking Water Source: Withdrawal of contaminated surface waters from LSC for use as drinking water is a viable use under the current land use scenarios for the MTA (and OJT). However, under current land use scenarios and the anticipated future land use, this is only possible after LSC exits lands controlled by the Navy. Contaminated groundwater from the MTA discharges through the karst system into Springs A and A', which then discharges into LSC. LSC serves as a tributary to the East Fork White River, which is used as a drinking water source with the nearest intake at Shoals (See Figure 1-2) (i.e., exposure to LSC surface waters as a drinking water source is a viable pathway under the current land use scenario).

Based on the above evaluation, a follow-on HHSRE was conducted for site workers, trespassers, and construction worker exposed to soils at the MTA and for off-site and on-site users of LSC surface waters. Therefore, for the MTA, the CMS will address excess risks to current receptors (i.e., site worker, construction worker, and trespasser) and to users of LSC surface waters.

2.2.1 MTA Soils

This section is a summary of the follow-on HHRSE as well as the conclusions from the follow-on HHRSE. Appendix B contains the detailed HHRSE.

The HHSRE evaluated the following current receptors:

- Base personnel (typical SWMU workers) specifically assigned work tasks at the ABG
- Construction workers periodically assigned work at the ABG
- Trespassers

These receptors are typically exposed to soils via the following exposure pathways:

- Direct contact (i.e., incidental ingestion, dermal contact)
- Inhalation of airborne soil particulates from the site

The risk characterization for COPCs in soils was conducted as follows:

- Except for lead, using the simple risk-ratio technique that estimates cancer and non-cancer risks based on the rationing of representative exposure point concentration to risk-based screening levels.

- For lead, using a qualitative comparison of arithmetic mean lead concentrations in soils to the U.S. EPA risk benchmarks for residential and industrial land use scenarios.

2.2.2 Summary and Conclusions for MTA Soils

- Cancer risks developed for COPCs detected in soils do not exceed the U.S. EPA target cancer risk range of $1x10^{-4}$ to $1x10^{-6}$ for the industrial worker, construction worker, or trespasser.

- Non-cancer risk estimates for the industrial worker and trespasser are less than the U.S. EPA hazard index (HI) threshold of 1.

- Non-cancer risk estimates for construction worker exposure to soils are 10 for COPC concentrations in both surface and subsurface soils; the primary risk drivers are barium, lead, and manganese.

  - Barium is not recommended for further evaluation in the CMS for SWMU 3 because non-cancer risk estimates based on sub-chronic inhalation reference doses available in the Health Effects Assessment Summary Table (HEAST), but not in the Integrated Risk Information System (IRIS) database, indicated that construction worker exposure to on-site barium concentrations would not result in HIs exceeding 1. Therefore, barium in MTA soils will not be carried forward in this CMS for human receptors.

- Manganese is not recommended for further evaluation in the CMS for SWMU 3 because the non-cancer risk estimates for the construction worker are based on a chronic inhalation reference dose (a sub-chronic inhalation reference dose is not available) developed using toxicity data reflective of a workers exposure to manganese oxide compounds in an occupation setting (not incidental exposure to soils). Therefore, manganese in the MTA soils will not be carried forward in this CMS for human receptors.

where is lead mentioned again?

- Lead is recommended for further evaluation in the CMS for SWMU 3.

- The area of concern for lead is a sub-area of the southeastern quadrant of the MTA that has arithmetic mean lead concentrations (681 mg/kg) exceeding the U.S. EPA Region 9 soil PRGs for residential and industrial land use scenario, and the calculated site-specific screening level (550 mg/kg) for the construction worker (see Figure 2-3).

Although the construction worker was evaluated in the follow-on HHRSE, because the lead area of concern is a sub-area within the active MTA unit, construction will not occur in this sub-area. To ensure that no construction will occur in the lead hot spot area, land use controls (LUCs) will be implemented for the sub-area. Therefore, for the construction worker, LUCs will be addressed in this CMS Report as the recommended corrective measure for the lead contaminated sub-area of the MTA.

2.3 MTA FOLLOW-ON ECOLOGICAL RISK ASSESSMENT

2.3.1 Surface Soils

Currently, and for the foreseeable future, open burning/open detonation operations will continue to occur at the active portion (MTA) of the ABG. Figure 2-4 is an aerial photograph of the MTA. This figure shows that the MTA consists of roads and other areas covered by gravel, pavement, concrete, etc., which is surrounded by mowed grass. The active area is surrounded by a heavily wooded area as seen in Figure 2-4. Because of the industrial nature of the site, with the exception of soil invertebrates, grass, and other herbaceous plants, few ecological receptors would be present in the active area except in passing. Therefore, there is not an ecologically significant ecological community that would be impacted by site contaminants under these conditions. After activities cease at the site, a risk-based closure plan would need to be prepared, and risks to ecological receptors would be evaluated at that time for the uses that would be designated in the closure plan.

Therefore, surface soils associated with the MTA will not be carried forward in this CMS for ecological receptors.

2.3.2 Surface Water

Elevated levels of various compounds in surface water may have a potential adverse impact to wildlife at the site; however, impacts as a result of these COPCs would be very localized and unlikely to impact the viability of any one species at the site because of the availability of similar habitat in close proximity to these locations. Population studies at SWMU 3 support this conclusion; animal, fish, macroinvertebrate and vegetation species are diverse and abundant and are similar to those that would be expected to occur in non-impacted areas (TtNUS, 1999).

Therefore, surface water associated with the MTA will not be carried forward in this CMS for ecological receptors.

2.3.3 Sediments

The majority of ecological risks posed by COPCs at the MTA appear to be limited to aquatic habitats at the SWMU. Elevated levels of barium, lead, and zinc in sediments at the site may have slight adverse effects to wildlife; however, population studies and tissue samples for fish and macroinvertebrates did not show any evidence of adverse effects (TtNUS, 1999). Based upon the CCCRA, barium, lead, and zinc in the MTA should not be carried forward in this CMS for ecological receptors.

However, in further support of the elimination of barium in sediments, a follow-on MTA ERA was conducted for barium (Appendix C). Barium was eliminated as an ecological COPC for sediments in LSC based on the following:

- Barium concentrations are greatest in samples collected within the MTA and decreased further downngradient, although they remained greater than the Apparent Effects Threshold (AET) and exceeded concentrations in samples collected upgradient of the MTA.

- Portions of LSC upgradient of Spring C are poor habitat for aquatic receptors, and significant impacts are unlikely because the number of receptors is limited by the poor habitat.

- Perennial portions of LSC (e.g., below Spring C) are currently supporting a variety of aquatic receptors indicating impacts from barium are not significant.

Therefore, based upon the CCCRA and the follow-on ERA, barium, lead, and zinc will not be carried forward in this CMS for ecological receptors.

2.4 OJT HUMAN HEALTH RISK ASSESSMENT

The human receptors evaluated for the OJT and LSC were the construction worker, maintenance worker, occupational worker, adolescent trespasser, off-site resident, off-site recreational user, and future adult and child residents. Human exposure pathways evaluated for the OJT and LSC were surface soil, subsurface soil, groundwater, surface water (high- and low-flow), and sediment (surface and deeper).

Two exposure units of different sizes were evaluated. These units were the 1-acre exposure unit described in the Quality Assurance Project Plan (QAPP), which encompasses the burn area/burn pit, and the entire 6-acre OJT and LSC study area (TtNUS, 2001).

Based on evaluation of data obtained during this investigation, consideration of site operational history, data generated during past investigations, results of the baseline HHRSE and ERA, and the QAPP decision rules for the OJT and LSC, the following conclusions were reached:

- The soils, groundwater, surface water, and sediment data collected during the RFI were adequate to support the development of baseline human health and ecological risk assessments for the OJT and LSC.

- Under current land use, no significant potential human health risks are expected for exposures to soil, sediment, surface water, or groundwater.

- Under future land use, non-carcinogenic risks exceeding an HI of 1.0 and/or Incremental Lifetime Cancer Risks (ILCRs) exceeding $1x10^{-4}$ were identified for on-site child and adult residents using surface water as a potable water source, mainly as a result of samples collected from location 03SWSD17. This location is downstream of Spring A, which is a direct conduit for groundwater contaminant transport from the ABG. 2A-DNT, 4A-DNT, and RDX were the major contributors to the elevated risks for surface water.

- Under future land use, non-carcinogenic risks exceeding an HI of 1.0 and/or ILCRs exceeding $1x10^{-4}$ were calculated for occupational workers, child recreational users, and on-site child and adult residents

using groundwater as a potable water source. TCA, TCE, and 2A-DNT were the major contributors to the elevated risks for groundwater.

- Unacceptable exposure of the future on-site child resident to surface soils was identified, primarily as a result of high lead concentrations at surface soil sampling location 03SB24.

- A CMS should be implemented to evaluate remedial alternatives to reduce the identified unacceptable risks. This CMS should consider all sources of contamination at the ABG, OJT, and LSC because groundwater, surface water, and sediment flow from the ABG toward the OJT and LSC.

Therefore, the following will be carried forward in this CMS for the OJT:

- Risks from exposure to surface soil lead concentrations at sampling location 03SB024 for the OJT future child receptor.

Additionally, the following will be addressed in Section 2.6 of this CMS:

- Risks from exposure to surface water as a potable water source at location 03SWSD17 for the future OJT on-site child and adult residents based on risks from 2A-DNT, 4A-DNT, and RDX.

- Exposure to groundwater as a potable water source for future OJT occupational workers, child recreational users, and on-site child and adult residents based on risks from TCA, TCE, and 2A-DNT.

2.5 OJT ECOLOGICAL RISK ASSESSMENT

An ERA was conducted at the OJT and LSC (TtNUS, 2005a) in accordance with the approved QAPP for SWMU 3 (TtNUS, 2001). The ecological receptors evaluated in the assessment included the following:

- Those directly exposed to chemicals in surface water, sediment, and surface soil (i.e., plants, invertebrates in soil and sediment, and aquatic organisms).

- Those indirectly exposed to chemicals via the food-chain (i.e., through the ingestion of plants, fish, and invertebrates).

Based on evaluation of the data obtained during the investigation, consideration of site operational history, data generated during past investigations, and the QAPP requirements, the following conclusions were reached:

- Several chemicals were retained as COPCs in the initial ecological screening process in surface soil due to exceedances of direct contact, risk-based COPC screening levels, or because no current medium-specific Ecological Data Quality Levels (EDQLs) are available. During the Step 3a evaluation, no chemicals initially selected as COPCs were retained for further evaluation. The majority of elevated detections were found at locations 03SS22 and 03SS24. Both of these sample locations are in the southern burn pit/burn area along the fringe of the road where the habitat for plants and invertebrates is poor. Based on field sheets and boring logs, the surface soil sample (0 to 2 feet) from 03SS24 consisted of a clayey silt, sand, gravel (top 1.5 feet) and silty clay (bottom 0.5 foot), and trace ash, while the surface soil sample (0 to 2 feet) from 03SS22 consisted of sand and gravel (top 0.4 foot) and clay with trace silt and sand (bottom 1.6 feet). Ash and burnt materials/cinders were found in the subsurface soil immediately below the surface soil samples. Therefore, it is not likely that a large earthworm population would inhabit this area because of the large amount of sand and gravel in the soil. It does not appear that plants are being adversely impacted because herbaceous plants are present along the road. Significant impacts to plants and invertebrates are therefore not expected because the poor habitat would limit the numbers of receptors, especially earthworms, that would inhabit this area. Although risks to plants and invertebrates from COPCs in the soil are possible, the potential risks from chemicals initially selected as COPCs are not great enough to warrant further evaluation.

- Several chemicals were retained as COPCs in the initial ecological screening process in sediment and surface water due to exceedances of direct contact, risk-based COPC screening levels, or because no current medium-specific EDQLs are available. During the Step 3a evaluation, no chemicals initially selected as COPCs were retained for further evaluation. Currently, the highest contamination concentrations in LSC are in areas where the creek is intermittent and there is little viable aquatic habitat, and chemicals present in the perennial portion of LSC do not appear to be adversely impacting aquatic receptors. Various aquatic insects, fish, crayfish, frogs, and salamanders were observed in the perennial portion of LSC during a June 2004 site visit.

- Chemicals detected in surface soil, sediment, and surface water that are considered persistent, bioaccumulative, and toxic (PBT) were retained as COPCs for evaluation in terrestrial wildlife food-chain models. During the Step 3a evaluation, no PBT chemicals were retained for further evaluation because No-Observable-Adverse-Effects-Level (NOAEL)-based Ecological Effects Quotient (EEQs)

using the average exposure assumptions were near or less than 1.0. In the herbivorous/insectivorous models, only lead in the American robin model had a NOAEL EEQ of significance (EEQ = 24) using the average exposure scenario; however, the exposure point concentration used in the model was elevated due to the maximum concentration detected at location 03SS24. This location is not likely to support earthworms due to the poor habitat in and surrounding the former burn pit. The NOAEL EEQ excluding location 03SS24 is 0.6. Several metals had NOAEL-based EEQs greater than 1.0 using the average exposure assumptions in the piscivorous mammal food-chain model. However, LSC is small and is not likely capable of supporting 100 percent of the raccoon's diet, especially considering the large home range of this wildlife receptor. When an area use factor (AUF) of 10 percent is applied to the food-chain models, NOAEL-based EEQs are less than 1.0.

Based upon the above, the chemicals in surface water, sediment, and surface soil at SWMU 3 will not been carried forward in this CMS for OJT ecological receptors.

2.6 LSC ALTERNATIVE WATER QUALITY STANDARDS

The annual groundwater monitoring reports (SAIC, 2002a; SAIC, 2002b; SAIC, 2003a; SAIC, 2003b) identified RDX, TCE, and barium as the major constituents present in MTA groundwater in statistically significant concentrations greater than RBTLs. The RFI for the Jeep Trail/LSC (TtNUS, 2005a) identified excess risk resulting from ingestion of surface water containing RDX, 2A-DNT and 4A-DNT for drinking water. The IDEM has established uses for all surface waters, including LSC. Protective criteria are established for various constituents to protect these uses. Based on the Indiana water quality standards (WQSs) for surface waters, concentrations of explosives including RDX, 2A-DNT, and 4A-DNT in LSC must be limited, at a minimum, to concentrations that would ensure maintenance of a balanced warm water aquatic community, and that would protect public water supplies (at the point where water is withdrawn for drinking water or industrial use), for the most stringent of the two criterion. The concentration of RDX in LSC is the explosive risk driver because, typically, the combined concentrations of 2A-DNT and 4A-DNT are minimal (2A-DNT and 4A-DNT were not detected in the surface water samples collected in 2004) when compared to the RDX concentrations in LSC.

Indiana WQS regulations do not contain a list of protective criteria for RDX, 2A-DNT, or 4A-DNT. However, the regulations do contain a procedure for calculation of water quality criteria (WQCs) that are protective of human health and the environment. Following is summary of the process that was used to establish these criteria. A detailed discussion of the methodology for the calculation of WQCs for these explosive compounds is contained in Appendix D.

As discussed in Section 1.4.4, the groundwater hydrology associated with SWMU 3 is complex. However, it has been determined that a karst system underlies part of the MTA that discharges groundwater from the BC/BC aquifer primarily at Springs A and A' but probably at Spring B as well. Additionally, it has been determined that another karst system underlies part of the OJT that discharges groundwater from the BC/BC aquifer at Spring C. Spring C is located upstream of Springs A, A', and B.

The surface water features of LSC and the streams into which it flows after it exits NSWC Crane property are shown in Figure 1-2. As previously discussed, LSC flows into Sulphur Creek; Sulphur Creek flows into Indian Creek; and Indian Creek flows into the East Fork White River.

In accordance with Indiana requirements, surface water quality criteria must be met at the location of the point of use. For protection of off-site receptors, these locations (see Figure 1-2) are defined as follows:

1. For the warm water aquatic receptors, this location would be below Spring C, where LSC becomes a perennial stream.

2. For full body contact recreational user (i.e., public health criterion, incidental water intake), this location would be LSC outside of the location where Springs A, A', B, and C mix with LSC.

3. For protection of public water supplies, this location would be the closest location from which LSC surface waters are withdrawn for public water supply (i.e., Shoals Water Intake).

Following is a discussion of how WQCs were determined for barium, TCE, RDX, 2A-DNT, and 4A-DNT:

Barium

Barium has been detected in wells, springs, and surface waters in excess of the RBTL (3.9 µg/L) established in the RCRA Permit. The MCS for protection of human health is the Safe Drinking Water Act (SDWA) Maximum Concentration Level (MCL) (2,000 µg/L). Groundwater data for MTA monitoring wells and Spring A were evaluated to determine whether this MCL was exceeded. Appendix E includes the barium data in groundwater, spring, and surface water samples collected at the ABG since 1998. From 1998 through 2004, barium concentrations from MTA monitoring wells and Spring A ranged from 94.8 to 154 µg/L and 96.2 to 142 µg/L for unfiltered and filtered samples, respectively. All of these concentrations are significantly less than the MCL of 2,000 µg/L.

where would RDX < MCL

Therefore, barium concentrations in groundwater and surface waters meet the MCL and will not be carried forward in this CMS for off-site human receptors.

RDX, 2A-DNT, and 4A-DNT

The concentration of RDX in groundwater is the explosive risk driver because, typically, the combined concentrations of 2A-DNT and 4A-DNT (greater than 96 percent of the groundwater explosives in samples collected in 2004) are less than the RDX concentrations in groundwater. Appendix E includes the data for these explosives in groundwater, spring, and surface water samples collected at the ABG since 1998.

Based on the Indiana WQCs for surface waters, RDX, 2A-DNT, or 4A-DNT concentrations in LSC must be limited, at a minimum, to concentrations that would ensure maintenance of a balanced warm water aquatic community and that would protect public water supplies (at the point where water is withdrawn for drinking water or industrial use) for the most stringent of the two criterion. Applicable State and federal criteria, standards, and regulations are as follows:

Caps?

- Under 327 Indiana Administrative Code (IAC) 2-1-6(a)(2)(C), procedures for calculation of criteria, the RDX chronic aquatic criterion (CAC) was determined to by 3,070 µg/L, and the RDX terrestrial life cycle safe concentration (TLSC) was determined to be 2,800 µg/L.

- The discharges from Springs A, A', B, and C can be considered to be equivalent National Pollution Discharge Elimination System (NPDES) discharge points.

- The RDX water quality-based effluent limitation (WQBEL) established under 327 IAC 5-2-11.1 for public health criteria (incidental water intake only) was determined to be 240 µg/L.

- The 2A-DNT or 4A-DNT WQBELs established under 327 IAC 5-2-11.1 for public health criteria (incidental water intake only) were each determined to be 4,100 µg/L.

- The RDX public water supply point of intake criterion is 3 µg/L.

- The 2A-DNT or 4A-DNT WQBELs for public water supply intake were determined to be 68 µg/L for amino-dinitrotoluene compounds.

Using the USGS database for the closest water intake (Shoals), explosives concentrations at the nearest downstream gauging location (East Fork White River at Shoals) were calculated to be 0.0026 µg/L for RDX, 0.002 µg/L for 2A-DNT, and 0.0002 µg/L for 4A-DNT under the following assumptions (See Appendix D for the details):

Spring A ?

- Spring C comprises the entire flow of LSC for 30 days.
- Spring C RDX concentrations are 63 µg/L, 2A-DNT concentrations are 70 µg/L, and 4A-DNT concentrations are 6.2 µg/L for 30 days.
- The LSC flow rate is 6 gpm for 30 days.
- The public water supply intake is located on the East Fork White River at Shoals.
- The monthly flow rate at Shoals is 142,279 gpm.
- No photolytic or biological degradation of RDX, 2A-DNT, or 4A-DNT occurs.

Based on these assumptions, the concentrations of RDX, 2A-DNT or 4A-DNT calculated for the Shoals intake are less than the applicable water quality criteria. Therefore, explosives in surface water will not be carried forward in this CMS for off-site human receptors.

TCE

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The concentration of TCE in groundwater is the risk driver because, typically, concentrations of TCA (no TCA was detected in groundwater samples collected in 2001) are less than TCE concentrations in groundwater. Additionally, TCE, and its degradation products, are generally not detected or only detected at trace concentrations in springs and LSC surface waters (See Section 2.7 for additional supporting information). Appendix E includes the TCE data for groundwater, spring, and surface water samples collected at the ABG since 1998.

The TCE appear to be volatizing in the karst systems underlying the MTA and OJT, and any TCE that would be present in the springs would volatize upon discharge to LSC.

Therefore, TCE and TCA in groundwater will not be carried forward in this CMS for surface water.

2.7 CONCEPTUAL SITE MODEL

Figure 2-5 is a schematic drawing of the conceptual site model for the MTA. It shows, in principle, that contaminants were released into surface/subsurface soils and migrated toward downgradient locations

from those releases to deeper soils, groundwater, springs, and LSC. Appendix G presents the detail conceptual site model. The following is a summary of the conceptual site model for the MTA:

- Groundwater underlying the MTA is contaminated with RDX, TCE, and degradation products of RDX and TCE in excess of risk-based concentrations. The presence of degradation products indicates that natural degradation is occurring.

- The relative distribution of RDX and TCE contamination sources between the overburden, bedrock, and karst system is not known.

- The distribution of RDX and TCE contamination sources in the overburden soil, bedrock, and karst system appears to be heterogeneous in nature.

- Current practices (open burning in containment structures) have eliminated any releases of contaminants to soils and groundwater. Therefore, the contaminant source is being depleted.

- MTA groundwater discharges through the karst system into LSC through Springs A and A'.

- TCE is volatized in the karst system and is not present in LSC surface waters.

- RDX concentrations in surface waters originating from Spring A discharges are less than applicable IDEM WQC for public water supply and incidental contact with surface waters.

- The existing use for the MTA is industrial. Receptors associated with the existing use (industrial) include the site worker, construction worker, and trespasser.

- Contaminated groundwater underlying the MTA is not used and therefore, does not present a risk under the industrial use scenario.

- Excess risk is present only for the construction worker resulting from exposure to metals.

- Excess risk is present for future residents ingesting groundwater. Reasonable future uses for the MTA do not include residential housing.

- The industrial nature of the MTA (OB operations, paved areas, etc.) eliminates ecological habit. Therefore, ecological uses are not viable at the MTA.

Figure 2-6 is a schematic drawing of the conceptual site model for the OJT. It shows, in principle, that contaminants were released into surface/subsurface soils and migrated toward downgradient locations from those releases to deeper soils, groundwater, springs, and LSC. Exposure to the contaminants could result in unacceptable health risks to humans. The following is a summary of the conceptual site model for the OJT:

- Groundwater underlying the OJT is contaminated with RDX and TCE.

- RDX and TCE contamination sources appear to be distributed among the overburden soil, bedrock, and karst system.

- The relative distribution of RDX and TCE contamination sources between the overburden, bedrock, and karst system is not known due to the heterogeneous distribution of contamination at the OJT.

- Open burning operations, which, resulted in the release of contaminants have not taken place since the 1980s. Therefore, the contaminant source is being depleted.

- OJT groundwater discharges through the karst system into LSC at Spring C.

- LSC becomes a perennial stream below the Spring C discharge point.

- RDX concentrations in surface waters originating from Spring C discharges are below applicable IDEM water quality criteria for public water supply and incidental contact with surface waters.

- TCE is volatized in the karst system and is not present in LSC surface waters.

- The existing use for the OJT is industrial. Receptors associated with the existing use (industrial) include the site worker, construction worker, and trespasser.

- Contaminated groundwater underlying the OJT is not used and; therefore, does not present a risk under the industrial use scenario.

- Excess risk is presented to future residents ingesting groundwater. Reasonable future uses for the OJT do not include residential housing.

- No excess risk to ecological receptors at the OJT or LSC has been identified.

2.8 CONCLUSIONS FOR CORRECTIVE MEASURES STUDY

Summary Table needed to depict how/where each cont. per media is eliminated or proceeds to CMS

Following are conclusions regarding the development of the CMS for the ABG. These recommendations are based on the conceptual site model which has been presented in this section.

- The CMS should focus on existing and planned future uses for the MTA and the OJT (industrial).

- Screening and detailed evaluation of alternatives to address risk to the construction worker at the MTA is not necessary. The alternatives evaluated should include only the no-action and land use controls

- Screening and detailed evaluations of alternatives to address excess risk from ingestion of ground water and exposure to soils is not necessary because the withdrawal of contaminated Beech Creek/ Big Clifty groundwater does not occur under the current and future industrial use scenario. However, to assure that no changes occur in land use the no-action and LUC alternatives should be evaluated.

- LTM of groundwater underlying the MTA and OJT should be included in the preferred alternative. The LTM program should be designed to provide information as to whether contaminants are naturally degrading.

- The LTM program should include monitoring of LSC surface waters to ensure that concentrations of contaminants remain below IDEM WQS.

- The LTM program should include periodic checks to determine whether any modifications occur in state-designated uses of LSC surface waters or any changes occur in the locations where the uses occur (i.e. public water supply intake). If such changes occur an evaluation should be conducted to determine whether contamination concentrations in LSC are adversely affecting the state-designated uses.

Using the USGS database for the closest water intake (Shoals), explosives concentrations at the nearest downstream gauging location (East Fork White River at Shoals) were calculated to be 0.0026 µg/L for RDX, 0.002 µg/L for 2A-DNT, and 0.0002 µg/L for 4A-DNT under the following assumptions (See Appendix D for the details):

Spring A?

- Spring C comprises the entire flow of LSC for 30 days.
- Spring C RDX concentrations are 63 µg/L, 2A-DNT concentrations are 70 µg/L, and 4A-DNT concentrations are 6.2 µg/L for 30 days.
- The LSC flow rate is 6 gpm for 30 days.
- The public water supply intake is located on the East Fork White River at Shoals.
- The monthly flow rate at Shoals is 142,279 gpm.
- No photolytic or biological degradation of RDX, 2A-DNT, or 4A-DNT occurs.

Based on these assumptions, the concentrations of RDX, 2A-DNT or 4A-DNT calculated for the Shoals intake are less than the applicable water quality criteria. Therefore, explosives in surface water will not be carried forward in this CMS for off-site human receptors.

TCE

p.2-14

The concentration of TCE in groundwater is the risk driver because, typically, concentrations of TCA (no TCA was detected in groundwater samples collected in 2001) are less than TCE concentrations in groundwater. Additionally, TCE, and its degradation products, are generally not detected or only detected at trace concentrations in springs and LSC surface waters (See Section 2.7 for additional supporting information). Appendix E includes the TCE data for groundwater, spring, and surface water samples collected at the ABG since 1998.

The TCE appear to be volatizing in the karst systems underlying the MTA and OJT, and any TCE that would be present in the springs would volatize upon discharge to LSC.

Therefore, TCE and TCA in groundwater will not be carried forward in this CMS for surface water.

2.7 CONCEPTUAL SITE MODEL

Figure 2-5 is a schematic drawing of the conceptual site model for the MTA. It shows that contaminants were released through surface/subsurface soils and spread toward downgradient locations from those

releases to deeper soils, groundwater, springs, and LSC. The following is a summary of the follow-on Conceptual Site Model for the MTA:

- The relative distribution of RDX, TCE, and barium contamination sources between the overburden, bedrock, and karst system is not known.
- The distribution of RDX, TCE, and barium contamination sources in the overburden soil, bedrock, and karst system appears to be heterogeneous in nature.
- Groundwater underlying the MTA is contaminated with RDX, TCE, degradation products of RDX and TCE, and barium.
- MTA groundwater discharges through a karst system into LSC through Springs A, A', and probably B.
- TCE and TCA are volatized in the karst system or shortly after entering LSC. Neither TCE nor TCA are present in LSC surface waters.
- RDX is present at concentrations greater than RBTLs in LSC surface waters, and unknown associated risks to off-site receptors exist.
- Excess risk is present for future residents ingesting groundwater.
- The arithmetic mean lead concentration in a sub-area of the MTA presents a risk to the current construction worker because it exceeds the U.S. EPA Region 9 soil PRG for the industrial land use scenario.

Figure 2-6 is a schematic drawing of the conceptual site model for the OJT. It shows that contaminants were released through surface/subsurface soils and spread toward downgradient locations from those releases to deeper soils, groundwater, springs, and LSC. Exposure to the contaminants could result in unacceptable health risks to humans. The following is a summary of the conceptual site model for the OJT:

- Groundwater underlying the OJT is contaminated with RDX and TCE.
- Excess risk is present for future residents ingesting groundwater.

- RDX, TCE, and barium contamination sources appear to be distributed among the overburden soil, bedrock, and karst system.

- The relative distribution of RDX, TCE, and barium contamination sources between the overburden, bedrock, and karst system is not known due to the heterogeneous distribution of contamination at the OJT.

- OJT groundwater discharges through a karst system into LSC through Spring C.

- TCE and TCA are volatized in the karst system or shortly after entering LSC. Neither TCE nor TCA are present in LSC surface waters.

2.8 ~~2.7.1~~ Conclusions for Corrective Measures Study or section 4

Following are the follow-on Conceptual Site Model recommendations for consideration in development of the CMS for the MTA, OJT, and LSC:

head?

- Contaminated groundwater from the MTA and OJT are discharged through Springs A, A', B, and C. There are no off-site impacts to human and ecological receptors; therefore, groundwater contaminants from the MTA and OJT will not be carried forward in this CMS.

- The distribution of sources of explosives (RDX), chlorinated solvents (TCE), and metals (barium) among the soils, bedrock, and karst system, within both the MTA and the OJT, is very heterogeneous due to the nature of the previous burning operations. Although the April 2004 soil sampling identified isolated areas of RDX, TCE, and barium contamination, the characterization study failed to identify a significant persistent source of contamination in soil (i.e., a soils source of RDX, TCE, and barium could not be identified).

- Risk from RDX, TCE, and metals in groundwater, surface water, and surface and subsurface soils has not been identified for the current off-site receptors; therefore, RDX, TCE, and barium contamination in groundwater, surface water, and surface and subsurface soils will not be carried forward in this CMS.

Summary Table needed to depict how/where each cont per media is eliminated or proceeds to CMS.

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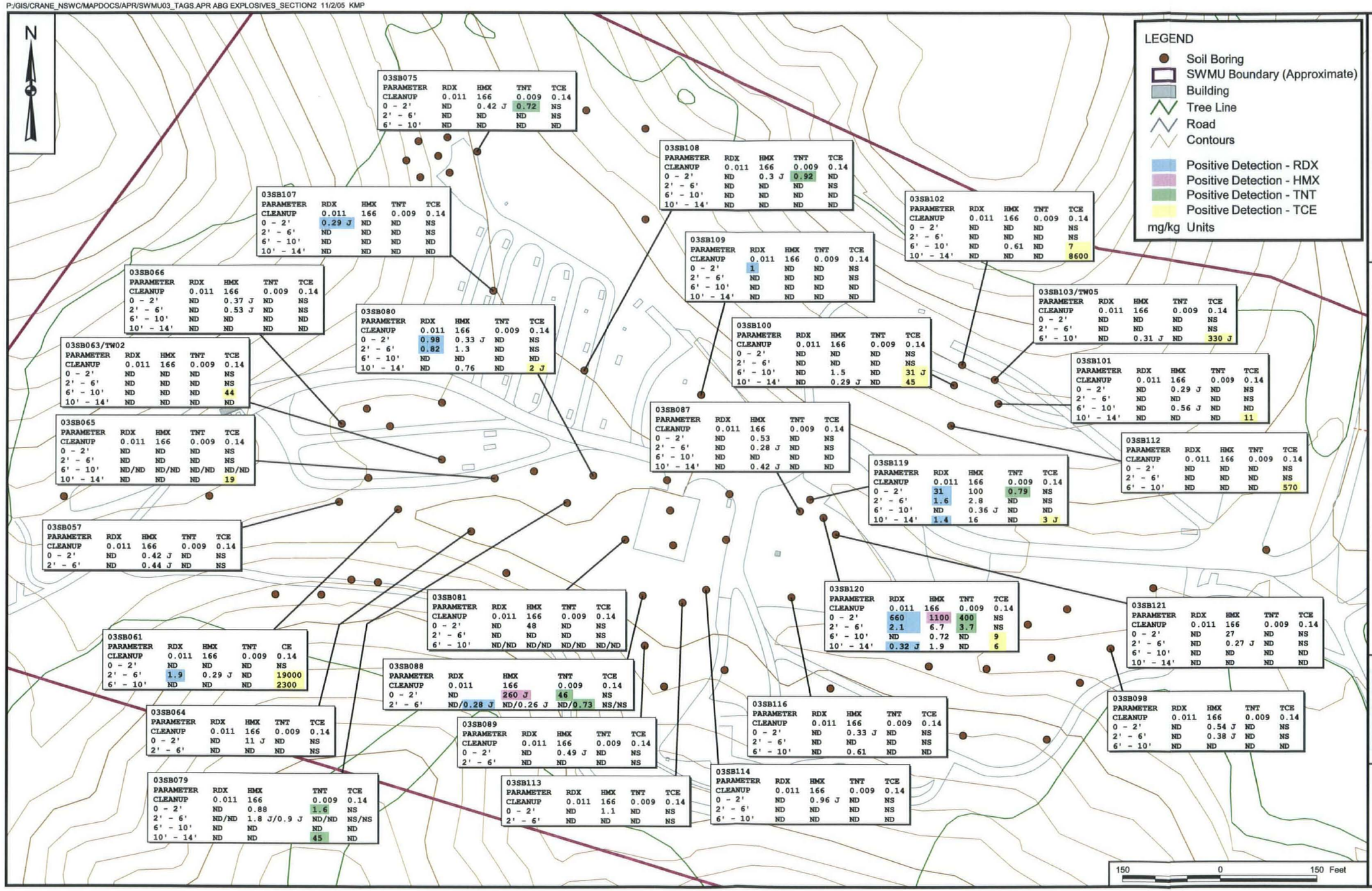

CONTRACT NO. CTO 0311

APPROVED BY — DATE

APPROVED BY — DATE

DRAWING NO. FIGURE 2-1 REV 0

PRIMARY ORGANIC CONTAMINANTS IN SURFACE AND SUBSURFACE SOILS (MG/KG)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS (MAIN TREATMENT AREA)
NSWC CRANE
CRANE, INDIANA

NAVFAC

DRAWN BY A. JANOCHA — DATE 9/14/04

CHECKED BY L. SINAGOGA — DATE 9/15/05

COST/SCHED-AREA

SCALE AS NOTED

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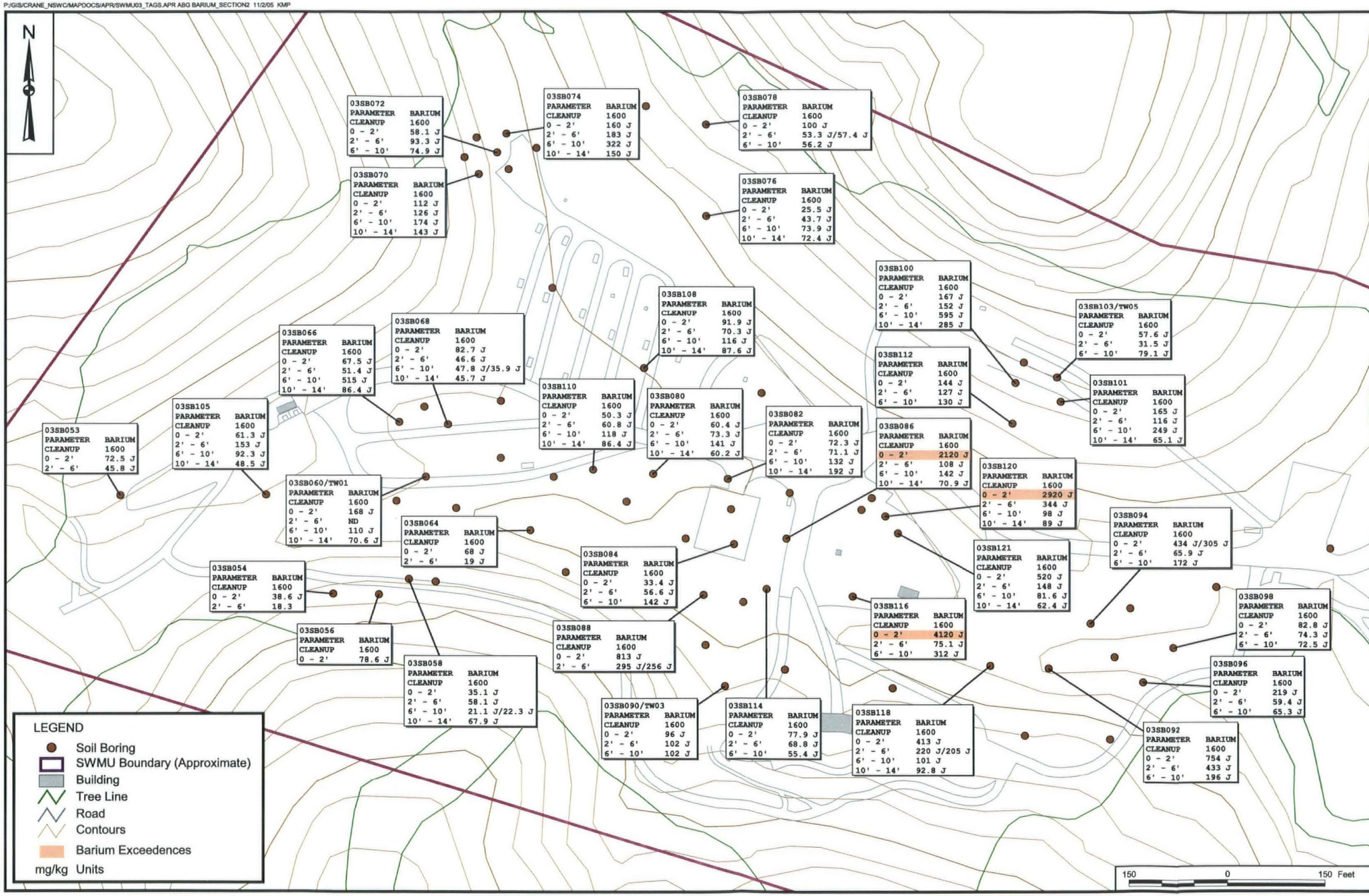

CONTRACT NO.
CTO 0311

APPROVED BY ___ DATE ___

APPROVED BY ___ DATE ___

DRAWING NO. FIGURE 2-2

REV 0

BARIUM CONCENTRATIONS IN SURFACE AND SUBSURFACE SOILS (MG/KG)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS (MAIN TREATMENT AREA)
NSWC CRANE
CRANE, INDIANA

NAVFAC

DRAWN BY A. JANOCHA DATE 9/14/04

CHECKED BY L. SINAGOGA DATE 9/15/05

COST/SCHED-AREA

SCALE AS NOTED

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CONTRACT NO.
CTO 0311

APPROVED BY ____ DATE ____

APPROVED BY ____ DATE ____

DRAWING NO. FIGURE 2 - 3

REV 0

LEAD CONCENTRATIONS IN SURFACE SOILS (MG/KG)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
(MAIN TREATMENT AREA)
NSWC CRANE
CRANE, INDIANA

NAVFAC

	DATE
DRAWN BY C. FOSTER	7/20/05
CHECKED BY V. PLACHY	11/03/05
COST/SCHED-AREA	
SCALE AS NOTED	

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CONTRACT NO.
CTO 0311

APPROVED BY	DATE

APPROVED BY	DATE

DRAWING NO. FIGURE 2-4

REV –

MAIN TREATMENT AREA AERIAL
SOIL BORING LOCATIONS
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
CRANE NSWC
CRANE, INDIANA

NAVFAC

DRAWN BY	DATE
C. FOSTER	3/28/05

CHECKED BY	DATE
V. PLACHY	6/8/05

COST/SCHED-AREA

SCALE
AS NOTED

FIGURE 2-5
CONCEPTUAL SITE MODEL SCHEMATIC DIAGRAM
MAIN TREATMENT AREA
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

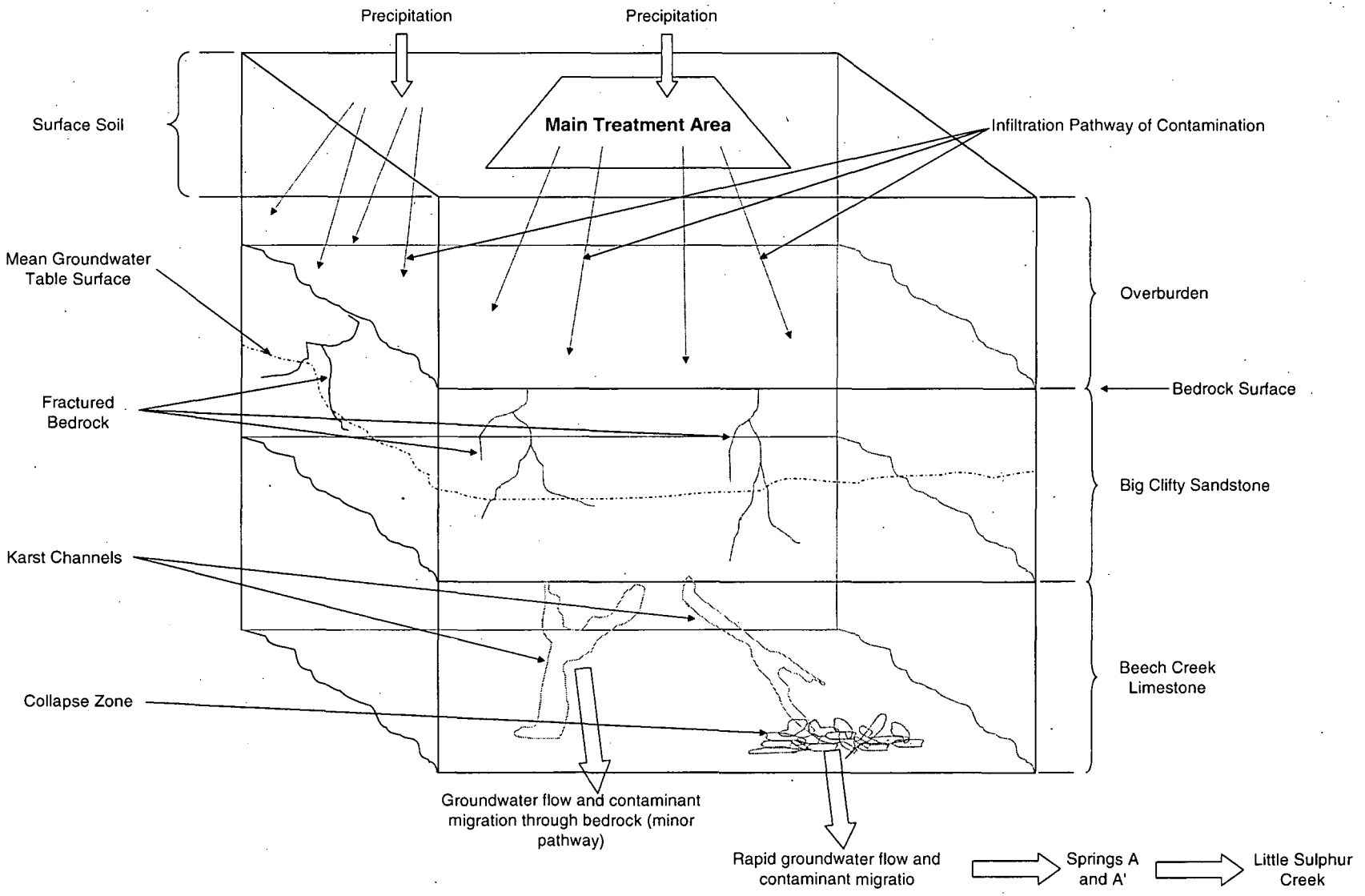
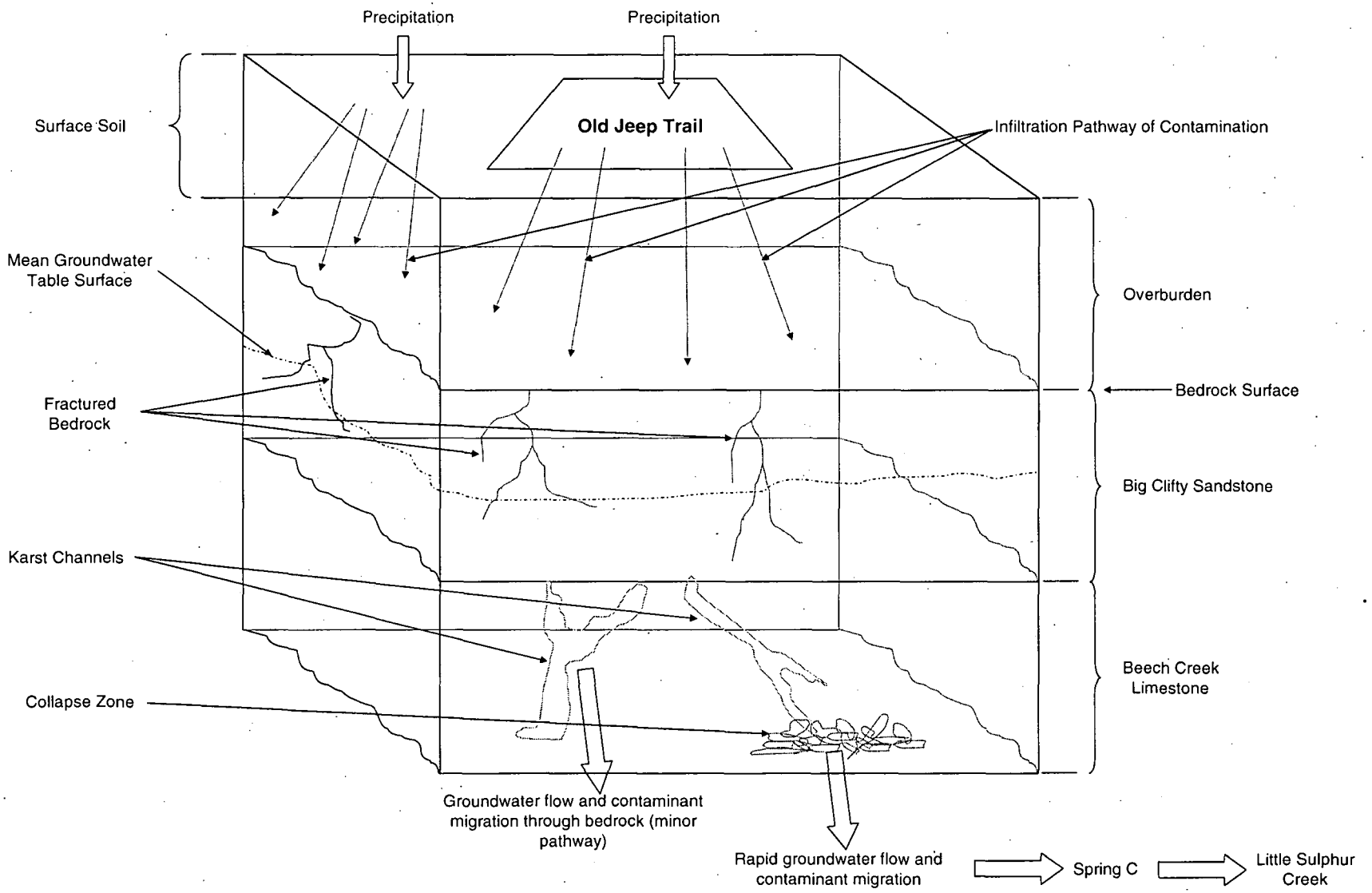


FIGURE 2-6
CONCEPTUAL SITE MODEL SCHEMATIC DIAGRAM
OLD JEEP TRAIL
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA



3.0 DEVELOPMENT OF CORRECTIVE MEASURES OBJECTIVES

The purpose of this section is to identify potentially applicable ARARs and TBC criteria and to develop Corrective Measure Objectives (CMOs) for soil and groundwater. The corrective measures objectives are based on contaminant characterization, risk assessment, and compliance with risk-based and ARAR-based action levels.

3.1 ARARs

how does AWQS fit in this section?

ARARs include the requirements, criteria, or limitations promulgated under federal and state law that address a chemical, location, or action at a site. The definition of ARARs is a follows:

- Any standard, requirement, criterion, or limitation under federal environmental law.
- Any promulgated standard, requirement, criterion, or limitation under a state environmental or facility-citing law that is more stringent that the associated federal standard, requirement criterion, or limitation.

One of the primary concerns during the development of CMOs is the degree of human health and environmental protection afforded by a given remedy. Consideration should be given to remedies that attain or exceed ARARs.

Definitions of the two types of ARARs, as well as TBC criteria, are given below:

- Applicable Requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that directly and fully address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a site.

- Relevant and Appropriate Requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not "applicable," address problems or situations sufficiently similar (relevant) to those encountered at a site such that their use is well suited (appropriate) to the particular site.

- TBC Criteria are non-promulgated, enforceable guidelines or criteria that may be useful for developing remedial actions or necessary for determining what is protective of human health and/or

the environment. Examples of TBC criteria include U.S. EPA Drinking Water Advisories and Risk-Based Concentrations (RBCs).

ARARs fall into three categories, based on the manner in which they are applied:

- Contaminant Specific – These include health/risk-based numerical values or methodologies that establish concentration or discharge limits for particular contaminants. Examples of contaminant-specific ARARs include MCLs and Clean Water Act (CWA) criteria.

- Location Specific – These restrictions are based on the concentrations of specific contaminants or the conduct of activities in specific locations. These may restrict or preclude certain remedial actions or may apply only to certain portions of a site.

- Action Specific – These are technology- or activity-based controls or restrictions on activities related to management of contaminants. Action-specific ARARs pertain to implementing a given remedy.

Summary listings of all contaminant-, location-, and action-specific ARARs and TBC criteria for SWMU 3 are provided in Tables 3-1, 3-2, and 3-3, respectively. Sections 3.1.1, 3.1.2, and 3.1.3 provide brief descriptions of each contaminant-, location-, and action-specific ARAR or TBC criteria, respectively, shown in Tables 3-1 through 3-3.

3.1.1 Contaminant-Specific ARARs and TBC Criteria

U.S. EPA Health Advisories are non-enforceable guidelines developed by the U.S. EPA Office of Drinking Water for contaminants that may be intermittently encountered in public water supply systems. Health advisories are available for short-term, longer-term, and lifetime exposures for a 10-kilogram (kg) child and a 70-kg adult. Health advisories may be pertinent for remedial action/corrective measures involving groundwater, especially for contaminants that are not regulated by the SDWA. U.S. EPA Health Advisories are TBC criteria.

U.S. EPA Generic SSLs are guidance that, if exceeded through three possible exposure pathways, may be of potential concern to human receptors: SSLs consider the following exposure pathways: direct ingestion of soil, inhalation of volatile compounds and fugitive dust, and migration of groundwater. SSLs are RBCs derived from equations combining exposure information assumptions with U.S. EPA toxicity data. SSLs for protection of groundwater use a simple linear equilibrium soil/water partition equation or leach test to estimate contaminant releases in soil leachate. SSLs are TBC criteria.

Reference Doses (RfDs), as defined in the U.S. EPA IRIS, are estimates (with uncertainty spanning perhaps an order of magnitude) of daily exposure to the human population (including sensitive subgroups) that are likely to be without an appreciable risk of deleterious effects during a lifetime. RfDs are developed for chronic and/or subchronic human exposure to hazardous chemicals and are based on the assumption that thresholds exist for certain toxic effects. The RfD is usually expressed as an acceptable dose in milligrams (mg) per unit body weight in kg per unit time (day). The RfD is derived by dividing the NOAEL or the Lowest-Observed-Adverse Effect Level (LOAEL) by an uncertainty factor (UF) times a modifying factor (MF). RfDs are TBC criteria.

U.S. EPA Carcinogenic Slope Factors (CSFs), as defined in the IRIS, are upper bounds, approximating a 95-percent confidence limit, on the increased cancer risk from a lifetime exposure to a contaminant. This estimate, usually expressed in units of proportion (of a population) affected per mg per kg per day (mg/kg/day), is generally reserved for use in the low-dose region of the dose-response relationship, that is, for exposures corresponding to risks less than 1 in 100. CSFs are TBC criteria.

U.S. EPA Region 9 PRGs are risk-based concentrations, derived from standardized equations combining exposure information assumptions with U.S. EPA toxicity data for contaminants in soil, air, and tap water. They are considered to be protective for humans (including sensitive groups) over a lifetime. However, PRGs are not always applicable to a particular site and do not address non-human health endpoints such as ecological impacts. PRGs are not de facto cleanup standards; however, they could be used to establish final cleanup levels for a site after a proper evaluation takes place. U.S. EPA Region 9 PRGs are risk-based concentrations that are intended to assist risk assessors and others in initial screening-level evaluations of environmental measurements. PRGs are TBC criteria.

IDEM Risk Integrated System of Closure (RISC) is a non-rule policy that incorporates environmental risk assessment principles to protect human health and the environment and to achieve consistent closure of contaminated soil and groundwater sites. As a non-rule policy document, RISC guidance does not have the effect of law. However, the policy provides a systematic approach for consistently and rationally implementing the laws and rules that govern site investigation and closure. Included in this policy are risk-based closure level constituent concentrations calculated to be protective of human health. The RISC is a TBC criterion.

3.1.2. Location-Specific ARARs and TBC Criteria

Endangered Species Act of 1973 [(16 (USC) 1531)] (50 CFR §17) provides to conserve the ecosystems upon which endangered and threatened species depend and to conserve and recover listed species. Corrective measure actions, if required, would need to be conducted in a manner such that the continued existence of any endangered or threatened species is not jeopardized or its critical habitat is not adversely affected. Consultation with the U.S. Fish and Wildlife Service is also required. SWMU 3 is located in Martin County. The State of Indiana has identified a list of endangered, threatened, and rare species for Martin County. The species include plants, insects, birds, reptiles, and birds. In addition, migrating species may move through the area. The Endangered Species Act of 1978 is a potential ARAR.

The Archaeological and Historic Preservation Act (AHPA) provides for the preservation of historical and archeological data (including relics and specimens) that might otherwise be irreparably lost or destroyed as the result of:

1) Flooding, the building of access roads, the erection of workmen's communities, the relocation of railroads and highways, and other alterations of the terrain caused by the construction of a dam by any agency of the US, or by any private person or corporation holding a license issued by any such agency.

2) Any alteration of the terrain caused as a result of any federal construction project or federally licensed activity or program findings or policy.

The purposes of the AHPA are to recognize the vital contribution of our wildlife resources to the nation, and their increasing public interest and significance, and to provide that wildlife conservation receives equal consideration and is coordinated with other features of water-resource development programs through planning, development, maintenance, and coordination of wildlife conservation and rehabilitation. In furtherance of the stated purposes, the U.S. Secretary of the Interior (Secretary) is authorized to provide assistance to, and cooperate with, federal, state, and public or private agencies and organizations in:

- Developing, protecting, rearing, and stocking all species of wildlife, resources thereof, and their habitat; controlling losses from disease or other causes; minimizing damages from overabundant species.

- Providing public shooting and fishing areas, including easements across public lands; carrying out other necessary measures.

The Secretary is also authorized to make surveys and investigations of the wildlife of the public domain, including lands and waters or interest acquired or controlled by an agency of the U.S., and to accept donations of land and contributions of funds in furtherance of the purposes of AHPA. The AHPA is a potential ARAR.

Federal Protection of Wetlands Executive Order (EO) 11990 authorizes federal protection of wetlands. The Order requires federal agencies to consider the potential effects of a proposed project on the survival and quality of wetlands including the conservation and long-term productivity of existing faunal species and habitat diversity and stability. EO 11990 applies to the issuance by federal agencies of permits, licenses, or allocations to private parties for activities involving wetlands on federal lands.

The purpose of EO 11990 is to "minimize the destruction, loss or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands." To meet these objectives, EO 11990 requires federal agencies, in planning their actions, to consider alternatives to wetland sites and limit potential damage if an activity affecting a wetland cannot be avoided. EO 11990 applies to:

- Acquisition, management, and disposition of federal lands and facilities construction and improvement projects that are undertaken, financed or assisted by federal agencies.

- Federal activities and programs affecting land use, including but not limited to, water and related land resources planning, regulation, and licensing activities.

EO 11990 is a potential ARAR.

Bald and Gold Eagle Protection Act (BGEPA) (16 USC 668a-d) prohibits any form of possession or taking of both bald and golden eagles. The statute imposes criminal and civil sanctions as well as an enhanced penalty provision for subsequent offenses. Further, the BGEPA provides for the forfeiture of anything used to acquire eagles in violation of the statute. The statute accepts from its prohibitions on possession the use of eagles or eagle parts for exhibition, scientific, and Indian religious uses. The BGEPA is a potential ARAR.

Indiana Non-game and Endangered Species Conservation Act (IESA) (IC 14-22-34) provides a list of those species and subspecies of wildlife indigenous to Indiana that are determined to be endangered in

Indiana. In addition, this rule governs the taking, possession, removal, capture, destruction, and management of State-listed endangered species. The IESA is a potential ARAR.

Indiana Wildlife Regulation (IWR) (IC 14-22-10) provides protection for wildlife from releases or discharges of contaminants or waste materials into State waters or land that may result in the destruction of wild animals. The State Department of Natural Resources has the authority and responsibility to protect and properly manage the fish and wildlife resources of the State. The release of contaminated waste during the remedy activity could be released on to soil and possibly result in discharge to State waters. The IWR is a potential ARAR.

Indiana Natural Heritage Protection Campaign (IC 14-31-2) promotes the preservation of areas of unusual natural interest for scientific, educational, recreational, cultural, and aesthetic purposes as a link to the Indiana's past and future. The rule also provides for the maintenance and management of those natural areas and the rare native species for which the areas are habitat. Remedy activities at SWMU 3 may result in disturbance of natural areas inhabited by Indiana rare species. The Indiana Heritage Protection Campaign is a potential ARAR.

3.1.3 Action-Specific ARARs and TBC Criteria

RCRA Solid Waste Management Regulations RCRA (40 CFR §258) provides for design and operating standards for solid waste (nonhazardous) landfills. CMAs that include solid waste landfills or where nonhazardous soil is stockpiled or disposed on site would have to comply with RCRA.

RCRA (40 CFR §261) provides for regulations that govern the procedures for identifying if a material is a hazardous waste. CMAs at SWMU 3 have the potential to generate specific materials that may be classifiable as characteristic or listed hazardous wastes. RCRA standards are applicable to generators of hazardous wastes (40 CFR §262). CMAs at SWMU 3 have the potential to generate waste for removal that may be determined to be hazardous. Generated wastes that are determined to be hazardous and transportation off-site are regulated under RCRA (40 CFR §263).

RCRA regulations are applicable to owners and operators of hazardous waste treatment storage and disposal (TSD) facilities as standards and interim standards (40 CFR §§264 and 265). These regulations would be applicable to waste removed from this site including both on-site and off-site management; however, the reuse of treated soils as backfill would not be subject to the disposal facility standard.

RCRA Land Disposal Restrictions (LDRs) (40 CFR §268) identifies hazardous wastes that are restricted from land disposal and waste analysis requirements. CMAs at SWMU 3 may include the treatment or disposal of contaminated soils/wastes and/or treatment residuals that may be considered hazardous wastes are subject to LDRs.

RCRA is a potentially applicable ARAR.

Department of Transportation (DOT) Rules for Hazardous Materials Transport (40 CFR §107 and §§171 to 179) regulate the transportation of hazardous materials including requirements that regulate packaging, marking, labeling, and transportation methods. CMAs at SWMU 3 have the potential to generate off-site shipments of contaminated waste including soil that could be classified as a hazardous material. The DOT rules for the transportation of hazardous materials are potential ARARs.

Indiana Environmental Remediation Act (IERA) (IC 13-30-10) requires certain environmental remediation plans to specify remediation objectives based on specified factors. The IERA directs IDEM to certify completion of plans and to issue covenants not to sue with respect to completed plans. The IERA is potentially applicable.

Indiana Solid Waste Management Board (ISWMB) (329 IAC) provides for design and operating standards for solid waste (nonhazardous) landfills. Additionally, Indiana adopted regulations identical to the federal regulations for the listing of hazardous waste (40 CFR §261), generators of hazardous wastes (40 CFR §262), and transporters of hazardous wastes (40 CFR §263). Additionally, Indiana adopted regulations identical to the federal standards and interim standards applicable to owners and operators of hazardous waste TSD facilities (40 CFR §§264 and 265). These regulations are potentially applicable.

3.2 MEDIUM-SPECIFIC CAOs

3.2.1 Human Health Risk

CAOs are developed in this section to address contaminated surface soil, subsurface soil, groundwater, and sediment at SWMU 3. CAOs generally identify COCs, receptors, pathways, and action cleanup levels.

3.2.1.1 Soil

3.2.1.1.1 MTA

The follow-on HHRSE for SWMU 3 concluded the following in regard to human health risk:

- For lead
  - Ingestion of soil would present risk to the construction worker.

3.2.1.1.2 OJT

The CAOs associated with human health risk for surface soils:

- For lead
  - Incidental and dermal contact with surface soil for the on-site future child resident

- For TNT
  - Incidental and dermal contact with surface soil for the on-site future child resident
  - Ingestion of surface soil for future adult resident

- For RDX
  - Incidental and dermal contact with surface soil for the on-site future child and life-long residents

3.2.1.2 Groundwater

3.2.1.2.1 OJT

The CAO associated with human health risk for groundwater:

- For TNT
  - Ingestion of groundwater for on-site future adult and life-long residents

- For 4A-DNT
  - Ingestion of groundwater for on-site future child resident

- For 1,1,2,2-tetrachloroethane (TCA),
  - Ingestion of groundwater for on-site life-long resident

3.2.1.3 Surface Water

The CAO associated with human health risk for surface water:

- For 2A-DNT
  - Ingestion of surface water for on-site future child resident
- For 4A-DNT
  - Ingestion of surface water for on-site future child and adult residents
- For RDX
  - Ingestion of surface water for on-site future child and life-long residents

3.3 CHEMICALS OF CONCERN

3.3.1 Human Health

3.3.1.1 Surface Soil

3.3.1.1.1 MTA

As discussed in Section 2.4, lead was retained as COC for soils at the MTA.

Unacceptable exposure for the current on-site receptor (construction worker) to surface soils was identified as the result of high lead concentrations in surface soil associated with a one-half acre sub-area of the MTA portion of SWMU 3 (Figure 2-3).

As discussed in Section 2.4.1, for the construction worker, LUCs will implemented as the recommended corrective measures for the lead-contaminated sub-area of the MTA.

3.3.1.1.2 OJT

Table 3-5 present the non-carcinogenic (HI) and/or the carcinogenic (ILCR) risks for various receptors from exposure to RDX and TNT in surface soil at the OJT.

3.3.1.2 Groundwater

3.3.1.2.1 OJT

Table 3-6 present the non-carcinogenic (HI) and/or the carcinogenic (ILCR) risks for various receptors from exposure to TCA, 4A-DNT, and TCE in groundwater at the OJT.

3.3.1.2 LSC

Table 3-7 present the non-carcinogenic (HI) and/or the carcinogenic (ILCR) risks for various receptors from exposure to 2A-DNT, 4A-DNT, lead, and RDX in surface water at the OJT.

3.4 MEDIA CLEANUP STANDARDS

3.4.1 Soils

3.4.1.1 MTA

As presented in Table 3-4, a lead MCS of 550 mg/kg is required for soils at the MTA to protect the current impacted on-site construction worker. However, if the lead hot spot (see Figure 2-3) is the only area remediated, a lead MCS of 540 mg/kg is required for soils at the MTA hot spot to protect the current impacted on-site construction worker.

3.4.2.2 OJT

Table 3-4 presents the soil MCSs by receptor for the OJT. A lead MCS of 400 mg/kg is required for soils at the OJT hot spot (see Figure 3-1) to protect the future on-site child receptor. A TNT MCS of 24 mg/kg is required for soils to protect the future on-site child receptor.

3.4.2 Surface Water

3.4.2.1 OJT

Table 3-4 presents the MCSs by receptor for OJT surface water.

2A-DNT/4A-DNT

A 2A-DNT MCS of 69 µg/L is required for surface water at the OJT to protect the future on-site child receptor. A 4A-DNT MCS of 68 µg/L is required for surface water at the OJT to protect future on-site child and adult residents.

RDX

An RDX MCS of 3 µg/L is required for surface water at the OJT to protect the future life-long resident based on a public water supply point of intake criterion of 3 µg/L (see Appendix C).

3.4.3 Groundwater

3.4.3.1 OJT

Table 3-4 presents the MCSs by receptor for OJT groundwater.

TCE

A TCE MCS of 5 µg/L is required for groundwater at the OJT to protect the future SWMU 3 worker, future recreational user, and the future on-site child, adult, and life-long residents.

2-ADNT/4-ADNT

2A-DNT and 4A-DNT MCSs of 62 µg/L are required for groundwater at the OJT to protect the future on-site child resident.

TCA

A TCA MCS of 9,32 µg/L is required for groundwater at the OJT to protect the future on-site adult resident.

TABLE 3-1

SUMMARY OF CONTAMINANT-SPECIFIC ARARs AND TBC CRITERIA
CMS REPORT FOR SWMU 3 – AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

Requirement	Citation	Status	Synopsis	Comment
FEDERAL				
U.S. EPA Health Advisories	EPA 822-B-96-002	TBC Criteria	U.S. EPA Office of Drinking Water guidelines for chemicals that may be encountered in public water supply systems.	Can be used for determining PRGs for groundwater.
U.S. EPA Generic Soil Screening Levels (SSLs)	EPA 540-R-96-018 Appendix A	TBC Criteria	Federal guidance that provides screening levels for protection of human health and groundwater from soil contaminants.	Can be used for determining PRGs for soil.
Reference Doses (RfDs) from Integrated Risk Information System (IRIS)	NA	TBC Criteria	EPA Office of Research and Development guidelines used in the public health assessment.	Can be used for determining risk-based PRGs.
U.S. Carcinogenic Slope Factors from IRIS	NA	TBC Criteria	EPA Environmental Criteria and Assessment Office; EPA Carcinogen Assessment Group guidelines used in the public health assessment.	Can be used for determining risk-based PRGs.
U.S. EPA Region 9 PRGs	NA	TBC Criteria	EPA Region 9 has developed primary remediation goals (PRGs) for contaminants in soil, air, and drinking water. These are risk-based concentrations are intended to assist risk assessors and others in initial screening-level evaluations of environmental measurements.	Can be used for determining PRGs.

TABLE 3-1

SUMMARY OF CONTAMINANT-SPECIFIC ARARs AND TBC CRITERIA
CMS REPORT FOR SWMU 3 – AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

Requirement	Citation	Status	Synopsis	Comment
Handbook on the Management of Ordnances and Explosives at Closed, Transferring, and Transferred Ranges and other Sites	Interim Final February 2002 (http://www.epa.gov/swerffrr/pdf/IFUXOCTTHandbook.pdf)	TBC Criteria	The handbook facilitates understanding of the wide variety of technical issues that surround the investigation and cleanup of closed, transferring, and transferred (CTT) ranges and other sites at current and former Department of Defense (DoD) facilities.	Explosive residues are present at the site. This handbook discusses common chemical residues of explosives that may or may not retain reactive and/or ignitable properties that could have a potential impact on human health and the environment through a variety of pathways (surface and subsurface, soil, air and water).

STATE

Indiana Department of Environmental Management (IDEM) Risk Integrated System of Closure (RISC) http://www.in.gov/idem/land/risc/techguide/riscguidance.pdf	NA	TBC Criteria	A non-rule policy that incorporates environmental risk assessment principles to protect human health and the environment and achieve consistent closure of contaminated soil and groundwater.	TBC Criteria in risk assessment.

TABLE 3-2

SUMMARY OF LOCATION-SPECIFIC ARARs AND TBC CRITERIA
CMS REPORT FOR SWMU 3 – AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE INDIANA

Requirement	Citation	Status	Synopsis	Comment
FEDERAL				
Endangered Species Act of 1973	16 USC 1531 50 CFR §§17 and 402	Potential ARAR	Requires federal agencies to ensure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the future existence or critical habitat of any endangered or threatened species.	The Indiana Bat and several bird species are either endangered, threatened or species of special interest may reside in the vicinity of SWMU 10. In addition, migrating species may occasionally move through the area.
The Archaeological and Historic Preservation Act	16 USC 469 36 CFR §65	Potential ARAR	Establishes requirements relating to potential loss or destruction of significant scientific, historical, or archeological data as a result of a proposed remedy.	Artifacts may be discovered during site work.
Federal Protection of Wetlands Executive Order	Executive Order (EO) 11990 40 CFR 6 Appendix A	Potential ARAR	Requires the action of federal agencies to minimize the destruction, loss, or degradation of wetlands and preserve and enhance the natural and beneficial values of wetlands	Applicable where there are wetlands at or near SWMU.

TABLE 3-2

SUMMARY OF LOCATION-SPECIFIC ARARs AND TBC CRITERIA
CMS REPORT FOR SWMU 3 – AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE INDIANA

Requirement	Citation	Status	Synopsis	Comment
Bald and Gold Eagle Protection Act	(16 U.S.C. §§ 668a-668d, 54 Stat. 250) as amended -- Approved June 8, 1940, and amended by P.L 86-70 (73 Stat. 143) June 25, 1959; P.L. 87-884 (76 Stat. 1346) October 24, 1962; P.L. 92-535 (86 Stat. 1064) October 23, 1972; and P.L. 95-616 (92 Stat. 3114) November 8, 1978.	Potential ARAR	Prohibitions. The Act imposes criminal and civil penalties on anyone (including associations, partnerships and corporations) in the U.S. or within its jurisdiction who, unless excepted, takes, possesses, sells, purchases, barters, offers to sell or purchase or barter, transports, exports or imports at any time or in any manner a bald or golden eagle, alive or dead; or any part, nest or egg of these eagles; or violates any permit or regulations issued under the Act. The definition of "take" includes pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb. The definition of "transport" includes convey or carry by any means; also deliver or receive for conveyance.	Applicable where that there are Bald Eagle nesting or habitat which might be disturbed during CMA at or near a SWMU.

TABLE 3-2

SUMMARY OF LOCATION-SPECIFIC ARARs AND TBC CRITERIA
CMS REPORT FOR SWMU 3 – AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE INDIANA

Requirement	Citation	Status	Synopsis	Comment
STATE				
Indiana Non-game and Endangered Species Conservation	IC 14-22-34	Potential ARAR	Establishes a list of those species and subspecies of wildlife indigenous to Indiana which are determined to be endangered in Indiana. In addition, this rule governs the taking, possession, removal, capture, destruction, and management of state listed endangered species.	The State of Indiana has identified a list of endangered, threatened, and rare species for Martin County including the Indiana Bat and Bald Eagle. The species include plants, insects, birds, reptiles, birds, and, migrating species that may move through or live in the SWMUs. These threatened or species of special interest that may reside in the vicinity of the SWMUs. In addition, migrating species may occasionally move through the area.
Indiana Wildlife Regulation	IC 14-22-10	Potential ARAR	Establishes protection for wildlife from releases or discharges of contaminants or waste materials into state waters or land that may result in the destruction of wild animals. The state Department of Natural Resources has the authority and responsibility to protect and properly manage the fish and wildlife resources of the state.	Any release of contaminated waste during the remedy activity that could be released on to soil and possibly result in discharge to state waters and result in harm to wild animals would have to comply with these requirements.

TABLE 3-2

SUMMARY OF LOCATION-SPECIFIC ARARs AND TBC CRITERIA
CMS REPORT FOR SWMU 3 – AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE INDIANA

Requirement	Citation	Status	Synopsis	Comment
Indiana Natural Heritage Protection Campaign	IC 14-31-2	Potential ARAR	Promotes the preservation of areas of unusual natural interest for scientific, educational, recreational, cultural, and aesthetic purposes as a link to the Indiana's past and future. The rules also provides for the maintenance and management of those natural areas and the rare native species for which the areas are habitat.	Remedy activities at SWMUs may result in disturbance of natural areas inhabited by Indiana rare species.

TABLE 3-3

SUMMARY OF ACTION-SPECIFIC ARARs AND TBC CRITERIA
CMS REPORT FOR SWMU 3 – AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

Requirement	Citation	Status	Synopsis	Comment
FEDERAL				
RCRA Solid Waste Management Regulations	40 CFR §258	Potential ARAR	Establishes design and operating standards for solid waste (nonhazardous) landfills.	Applicable if nonhazardous soil is stockpiled or disposed on site.
RCRA Identification and Listing of Hazardous Waste	40 CFR §261	Potential ARAR	Regulations that govern the procedures for identifying if a material is a hazardous waste.	Specific materials at the site may be classifiable as a characteristic or listed hazardous waste.
RCRA Standards Applicable to Generators of Hazardous Waste	40 CFR §262	Potential ARAR	Establishes standards for generators of hazardous waste.	Applicable for removed wastes determined to be hazardous.
RCRA Standards Applicable to Transporters of Hazardous Waste	40 CFR §263	Potential ARAR	Establishes standards for off-site transportation of hazardous waste.	Applicable for removed wastes determined to be hazardous that are transported off site.
RCRA Standards and Interim Standards for Owners and Operators of Hazardous Waste TSD Facilities	40 CFR §§264 and 265	Potential ARAR	Regulations that govern the treatment, storage, and disposal of hazardous waste.	These regulations would be applicable to waste removed from this site including both on-site and off-site management; however, the reuse of treated soils as backfill would not be subject to the disposal facility standard.
RCRA Land Disposal Restrictions (LDRs)	40 CFR §268	Potential ARAR	Identifies hazardous wastes that are restricted from land disposal and waste analysis requirements.	Treatment or disposal of contaminated soils/ wastes and/or treatment residuals may be considered hazardous waste subject to land disposal restrictions.

TABLE 3-3

SUMMARY OF ACTION-SPECIFIC ARARs AND TBC CRITERIA
CMS REPORT FOR SWMU 3 – AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

Requirement	Citation	Status	Synopsis	Comment
Department of Transportation (DOT) Rules for Hazardous Materials Transport	49 CFR §107 and §§171 to 179	Potential ARAR	Regulations for the transportation of hazardous materials. Requirements cover packaging, marking, labeling, and transportation methods.	Off-site shipments of any contaminated soil that is classified as a hazardous material from this site would have to comply with these regulations.
STATE				
Indiana Environmental Remediation Act	IC 13-30-10	Potential ARAR	This rule requires certain environmental remediation plans to specify remediation objectives based on specified factors. It directs the IDEM to certify completion of plans and to issue covenants not to sue with respect to completed plans.	Applicable to certain remediation plans.

TABLE 3-3

SUMMARY OF ACTION-SPECIFIC ARARs AND TBC CRITERIA
CMS REPORT FOR SWMU 3 – AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

Requirement	Citation	Status	Synopsis	Comment
IDEM Solid Waste Management Board	329 IAC 3 329 IAC 10 329 IAC 11 329 IAC 12 329 IAC 13	Potential ARAR	Establishes design and operating standards for solid waste (nonhazardous) landfills. Indiana adoption of federal identification and listing of hazardous waste (40 CFR §261), applicable to generators of hazardous wastes (40 CFR §262), applicable to transporters of hazardous wastes (40 CFR §263), and for management of specific hazardous wastes and types of hazardous waste facilities (40 CFR §266 Subpart M). Indiana adoption of federal standards and interim standards applicable to owners and operators of wastes treatment, storage, and disposal facilities (40 CFR §§264 and 265),	Applicable if nonhazardous soil is stockpiled or disposed on-site. Specific materials at the site may be classifiable as a characteristic or listed hazardous waste. These regulations could be applicable to waste removed from this site including both on-site and off-site management. These regulations detail storage and transportation requirements for solid waste military munitions as well as emergency responses.
Indiana Water Pollution Control Board (IWPCB)	327 IAC 5-4 327 IAC 15-15	Potential ARAR	NPDES permits are required for any discharge to surface water.	Any alternative that includes discharges to surface water would have to comply with the permit requirements.

TABLE 3-4

HUMAN HEALTH MEDIA CLEANUP STANDARDS
CMS REPORT FOR SMWU 3 - AMMUNTION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

COC	Media Cleanup Standards		
	Surface Soil (mg/kg)	Surface Water (µg/L)	Groundwater (µg/L)
MTA			
Construction Worker			
Lead[1]	540.		
OJT			
Future SWMU Worker			
Trichloroethene			21.
Future Child Resident			
2,4,6 Trinitrotoluene	24.		
2-Amino-4,6-dinitrotoluene		68.	0.62
4-Amino-2,6-dinitrotoluene		68.	0.62
Lead[2]	400.		
Trichloroethene			5.
Future Adult Resident			
1,1,2,2-Tetrachloroethane			0.43
2,4,6 Trinitrotoluene	51.		
4-Amino-2,6-dinitrotoluene		68	
Trichloroethene			5.
Future Child Recreational User			
Trichloroethene			91.
Future Life-Long Resident			
RDX[3]	4.4	3.	
Trichloroethene			5.

1 — The MSC for cleaning up the lead hotspot only is 540 mg/kg based upon the follow-on Human Health Risk Evaluation for the MTA.

2 — The MSC if for cleaning up the lead hotspot only at the OJT.

3 — The RDX MSC is based upon a public water supply point of intake criterion is 3 µg/L as presented in Appendix D.

COC — Chemical of concern.
MCS — Media cleanup standard.
N/A — not applicable to this media for this COC.
mg/kg — milligrams per kilogram.
µg/L — micrograms per liter.
AGT — Ammunition Burning Grounds.
MTA — Main Treatment Area.
RDX — hexahydro-1,3,5-trinitro-1,3,5-triazine.

APPENDIX E

SAMPLE DATA
FOR
SWMU 3 - AMMUNITION BURNING GROUNDS

TABLE E-1
2-AMINO-4,6-DINITROTOLUENE AND 4-AMINO-2,6-DINITROTOLUENE CONCENTRATIONS IN SPRING A
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	2-A-DNT µg/L		4-A-DNT µg/L	
03-SPR-A	02/28/99	0.29	U	0.29	U
03-SPR-A	05/20/99	0.33	U	0.77	
03-SPR-A	05/20/99	0.73	U	0.8	
03-SPR-A	09/13/99	2.1		4.9	
03-SPR-A	03/29/00	0.66	U	0.66	U
03-SPR-A	03/29/00	1.9	U	1.9	U
03-SPR-A	06/26/00	0.95999	U	1.	
03-SPR-A	09/29/00	70.			
03-SPR-A	12/18/00	0.73	U	0.73	U
03-SPR-A	04/10/01	0.51999	U	0.82999	
03-SPR-A	07/10/01	0.70999	U	0.75	
03-SPR-A	07/10/01	0.56	U	0.81	
03-SPR-A	09/17/01	1.8		3.9	
03-SPR-A	12/20/01	0.97	U	0.97	U
03-SPR-A	12/20/01	0.41999	U	0.41999	U
03-SPR-A	03/12/02	0.57999	U	0.57999	U
03-SPR-A	06/20/02	1.1		2.5	
03-SPR-A	06/20/02	1.3		2.4	
03-SPR-A	09/10/02	1.5		2.7	
03-SPR-A	12/09/02	1.6		3.7	J
03-SPR-A	03/07/03	0.43999	U	0.43999	U
03-SPR-A	06/30/03	1.2		2.8	
03-SPR-A	09/09/03	1.7		3.7	
03-SPR-A	12/17/03	0.52999	U	0.52999	U
03-SPR-A	03/16/04	0.54	U	0.54	U
03-SPR-Ap	04/24/04	0.252	U	0.54	
03-SPR-A	06/29/04	1.2		3.	
03-SPR-A	09/16/04	2.4		6.2	

70.

2-A-DNT — 2-amion-4,6-dinitrotoluene
4-A-DNT — 4-amino-2,6-dinitrotoluene

Maximum Value
Location/Date of Maximum Value

CRITERIA (µg/L)	
2-A-DNT	2-A-DNT
68	68

TABLE E-2
2-AMINO-4,6-DINITROTOLUENE AND 4-AMINO-2,6-DINITROTOLUENE CONCENTRATIONS IN SPRING C
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE GIS	SAMPLE DATE	2-A-DNT µg/L		4-A-DNT µg/L	
03-SPR-C	19990228	02/28/99	1.6	U	1.6	U
03-SPR-C	19990520	05/20/99	0.66	U	0.66	U
03-SPR-C	19990913	09/13/99	0.31	U	0.31	U
03-SPR-C	19990913	09/13/99	0.4	U	0.4	U
03-SPR-C	20000314	03/14/00	0.95999	U	0.95999	U
03-SPR-C	20000314	03/14/00	0.76999	U	0.76999	U
03-SPR-C	20000628	06/28/00	0.79	U	0.79	U
03-SPR-C	20000628	06/28/00	1.	U	1.	U
03-SPR-C	20000929	09/29/00				
03-SPR-C	20001219	12/19/00	1.2	U	1.2	U
03-SPR-C	20010410	04/10/01	0.83999	U	0.83999	U
03-SPR-C	20010710	07/10/01	0.38999	U	0.38999	U
03-SPR-C	20010917	09/17/01	0.62	U	0.62	U
03-SPR-C	20011218	12/18/01	0.50999	U	0.50999	U
03-SPR-C	20020311	03/11/02	0.36	U	0.36	U
03-SPR-C	20020624	06/24/02	1.2	U	1.2	U
03-SPR-C	20020909	09/09/02	0.62999	U	0.62999	UJ
03-SPR-C	20021212	12/12/02	1.2	U	1.2	U
03-SPR-C	20030310	03/10/03	1.2	U	1.2	U
03-SPR-C	20030626	06/26/03	1.4	U	1.4	U
03-SPR-C	20030909	09/09/03	0.91	U	0.91	U
03-SPR-C	20031218	12/18/03	0.5	U	0.5	U
03-SPR-C	20031218	12/18/03	0.5	U	0.5	U
03-SPR-C	20040303	03/03/04	0.52999	U	0.52999	U
03-SPR-C	20040303	03/03/04	0.52999	U	0.52999	U
03-SPR-C	20040629	06/29/04	0.52999	U	0.52999	U
03-SPR-C	20040629	06/29/04	0.52999	U	0.52999	U
03-SPR-C	20040916	09/16/04	0.50999	U	0.50999	U
			1.6			

2-A-DNT — 2-amion-4,6-dinitrotoluene
4-A-DNT — 4-amino-2,6-dinitrotoluene

Maximum Value
Location/Date of Maximum Value

CRITERIA (µg/L)	
2-A-DNT	4-A-DNT
68	**68**

TABLE E-3
FILTERED AND TOTAL BARIUM CONCENTRATIONS IN SURFACE WATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	BARIUM[1] µg/L	BARIUM[2] µg/L
CRA	11/5/1998	158	146
CRB	11/5/1998	131	130
CRA	2/28/1999	37.1	48.3
CRB	2/28/1999	35	39.7
CRA	5/20/1999	65.8	59.6
CRB	5/20/1999	64.9	60.4
CRB	9/13/1999	158	158
CRA	3/8/2000	70.7	72.1
CRB	3/8/2000	70.3	67.2
CRA	6/9/2000		127
CRB	6/9/2000		128
CRB	12/12/2000	49	42.9
CRA	12/18/2000	46.2	45.4
03SWSD15	6/10/2001	61.6	63.1
03SWSD16	6/10/2001	83.1	81.7
03SWSD17	6/10/2001	96.1	105
03SWSD18	6/10/2001	98.3	97.7
03SWSD19	6/10/2001	97.5	98.3
03SWSD01	6/11/2001	63 J	58.2 J
03SWSD06	6/11/2001	120 J	114 J
03SWSD02	6/12/2001	76 J	72.8 J
03SWSD03	6/12/2001	73.9 J	60.9 J
03SWSD01	9/9/2001	56.7 J	47.1 J
03SWSD02	9/9/2001	55.7 J	47 J
03SWSD03	9/9/2001	78.7 J	76.5 J
03SWSD06	9/9/2001	124 J	106 J
03SWSD08	9/9/2001	58.7 J	40.4 J
03SWSD09	9/9/2001	126 J	85.8 J
03SWSD11	9/9/2001	103 J	75.7 J
03SWSD13	9/9/2001	76.1 J	51.8 J
03SWSD14	9/9/2001	45.6 J	37.7 J
03SWSD15	9/9/2001	74.3 J	80 J
03SWSD16	9/9/2001	132 J	136 J
03SWSD17	9/9/2001	131 J	141 J
03SWSD18	9/9/2001	156 J	147 J
03SWSD19	9/9/2001	145 J	138 J
CRB	9/21/2004		
	Maximum:	158	

1 - total barium.
2 - filtered barium.

Location/Date of Maximum Value

TABLE E-4
TRICHLORETHENE CONCENTRATIONS IN SURFACE WATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	TCE µg/L
CRA	11/5/1998	0.5 U
CRB	11/5/1998	0.5 U
CRA	2/28/1999	0.5 U
CRB	2/28/1999	0.5 U
CRA	5/20/1999	0.5 U
CRB	5/20/1999	0.5 U
CRB	9/13/1999	0.5 U
CRA	3/8/2000	0.5 U
CRB	3/8/2000	0.5 U
CRB	12/12/2000	0.5 U
CRA	12/18/2000	0.5 U
03SWSD15	6/10/2001	0.5 U
03SWSD16	6/10/2001	0.5 U
03SWSD17	**6/10/2001**	0.4 J
03SWSD18	6/10/2001	0.5 U
03SWSD19	6/10/2001	0.5 U
03SWSD01	6/11/2001	0.5 U
03SWSD06	6/11/2001	0.5 U
03SWSD02	6/12/2001	0.5 U
03SWSD03	6/12/2001	0.5 U
03SWSD01	9/9/2001	0.5 U
03SWSD02	9/9/2001	0.5 U
03SWSD03	9/9/2001	0.5 U
03SWSD06	9/9/2001	0.5 U
03SWSD08	9/9/2001	0.5 U
03SWSD09	9/9/2001	0.5 U
03SWSD11	9/9/2001	0.5 U
03SWSD13	9/9/2001	0.5 U
03SWSD14	9/9/2001	0.5 U
03SWSD15	9/9/2001	0.5 U
03SWSD16	9/9/2001	0.5 U
03SWSD17	9/9/2001	0.5 U
03SWSD18	9/9/2001	0.5 U
03SWSD19	9/9/2001	0.5 U
CRB	9/21/2004	
	Maximum	0.4

TCE — trichloroethene

Location/Date of Maximum Value

TABLE E-5
2-ADNT AND 4-ADNT CONCENTRATIONS IN SURFACE WATER
(1999 THROUGH 2004)
CORRECTIVE MEASURES STUDY REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	2-A-DNT (µg/L)	4-A-DNT (µg/L)
CRA	11/5/1998	0.71 U	0.71 U
CRB	11/5/1998	0.9 U	1.2 J
CRA	2/28/1999	0.7 U	0.7 U
CRB	2/28/1999	0.65 U	0.65 U
CRA	5/20/1999	0.55 U	0.55 U
CRB	5/20/1999	0.6 U	0.6 U
CRB	9/13/1999	0.52 U	0.52 U
CRA	3/8/2000	1.3 U	1.3 U
CRB	3/8/2000	0.53 U	0.53 U
CRB	12/12/2000	0.97 U	0.97 U
CRA	12/18/2000	0.94 U	0.94 U
03SWSD15	6/10/2001	0.35 U	0.35 U
03SWSD16	6/10/2001	0.35 U	0.35 U
03SWSD17	6/10/2001	0.37 J	0.83
03SWSD18	6/10/2001	0.35 U	0.68 J
03SWSD19	6/10/2001	0.35 U	0.54 J
03SWSD01	6/11/2001	0.35 U	0.35 U
03SWSD06	6/11/2001	0.75 J	1.7
03SWSD02	6/12/2001	0.35 U	0.35 U
03SWSD03	6/12/2001	0.35 U	0.35 U
03SWSD01	9/9/2001	0.35 U	0.35 U
03SWSD02	9/9/2001	0.35 U	0.35 U
03SWSD03	9/9/2001	0.35 U	0.35 U
03SWSD06	9/9/2001	0.35 U	1.4 J
03SWSD08	9/9/2001	0.35 U	0.35 U
03SWSD09	9/9/2001	0.35 U	0.35 U
03SWSD11	9/9/2001	0.35 U	0.35 U
03SWSD13	9/9/2001	0.35 U	0.35 U
03SWSD14	9/9/2001	0.35 U	0.35 U
03SWSD15	9/9/2001	0.35 U	0.35 U
03SWSD16	9/9/2001	0.35 U	0.35 U
03SWSD17	9/9/2001	1.5 J	2.9
03SWSD18	9/9/2001	0.35 U	0.35 U
03SWSD19	9/9/2001	0.35 U	0.35 U
CRB	9/21/2004	0.52 U	0.52 U
	Maximum	2.9	

2-ADNT — 2-amion-4,6-dinitrotoluene
4-ADNT — 4-amino-2,6-dinitrotoluene

Location/Date of Maximum Value

CRITERIA (µg/L)	
2-A-DNT	4-A-DNT
68	68

TABLE E-6
HEXAHYDRO-1,3,5-TRINITRO-1,3,5-TRIAZINE CONCENTRATIONS IN SURFACE WATER
(1999 THROUGH 2004)
CORRECTIVE MEASURES STUDY REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	RDX (µg/L)
CRA	11/5/1998	28
CRB	11/5/1998	20
CRA	2/28/1999	1.6
CRB	2/28/1999	1
CRA	5/20/1999	3.6
CRB	5/20/1999	3.1
CRB	9/13/1999	3.8
CRA	3/8/2000	4.5 J
CRB	3/8/2000	7.2 J
CRB	12/12/2000	1.1
CRA	12/18/2000	1.9
03SWSD15	6/10/2001	2.4 J
03SWSD16	6/10/2001	2.3
03SWSD17	6/10/2001	11
03SWSD18	6/10/2001	9.5
03SWSD19	6/10/2001	7.7 J
03SWSD01	6/11/2001	0.35 U
03SWSD06	6/11/2001	4.4
03SWSD02	6/12/2001	0.35 U
03SWSD03	6/12/2001	0.35 U
03SWSD01	9/9/2001	0.35 U
03SWSD02	9/9/2001	0.35 U
03SWSD03	9/9/2001	0.35 U
03SWSD06	9/9/2001	8.3
03SWSD08	9/9/2001	0.35 U
03SWSD09	9/9/2001	1.5 J
03SWSD11	9/9/2001	4.8
03SWSD13	9/9/2001	0.94
03SWSD14	9/9/2001	0.35 U
03SWSD15	9/9/2001	0.84
03SWSD16	9/9/2001	0.62
03SWSD17	**9/9/2001**	63
03SWSD18	9/9/2001	39 J
03SWSD19	9/9/2001	10
CRB	9/21/2004	14
	Maximum	63

RDX — hexahydro-1,3,5-trinitro-1,3,5-triazine

Value Exceeding Criteria
Location/Date of Maximum Value

CRITERIA (µg/L)
3

TABLE E-7
FILTERED AND TOTAL BARIUM CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	BARIUM[1] (µg/L)		BARIUM[2] (µg/L)
03B04	02/23/99	77.4		95.9
03C25	02/24/99	15.6		20.8
03C10	02/25/99	42.4		47.7
03C11	02/25/99	22.9		26.2
03C12	02/25/99	88.7		105.
03C02P2	02/26/99	61.2		71.6
03C07	02/26/99	29.6		41.
03C03	02/27/99	38.3		47.8
03C04	02/27/99	31.4		49.
03C09P2	03/01/99	15.4		13.4
03C15	03/01/99	23.1		22.9
03C26	03/02/99	37.4		36.9
03C27	03/02/99	34.3		32.7
03C17	03/08/99	11.		11.
03C30	03/08/99	61.1		57.7
03B02	03/10/99	76.1		75.2
03C20	03/11/99	29.7		29.9
03C08P2	03/12/99	70.2		63.1
03B04	05/17/99	83.9		74.
03B02	05/18/99	82.2		74.8
03C03	05/18/99	39.		35.4
03C17	05/18/99	11.7		10.
03C02P2	05/19/99	85.9		76.3
03C07	05/19/99	30.7		26.
03C09P2	05/19/99	14.8		11.8
03C04	05/21/99	28.7		29.2
03C11	05/21/99	54.3		38.3
03C10	05/22/99	44.3		44.3
03C12	05/22/99	90.9		89.3
03C20	05/22/99	33.9		30.6
03C15	05/23/99	23.		21.
03C26	05/23/99	37.9		35.2
03C08P2	05/24/99	16.4		62.9
03C27	05/24/99	31.9		31.1
03C30	05/24/99	69.1		66.4
03C25	05/25/99	1.1	U	15.8
03C02P2	09/07/99	105.		105.
03C10	09/08/99	46.6		44.
03C12	09/08/99	96.9		99.6
03C15	09/08/99	25.1		24.9
03C27	09/08/99	33.		33.2
03B02	09/09/99	88.		91.3
03B04	09/09/99	95.		107.
03C17	09/09/99	13.2		13.8

TABLE E-7
FILTERED AND TOTAL BARIUM CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	BARIUM[1] (µg/L)	BARIUM[2] (µg/L)
03C11	09/10/99	23.1	27.
03C25	09/10/99	16.8	18.1
03C30	09/10/99	17.2	73.
03C03	09/11/99	42.3	49.7
03C04	09/11/99	30.6	31.7
03C07	09/11/99	31.9	32.9
03C09P2	09/11/99	15.2	15.3
03C08P2	09/12/99	81.8	89.6
03C26	09/12/99	41.6	47.3
03C20	09/14/99	30.4	34.4
WATER WELL	09/23/99	40.6	37.6
03C02P2	03/06/00	101.	95.3
03C04	03/14/00	30.9	25.9
03C07	03/14/00	32.8	33.7
03C12	03/15/00	92.1	96.
03C30	03/21/00	61.1	46.
03C11	03/22/00	23.6	22.4
03C15	03/23/00	22.8	23.6
03C20	03/23/00	32.1	32.7
03C25	03/24/00	16.6	16.9
03C09P2	03/25/00	13.9	13.7
03B04	03/27/00	87.8	86.8
03B02	03/28/00	83.4	79.3
03C27	03/28/00	33.3	34.1
03C26	03/29/00	38.4	39.7
03C08P2	03/30/00	64.7	59.9
03C03	04/01/00	42.7	42.9
03C10	04/01/00	45.1	45.4
03C17	04/01/00	13.3	12.2
03C17	05/25/00	13.6	12.9
03C25	05/25/00		15.2
03C20	06/01/00	34.4	36.4
03C12	06/05/00		102.
03C09P2	06/06/00	14.9	15.4
03C11	06/06/00		24.9
03C15	06/07/00	23.9	25.6
03C02P2	06/08/00	99.8	108.
03C07	06/15/00	33.8	34.4
03C03	06/19/00	44.8	45.4
03C08P2	06/20/00	61.	60.2
03C26	06/21/00	43.2	44.2
03C27	06/21/00	35.4	36.9
03B02	06/23/00	92.9	93.1
03C10	06/23/00	51.2	50.3

TABLE E-7
FILTERED AND TOTAL BARIUM CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	BARIUM[1] (µg/L)	BARIUM[2] (µg/L)
03B04	06/26/00	96.3	98.7
03C04	06/27/00	23.7	23.7
03C30	06/28/00	58.6	54.2
03B02	09/07/00	94.6	88.2
03C25	09/07/00	18.9	16.4
03B04	09/08/00	107.	96.4
03C07	09/08/00	33.7	30.9
03C10	09/08/00	48.5	44.8
03C03	09/12/00	44.9	39.9
03C17	09/12/00	13.8	12.1
03C27	09/12/00	38.4	35.
03C04	09/13/00	43.4	20.7
03C08P2	09/13/00	27.2	56.1
03C12	09/13/00	40.1	114.
03C26	09/14/00	60.	38.
03C09P2	09/15/00	16.2	13.4
03C11	09/15/00	24.	22.6
03C02P2	09/18/00	132.	123.
03C15	09/18/00	24.	23.2
03C20	09/18/00	33.	32.2
03C30	09/19/00		
03C25	11/29/00	18.1	17.8
03C02P2	11/30/00	70.3	68.1
03C27	11/30/00	37.2	37.8
03C03	12/01/00	45.2	44.2
03C09P2	12/01/00	15.1	14.7
03C10	12/01/00	47.1	48.6
03B04	12/04/00	104.	97.
03B02	12/05/00	97.5	88.7
03C04	12/05/00	26.9	22.2
03C17	12/05/00	13.1	12.3
03C30	12/07/00	54.7	49.5
03C11	12/11/00	23.7	22.6
03C12	12/14/00	111.	104.
03C15	12/21/00	25.6	24.5
03C07	12/27/00	32.6	30.8
03C20	12/28/00	34.3	33.4
03C08P2	01/02/01	71.8	65.9
03C26	01/04/01	42.6	40.
03C02P2	03/05/01	66.7	66.1
03C25	03/06/01	17.8	16.9
03B02	03/07/01	75.4	75.8
03B04	03/08/01	87.2	82.4
03C04	03/12/01	24.6	21.4

TABLE E-7
FILTERED AND TOTAL BARIUM CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	BARIUM[1] (µg/L)		BARIUM[2] (µg/L)	
03C12	03/13/01	92.2		91.9	
03C03	03/14/01	37.8		37.6	
03C09P2	03/14/01	14.3		13.3	
03C10	03/19/01	44.9		43.6	
03C11	03/20/01	22.6		21.8	
03C07	03/21/01	34.2		30.9	
03C20	03/21/01	32.1		31.3	
03C27	03/22/01	30.5		30.5	
03C15	03/26/01	25.5		25.4	
03C26	03/27/01	39.4		38.6	
03C08P2	03/28/01	69.5		64.4	
03C17	04/02/01	13.8		11.1	
03C30	04/03/01	51.2		54.2	
03-07	06/07/01	153.	J		
03-20	06/09/01	44.8	J		
03-23	06/09/01	58.3	J		
03C09P2	06/12/01				
03C02P2	06/13/01				
03C25	06/18/01				
03C15	06/19/01				
03C10	06/20/01				
03B02	06/21/01				
03B04	06/21/01				
03-13	06/23/01	66.8	J		
03-17	06/24/01	26.2	J		
03-18	06/24/01	58.6	J		
03-11	06/25/01	88.6	J		
03-12	06/25/01	46.2	J		
03-14	06/25/01	96.5	J		
03-24	06/25/01	50.9	J		
03-25	06/25/01	19.4	J	18.1	J
03C27	06/25/01	31.		31.6	
03C07	06/26/01	29.7		33.	
03C26	06/26/01	37.8		39.	
03C04	06/27/01	23.7		17.	
03C11	06/27/01	19.9		19.7	
03C12	06/27/01	89.		91.6	
03C08P2	06/28/01	63.		56.5	
03C20	06/28/01	31.4		31.3	
03C03	07/02/01	36.4		41.1	
03C17	07/03/01	13.		17.5	
03C30	07/03/01	48.2		50.6	
03-15	07/10/01	88.5	J		
03-16	07/10/01	43.	J		

TABLE E-7
FILTERED AND TOTAL BARIUM CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	BARIUM[1] (µg/L)	BARIUM[2] (µg/L)
03-21	07/10/01	275. J	
03-22	07/10/01	173. J	
03-10	07/11/01	71.3 J	
03C03	08/29/01	37.7	39.9
03C25	08/30/01	16.4	16.2
03C27	09/04/01	31.3	31.9
03C09P2	09/05/01	13.4	12.9
03C20	09/05/01	30.4	30.8
03C15	09/06/01	25.6	25.6
03C02P2	09/10/01	113.	113.
03C04	09/10/01		
03C08P2	09/17/01	55.	57.6
03C17	09/17/01	11.8	10.4
03C07	09/18/01	29.6	29.7
03C04	09/19/01	22.2	20.
03C26	09/19/01	37.9	37.5
03C30	09/20/01	45.7	41.
03C25	11/13/01	17.8	16.7
03C02P2	11/26/01	85.6	90.1
03C15	11/27/01	27.4	29.3
03C03	11/30/01	35.8	38.5
03C04	12/03/01	22.6	21.3
03C20	12/03/01	31.1	32.1
03C26	12/04/01	37.9	39.1
03C08P2	12/05/01	56.5	54.6
03C30	12/10/01	51.2	50.4
03C07	12/11/01	33.5	32.2
03C17	12/13/01	14.7	11.6
03C09P2	12/17/01	17.6	13.9
03C27	12/19/01	42.8	39.
03C25	02/08/02	17.8	16.7
03C02P2	02/11/02	71.	68.
03C03	02/22/02	33.8	44.5
03C09P2	02/22/02	13.7	15.3
03C04	02/25/02	24.7	21.1
03C26	02/25/02	36.1	45.9
03C07	02/27/02	27.	36.3
03C08P2	02/28/02	64.8	79.4
03C20	02/28/02	28.7	37.3
03C27	03/04/02	30.7	38.8
03C17	03/05/02	11.1	12.5
03C15	03/06/02	25.9	28.2
03C30	03/07/02	54.2	50.5
03C03	05/14/02	34.3	35.5

TABLE E-7
FILTERED AND TOTAL BARIUM CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	BARIUM[1] (µg/L)	BARIUM[2] (µg/L)
03C09P2	05/15/02	13.	12.
03C02P2	05/16/02	62.8	63.
03C26	05/20/02	35.5	35.5
03C20	05/21/02	28.4	28.8
03C17	05/22/02	11.	9.5
03C27	05/28/02	27.3	29.
03C30	05/30/02	58.	36.7
03C15	06/05/02	27.8	27.1
03C08P2	06/06/02	62.5	56.7
03C04	06/10/02	21.9	17.
03C07	06/18/02	30.3	31.2
03C03	08/20/02	34.8	35.3
03C26	08/20/02	36.5	35.9
03C15	08/21/02	26.5	25.5
03C20	08/22/02	30.1	30.9
03C30	08/26/02	50.6	46.7
03C27	08/27/02	27.6	26.7
03C04	08/28/02	20.	18.3
03C07	08/28/02	25.9	26.1
03C09P2	08/29/02	14.1	11.7
03C08P2	09/03/02	57.1	51.6
03C02P2	09/04/02	80.2	79.8
03C09P2	09/04/02		
03C04	09/05/02		
03C17	09/05/02	12.5	10.8
03C25	09/10/02	16.4	15.6
03C25	10/31/02	15.8	15.1
03C03	11/04/02	39.5	39.2
03C09P2	11/06/02	19.6	13.5
03C02P2	11/07/02	106.	105.
03C26	11/12/02	37.8	42.1
03C17	11/13/02	12.1	11.1
03C27	11/14/02	28.8	29.1
03C20	11/18/02	31.5	30.7
03C04	11/19/02	24.1	17.5
03C08P2	11/20/02	59.9	55.
03C07	11/25/02	29.4	28.8
03C15	11/26/02	28.5	28.
03C30	12/04/02	57.3	33.6
03C03	02/24/03	36.2	36.5
03C08P2	02/25/03	64.7	57.3
03C09P2	02/26/03	16.5	12.4
03C30	02/27/03	53.2	49.4
03C26	03/03/03	37.9	38.7

TABLE E-7
FILTERED AND TOTAL BARIUM CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	BARIUM[1] (µg/L)	BARIUM[2] (µg/L)
03C02P2	03/04/03	61.6	60.9
03C15	03/05/03	28.4	27.9
03C07	03/06/03	28.8	29.4
03C04	03/11/03	34.7	18.2
03C17	03/11/03	11.4	10.9
03C20	03/12/03	30.4	31.
03C09P2	05/19/03	16.8	12.
03C03	05/21/03	35.6	36.4
03C25	05/27/03	15.4	15.4
03C26	05/29/03	37.2	37.7
03C27	06/02/03	25.8	26.
03C20	06/04/03	28.6	28.4
03C08P2	06/09/03	55.8	52.6
03C02P2	06/10/03	83.9	85.4
03C15	06/17/03	24.9	25.2
03C07	06/18/03	30.1	30.7
03C17	06/19/03	10.	9.
03C04	06/23/03	21.8	15.5
03C30	06/24/03	39.5	46.
03C26	08/22/03	37.4	38.3
03C03	08/25/03	34.1	37.2
03C20	08/25/03	30.5	31.7
03C02P2	08/26/03	86.2	93.3
03C07	08/26/03	26.9	28.8
03C30	08/27/03	44.9	34.9
03C09P2	08/28/03	16.6	12.4
03C04	09/02/03	21.2	16.7
03C08P2	09/03/03	53.3	53.
03C15	09/04/03	23.3	23.7
03C27	09/05/03	26.4	28.4
03C17	09/08/03	10.6	9.8
03C25	09/09/03	15.8	15.4
03C03	11/06/03	36.8	35.7
03C25	11/10/03	16.4	16.3
03C09P2	11/12/03	19.3	12.6
03C20	11/17/03	31.3	31.9
03C26	11/20/03	39.5	40.4
03C27	11/25/03	31.7	33.4
03C02P2	12/01/03	72.2	72.8
03C15	12/02/03	25.7	26.4
03C08P2	12/08/03	57.6	52.4
03C04	12/09/03	25.2	18.9
03C30	12/11/03	56.8	36.5
03C07	12/15/03	28.5	29.9

TABLE E-7
FILTERED AND TOTAL BARIUM CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	BARIUM[1] (µg/L)		BARIUM[2] (µg/L)	
03C17	12/22/03	10.9		10.5	
03C25	02/26/04	16.3		15.6	
03C02P2	02/27/04	45.4		43.8	
03C04	03/02/04	23.5		18.8	
03C26	03/02/04	37.7		38.1	
03C03	03/05/04	36.1		36.4	
03C09P2	03/08/04	18.7		12.5	
03C20	03/09/04	29.8		31.2	
03C08P2	03/10/04	59.3		56.	
03C17	03/11/04	11.2		11.	
03C07	03/12/04	26.7		28.3	
03C27	03/15/04	28.2		29.2	
03C30	03/15/04	48.4		34.	
03C15	03/17/04	27.6		27.4	
03-01	04/04/04	26.1	J		
03-38	04/04/04	19.2	J		
03-33	04/06/04	71.2	J	71.1	J
03C01P2	04/06/04	49.4	J		
03C06	04/06/04	49.8	J		
03C21	04/06/04	39.4	J		
03-09	04/07/04	54.8	J		
03-31	04/07/04	14.6	J		
03C03P2	04/07/04	93.3	J	83.8	J
03C14	04/07/04	60.4	J		
03-16	04/08/04	46.6	J		
03-21	04/08/04	252.	J		
03-24	04/08/04	42.9	J		
03C05	04/08/04	52.7	J		
03C28	04/08/04	69.	J		
03SB060/TW01	04/17/04	230.	J		
03-12	04/18/04	49.8	J		
03-15	04/18/04	73.4	J		
03SB063/TW02	04/19/04	62.9	J	53.5	J
03SB090/TW03	04/19/04	1,140.	J	124.	J
03SB103/TW05	04/21/04	160.	J	168.	J
03TW04	04/21/04	259.	J	247.	J
03-39	04/22/04	14.6	J		
03-07	04/24/04	136.	J		
03SB050/TW06	04/24/04	3,780.	J	3,830.	J
03C25	06/01/04	16.3		15.4	
03C03	06/07/04	36.9		37.2	
03C02P2	06/08/04	96.1		94.1	
03C04	06/16/04	22.8		18.	
03C26	06/16/04	39.7		39.4	

TABLE E-7
FILTERED AND TOTAL BARIUM CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	BARIUM(1) (µg/L)	BARIUM(2) (µg/L)
03C09P2	06/17/04	20.9	12.2
03C20	06/18/04	32.8	31.5
03C15	06/21/04	28.	29.3
03C27	06/22/04	28.3	28.4
03C07	06/28/04	27.5	29.
03C08P2	06/30/04	65.	61.
03C17	06/30/04	10.4	9.8
03C30	06/30/04	56.4	39.4
03C25	09/02/04	19.	14.8
03C03	09/07/04	38.	36.6
03C04	09/08/04	24.3	18.3
03C20	09/08/04	34.1	32.4
03C02P2	09/09/04	97.4	97.2
03C09P2	09/13/04	18.	12.6
03C30	09/13/04	55.7	33.5
03C07	09/14/04	27.1	27.7
03C26	09/14/04	45.6	40.9
03C08P2	09/15/04	55.4	54.7
03C27	09/17/04	27.9	30.1
03C15	09/20/04	28.6	28.4
03C17	09/20/04	12.4	10.1
		3,830.	

1 - total barium.
2 - filtered barium.

Location/Date of Maximum Value

TABLE E-8
TRICHLORETHENE CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	TCE (µg/L)	
03B04	02/23/99	0.5	U
03C25	02/24/99	0.5	U
03C10	02/25/99	63.	
03C11	02/25/99	2,100.	
03C12	02/25/99	22.	
03C02P2	02/26/99	7.7	
03C07	02/26/99	4.7	
03C03	02/27/99	0.5	U
03C04	02/27/99	0.5	U
03C09P2	03/01/99	160.	
03C15	03/01/99	0.5	U
03C26	03/02/99	4.2	
03C27	03/02/99	4.	
03C17	03/08/99	0.5	U
03C30	03/08/99	0.5	U
03B02	03/10/99	0.5	U
03C20	03/11/99	3,700.	
03C08P2	03/12/99	71.	
03B04	05/17/99	0.5	U
03B02	05/18/99	0.5	U
03C03	05/18/99	0.5	U
03C17	05/18/99	0.5	U
03C02P2	05/19/99	3.2	
03C07	05/19/99	3.	
03C09P2	05/19/99	150.	
03C04	05/21/99	0.6	
03C11	05/21/99	760.	
03C10	05/22/99	63.	
03C12	05/22/99	19.	
03C20	05/22/99	3,300.	
03C15	05/23/99	0.5	U
03C26	05/23/99	9.1	
03C08P2	05/24/99	61.	
03C27	05/24/99	3.8	
03C30	05/24/99	0.5	U
03C25	05/25/99	0.5	U
03C02P2	09/07/99	10.	
03C10	09/08/99	61.	
03C12	09/08/99	21.	
03C15	09/08/99	0.5	U
03C27	09/08/99	4.2	
03B02	09/09/99	0.5	U
03B04	09/09/99	0.5	U
03C17	09/09/99	0.5	U

TABLE E-8
TRICHLORETHENE CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	TCE (µg/L)	
03C11	09/10/99	2,300	
03C25	09/10/99	0.5	U
03C30	09/10/99	0.5	U
03C03	09/11/99	0.5	U
03C04	09/11/99	0.5	U
03C07	09/11/99	4.3	
03C09P2	09/11/99	170	
03C08P2	09/12/99	63	
03C26	09/12/99	8.9	
03C20	09/14/99	3,400	
WATER WELL	09/23/99	0.5	U
03C02P2	03/06/00	12	
03C04	03/14/00	0.5	U
03C07	03/14/00	4.5	
03C12	03/15/00	21	
03C30	03/21/00	0.5	U
03C11	03/22/00	2,200	
03C15	03/23/00	0.5	U
03C20	03/23/00	3,300	
03C25	03/24/00	0.5	U
03C09P2	03/25/00	120	
03B04	03/27/00	0.5	U
03B02	03/28/00	0.5	U
03C27	03/28/00	4.2	
03C26	03/29/00	10	
03C08P2	03/30/00	63	
03C03	04/01/00	0.5	U
03C10	04/01/00	54	
03C17	04/01/00	0.5	U
03C17	05/25/00	0.5	U
03C25	05/25/00	0.5	U
03C20	06/01/00	3,300	
03C12	06/05/00	20	
03C09P2	06/06/00	110	
03C11	06/06/00	2,500	
03C15	06/07/00	0.5	U
03C02P2	06/08/00	9.2	
03C07	06/15/00	2.9	
03C03	06/19/00	0.5	U
03C08P2	06/20/00	77	
03C26	06/21/00	10	
03C27	06/21/00	4.4	
03B02	06/23/00	0.5	U
03C10	06/23/00	72	

TABLE E-8
TRICHLORETHENE CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	TCE (µg/L)	
03B04	06/26/00	0.5	U
03C04	06/27/00	0.5	U
03C30	06/28/00	0.5	U
03B02	09/07/00	0.5	U
03C25	09/07/00	0.5	U
03B04	09/08/00	0.5	U
03C07	09/08/00	4.6	
03C10	09/08/00	68	
03C03	09/12/00	0.5	U
03C17	09/12/00	0.5	U
03C27	09/12/00	3.8	
03C04	09/13/00	0.5	U
03C08P2	09/13/00	66	
03C12	09/13/00	20	
03C26	09/14/00	8.2	
03C09P2	09/15/00	120	
03C11	09/15/00	2,300	
03C02P2	09/18/00	11	
03C15	09/18/00	0.5	U
03C20	09/18/00	4,500	
03C30	09/19/00	0.5	U
03C25	11/29/00	0.5	U
03C02P2	11/30/00	2.9	
03C27	11/30/00	3.8	
03C03	12/01/00		
03C09P2	12/01/00	130	
03C10	12/01/00	68	
03B04	12/04/00	0.5	U
03B02	12/05/00	0.5	U
03C04	12/05/00	0.5	U
03C17	12/05/00	0.5	U
03C30	12/07/00	0.5	U
03C11	12/11/00	2,300	
03C12	12/14/00	25	
03C15	12/21/00	0.5	U
03C07	12/27/00	5.9	
03C20	12/28/00	3,500	
03C08P2	01/02/01	67	
03C26	01/04/01	9.6	
03C02P2	03/05/01	5.	
03C25	03/06/01	0.5	U
03B02	03/07/01	0.5	U
03B04	03/08/01	0.5	U
03C04	03/12/01	0.5	U

TABLE E-8
TRICHLORETHENE CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	TCE (µg/L)	
03C12	03/13/01	19.	
03C03	03/14/01	0.5	U
03C09P2	03/14/01	150.	
03C10	03/19/01	55.	
03C11	03/20/01	2,300.	
03C07	03/21/01	20.	
03C20	03/21/01	3,200.	
03C27	03/22/01	13.	
03C15	03/26/01	0.5	U
03C26	03/27/01	8.8	
03C08P2	03/28/01	66.	
03C17	04/02/01	0.5	U
03C30	04/03/01	0.5	U
03-07	06/07/01	640.	
03-20	06/09/01	0.3	J
03-23	06/09/01	0.5	U
03C09P2	06/12/01	120.	
03C02P2	06/13/01	9.4	
03C25	06/18/01	0.5	U
03C15	06/19/01	0.5	U
03C10	06/20/01	48.	
03B02	06/21/01	0.5	U
03B04	06/21/01	0.5	U
03-13	06/23/01	0.5	U
03-17	06/24/01	0.5	U
03-18	06/24/01	0.5	U
03-11	06/25/01	0.5	U
03-12	06/25/01	3.7	J
03-14	06/25/01	0.5	U
03-24	06/25/01	23.	J
03-25	06/25/01	0.5	U
03C27	06/25/01	3.	
03C07	06/26/01	5.	
03C26	06/26/01	8.8	
03C04	06/27/01	0.5	U
03C11	06/27/01	1,900.	
03C12	06/27/01	16.	
03C08P2	06/28/01	57.	
03C20	06/28/01	2,400.	
03C03	07/02/01	0.5	U
03C17	07/03/01	0.5	U
03C30	07/03/01	0.5	U
03-15	07/10/01	57.	J
03-16	07/10/01	0.5	U

TABLE E-8
TRICHLORETHENE CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	TCE (µg/L)	
03-21	07/10/01	1.6	U
03-22	07/10/01	6	J
03-10	07/11/01	0.9	U
03C03	08/29/01	0.5	U
03C25	08/30/01	0.5	U
03C27	09/04/01	3.7	
03C09P2	09/05/01	180	
03C20	09/05/01	3,500	
03C15	09/06/01	0.6	
03C02P2	09/10/01	7.1	
03C04	09/10/01	0.6	
03C08P2	09/17/01	59	
03C17	09/17/01	0.5	U
03C07	09/18/01	5.5	
03C04	09/19/01		
03C26	09/19/01	11	
03C30	09/20/01	0.5	U
03C25	11/13/01	0.5	U
03C02P2	11/26/01	11	
03C15	11/27/01	0.5	U
03C03	11/30/01	0.5	U
03C04	12/03/01	0.6	
03C20	12/03/01	2,900	
03C26	12/04/01	11	
03C08P2	12/05/01	67	
03C30	12/10/01	0.5	U
03C07	12/11/01	4.2	
03C17	12/13/01	0.5	U
03C09P2	12/17/01	180	
03C27	12/19/01	4.9	
03C25	02/08/02	0.5	U
03C02P2	02/11/02	3.9	
03C03	02/22/02	0.5	U
03C09P2	02/22/02	170	
03C04	02/25/02	0.6	
03C26	02/25/02	10	
03C07	02/27/02	4.3	
03C08P2	02/28/02	58	
03C20	02/28/02	3,000	
03C27	03/04/02	3.2	
03C17	03/05/02	0.5	U
03C15	03/06/02	0.5	U
03C30	03/07/02	0.5	U
03C03	05/14/02	0.5	U

TABLE E-8
TRICHLORETHENE CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	TCE (µg/L)	
03C09P2	05/15/02	97	J
03C02P2	05/16/02	2.9	
03C26	05/20/02	13	
03C20	05/21/02	1,900	
03C17	05/22/02	0.8	
03C27	05/28/02	4.	
03C30	05/30/02	0.5	U
03C15	06/05/02	0.5	U
03C08P2	06/06/02	47	
03C04	06/10/02	0.5	
03C07	06/18/02	4.5	
03C03	08/20/02	0.5	U
03C26	08/20/02	13	
03C15	08/21/02	0.5	U
03C20	08/22/02	1,500	
03C30	08/26/02	0.5	U
03C27	08/27/02	3.9	
03C04	08/28/02	0.5	U
03C07	08/28/02	4.3	
03C09P2	08/29/02		
03C08P2	09/03/02	58	
03C02P2	09/04/02	3.1	
03C09P2	09/04/02	190	
03C04	09/05/02		
03C17	09/05/02	0.5	U
03C25	09/10/02	0.5	U
03C25	10/31/02	1.	U
03C03	11/04/02	1.	U
03C09P2	11/06/02	160	
03C02P2	11/07/02	12	
03C26	11/12/02	13	
03C17	11/13/02	1.	U
03C27	11/14/02	3.8	
03C20	11/18/02	2,000	
03C04	11/19/02	0.8	J
03C08P2	11/20/02	59	
03C07	11/25/02	72	
03C15	11/26/02	1.	U
03C30	12/04/02	1.	U
03C03	02/24/03	1.	U
03C08P2	02/25/03	73	
03C09P2	02/26/03	180	
03C30	02/27/03	1.	U
03C26	03/03/03	17	

TABLE E-8
TRICHLORETHENE CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	TCE (µg/L)	
03C02P2	03/04/03	2.3	
03C15	03/05/03	1.	U
03C07	03/06/03	5.8	
03C04	03/11/03	1.	U
03C17	03/11/03	1.	U
03C20	03/12/03	2,600	
03C09P2	05/19/03	110	
03C03	05/21/03	0.5	U
03C25	05/27/03	0.5	U
03C26	05/29/03	13	
03C27	06/02/03	3.5	
03C20	06/04/03	2,000	
03C08P2	06/09/03	55	
03C02P2	06/10/03	4.8	
03C15	06/17/03	0.5	U
03C07	06/18/03	0.5	U
03C17	06/19/03	0.5	U
03C04	06/23/03	0.3	J
03C30	06/24/03	0.5	U
03C26	08/22/03	9.3	
03C03	08/25/03	0.5	U
03C20	08/25/03	3,200	
03C02P2	08/26/03	10	
03C07	08/26/03	5.2	
03C30	08/27/03	0.5	U
03C09P2	08/28/03	160	
03C04	09/02/03	0.5	
03C08P2	09/03/03	62	
03C15	09/04/03	0.5	U
03C27	09/05/03	3.8	
03C17	09/08/03	0.5	U
03C25	09/09/03	0.5	U
03C03	11/06/03	0.5	U
03C25	11/10/03	0.5	U
03C09P2	11/12/03	0.5	U
03C20	11/17/03	2,700	
03C26	11/20/03	15	
03C27	11/25/03	3.8	
03C02P2	12/01/03	2.9	
03C15	12/02/03	0.5	U
03C08P2	12/08/03	58	
03C04	12/09/03	0.4	J
03C30	12/11/03	0.5	U
03C07	12/15/03	5.7	

TABLE E-8
TRICHLORETHENE CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	TCE (µg/L)	
03C17	12/22/03	0.5	U
03C25	02/26/04	0.5	U
03C02P2	02/27/04	15	
03C04	03/02/04	0.5	U
03C26	03/02/04	3.4	
03C03	03/05/04	0.5	U
03C09P2	03/08/04	110	
03C20	03/09/04	1,400	
03C08P2	03/10/04	54	
03C17	03/11/04	0.5	U
03C07	03/12/04	5.2	
03C27	03/15/04	3.5	
03C30	03/15/04	0.5	U
03C15	03/17/04	0.5	U
03-01	04/04/04	52	
03-38	04/04/04	130	
03-33	04/06/04	0.8	J
03C01P2	04/06/04	0.3	U
03C06	04/06/04	7.5	
03C21	04/06/04	0.3	U
03-09	04/07/04	0.3	U
03-31	04/07/04	0.6	J
03C03P2	04/07/04	120	
03C14	04/07/04	0.3	U
03-16	04/08/04	0.3	U
03-21	04/08/04	0.6	J
03-24	04/08/04	17	
03C05	04/08/04	0.3	U
03C28	04/08/04	0.3	U
03SB060/TW01	04/17/04	0.3	U
03-12	04/18/04	2.2	
03-15	04/18/04	30	
03SB063/TW02	04/19/04	310	
03SB090/TW03	04/19/04	0.3	U
03SB103/TW05	04/21/04	23	
03TW04	04/21/04	0.3	U
03-39	04/22/04	180	
03-07	04/24/04	920	
03SB050/TW06	04/24/04	0.3	U
03C25	06/01/04	0.5	U
03C03	06/07/04	0.5	U
03C02P2	06/08/04	4.2	
03C04	06/16/04	0.5	
03C26	06/16/04	15	

TABLE E-8
TRICHLORETHENE CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	TCE (µg/L)	
03C09P2	06/17/04	160	
03C20	06/18/04	2,000	
03C15	06/21/04	0.5	U
03C27	06/22/04	2.8	
03C07	06/28/04	4.4	
03C08P2	06/30/04	53	
03C17	06/30/04	0.5	U
03C30	06/30/04	0.5	U
03C25	09/02/04	0.5	UJ
03C03	09/07/04	0.5	UJ
03C04	09/08/04	0.5	UJ
03C20	09/08/04	2,400	
03C02P2	09/09/04	9.1	J
03C09P2	09/13/04	180	J
03C30	09/13/04	0.5	UJ
03C07	09/14/04	6.1	J
03C26	09/14/04	13	J
03C08P2	09/15/04	47	J
03C27	09/17/04	2.8	J
03C15	09/20/04	0.5	UJ
03C17	09/20/04	0.5	UJ
	Maximum	4,500.	

Value Exceeding Criteria
Location/Date of Maximum Value

CRITERIA (µg/L)
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TABLE E-9
2-AMINO-4,6-DINITROTOLUENE AND 4-AMINO-2,6-DINITROTOLUENE CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	2-A-DNT (µg/L)		4-A-DNT (µg/L)	
03B04	02/23/99	0.94	U	0.94	U
03C25	02/24/99	1.2	U	1.2	U
03C10	02/25/99	1.5	U	1.5	U
03C11	02/25/99	1.	U	1.	U
03C12	02/25/99	0.74	U	0.74	U
03C02P2	02/26/99	0.49	U	0.49	U
03C07	02/26/99	1.2	U	1.2	U
03C03	02/27/99	1.	U	1.	U
03C04	02/27/99	0.46	U	0.46	U
03C09P2	03/01/99	0.44	U	0.44	U
03C15	03/01/99	0.49	U	0.49	U
03C26	03/02/99	1.4	U	1.4	U
03C27	03/02/99	1.3	U	1.3	U
03C17	03/08/99	1.2	U	1.2	U
03C30	03/08/99	0.56	U	0.56	U
03B02	03/10/99	0.58	U	0.58	U
03C20	03/11/99	12		18	
03C08P2	03/12/99	2.6		4.5	
03B04	05/17/99	0.52	U	0.52	U
03B02	05/18/99	0.95	UJ	0.95	UJ
03C03	05/18/99	0.2	U	0.2	U
03C17	05/18/99	0.36	U	0.36	U
03C02P2	05/19/99	0.68	U	0.68	U
03C07	05/19/99	0.64	U	0.64	U
03C09P2	05/19/99	0.75	U	0.75	U
03C04	05/21/99	1.	U	1.	U
03C11	05/21/99	0.71	U	0.71	U
03C10	05/22/99	0.65	U	0.65	U
03C12	05/22/99	0.3	U	0.3	U
03C20	05/22/99	11		17	
03C15	05/23/99	1.1	U	1.1	U
03C26	05/23/99	0.81	U	0.81	U
03C08P2	05/24/99	2.6		0.44	U
03C27	05/24/99	0.55	U	0.55	U
03C30	05/24/99	0.79	U	0.79	U
03C25	05/25/99	1.	U	1.	U
03C02P2	09/07/99	0.95	U	0.95	U
03C10	09/08/99	0.49	U	1.3	J
03C12	09/08/99	0.75	U	0.75	U
03C15	09/08/99	1.4	U	1.4	U
03C27	09/08/99	0.86	U	0.86	U
03B02	09/09/99	0.3	U	0.3	U
03B04	09/09/99	0.64	U	0.64	U

TABLE E-9
2-AMINO-4,6-DINITROTOLUENE AND 4-AMINO-2,6-DINITROTOLUENE CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	2-A-DNT (µg/L)		4-A-DNT (µg/L)	
03C17	09/09/99	1.4	U	1.4	U
03C11	09/10/99	0.51	U	0.56	J
03C25	09/10/99	0.79	U	0.79	U
03C30	09/10/99	0.25	U	0.25	U
03C03	09/11/99	0.7	U	0.7	U
03C04	09/11/99	1.5	U	1.5	U
03C07	09/11/99	0.23	U	0.4	J
03C09P2	09/11/99	0.31	U	0.31	U
03C08P2	09/12/99	2.1	J	3.9	J
03C26	09/12/99	0.61	U	0.61	U
03C20	**09/14/99**	12		19	
WATER WELL	09/23/99	0.88	U	0.88	U
03C02P2	03/06/00	0.41999	U	0.41999	U
03C04	03/14/00	0.52999	U	0.52999	U
03C07	03/14/00	1.3	U	1.3	U
03C12	03/15/00	0.46	U	0.46	U
03C30	03/21/00	1.3	U	1.3	U
03C11	03/22/00	1.2	U	1.2	U
03C15	03/23/00	1.1	U	1.1	U
03C20	03/23/00	12		14	
03C25	03/24/00	0.73	U	0.73	U
03C09P2	03/25/00	0.75	U	0.75	U
03B04	03/27/00	0.68	U	0.68	U
03B02	03/28/00	0.6	U	0.6	U
03C27	03/28/00	0.87	U	0.87	U
03C26	03/29/00	1.	U	1.	U
03C08P2	03/30/00	2.9		3.9	
03C03	04/01/00	1.2	U	1.2	U
03C10	04/01/00	0.94999	U	0.94999	U
03C17	04/01/00	0.52999	U	0.52999	U
03C17	05/25/00	0.73	U	0.73	U
03C25	05/25/00				
03C20	06/01/00	14		18	
03C12	06/05/00				
03C09P2	06/06/00	1.	U	1.	U
03C11	06/06/00				
03C15	06/07/00	0.57999	U	0.57999	U
03C02P2	06/08/00	1.1	U	1.1	U
03C07	06/15/00	1.3	U	1.3	U
03C03	06/19/00	1.1	U	1.1	U
03C08P2	06/20/00	3.1		4.5	
03C26	06/21/00	1.2	U	1.2	U
03C27	06/21/00	1.3	U	1.3	U

TABLE E-9
2-AMINO-4,6-DINITROTOLUENE AND 4-AMINO-2,6-DINITROTOLUENE CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	2-A-DNT (µg/L)		4-A-DNT (µg/L)	
03B02	06/23/00	0.79	U	0.79	U
03C10	06/23/00	0.55	U	0.70999	
03B04	06/26/00	1.1	U	1.1	U
03C04	06/27/00	0.61	U	0.61	U
03C30	06/28/00	1.1	U	1.1	U
03B02	09/07/00	0.21999	U	0.21999	U
03C25	09/07/00	0.87999	U	0.87999	U
03B04	09/08/00	0.87999	U	0.87999	U
03C07	09/08/00	0.63999	U	0.63999	U
03C10	09/08/00	0.87	U	1.	
03C03	09/12/00	0.68	U	0.68	U
03C17	09/12/00	1.4	U	1.4	U
03C27	09/12/00	1.1	U	1.1	U
03C04	09/13/00	1.1	U	1.1	U
03C08P2	09/13/00	2.		3.4	
03C12	09/13/00	0.52999	U	0.52999	U
03C26	09/14/00	0.41999	U	0.41999	U
03C09P2	09/15/00	0.46	U	0.46	U
03C11	09/15/00	1.6	U	1.6	U
03C02P2	09/18/00	0.51999	U	0.51999	U
03C15	09/18/00	0.76999	U	0.76999	U
03C20	09/18/00	12.		17.	
03C30	09/19/00				
03C25	11/29/00	0.64999	U	0.64999	U
03C02P2	11/30/00	0.83999	U	0.83999	U
03C27	11/30/00	0.68	U	0.68	U
03C03	12/01/00	1.4	U	1.4	U
03C09P2	12/01/00	0.99	U	0.99	U
03C10	12/01/00	0.94999	U	1.4	
03B04	12/04/00	1.4	U	1.4	U
03B02	12/05/00	0.87999	U	0.87999	U
03C04	12/05/00	1.5	U	1.5	U
03C17	12/05/00	0.52999	U	0.52999	U
03C30	12/07/00	0.68	U	0.68	U
03C11	12/11/00	0.83999	U	0.83999	U
03C12	12/14/00	1.	U	1.	U
03C15	12/21/00	0.46999	U	0.46999	U
03C07	12/27/00	0.83999	U	0.83999	U
03C20	12/28/00	11.		16.	
03C08P2	01/02/01	2.7		4.2	
03C26	01/04/01	1.3	U	1.3	U
03C02P2	03/05/01	0.94999	U	0.94999	U
03C25	03/06/01	0.82999	U	0.82999	U

TABLE E-9
2-AMINO-4,6-DINITROTOLUENE AND 4-AMINO-2,6-DINITROTOLUENE CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	2-A-DNT (µg/L)		4-A-DNT (µg/L)	
03B02	03/07/01	0.79	U	0.79	U
03B04	03/08/01	0.81	U	0.81	U
03C04	03/12/01	1.	U	1.	U
03C12	03/13/01	0.89999	U	0.89999	U
03C03	03/14/01	0.36	U	0.36	U
03C09P2	03/14/01	0.87	U	0.87	U
03C10	03/19/01	0.74	U	0.93	
03C11	03/20/01	0.70999	U	0.70999	U
03C07	03/21/01	0.89999	U	0.89999	U
03C20	03/21/01	12.		16.	
03C27	03/22/01	1.	U	1.	U
03C15	03/26/01	1.	U	1.	U
03C26	03/27/01	1.2	U	1.2	U
03C08P2	03/28/01	2.3		3.2	
03C17	04/02/01	1.2	U	1.2	U
03C30	04/03/01	1.9	U	1.9	U
03-07	06/07/01	0.35	U	0.35	U
03-20	06/09/01	0.35	U	0.35	U
03-23	06/09/01	0.35	U	0.62	J
03C09P2	06/12/01	1.1	U	1.1	U
03C02P2	06/13/01	0.70999	U	0.70999	U
03C25	06/18/01	1.	U	1.	U
03C15	06/19/01	0.49	U	0.49	U
03C10	06/20/01	0.91	U	1.1	
03B02	06/21/01	0.31	U	0.31	U
03B04	06/21/01	0.34999	U	0.34999	U
03-13	06/23/01	0.47	R	0.77	J
03-17	06/24/01	0.35	U	0.35	U
03-18	06/24/01	0.35	U	0.35	U
03-11	06/25/01	0.35	U	0.35	U
03-12	06/25/01	1.		1.5	
03-14	06/25/01	0.55	J	0.82	J
03-24	06/25/01	0.35	U	0.35	U
03-25	06/25/01	0.35	U	0.35	U
03C27	06/25/01	0.73	U	0.73	U
03C07	06/26/01	0.83999	U	0.83999	U
03C26	06/26/01	1.6	U	1.6	U
03C04	06/27/01	0.70999	U	0.70999	U
03C11	06/27/01	0.76999	U	0.76999	U
03C12	06/27/01	0.61	U	0.61	U
03C08P2	06/28/01	2.8		3.5	
03C20	06/28/01	12.		14.	
03C03	07/02/01	0.36	U	0.36	U

TABLE E-9
2-AMINO-4,6-DINITROTOLUENE AND 4-AMINO-2,6-DINITROTOLUENE CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	2-A-DNT (µg/L)		4-A-DNT (µg/L)	
03C17	07/03/01	0.36	U	0.36	U
03C30	07/03/01	0.93999	U	0.93999	U
03-15	07/10/01	0.12	U	0.35	U
03-16	07/10/01	0.12	U	0.35	U
03-21	07/10/01	2.6		10	
03-22	07/10/01	0.12	U	0.35	U
03-10	07/11/01	0.12	U	0.35	U
03C03	08/29/01	0.89999	U	0.89999	U
03C25	08/30/01	1.1	U	1.1	U
03C27	09/04/01	0.4	U	0.4	U
03C09P2	09/05/01	0.79	U	0.79	U
03C20	09/05/01	12		15	
03C15	09/06/01	0.43999	U	0.43999	U
03C02P2	09/10/01	0.52999	U	0.52999	U
03C04	09/10/01	1.2	U	1.2	U
03C08P2	09/17/01	2.7		3.7	
03C17	09/17/01	1.8	U	1.8	U
03C07	09/18/01	0.76999	U	0.76999	U
03C04	09/19/01				
03C26	09/19/01	0.99	U	0.99	U
03C30	09/20/01	1.2	U	1.2	U
03C25	11/13/01	0.68	U	0.68	U
03C02P2	11/26/01	0.81999	U	0.81999	U
03C15	11/27/01	0.52999	U	0.52999	U
03C03	11/30/01	1.1	U	1.1	U
03C04	12/03/01	1.6	U	1.6	U
03C20	12/03/01	9.9		15	
03C26	12/04/01	1.1	U	1.1	U
03C08P2	12/05/01	2.3		3.6	
03C30	12/10/01	0.95999	U	0.95999	U
03C07	12/11/01	1.7	U	1.7	U
03C17	12/13/01	1.	U	1.	U
03C09P2	12/17/01	0.73	U	0.73	U
03C27	12/19/01	0.74	U	0.74	U
03C25	02/08/02	0.97	U	0.97	U
03C02P2	02/11/02	0.68999	U	0.68999	U
03C03	02/22/02	0.50999	U	0.50999	U
03C09P2	02/22/02	0.31	U	0.31	U
03C04	02/25/02	0.91	U	0.91	U
03C26	02/25/02	0.57999	U	0.57999	U
03C07	02/27/02	0.40999	U	0.40999	U
03C08P2	02/28/02	2.7		3.7	
03C20	02/28/02	13		18	

TABLE E-9
2-AMINO-4,6-DINITROTOLUENE AND 4-AMINO-2,6-DINITROTOLUENE CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	2-A-DNT (µg/L)	4-A-DNT (µg/L)
03C27	03/04/02	0.38999 U	0.38999 U
03C17	03/05/02	0.52999 U	0.52999 U
03C15	03/06/02	0.34 U	0.34 U
03C30	03/07/02	0.37 U	0.37 U
03C03	05/14/02	1.1 U	1.1 U
03C09P2	05/15/02	1.3 U	1.3 U
03C02P2	05/16/02	0.66 U	0.66 U
03C26	05/20/02	0.87999 U	0.87999 U
03C20	05/21/02	12	15
03C17	05/22/02	0.83999 U	0.83999 U
03C27	05/28/02	0.77999 U	0.77999 U
03C30	05/30/02	1.3 U	1.3 U
03C15	06/05/02	0.92 U	0.92 U
03C08P2	06/06/02	2.5	3.1
03C04	06/10/02	0.99 U	0.99 U
03C07	06/18/02	0.57999 U	0.57999 U
03C03	08/20/02	0.37999 U	0.37999 UJ
03C26	08/20/02	0.6 U	0.6 UJ
03C15	08/21/02	0.47999 U	0.47999 UJ
03C20	08/22/02	0.4 U	0.4 UJ
03C30	08/26/02	0.28 U	0.28 UJ
03C27	08/27/02	0.57999 U	0.57999 UJ
03C04	08/28/02	0.	
03C07	08/28/02	0.40999 U	0.40999 UJ
03C09P2	08/29/02	0.46 U	0.46 UJ
03C08P2	09/03/02	2.4	3.2
03C02P2	09/04/02	0.34999 U	0.34999 UJ
03C09P2	09/04/02		
03C04	09/05/02	0.57999 U	0.57999 UJ
03C17	09/05/02	0.4 U	0.4 UJ
03C25	09/10/02	0.41999 U	0.41999 UJ
03C25	10/31/02	0.34999 U	0.34999 U
03C03	11/04/02	0.69999 U	0.69999 U
03C09P2	11/06/02	1.2 U	1.2 U
03C02P2	11/07/02	0.33 U	0.33 U
03C26	11/12/02	0.70999 U	0.70999 UJ
03C17	11/13/02	1.1 U	1.1 UJ
03C27	11/14/02	0.77999 U	0.77999 UJ
03C20	11/18/02	13	15 J
03C04	11/19/02	0.89999 U	0.89999 UJ
03C08P2	11/20/02	2.5	3.3 J
03C07	11/25/02	1. U	1. U
03C15	11/26/02	1.1 U	1.1 U

TABLE E-9
2-AMINO-4,6-DINITROTOLUENE AND 4-AMINO-2,6-DINITROTOLUENE CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	2-A-DNT (µg/L)		4-A-DNT (µg/L)	
03C30	12/04/02	1.2	U	1.2	UJ
03C03	02/24/03	1.4	U	1.4	U
03C08P2	02/25/03	2.		2.6	
03C09P2	02/26/03	0.68	U	0.68	U
03C30	02/27/03	1.1	U	1.1	U
03C26	03/03/03	0.91	U	0.91	U
03C02P2	03/04/03	1.1	U	1.1	U
03C15	03/05/03	1.3	U	1.3	U
03C07	03/06/03	1.1	U	1.1	U
03C04	03/11/03	0.99	U	0.99	U
03C17	03/11/03	1.3	U	1.3	U
03C20	03/12/03	12.		14.	
03C09P2	05/19/03	0.56999	U	0.56999	U
03C03	05/21/03	1.2	U	1.2	U
03C25	05/27/03	1.1	U	1.1	U
03C26	05/29/03	0.21999	U	0.21999	U
03C27	06/02/03	0.81	U	0.81	U
03C20	06/04/03	11.		13.	
03C08P2	06/09/03	2.2		2.9	
03C02P2	06/10/03	1.3	U	1.3	U
03C15	06/17/03	1.	U	1.	U
03C07	06/18/03	1.9	U	1.9	U
03C17	06/19/03	1.7	U	1.7	U
03C04	06/23/03	0.79	U	0.79	U
03C30	06/24/03	0.76999	U	0.76999	U
03C26	08/22/03	0.70999	U	0.70999	U
03C03	08/25/03	0.83999	U	0.83999	U
03C20	08/25/03	10.		12.	
03C02P2	08/26/03	0.46	U	0.46	U
03C07	08/26/03	0.81	U	0.81	U
03C30	08/27/03	1.2	U	1.2	U
03C09P2	08/28/03	1.4	U	1.4	U
03C04	09/02/03	1.4	U	1.4	U
03C08P2	09/03/03	2.		2.5	
03C15	09/04/03	1.	U	1.	U
03C27	09/05/03	0.3	U	0.3	U
03C17	09/08/03	1.5	U	1.5	U
03C25	09/09/03	0.31	U	0.31	U
03C03	11/06/03	0.50999	U	0.50999	U
03C25	11/10/03	0.52999	U	0.52999	U
03C09P2	11/12/03	0.49	U	0.49	U
03C20	11/17/03	10.		13.	
03C26	11/20/03	0.54	U	0.54	U

TABLE E-9
2-AMINO-4,6-DINITROTOLUENE AND 4-AMINO-2,6-DINITROTOLUENE CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	2-A-DNT (µg/L)	4-A-DNT (µg/L)
03C27	11/25/03	0.52999 U	0.52999 U
03C02P2	12/01/03	0.52999 U	0.52999 U
03C15	12/02/03	0.50999 U	0.50999 U
03C08P2	12/08/03	2.1	2.9
03C04	12/09/03	0.51999 U	0.51999 U
03C30	12/11/03	0.56 U	0.56 U
03C07	12/15/03	0.6 U	0.6 U
03C17	12/22/03	0.56 U	0.56 U
03C25	02/26/04	0.49 U	0.49 U
03C02P2	02/27/04	0.51999 U	0.51999 U
03C04	03/02/04	0.56 U	0.56 U
03C26	03/02/04	0.52999 U	0.52999 U
03C03	03/05/04	0.56999 U	0.56999 U
03C09P2	03/08/04	0.52999 U	0.52999 U
03C20	03/09/04	13	16
03C08P2	03/10/04	2.4	3.3
03C17	03/11/04	0.52999 U	0.52999 U
03C07	03/12/04	0.47999 U	0.54
03C27	03/15/04	0.50999 U	0.50999 U
03C30	03/15/04	0.54 U	0.54 U
03C15	03/17/04	0.51999 U	0.51999 U
03-01	04/04/04	0.35 J	0.78
03-38	04/04/04	0.36 J	0.99
03-33	04/06/04	0.24 U	0.24 U
03C01P2	04/06/04	0.272 U	0.272 U
03C06	04/06/04	0.25 U	0.25 U
03C21	04/06/04	0.258 U	0.258 U
03-09	04/07/04	0.264 U	0.264 U
03-31	04/07/04	0.26 U	0.26 U
03C03P2	04/07/04	4.3	4.5
03C14	04/07/04	0.248 U	0.248 U
03-16	04/08/04	0.255 U	0.255 U
03-21	04/08/04	0.68 J	2.7
03-24	04/08/04	0.24 U	0.24 U
03C05	04/08/04	0.258 U	0.258 U
03C28	04/08/04	0.253 U	0.253 U
03SB060/TW01	04/17/04	0.25 U	0.25 U
03-12	04/18/04	0.56 J	0.91
03-15	04/18/04	0.26 U	0.26 U
03SB063/TW02	04/19/04	0.24 U	0.24 U
03SB090/TW03	04/19/04	0.242 U	0.242 U
03SB103/TW05	04/21/04	0.81 J	2.2
03TW04	04/21/04	0.24 U	0.24 U

TABLE E-9
2-AMINO-4,6-DINITROTOLUENE AND 4-AMINO-2,6-DINITROTOLUENE CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	2-A-DNT (µg/L)		4-A-DNT (µg/L)	
03-39	04/22/04	0.27	U	0.7	
03-07	04/24/04	0.25	U	0.43	J
03SB050/TW06	04/24/04	0.266	U	0.266	U
03C25	06/01/04	0.54	U	0.54	U
03C03	06/07/04	0.49	U	0.49	U
03C02P2	06/08/04	0.55	U	0.55	U
03C04	06/16/04	0.56	U	0.56	U
03C26	06/16/04	0.54	U	0.54	U
03C09P2	06/17/04	0.52999	U	0.58999	
03C20	06/18/04	11.		13.	
03C15	06/21/04	0.54	U	0.54	U
03C27	06/22/04	0.55	U	0.55	U
03C07	06/28/04	0.55	U	0.55	U
03C08P2	06/30/04	1.8		2.5	
03C17	06/30/04	0.52999	U	0.52999	U
03C30	06/30/04	0.54	U	0.54	U
03C25	09/02/04	0.56	U	0.56	U
03C03	09/07/04	0.52999	U	0.52999	U
03C04	09/08/04	0.52999	U	0.52999	U
03C20	09/08/04	9.4		12.	
03C02P2	09/09/04	0.51999	U	0.51999	U
03C09P2	09/13/04	0.54	U	0.54	U
03C30	09/13/04	0.52999	U	0.52999	U
03C07	09/14/04	0.52999	U	0.52999	U
03C26	09/14/04	0.56999	U	0.56999	U
03C08P2	09/15/04	2.2		3.	
03C27	09/17/04	0.52999	U	0.52999	U
03C15	09/20/04	0.55	U	0.55	U
03C17	09/20/04	0.52999	U	0.52999	U
	Maximum	19.			

2-A-DNT — 2-amion-4,6-dinitrotoluene
4-A-DNT — 4-amino-2,6-dinitrotoluene

Value Exceeding Criteria
Location/Date of Maximum Value

CRITERIA (µg/L)	
2-A-DNT	**4-A-DNT**
0.62	**0.62**

TABLE E-10
HEXAHYDRO-1,3,5-TRINITRO-1,3,5-TRIAZINE CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	RDX (µg/L)	
03B04	02/23/99	0.94	U
03C25	02/24/99	1.2	U
03C10	02/25/99	140.	
03C11	02/25/99	34.	
03C12	02/25/99	14.	
03C02P2	02/26/99	2.9	
03C07	02/26/99	23.	
03C03	02/27/99	1.	U
03C04	02/27/99	0.46	U
03C09P2	03/01/99	130.	
03C15	03/01/99	0.49	U
03C26	03/02/99	1.4	U
03C27	03/02/99	1.3	U
03C17	03/08/99	1.2	U
03C30	03/08/99	0.56	U
03B02	03/10/99	0.58	U
03C20	03/11/99	180.	
03C08P2	03/12/99	110.	
03B04	05/17/99	0.52	U
03B02	05/18/99	0.95	UJ
03C03	05/18/99	0.2	U
03C17	05/18/99	0.36	U
03C02P2	05/19/99	1.9	
03C07	05/19/99	19.	
03C09P2	05/19/99	150.	
03C04	05/21/99	1.	U
03C11	05/21/99	12.	
03C10	05/22/99	100.	
03C12	05/22/99	11.	
03C20	05/22/99	150.	
03C15	05/23/99	1.1	U
03C26	05/23/99	0.81	U
03C08P2	05/24/99	81.	
03C27	05/24/99	0.55	U
03C30	05/24/99	0.79	U
03C25	05/25/99	1.	U
03C02P2	09/07/99	17.	
03C10	09/08/99	100.	
03C12	09/08/99	28.	
03C15	09/08/99	1.4	U
03C27	09/08/99	0.86	U
03B02	09/09/99	0.3	U
03B04	09/09/99	0.64	U

TABLE E-10
HEXAHYDRO-1,3,5-TRINITRO-1,3,5-TRIAZINE CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	RDX (µg/L)	
03C17	09/09/99	1.4	U
03C11	09/10/99	25.	
03C25	09/10/99	0.79	U
03C30	09/10/99	0.25	U
03C03	09/11/99	0.7	U
03C04	09/11/99	1.5	U
03C07	09/11/99	21.	
03C09P2	09/11/99	130.	
03C08P2	09/12/99	86.	
03C26	09/12/99	0.8	
03C20	09/14/99	170.	
WATER WELL	09/23/99	0.88	U
03C02P2	03/06/00	12.	J
03C04	03/14/00	0.5	U
03C07	03/14/00	34.	
03C12	03/15/00	12.	
03C30	03/21/00	1.2	U
03C11	03/22/00	31.	
03C15	03/23/00	0.99	U
03C20	03/23/00	190.	
03C25	03/24/00	0.68	U
03C09P2	03/25/00	160.	
03B04	03/27/00	0.62999	U
03B02	03/28/00	0.56	U
03C27	03/28/00	0.81999	U
03C26	03/29/00	1.2	
03C08P2	03/30/00	90.	
03C03	04/01/00	1.1	U
03C10	04/01/00	130.	
03C17	04/01/00	0.5	U
03C17	05/25/00	0.68	U
03C25	05/25/00	0.84	U
03C20	06/01/00	210.	
03C12	06/05/00	26.	
03C09P2	06/06/00	180.	
03C11	06/06/00	29.	
03C15	06/07/00	0.55	U
03C02P2	06/08/00	17.	
03C07	06/15/00	27.	
03C03	06/19/00	1.	U
03C08P2	06/20/00	95.	
03C26	06/21/00	1.1	U
03C27	06/21/00	1.2	U

TABLE E-10
HEXAHYDRO-1,3,5-TRINITRO-1,3,5-TRIAZINE CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	RDX (µg/L)	
03B02	06/23/00	0.74	U
03C10	06/23/00	110.	
03B04	06/26/00	1.1	U
03C04	06/27/00	0.56999	U
03C30	06/28/00	1.1	U
03B02	09/07/00	0.21999	U
03C25	09/07/00	0.87999	U
03B04	09/08/00	0.87999	U
03C07	09/08/00	30.	
03C10	09/08/00	120.	
03C03	09/12/00	0.68	U
03C17	09/12/00	1.4	U
03C27	09/12/00	1.1	U
03C04	09/13/00	1.1	U
03C08P2	09/13/00	87.	
03C12	09/13/00	15.	
03C26	09/14/00	0.51999	
03C09P2	09/15/00	150.	
03C11	09/15/00	35.	
03C02P2	09/18/00	12.	
03C15	09/18/00	0.76999	U
03C20	09/18/00	190.	
03C30	09/19/00	0.61	U
03C25	11/29/00	0.61	U
03C02P2	11/30/00	0.79	U
03C27	11/30/00	0.62999	U
03C03	12/01/00	1.3	U
03C09P2	12/01/00	170.	
03C10	12/01/00	130.	
03B04	12/04/00	1.3	U
03B02	12/05/00	0.82999	U
03C04	12/05/00	1.4	U
03C17	12/05/00	0.5	U
03C30	12/07/00	0.62999	U
03C11	12/11/00	32.	
03C12	12/14/00	18.	
03C15	12/21/00	0.43999	U
03C07	12/27/00	19.	
03C20	12/28/00	180.	
03C08P2	01/02/01	92.	
03C26	01/04/01	1.2	U
03C02P2	03/05/01	1.5	
03C25	03/06/01	0.82999	U

TABLE E-10
HEXAHYDRO-1,3,5-TRINITRO-1,3,5-TRIAZINE CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	RDX (µg/L)	
03B02	03/07/01	0.79	U
03B04	03/08/01	0.81	U
03C04	03/12/01	1.	U
03C12	03/13/01	11.	
03C03	03/14/01	0.36	U
03C09P2	03/14/01	170.	
03C10	03/19/01	130.	
03C11	03/20/01	31.	
03C07	03/21/01	29.	
03C20	03/21/01	170.	
03C27	03/22/01	1.	U
03C15	03/26/01	1.	U
03C26	03/27/01	1.2	U
03C08P2	03/28/01	79.	
03C17	04/02/01	1.2	U
03C30	04/03/01	1.9	U
03-07	06/07/01	1.5	J
03-20	06/09/01	0.35	U
03-23	06/09/01	12.	
03C09P2	06/12/01	180.	
03C02P2	06/13/01	12.	
03C25	06/18/01	0.93999	U
03C15	06/19/01	0.46	U
03C10	06/20/01	120.	
03B02	06/21/01	0.28999	U
03B04	06/21/01	0.33	U
03-13	06/23/01	16.	
03-17	06/24/01	4.2	
03-18	06/24/01	3.8	
03-11	06/25/01	0.35	U
03-12	06/25/01	35.	
03-14	06/25/01	11.	
03-24	06/25/01	7.2	
03-25	06/25/01	0.35	U
03C27	06/25/01	0.68	U
03C07	06/26/01	39.	
03C26	06/26/01	1.5	U
03C04	06/27/01	0.67	U
03C11	06/27/01	34.	
03C12	06/27/01	9.3	
03C08P2	06/28/01	88.	
03C20	06/28/01	180.	
03C03	07/02/01	0.34	U

TABLE E-10
HEXAHYDRO-1,3,5-TRINITRO-1,3,5-TRIAZINE CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	RDX (µg/L)	
03C17	07/03/01	0.34	U
03C30	07/03/01	0.87999	U
03-15	07/10/01	4.8	
03-16	07/10/01	24.	
03-21	07/10/01	280.	J
03-22	07/10/01	18.	
03-10	07/11/01	14.	
03C03	08/29/01	0.83999	U
03C25	08/30/01	1.1	U
03C27	09/04/01	0.37999	U
03C09P2	09/05/01	180.	
03C20	09/05/01	170.	
03C15	09/06/01	0.40999	U
03C02P2	09/10/01	7.7	
03C04	09/10/01	1.2	U
03C08P2	09/17/01	92.	
03C17	09/17/01	1.7	U
03C07	09/18/01	42.	
03C04	09/19/01	0.	
03C26	09/19/01	1.1	
03C30	09/20/01	1.1	U
03C25	11/13/01	0.62999	U
03C02P2	11/26/01	4.5	
03C15	11/27/01	0.5	U
03C03	11/30/01	1.1	U
03C04	12/03/01	1.5	U
03C20	12/03/01	190.	
03C26	12/04/01	1.4	
03C08P2	12/05/01	92.	
03C30	12/10/01	0.89999	U
03C07	12/11/01	36.	
03C17	12/13/01	0.93999	U
03C09P2	12/17/01	190.	
03C27	12/19/01	0.69999	U
03C25	02/08/02	0.92	U
03C02P2	02/11/02	1.4	
03C03	02/22/02	0.50999	U
03C09P2	02/22/02	190.	
03C04	02/25/02	0.91	U
03C26	02/25/02	0.57999	U
03C07	02/27/02	38.	
03C08P2	02/28/02	89.	
03C20	02/28/02	200.	

TABLE E-10
HEXAHYDRO-1,3,5-TRINITRO-1,3,5-TRIAZINE CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	RDX (µg/L)
03C27	03/04/02	0.38999 U
03C17	03/05/02	0.52999 U
03C15	03/06/02	0.34 U
03C30	03/07/02	0.37 U
03C03	05/14/02	1. U
03C09P2	05/15/02	190.
03C02P2	05/16/02	2.3
03C26	05/20/02	1.1
03C20	05/21/02	200.
03C17	05/22/02	0.79 U
03C27	05/28/02	0.73 U
03C30	05/30/02	1.2 U
03C15	06/05/02	0.87 U
03C08P2	06/06/02	96.
03C04	06/10/02	0.93 U
03C07	06/18/02	36.
03C03	08/20/02	0.37999 U
03C26	08/20/02	1.6
03C15	08/21/02	0.47999 U
03C20	08/22/02	210.
03C30	08/26/02	0.28 U
03C27	08/27/02	0.57999 U
03C04	08/28/02	0.
03C07	08/28/02	30.
03C09P2	08/29/02	230.
03C08P2	09/03/02	99.
03C02P2	09/04/02	14.
03C09P2	09/04/02	0.
03C04	09/05/02	0.57999 U
03C17	09/05/02	0.4 U
03C25	09/10/02	0.41999 U
03C25	10/31/02	0.34999 U
03C03	11/04/02	0.69999 U
03C09P2	11/06/02	180.
03C02P2	11/07/02	6.1
03C26	11/12/02	1.6
03C17	11/13/02	1.1 U
03C27	11/14/02	0.77999 U
03C20	11/18/02	250.
03C04	11/19/02	0.89999 U
03C08P2	11/20/02	89.
03C07	11/25/02	45.
03C15	11/26/02	1.1 U

TABLE E-10
HEXAHYDRO-1,3,5-TRINITRO-1,3,5-TRIAZINE CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	RDX (µg/L)	
03C30	12/04/02	1.2	U
03C03	02/24/03	1.4	U
03C08P2	02/25/03	68.	
03C09P2	02/26/03	170.	
03C30	02/27/03	1.1	U
03C26	03/03/03	1.7	
03C02P2	03/04/03	1.1	U
03C15	03/05/03	1.3	U
03C07	03/06/03	35.	
03C04	03/11/03	0.99	U
03C17	03/11/03	1.3	U
03C20	03/12/03	200.	
03C09P2	05/19/03	160.	
03C03	05/21/03	1.2	U
03C25	05/27/03	1.1	U
03C26	05/29/03	0.88999	
03C27	06/02/03	0.81	U
03C20	06/04/03	190.	
03C08P2	06/09/03	73.	
03C02P2	06/10/03	10.	
03C15	06/17/03	1.	U
03C07	06/18/03	31.	
03C17	06/19/03	1.7	U
03C04	06/23/03	0.79	U
03C30	06/24/03	0.76999	U
03C26	08/22/03	1.6	
03C03	08/25/03	0.83999	U
03C20	08/25/03	180.	
03C02P2	08/26/03	9.8	
03C07	08/26/03	24.	
03C30	08/27/03	1.2	U
03C09P2	08/28/03	190.	
03C04	09/02/03	1.4	U
03C08P2	09/03/03	73.	
03C15	09/04/03	1.	U
03C27	09/05/03	0.3	U
03C17	09/08/03	1.5	U
03C25	09/09/03	0.31	U
03C03	11/06/03	0.50999	U
03C25	11/10/03	0.52999	U
03C09P2	11/12/03	200.	
03C20	11/17/03	220.	
03C26	11/20/03	1.8	

TABLE E-10
HEXAHYDRO-1,3,5-TRINITRO-1,3,5-TRIAZINE CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	RDX (µg/L)
03C27	11/25/03	0.52999 U
03C02P2	12/01/03	2.7
03C15	12/02/03	0.50999 U
03C08P2	12/08/03	82.
03C04	12/09/03	0.51999 U
03C30	12/11/03	0.56 U
03C07	12/15/03	39.
03C17	12/22/03	0.56 U
03C25	02/26/04	0.49 U
03C02P2	02/27/04	1.1
03C04	03/02/04	0.56 U
03C26	03/02/04	1.8
03C03	03/05/04	0.56999 U
03C09P2	03/08/04	240.
03C20	03/09/04	270.
03C08P2	03/10/04	92.
03C17	03/11/04	0.52999 U
03C07	03/12/04	43.
03C27	03/15/04	0.50999 U
03C30	03/15/04	0.54 U
03C15	03/17/04	0.51999 U
03-01	04/04/04	70.
03-38	04/04/04	130.
03-33	04/06/04	22.
03C01P2	04/06/04	0.272 U
03C06	04/06/04	0.25 U
03C21	04/06/04	0.258 U
03-09	04/07/04	0.264 U
03-31	04/07/04	1.8
03C03P2	04/07/04	620.
03C14	04/07/04	0.9
03-16	04/08/04	19.
03-21	04/08/04	120.
03-24	04/08/04	7.7
03C05	04/08/04	0.258 U
03C28	04/08/04	0.253 U
03SB060/TW01	04/17/04	0.99
03-12	04/18/04	39.
03-15	04/18/04	13.
03SB063/TW02	04/19/04	2.3
03SB090/TW03	04/19/04	0.242 U
03SB103/TW05	04/21/04	76.
03TW04	04/21/04	0.73

TABLE E-10
HEXAHYDRO-1,3,5-TRINITRO-1,3,5-TRIAZINE CONCENTRATIONS IN GROUNDWATER
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	RDX (µg/L)
03-39	04/22/04	78.
03-07	04/24/04	1.1
03SB050/TW06	04/24/04	0.266 U
03C25	06/01/04	0.54 U
03C03	06/07/04	0.49 U
03C02P2	06/08/04	10.
03C04	06/16/04	0.56 U
03C26	06/16/04	3.1
03C09P2	06/17/04	330.
03C20	06/18/04	190.
03C15	06/21/04	0.54 U
03C27	06/22/04	0.55 U
03C07	06/28/04	36.
03C08P2	06/30/04	77.
03C17	06/30/04	0.52999 U
03C30	06/30/04	0.54 U
03C25	09/02/04	0.56 U
03C03	09/07/04	0.52999 U
03C04	09/08/04	0.52999 U
03C20	09/08/04	180.
03C02P2	09/09/04	9.4
03C09P2	09/13/04	200.
03C30	09/13/04	0.52999 U
03C07	09/14/04	37.
03C26	09/14/04	2.1
03C08P2	09/15/04	82.
03C27	09/17/04	0.52999 U
03C15	09/20/04	0.55 U
03C17	09/20/04	0.52999 U
		330

RDX — hexahydro-1,3,5-trinitro-1,3,5-triazine

Location/Date of Maximum Value

TABLE E-11
HEXAHYDRO-1,3,5-TRINITRO-1,3,5-TRIAZINE CONCENTRATIONS IN SPRING A
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	RDX µg/L
03-SPR-A	02/28/99	1.5
03-SPR-A	05/20/99	6
03-SPR-A	05/20/99	6.6
03-SPR-A	09/13/99	120
03-SPR-A	03/29/00	7.4
03-SPR-A	03/29/00	8.5
03-SPR-A	06/26/00	11
03-SPR-A	09/29/00	9.2
03-SPR-A	12/18/00	1.9
03-SPR-A	04/10/01	10
03-SPR-A	07/10/01	5.1
03-SPR-A	07/10/01	4.9
03-SPR-A	09/17/01	52
03-SPR-A	12/20/01	3.5
03-SPR-A	12/20/01	2.9
03-SPR-A	03/12/02	3.4
03-SPR-A	06/20/02	37
03-SPR-A	06/20/02	35
03-SPR-A	09/10/02	140
03-SPR-A	12/09/02	73
03-SPR-A	03/07/03	1.6
03-SPR-A	06/30/03	50
03-SPR-A	09/09/03	66
03-SPR-A	12/17/03	2.5
03-SPR-A	03/16/04	11
03-SPR-Ap	04/24/04	7.4
03-SPR-A	06/29/04	52
03-SPR-A	09/16/04	100
		140.

Value Exceeds Criteria
Location/Date of Maximum Value

RDX — hexahydro-1,3,5-trinitro-1,3,5-triazine

CRITERIA (µg/L)
3

TABLE E-12
HEXAHYDRO-1,3,5-TRINITRO-1,3,5-TRIAZINE CONCENTRATIONS IN SPRING C
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	RDX µg/L
03-SPR-C	02/28/99	1.7
03-SPR-C	05/20/99	1.9
03-SPR-C	09/13/99	0.72
03-SPR-C	09/13/99	0.77
03-SPR-C	03/14/00	1.8
03-SPR-C	03/14/00	1.7
03-SPR-C	06/28/00	4.1
03-SPR-C	06/28/00	5
03-SPR-C	09/29/00	3.2
03-SPR-C	12/19/00	1.7
03-SPR-C	04/10/01	1.4
03-SPR-C	07/10/01	4.9
03-SPR-C	09/17/01	3.6
03-SPR-C	12/18/01	1.6
03-SPR-C	03/11/02	2.5
03-SPR-C	06/24/02	3.9
03-SPR-C	09/09/02	0.62999 U
03-SPR-C	12/12/02	3.1
03-SPR-C	03/10/03	1.7
03-SPR-C	06/26/03	3.6
03-SPR-C	09/09/03	6.4
03-SPR-C	12/18/03	2.9
03-SPR-C	12/18/03	2.5
03-SPR-C	03/03/04	1.1
03-SPR-C	03/03/04	1.2
03-SPR-C	06/29/04	4.9
03-SPR-C	06/29/04	4.3
03-SPR-C	09/16/04	1.9
		6.4

Value Exceeds Criteria
Location/Date of Maximum Value

RDX — hexahydro-1,3,5-trinitro-1,3,5-triazine

CRITERIA (µg/L)
3

TABLE E-13
FILTERED AND TOTAL TRICHLOETHENE CONCENTRATIONS IN SPRING A
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	TCE (µg/L)	
03-SPR-A	02/28/99	0.6	
03-SPR-A	05/20/99	0.5	U
03-SPR-A	05/20/99	0.5	U
03-SPR-A	09/13/99	0.5	U
03-SPR-A	03/29/00	0.3	J
03-SPR-A	03/29/00	0.5	U
03-SPR-A	06/26/00	0.5	U
03-SPR-A	09/29/00	0.5	U
03-SPR-A	12/18/00	0.5	U
03-SPR-A	04/10/01	0.5	U
03-SPR-A	07/10/01	0.4	J
03-SPR-A	07/10/01	0.4	J
03-SPR-A	09/17/01	0.5	U
03-SPR-A	12/20/01	0.4	J
03-SPR-A	12/20/01	0.4	J
03-SPR-A	03/12/02	0.5	U
03-SPR-A	06/20/02	0.5	U
03-SPR-A	06/20/02	0.5	U
03-SPR-A	09/10/02	0.5	U
03-SPR-A	12/09/02	1.	U
03-SPR-A	03/07/03	1.	U
03-SPR-A	06/30/03	0.5	U
03-SPR-A	09/09/03	0.5	U
03-SPR-A	12/17/03	0.5	U
03-SPR-A	03/16/04	0.5	U
03-SPR-Ap	04/24/04	1.	J
03-SPR-A	06/29/04	0.5	U
03-SPR-A	09/16/04	0.5	UJ
		1.	

TCE — trichloroethene

Location/Date of Maximum Value

TABLE E-14
FILTERED AND TOTAL TRICHLOETHENE CONCENTRATIONS IN SPRING C
(1999 THROUGH 2004)
CMS REPORT FOR SWMU 3 - AMMUNITION BURNING GROUNDS
NSWC CRANE
CRANE, INDIANA

LOCATION	SAMPLE DATE	TCE (µg/L)	
03-SPR-C	02/28/99	0.5	U
03-SPR-C	05/20/99	0.5	U
03-SPR-C	09/13/99	0.5	U
03-SPR-C	09/13/99	0.5	U
03-SPR-C	03/14/00	0.5	U
03-SPR-C	03/14/00	0.5	U
03-SPR-C	06/28/00	0.5	U
03-SPR-C	06/28/00	0.5	U
03-SPR-C	09/29/00	0.5	U
03-SPR-C	12/19/00	0.5	U
03-SPR-C	04/10/01	0.5	U
03-SPR-C	07/10/01	0.5	U
03-SPR-C	09/17/01	0.5	U
03-SPR-C	12/18/01	0.5	U
03-SPR-C	03/11/02	0.5	U
03-SPR-C	06/24/02	0.5	U
03-SPR-C	09/09/02	0.5	U
03-SPR-C	12/12/02	1.	U
03-SPR-C	03/10/03	1.	U
03-SPR-C	06/26/03	0.5	U
03-SPR-C	09/09/03	0.5	U
03-SPR-C	12/18/03	0.5	U
03-SPR-C	12/18/03	0.5	U
03-SPR-C	03/03/04	0.5	U
03-SPR-C	03/03/04	0.5	U
03-SPR-C	06/29/04	0.5	U
03-SPR-C	06/29/04	0.5	U
03-SPR-C	09/16/04	0.5	UJ
	Maximum:	0.	

TCE — trichloroethene