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Quality Assurance Project Plan Addendum No. 1

for

Mustard Gas Burial Ground (SWMU 01)

RCRA Corrective Measures Study

Volume 1 of 2 - Text and Appendices A - C

Naval Surface Warfare Center Crane

Crane, Indiana

Southern Division
Naval Facilities Engineering Command

Contract Number N62467-94-D-0888

Contract Task Order 0315

January 2004

DEPARTMENT OF THE NAVY
CRANE DIVISION
NAVAL SURFACE WARFARE CENTER
300 HIGHWAY 361
CRANE INDIANA 47522-5001

IN REPLY REFER TO:

5090/S4.7.5
Ser RP3/4010

16 JAN 2004

U.S. Environmental Protection Agency, Region V
Waste, Pesticides, & Toxics Division
Waste Management Branch
Corrective Action Section
ATTN: Mr. Peter Ramanauskas (DW-8J)
77 West Jackson Blvd.
Chicago, IL 60604

Dear Mr. Ramanauskas:

Crane Division, Naval Surface Warfare Center (NSWC Crane) submits the Resource Conservation and Recovery Act (RCRA) Corrective Measures Study (CMS) Final Quality Assurance Project Plan (QAPP) Addendum for the Mustard Gas Burial Ground (MGBG), Solid Waste Management Unit 01. Two copies of change pages for Volume I and a complete Volume II are provided as enclosure (1). The permit required Certification Statement is provided as enclosure (2).

NSWC Crane point of contact is Mr. Thomas J. Brent, Code RP3-TB, telephone 812-854-6160.

Sincerely,

James M. Hunsicker

JAMES M. HUNSICKER
Manager, Environmental Protection
By direction of the Commanding Officer

Encl:
(1) RCRA CMS Final QAPP Addendum for MGBG
(2) Certification Statement

Copy to:
ADMINISTRATIVE RECORD
SOUTHNAVFACENGCOM (Code ES32) (w/o encl)
IDEM (Doug Griffin)
TTNUS (Tom Johnston) (w/o encl)

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

SIGNATURE

Environmental Protection Department Manager 1/16/04
TITLE DATE

Change pages for Volume 1 text, tables, and figures of the Mustard Gas Burial Ground RCRA CMS QAP Addendum No. 1

Instructions:

Excluding this separator page, replace all text, tables, and figures in the draft QAPP Addendum No. 1 with the corresponding pages provided here.

100304/P

QUALITY ASSURANCE PROJECT PLAN ADDENDUM NO. 1
FOR
MUSTARD GAS BURIAL GROUND (SWMU 01)
RCRA CORRECTIVE MEASURES STUDY

NAVAL SURFACE WARFARE CENTER
CRANE
CRANE, INDIANA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
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Naval Facilities Engineering Command
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North Charleston, South Carolina 29406

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ACRONYM LIST

amsl	Above mean sea level
bgs	Below ground surface
CMS	Corrective Measures Study
CTO	Contract Task Order
DCA	Dichloroethane
DNAPL	Dense non-aqueous-phase liquid
DO	Dissolved oxygen
DOD	Department of Defense
Eh	Redox potential
FOL	Field Operations Leader
Ft/yr	Feet per year
HASP	Health and Safety Plan
HD	Mustard gas
HWY	Highway
IDW	Investigation-derived waste
MDA	Minimum detectable activity
MDL	Method detection limit
mg\L	Milligram per liter
MGBG	Mustard Gas Burial Ground
mL	Milliliter
mL/min	Milliliter per mInute
MNA	Monitored natural attenuation
MS	Matrix spike
MSD	Matrix spike duplicates
NAD83	1983 North American Datum
NAPL	Non-aqueous Phase Liquid
NAVD	North American Vertical Datum
NFESC	Naval Facilities Engineering Service Center
NGVD	National Geodetic Vertical Datum
NOAA	National Oceanic and Atmospheric Administration
NRC	Nuclear Regulatory Commission
NSWC	Naval Surface Warfare Center
NTU	Nephelometric turbidity unit

ORP	Oxidation-reduction potential
PBA	Primary Burial Area
PCA	Tetrachloroethane
PCE	Tetrachloroethene
PCB	Polychlorinated biphenyl
PID	Photoionization detector
PPE	Personal protective equipment
PVC	Polyvinyl chloride
QA	Quality Assurance
QC	Quality Control
QAM	Quality Assurance Manager
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RFD	Reference Dose
RFI	RCRA Facility Investigation
RL	Reporting limit
RPD	Relative percent difference
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
SSO	Site Safety Officer
SVOC	Semivolatile organic compounds
SWMU	Solid Waste Management Unit
TCE	Trichloroethene
TP	Test pit
TOM	Task Order Manager
TOX	Total organic halogen
TtNUS	Tetra Tech NUS, Inc.
µg/kg	Micrograms per kilogram
USACE	United States Army Corps of Engineers
U.S. EPA	United States Environmental Protection Agency
UXO	Unexploded ordnance
VOC	Volatile organic compound

1.0 INTRODUCTION

The Naval Surface Warfare Center (NSWC) Crane prepared a Quality Assurance Project Plan (QAPP) for a Phase III Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) at Solid Waste Management Unit (SWMU) 01 – Mustard Gas Burial Ground (MGBG) [Tetra Tech NUS, Inc. (TtNUS), 2001]. That QAPP, developed under TtNUS Contract Task Order (CTO) 0131 and CTO 0158, was approved by the United States Environmental Protection Agency (U.S. EPA) Region 5. Field work (Round 1) was conducted in July, August, and September 2001 in accordance with the approved QAPP. The work culminated in the issuance of a technical memorandum that summarized the completed activities and the understanding of site conditions. Recommendations for additional data collection were made in that memorandum (TtNUS, 2002) and were discussed with the U.S. EPA by teleconference. A second round of field work was planned (Round 2) and a Round 2-specific Sampling and Analysis Plan (SAP) was generated to govern the additional field work. The Round 2 documents were approved by the U.S. EPA, and the Round 2 field work was conducted in May and June 2002.

After completing the Round 2 field work, the field activities and collected data were analyzed and presented in the Phase III RFI Report (TtNUS, 2003). The Phase III RFI Report indicated that unacceptable health risks to human receptors exist at SMWU 01. The unacceptable risks are due almost exclusively to potential exposure to ground water contaminated with chlorinated volatile organic compounds (VOCs). Much less risk to humans was identified for potential exposure to bis(2-ethylhexyl)phthalate, hexachloroethane, heptachlor, arsenic, and manganese in ground water (TtNUS, 2003). Risks to ecological receptors were assessed to be low to negligible at the MGBG.

Because of the unacceptable ground water risks, a RCRA Corrective Measures Study (CMS) is being implemented to evaluate remedial options. This QAPP Addendum No. 1 was prepared to govern field work, data generation, and data interpretation associated with the CMS. The field work and many of the data reduction activities described in this QAPP Addendum are extensions of activities that were conducted for the Phase III RFI recently completed for the MGBG (TtNUS, 2003). Therefore, instead of repeating much of the information contained in that report and the approved QAPP, this QAPP Addendum No. 1 cross-references the Phase III RFI QAPP, where appropriate, and focuses on activities that do not appear in the Phase III RFI QAPP (TtNUS, 2001).

The project objectives for the CMS are described below, and elements of the MGBG physical characteristics and operational history most important to this CMS are summarized. Additional details may be found in the Phase III RFI Report (TtNUS, 2003) and other references cited in that report. All

pertinent details will be provided in the CMS report that will be generated at the conclusion of the CMS activities described in this QAPP Addendum.

This section, Section 1.0, is the introduction to the QAPP Addendum No. 1. Section 2.0 includes a description of the project organization. Section 3.0 is a description of field activities. These sections and Appendix B (Standard Operating Procedures [SOPs] for field work) are the most critical sections of the QAPP Addendum for performing the CMS field work. These sections and the remaining nine QAPP Addendum sections (Sections 4 through 12, plus appendices) that form Volume 1 of the QAPP Addendum No. 1 are listed in the Table of Contents. Data collected during the RFI are summarized in Appendix A. Tables A-1 through A-5 of that appendix contain all data for the recently completed Phase III RFI and represent the most current knowledge concerning chemical concentrations at the MGBG. Tables A-6 through A-10 summarize, by environmental medium (e.g., surface soil or ground water), the results for all chemicals detected at least once during the Phase III RFI. As stated above, SOPs for field work are provided in Appendix B. Appendix C is the Health and Safety Plan (HASP) written specifically to govern activities associated with the CMS field work. All laboratory SOPs that have changed from the approved QAPP (TtNUS, 2001) or were added to this QAPP Addendum are contained in Appendix D.

1.1 PROJECT OBJECTIVE

The overall project objective is to identify, evaluate, and recommend one or more cost-effective corrective measures for safely reducing contamination in ground water at the MGBG, which will result in a reduction of potential human health risks to acceptable levels in a reasonable time frame. The target environmental medium for this study is ground water contaminated with, or having the potential to become contaminated with, contaminants released at the MGBG.

Some limited data collection to fill data gaps and to support this objective is planned for the outset of the CMS. The data collection is focused on VOCs in ground water. Risk from exposure to bis(2-ethylhexyl)phthalate, hexachloroethane, and heptachlor are at the extreme low end of the U.S. EPA risk management of 1E-6 to 1E-4 incremental lifetime cancer risk (TtNUS, 2003). Data for these three chemicals, arsenic, and manganese are sufficient to directly support the CMS.

1.2 SITE LOCATION AND DESCRIPTION

1.2.1 Site Location

NSWC Crane is located in a rural, sparsely populated region of south-central Indiana, approximately 75 miles southwest of Indianapolis, 60 miles northwest of Louisville, Kentucky, and immediately east of

Burns City and Crane Village, Indiana. Location maps of the NSWC Crane facility are provided as Figures 1-1 and 1-2 of the approved MGBG QAPP (TtNUS, 2001).

The MGBG is located adjacent to Crane Highway (HWY)-251 (a gravel road), which is accessible from the asphalt-paved Crane HWY-161 (see Figure 1-5 of TtNUS, 2003). The MGBG is an approximately 2-acre, almost rectangular area located atop a topographic ridge and situated between two earth-covered, aboveground magazines (numbered 1407 and 1409). Each magazine is located at least 50 feet from the former MGBG fence line (the fence was removed in 1995). The ridge is curved, and in the vicinity of the MBGB, is oriented northwest to southeast. It is covered with tall grasses and weeds, a few small trees, and saplings (see Figures 1-2 and 2-1b of TtNUS, 2003). Sections of the MGBG perimeter are lined with small stands of larger trees, especially on the northeastern and southern edges. Within the MGBG and sharing a common perimeter edge is the Primary Burial Area (PBA), which represents approximately 10 percent of the nominal 2-acre MGBG area (see Figure 1-21 of TtNUS, 2003).

The MGBG is crowned at approximately 7 to 10 feet above the highway surface. Immediately west of the MGBG is an access road that was evidently constructed when ground water monitoring wells were installed in the area in the 1980s. This road curves around the western edge of the MGBG and proceeds down the northern slope of the ridge. Spurs from this road run parallel to the elevation contours of the ridge to form terraces. Some of the oldest MGBG ground water monitoring wells were installed along these terraces. The access road and spurs are unpaved and rutted.

1.2.2 Climatology and Meteorology

NSWC Crane is located in a warm, temperate climatic zone. Temperature ranges from an average maximum July temperature of 89°F to an average minimum January temperature of 26°F. Precipitation is fairly evenly distributed throughout the calendar year, with the maximum precipitation occurring during the spring and early summer. The average annual precipitation at NSWC Crane is 44 inches, consisting of 42 inches of rain and 15 inches of snow. The average humidity ranges from 40 to 90 percent in summer and 60 to 90 percent in winter. The prevailing wind direction is from the southwest from April through December and is from the northwest during January through March [National Oceanic and Atmospheric Administration (NOAA), 1988]. The annual prevailing wind direction for the region is from the southwest, and the annual average wind speed for the area is about 9.6 miles per hour. A wind rose is provided as Figure 1-6 of TtNUS, 2003.

1.2.3 Physiography, Topography, and Ground Cover

The surface elevation at the MGBG ranges from approximately 660 to 680 feet above mean sea level (amsl) (see Figure 1-5 of TtNUS, 2003). The main surface water features in the area include a deeply-incised stream bed about 525 feet north of the MGBG at an elevation of approximately 530 to 580 feet amsl and a deeply-incised stream bed about 1,200 feet south-southwest of the MGBG at an elevation of about 510 to 560 feet amsl as it passes south of the MGBG. Total relief in the immediate vicinity of the MGBG is approximately 150 feet. The steepest slopes near the MGBG occur on the northern side and are about 30 percent, based on visual estimates.

The area to the north (including the northeastern corner of the MGBG) is heavily wooded with mature deciduous trees including oak, maple, sycamore, and American beech. The forest understory in this area consists of sparse patches of ground vegetation (e.g., ferns, grasses, moss). The stream bed to the north is typically dry, is approximately 10 feet wide in the vicinity of the MGBG, and the substrate is sand and exposed rocks. Two primary drainage ditches (both typically dry) lead from the MGBG to this intermittent drainage channel.

One drainage ditch and a culvert transport runoff from the southern side of the MGBG under the road (HWY-251) and into an intermittently flowing tributary stream located about 400 feet south-southwest of the MGBG.

1.2.4 Geology and Stratigraphy

The unconsolidated overburden deposits at NWSC Crane generally consist of two types: Quaternary- and Pleistocene-age alluvial and colluvial deposits near the floodplains of the major streams and unconsolidated residual soil and loess on sides and tops of ridges. Residual soils on ridge top areas, such as the MGBG area, are generally classified as Zanesville or Wellston silt loams. These residual soils are well-drained to moderately drained. They have a brown organic silt loam at the surface (typically about 8 inches thick), which is underlain by 42 to 48 inches of mottled tan, gray, and yellow clay with varying percentages of sand and silt. Occasionally, a clay hardpan occurs between 25 and 32 inches below ground surface (bgs). The Wells-Berks-Gilpin soil complex is found on all of the hillsides near the MGBG (McElrath, 1988). This soil complex forms on very steep to moderately steep slopes and is well drained. In a typical profile, 1 to 2 inches of dark gray to brown silt loam is found at the surface. The subsurface soil is composed of light to dark yellowish-brown silty loam to silty clay loam. All of these soils contain about 15 to 35 percent clay.

Surface topography, geographic setting, and prominent physical features of the MGBG area are shown on Figure 1-1 of this QAPP Addendum No. 1. Four geologic cross sections have been prepared for the MGBG area and are presented in Figures 1-2 through 1-5. The traces of these cross sections are shown on Figure 1-1. The residual soils that lie on the top and the sides of the MGBG ridge typically range from 5 to 15 feet thick. In some places, the overburden soils are thicker. For example, in the area located approximately 800 feet east of the MGBG near well 01T02, the overburden is closer to 30 feet thick (Figure 1-4).

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 Group (Figure 1-6). The Mansfield Formation (uppermost bedrock) consists of alternating beds of shales (e.g., black shale and carbonaceous shale), sandstone, mudstone, siltstone, and thin discontinuous coal units and is typically about 110 to 150 feet thick near the MGBG (Figures 1-3 through 1-5). The underlying Stephensport Group includes a number of sandstone and limestone formations including the Big Clifty Sandstone and the Beech Creek Limestone (Figure 1-6). The Stephensport Group is generally 130 to 190 feet thick. The bedrock formations dip west-southwest at about 25 feet per mile.

The sideslopes and upland areas near the MGBG are composed of Mansfield Formation, as shown in Figures 1-2 through 1-5. The base of the Mansfield Formation is at about 525 to 545 feet amsl in the vicinity of the MGBG. As a result, Upper Mississippian limestone formations crop out in the very bottom of the major gullies that lie northwest and southwest of the MGBG (where the gullies drop below 545 feet amsl in elevation).

1.2.5 Hydrology and Hydrogeology

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. The MGBG is located in Drainage Basin IV, the Boggs Creek Basin (Figure 1-2 of TtNUS, 2003). Runoff from the MGBG drains into two unnamed tributary valleys that flow northwestward about 0.7 mile into Goldsberry Hollow, which in turn flows southwestward into Boggs Creek (Figure 1-7). Boggs Creek then flows southward into a large reservoir located at the southern boundary of NWSC Crane. From the reservoir, Boggs Creek continues to flow southward about 6 miles where it joins the East Fork of the White River. The Boggs Creek Basin (Basin No. IV, Figure 1-2 of TtNUS, 2003) drains approximately 70 percent of NSWC Crane.

Ground water in the unglaciated 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. Water enters the shallow ground water system as recharge over most of the uplands and sideslopes. Shallow ground water elevations generally mimic topography; highest ground water elevations are typically found along ridge crests, and lowest ground water elevations are located within stream valleys. Ground water moves downward in the ridges and laterally to discharge to the deeper gullies and stream valleys as springs, seeps, and baseflow.

Contours of ground water elevations measured at the MGBG during the Phase III RFI are presented in Figure 1-8 of this QAPP Addendum No. 1. The measured depth to ground water at the MGBG generally ranges from 5 feet to 40 feet bgs and averages 15.5 feet bgs. Seasonal fluctuations of ground water levels rarely exceed 2 feet in individual wells. Based on ground water potentiometric contours (Figure 1-8), lateral ground water flow at the MGBG is primarily to the north-northeast and to the southwest (Dunbar, 1984; TtNUS, 2003). There is also some lateral ground water flow to the northwest and southeast based on the potentiometric contours; however, flow in these directions is expected to be a smaller component of total flow because the gradients are much smaller in the northwest and southeast directions. The distribution of VOC contaminants in shallow ground water is somewhat contradictory because the VOC plume has migrated primarily toward the west and northwest (from near well 01-02 toward well 01-25, Figure 1-8). Much lower concentrations of VOCs have been detected on the northern side of the MGBG. Bedrock fractures and joints are evidently oriented primarily in a northwest-southeast direction and ground water is moving in the northwest direction along these preferential pathways (i.e., vertical fractures).

There is also a downward hydraulic gradient at the MGBG (Figures 1-2, 1-4, and 1-5) that could transport some contaminants vertically downward, but samples collected from four deeper wells (the deepest of which has a total depth of 153 feet bgs) have so far shown only a trace concentration of trichloroethene (TCE) (1 µg/L in 01T03). No 1,1,2,2-tetrachloroethane (1,1,2,2-PCA) was detected in the deeper wells. Therefore, the migration rate of contaminants vertically downward is considered to be very low.

1.3 SITE OPERATIONAL AND INVESTIGATIVE HISTORY

A synopsis of chemical and radiochemical releases and investigative activities is presented in Table 1-1; details are presented in TtNUS, 2003. A brief summary of VOC contamination in MGBG ground water is presented below because of its significance to this project.

In the early 1970s mustard gas bombs and thorium-related materials were discovered at the MGBG and were exhumed. Mustard gas (an oily liquid) spilled onto the ground and was decontaminated with hypochlorite solution.

In the early 1980s, ground water monitoring efforts detected the presence of VOCs in ground water at the MGBG. In three separate well installation efforts spanning the early to mid 1980s, a series of ground water monitoring wells was installed to delineate the ground water contaminant plume. Other environmental media such as soils, sediments, and surface water were not investigated at that time.

The ground water contaminants detected in the 1980s were dominated by chlorinated VOCs with total organic halogen (TOX) concentrations from non-detectable levels to 600 milligrams per liter (mg/L). The primary contaminants were TCE and 1,1,2,2,-PCA. Continued monitoring into 1986 and the most recently completed Phase III RFI indicate that the primary contaminants have not changed, although the contaminant concentrations have decreased over time (see Figures 5-6 through 5-9 and 6-3 through 6-6 of TtNUS, 2003). The highest concentrations of VOCs in ground water have been consistently detected in well 01-02, which is located on the northern side of the PBA. The presumed source of the VOCs is past spillage or disposal of VOCs within or near to the PBA south of well 01-02.

The most recent RFI completed in 2003 (TtNUS, 2003) involved an investigation of the following environmental media:

- Surface and subsurface soils (58 soil samples collected to a depth of 10 feet or bedrock depth) across and within 20 feet of the former MGBG perimeter fence line.

- Shallow (4 to 75 feet depth bgs) and deep (up to 153 feet bgs) ground water surrounding the MGBG (49 ground water samples in total).

- Surface water (four samples) and sediments (16 samples) to the north and south of, and as far as approximately 0.5 miles downstream of, the MGBG.

Samples were analyzed for a wide range of contaminants, depending on the environmental medium and intended data use, including:

- Mustard gas and associated degradation products.

- Radionuclides (especially select thorium isotopes).

- VOCs and semivolatile organic compounds (SVOCs).

- Chlorinated herbicides, pesticides, and polychlorinated biphenyls (PCBs).
- Metals and gross radiation levels.
- Analytes suitable for evaluating the potential use of natural attenuation as a remedy for chlorinated VOCs in ground water.
- Miscellaneous parameters for evaluating the fate and transport of chemicals in the various environmental media.

The Phase III RFI yielded no detections of mustard gas (HD) or its degradates. Observed radiation levels, including radionuclide-specific analyses, were within background levels across the MGBG. In addition, virtually no VOCs were detected in the surface and subsurface soil, as can be seen by a review of data in Appendix A. Only traces of 1,1,2,2-PCA (2 µg/kg) and chloroform (4 µg/kg) were detected in a single soil sample (01SB090206) in the area now known as the PBA. Methylene chloride (also a chlorinated VOC) and acetone (a non-chlorinated VOC) were detected in several soil samples at concentrations across the MGBG that are typical of laboratory contamination (TtNUS, 2003). All human health risk was attributed to ground water contamination with an overwhelming proportion of the risk attributed to chlorinated VOCs in ground water. Ecological risks were assessed to be low to negligible. Because VOCs were detected in shallow ground water but were virtually undetected in overlying soils, an attempt to more precisely establish the source area in soil, if one exists, is planned as part of this CMS.

1.4 PHYSICAL SITE CONCEPTUAL MODEL

Although several different identified and unidentified chemicals are known to have been released directly to soils at the MGBG, only concentrations of VOCs in ground water are of high enough concentrations to present unacceptable risk to human or ecological receptors (TtNUS, 2003). Cancer risks from exposure to ground water VOCs when using ground water as a drinking water source were estimated in Section 7.0 of the Phase III RFI Report (TtNUS, 2003) to exceed 1.0E-1, and the non-cancer hazard indices were estimated to be greater than 10 for seven VOCs. The elevated risks were due to exposure to chlorinated VOCs [especially, 1,1,2,2-PCA, 1,2-dichloroethane (1,2-DCA), chloroform, tetrachloroethene (PCE), and TCE]. All other risks resulting from exposure of human receptors to contaminants in soil, sediment, or surface water were less than U.S. EPA benchmarks for carcinogenic and noncarcinogenic effects.

Based on the site history and observed chemical concentrations in ground water and other environmental media, there appears to be one significant VOC source area. The release mechanism in the source area that contaminated the ground water is unknown, although it is logical to expect that it could have been a release to surface or subsurface soils in or near to the PBA. The relatively thin soil overburden in this area would have facilitated migration of the soil contaminants into the bedrock and subsequently into ground water. Infiltration of precipitation would also have transported the contamination downward and into bedrock.

The ground water VOC contamination generally follows hydraulic gradients, although the plume moves primarily northwestward rather than moving directly northward as might be expected based on hydraulic gradients alone (see Figure 1-8). It is believed that the westward-dipping bedrock and northwest-trending fractures are influencing the VOC plume migration pattern.

Ground water, recharged with infiltrating precipitation, flows in all directions from the source area, with a tendency to flow primarily toward the west and northwest. The greatest mass of VOC contamination has moved from the source area located at or near the PBA toward the northwest along the ridge axis (Figure 1-9). Although Figure 1-9 shows only TCE concentrations, all ground water VOC concentrations follow a similar spatial distribution pattern. VOCs have also moved toward the north and south, although the southward transport pathway is considerably less significant (i.e., lower concentrations) than the northward or northwestward pathway. Based on data to date, the VOC source is located within or near to the PBA (an area approximately 100 feet by 75 feet, or less than 0.2 acre).

Contaminant movement in the vicinity of explosives magazine 1410 located west of the MGBG is expected to follow the topography along with the ground water flow. Thus, the western edge of the ground water VOC plume is expected to turn slightly northward near Magazine 1410 as indicated by the isoconcentration plot presented as Figure 1-9. Contaminant transport to the east and southeast has been limited as measured by VOC concentrations in wells in these areas. This is consistent with the concept that the ground water follows the topography with a primary westerly or northwesterly flow direction, presumably influenced by bedrock fracturing.

The data presented in the Phase III RFI Report (TtNUS, 2003), when considered in the context of the earlier ground water data, indicate that the plume size has been relatively stable since the mid 1980s (TtNUS, 2003). The VOC contaminants have migrated approximately 800 feet westward from the source area between the time of release and present time. The westward-most concentrations have not changed significantly over the past 20 years (compare historical data, Figure 1-5 from TtNUS, 2001, with more recent data, Figures 1-18 and 1-19 of TtNUS, 2003). Assuming a one-time release in 1960, the

VOC migration rate is about 20 feet per year (ft/yr). Because the boundaries of the plume do not appear to be expanding significantly, a tentative evaluation of site data suggests that natural attenuation may be preventing the plume from expanding (i.e., although contaminants are migrating at a rate of 20 ft/yr, they are degrading at a similar rate).

1.5 DATA GAPS AND PLANNED DATA COLLECTION

The RFI Report provided site characterization data on which this CMS will be based; however, for reasons described below, additional data collection is required at the outset of the CMS as follows:

- Large TCE and 1,1,2,2-PCA concentration fluctuations in the most contaminated portion of the VOC plume have been observed over the past 20 years, especially in wells 01-02 and 01-05 (TtNUS, 2003). These temporal concentration data are presented in Figures 6-3 and 6-4 of the RFI report (TtNUS, 2003). Additional data collection is warranted to better estimate VOC concentrations across the VOC-contaminated ground water plume that extends from the vicinity of well 01-02 toward the northwest and west of the MBGB (Figures 5-8 and 5-9 of TtNUS, 2003).

- Overall VOC concentrations in the plume interior were demonstrated in the Phase III RFI to be decreasing since the mid 1980s. The additional VOC data collection will be used to extend the temporal VOC concentration trend lines for the most significant VOC contaminants in various parts of the plume, including the plume perimeter. In this case, the most important VOCs are TCE, 1,1,2,2-PCA, and any degradation daughter products that appear to be useful for evaluating remedial options.

- Data associated with the natural attenuation of chlorinated organic compounds was collected in Round 2 of the recently completed RFI field work (TtNUS, 2003). The data are presented in Figure 6-2 (TtNUS, 2003). These data will be supplemented with another round of data collection for these and additional natural attenuation parameters. These data will be used with the available VOC data to evaluate the efficacy of natural attenuation of VOCs in ground water at the MGBG.

- The concentrations observed in ground water to date indicate that a dense non-aqueous phase liquid (DNAPL) contamination source may be present at the MGBG, although a DNAPL source was not located in soils during the RFI. This could be the result of released organic solvents having migrated directly into the bedrock, with little VOC contamination remaining in the soils. The bedrock is shallow in and near the PBA, where contaminant releases apparently occurred. If a soil VOC hot spot does exist, remediation of such a hot spot could prove to be a cost-effective way to dramatically reduce the

VOC contaminant source. Therefore, soil test pitting and VOC screening will be conducted to help establish whether such a hot spot exists and, if it exists, to establish more precisely where it is located. In conjunction with these activities, VOC screening data will be used to establish locations to install two new ground water monitoring wells.

- A refinement of the understanding of hydraulic gradients across the MGBG will assist in the CMS remedial option evaluations. The two additional ground water monitoring wells will be installed within the MGBG to provide data for this purpose.

- Because the MGBG (especially the PBA) was once contaminated with radioactive thorium, the project team decided that it was prudent to continue monitoring for gross gamma radiation levels using handheld instruments during the soil test pitting activities.

- Although HD was once present at the MGBG, continued monitoring for that contaminant is not necessary because HD persistence is more limited than that of radioactive thorium, and because no HD was detected in any media during the Phase III RFI (TtNUS, 2003).

Based on the above data gaps and the needs of this CMS, a list of required measurements and rationales for their analyses was developed and is presented in Table 1-2. The specific field analytes and measurement methods are listed in Table 1-3; specific laboratory analytes and target method detection limits are listed in Table 1-4. Rationales for the measurements are summarized as follows:

- Field measurements:

  - Natural attenuation field measurements will support the evaluation of the efficacy of natural attenuation. Ground water levels are being measured to add to the body of knowledge regarding the potentiometric ground water surface at and near to the MGBG. This information will be used to update the site conceptual model regarding ground water flow directions.

  - A subset of the field measurements (enumerated in Section 3.5.7) is being collected to ensure that sampling conditions are stable prior to ground water sample collection.

- Laboratory measurements:

  - The reduced forms of manganese and iron are being measured to support the natural attenuation evaluation. Hardness will also be measured to assist in evaluating remediation technologies and aquifer characteristics for natural attenuation of VOCs in ground water.

  - VOCs – These chemicals are the major contributors to human health risk. The VOC concentrations must be characterized further in the VOC contaminant source area and throughout the ground water VOC plume to support this CMS. VOC concentrations will be measured in samples collected from all MGBG wells. Several VOCs that appear on the 40 Code of Federal Regulations Part 264 Appendix IX list of volatile organic compounds were analyzed as semivolatile organic compounds in the recently completed Phase III RFI (TtNUS, 2003). These compounds are: 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, 2-picoline, bis(2-chloroisopropyl)ether, hexachlorobenzene, hexachlorobutadiene, hexachlorocyclopentadiene, hexachloroethane, and pyridine. Of these, only hexachloroethane was detected in any sample. The hexachloroethene (concentration estimated to be 5 µg/L) was detected only in sample 01GW0201. Therefore, these 10 compounds are not being analyzed for the CMS.

  - Four other VOCs (1,4-dioxane, acetonitrile, 2-butanol, and propionitrile) were quantified during the RFI by using SW-846 method 8015B. This is a separate analysis from SW-846 method 8260B, which is the method used for the main list of VOCs. Use of method 8015B was driven by the desire to achieve lower detection limits than is possible by using method 8260B. None of these four VOCs were detected in any MGBG RFI sample using the more sensitive method 8015B. Because of this, these four chemicals are not considered to be chemicals of concern. To avoid the additional costs associated with analysis of samples by two different methods, but to maintain the same list of analytes for the VOC analytical fraction, these four chemicals will be analyzed by the (less sensitive) method 8260B. The data for these chemicals may be rejected during data validation, but this strategy will avoid questions concerning the differences in analyte lists for the various analytical fractions.

  - Laboratory Natural Attenuation Parameters – These measurements will be used to evaluate the effectiveness of natural attenuation for VOCs in MGBG ground water. These parameters will be analyzed only in samples collected from wells that are selected to support the natural attenuation evaluation.

1.6 DECISION RULES

The decision rules of the approved MGBG QAPP (TtNUS, 2001) do not apply to this CMS because the site characterization and risk assessment have been completed for the RFI. The evaluation process for selecting an appropriate remedial action is presented in Section 8.0 of this QAPP Addendum No. 1.

TABLE 1-1

HISTORICAL INVESTIGATION SUMMARY
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Event	Summary/Conclusions
March 1973 Chemical Safety Survey	• Unknowns were identified regarding chemical agent and explosives content of munitions disposed at the MGBG. • Recommendation was to recover the chemical munitions and render the area safe.
1974 Exhumation (U.S. Navy, 1974)	• Enough thorium/illuminant materials and other bomb-related hardware were recovered to fill seven 55-gallon drums. Items found included 92 pyrotechnic devices buried approximately 2.5 feet to 5.5 feet deep. All radioactive waste was thought to have been removed and sent to a Nuclear Regulatory Commission (NRC)-licensed burial ground (Barnwell, South Carolina) in 1975. • Ten HD bombs were exhumed. Of those, seven had evidently been cleaned of HD prior to burial. One more contained HD, an unspecified quantity of which was released to the ground. The released HD was reacted with hypochlorite solution to decompose it, and the excavation was back-filled with vent pipes in place to release hydrogen chloride gas formed during the decomposition reaction. Two other bombs were suspected to contain HD. Detected HD was about 40% pure, evidently undergoing chemical decomposition. Exhumation was terminated and transferred to Army personnel. In 1976, hardware from seven bombs was transferred to Magazine 1403; the three remaining bombs were wrapped in plastic and overpacked in 8-inch propellant charge shipping containers then also stored in Magazine 1403. • Exhumation personnel recommended resuming exhumation of four other areas in autumn when temperatures are lower and the chance of HD overpressure in the bombs is limited.
1977 Magnetometer Survey	• New metal contacts were identified both inside and outside the MGBG and were plotted.
1980 Exhumation (U.S. Navy, 1980)	• Metal contacts plotted in 1977 as being *outside* of MGBG were found to be innocuous (barbed wire and "junk"). • Most metal contacts *within* the MGBG detected during the 1977 survey were also junk or barbed wire. • Six items removed from plots marked "mustard of [various] poundages" were empty M70A1 aerial bombs. Otherwise, no connection between the pounds of material recorded and live agent was found. Only mud (no live chemical agent) was found inside the six aerial bombs. • No trace of agent was found in soils surrounding the empty bombs (analysis was done using a field test kit). • The three bombs suspected in 1974 of containing mustard gas contained approximately 3, 1.5, and 0 gallons of agent, respectively. None was found to be full of agent, indicating that they were partially overlooked when bombs were drained of HD prior to burial. Some agent that was spilled on the ground was decontaminated with HTH chlorine solution. • Most material found was illuminating device hardware/composition remaining from a research and development project. • One HD identification kit containing 6 ounces of HD was exhumed.

TABLE 1-1

HISTORICAL INVESTIGATION SUMMARY
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Event	Summary/Conclusions
1980 Exhumation (U.S. Navy, 1980) (Continued)	• An unidentified quantity of radioactive waste was located apart from the other buried material in a configuration illustrating a simple "stack type" burial. • Three additional thorium nitrate burial areas were located. • Three 55-gallon drums were filled with radioactive thorium nitrate containers. • The MGBG site was declared "not to pose an environmental insult." • Thorium nitrate disposal sites located at the NSWC Crane were considered to have been decontaminated and were approved by the Navy for release for radiologically unrestricted use.
1995 Geophysical Survey (complete MGBG area)	• The objective was to detect and delineate anomalies indicating buried structures, objects, or disturbed zones with past hazardous waste burial. • Electromagnetic conductivity and magnetic surveys were used. • Two geophysical anomalies were identified, the origins of which were unexplained.
18 January 2000 site reconnaissance and related communications	• Site "historian" explains that one of two anomalies identified during the 1995 geophysical survey is a discarded metal horse tub and collection of steel fence posts. The nature of the second anomaly was not identified but is asserted not to be ordnance-related.
September 2003, RCRA Phase III RFI	• Objective was to characterize all media with regard to nature and extent of contamination and risks to humans and ecological receptors. The report summarized two rounds of sampling conducted from July through September 2001 and from May through June 2002. The only unacceptable risk to humans was identified as being health risk associated with exposure to ground water. VOCs were overwhelmingly the greatest contributor to this risk with minor contributions from bis(2-ethylhexyl) phthalate, hexachloroethane, heptachlor, arsenic, and manganese. All ecological risks were low to negligible. Mustard gas and degradation products were not detected. Radionuclide concentrations and gross radiation levels were within background values. Implementation of a CMS was recommended. • The two remaining geophysical contacts were exhumed and found to be a broken metal fence post and large metal plates. This material was nonhazardous.

TABLE 1-2

PROJECT TARGET PARAMETERS AND RATIONALES
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Parameter	Environmental Medium			Intended Data Use
	GW	SS	SB	
Appendix IX VOCs (all GW samples and select soil samples from the bottoms of test pits, any additional soil sampling contingent upon detecting VOCs)	X	X	X	To establish absence or presence and extent of contamination. To provide data for evaluating CMS alternatives.
Volatile Fatty Acids (Acetic, Propionic, Butyric, Pentanoic, *i*-Pentanoic, Pyruvic, Lactic, *i*-Hexanoic, *n*-Hexanoic)	X			To provide data for evaluating the efficacy of natural attenuation or enhanced natural attenuation.
Dissolved hydrogen	X			To provide data for evaluating the efficacy of natural attenuation or enhanced natural attenuation.
Nitrate + Nitrite as Nitrogen	X			To provide data for evaluating the efficacy of natural attenuation or enhanced natural attenuation. Nitrate may compete at higher concentrations with a reductive chemical degradation pathway.
Select Gamma Emitters (contingent upon field screening indicating that soil gamma radiation exceeds background gamma radiation levels)		X	X	Contingency for evaluating extent of radiological contamination, if any is detected.
Total Inorganic Carbon	X			For aquifer characterization.
Total Organic Carbon	X			To provide data for evaluating the efficacy of natural attenuation or enhanced natural attenuation. Carbon is an energy source; it drives dechlorination; it can be natural or anthropogenic.
Depositional Environment (contingent upon soil sample collection)		X	X	To classify soil samples according to depositional environment, in the event that soil samples are collected.
Dissolved Oxygen (f)	X			To provide data for evaluating the efficacy of natural attenuation or enhanced natural attenuation. It is a potential reductive pathway suppressant at higher concentrations.
Grain Size (f) (contingent upon soil sample collection)		X	X	To establish which background data set is most comparable for background comparisons, if soil samples are collected.
Total Hardness	X			To evaluate water quality for evaluating remedial options.
Oxidation-Reduction Potential (f)	X			To provide data for evaluating CMS alternatives.
pH (f - water samples only)	X			To provide data for evaluating CMS alternatives. Measured to establish well stabilization prior to collecting ground water samples. Generally useful for data interpretation and potential future uses. $5 < pH < 9$ is optimal for a reductive pathway; $pH < 5$ or $pH > 9$ is outside optimal range for reductive pathway.

TABLE 1-2

PROJECT TARGET PARAMETERS AND RATIONALES
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Parameter	Environmental Medium			Intended Data Use
	GW	SS	SB	
Sample Depth/Location (f)	X			To identify sample locations in the vertical and horizontal directions.
Specific Conductance (f)	X			To establish well stabilization prior to collecting ground water samples.
Temperature (f)	X			To establish well stabilization prior to collecting ground water samples. Also measured because pH and specific conductivity are temperature dependent. At > 20°, biochemical processes accelerate.
Turbidity (f)	X			To establish well stabilization prior to collecting ground water samples.
Ground Water Level (f)	X			To calculate ground water potentiometric surface.
Gross Gamma Screening, soil only (f)		X	X	Health and safety precaution for intrusive work in an area once contaminated with radionuclides, used to determine whether gamma spectrometric analysis is required on soil.
Alkalinity (f)	X			To provide data for evaluating CMS alternatives. It results from interaction of carbon dioxide and aquifer minerals and indicates whether samples are collected from similar aquifer material.
Carbon dioxide (f)	X			To provide data for evaluating the efficacy of natural attenuation or enhanced natural attenuation. Ultimate oxidative daughter product.
Chloride	X			To provide data for evaluating the efficacy of natural attenuation or enhanced natural attenuation. Daughter product of organic chlorine compounds. Hypochlorite used to decontaminate previous mustard gas spills could confound the utility of this data.
Ferrous Iron (+2) (f)	X			To provide data for evaluating the efficacy of natural attenuation or enhanced natural attenuation. Indicates whether a reductive degradation pathway is possible. Vinyl chloride may be oxidized under ferrous iron reducing conditions.
Manganese (+2) (f)	X			To provide data for evaluating the efficacy of natural attenuation or enhanced natural attenuation. Indicates whether a reductive degradation pathway is possible.
Hydrogen Sulfide (f)	X			To provide data for evaluating the efficacy of natural attenuation or enhanced natural attenuation. Indicates whether a reductive degradation pathway is possible.

TABLE 1-2

PROJECT TARGET PARAMETERS AND RATIONALES
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Parameter	Environmental Medium			Intended Data Use
	GW	SS	SB	
Sulfide (f)	X			To provide data for evaluating the efficacy of natural attenuation or enhanced natural attenuation. Indicates whether a reductive degradation pathway is possible.
Nitrite (f)	X			To provide data for evaluating the efficacy of natural attenuation or enhanced natural attenuation.
VOC Screening, soil (f)		X	X	Used to determine whether VOC analysis is required on soil.
Sulfate	X			To provide data for evaluating the efficacy of natural attenuation or enhanced natural attenuation. May compete at higher concentrations with a reductive degradation pathway.
Dissolved Organic Gases (Acetylene, *n*-Butane, *i*-Butane, Ethane, Ethene, Methane, Propane, and Propene)	X			To help quantify dechlorination and the extent of natural attenuation. To provide data for evaluating the efficacy of natural attenuation or enhanced natural attenuation.

(f) Field analysis

GW – Ground water.
SS – Surface soil.
SB – Subsurface soil.

TABLE 1-3

AQUEOUS FIELD TARGET PARAMETERS AND METHOD DETECTION LIMITS SWMU 01 - MUSTARD GAS BURIAL GROUND NSWC CRANE CRANE, INDIANA

Parameter	Reporting Limit (mg/L, unless otherwise noted)	Precision Requirement (1 S.D.) (mg/L, unless otherwise noted)	Measurement Method
Natural Attenuation Field Parameters			
Alkalinity	50	20	Field Test Kit (e.g., CHEM K-9810 or 9815)
Carbon Dioxide	10	20 %	Field Test Kit (e.g., CHEM K-1910)
Dissolved Oxygen	0.2	0.2	D.O. Meter/Probe and Chemical Test Kit
Iron (+2) (ferrous iron)	0.5	20 %	Field Test Kit (HACH 1037-69)
Hydrogen Sulfide	0.1		Field Test Kit (e.g., HACH)
Manganese (+2)	0.12	30 %	Field Test Kit (e.g., HACH 24300-00)
Nitrite	0.02	0.02	Field Test Kit (e.g., HACH 25120-25)
Oxidation-Reduction Potential	NA	300 mV	ORP Meter/Electrode (e.g., YSI 6-series EMS)
Sulfide	0.02	0.02	Field Test Kit (e.g., HACH 1816-32 and 1817-32)
Well Stabilization Field Measurements			
pH	NA	0.1 S. U. (meter) 0.5 S. U. (paper)	Meter/Electrode (pH paper for checking anomalous measurements)
Specific Conductance	0.02 uS/cm^2	50 uS/cm^2	Conductivity Meter
Temperature	0 °C	0.1 °C	Thermometer
Turbidity	1 NTU	1 NTU	Nephelometer (LaMotte Turbidity Meter)
Ground Water Level	0.01 foot	0.01 foot	Electronic water level indicator

CHEM = CHEMEtrics, Inc.
EMS = Environmental Monitoring System.
HACH = HACH Chemical Company.
NA – Not applicable.
mg/L = Milligrams per liter.
uS/cm^2 = microSiemens per square centimeter.
NTU = Nephelometric turbidity unit.
°C = Degrees Celsius.
S.D. = Standard deviation.
S.U. = Standard units.
YSI = Yellow Springs Instruments.

TABLE 1-4

LABORATORY ANALYTICAL PARAMETERS, DETECTION AND REPORTING LIMITS, AND TARGET MDLs
NSWC CRANE, CRANE , INDIANA

Parameter	Aqueous Matrix			Solid Matrix		
	Laboratory MDL (ug/L)	Laboratory RL (ug/L)	Target MDL[1] (ug/L)	Laboratory MDL/MDA (mg/kg)	Laboratory RL (mg/kg)	Target MDL[1] (mg/kg)
APPENDIX IX VOLATILE ORGANIC COMPOUNDS SW-846 METHOD 8260B						
1,1,1,2-Tetrachloroethane	0.2	1	0.43	0.001	0.005	0.0071
1,1,1-Trichloroethane	0.2	1	88	0.001	0.005	0.097
1,1,2,2-Tetrachloroethane	0.3	1	0.055	0.002	0.005	0.00017
1,1,2-Trichloroethane	0.2	1	0.2	0.001	0.005	0.00091
1,1-Dichloroethane	0.1	1	47	0.001	0.005	0.000575
1,1-Dichloroethene	0.2	1	7	0.001	0.005	0.0029
1,2,3-Trichloropropane	0.2	1	0.0056	0.001	0.005	0.0000037
1,2-Dibromo-3-chloropropane	0.5	1	0.048	0.003	0.005	0.000092
1,2-Dibromoethane	0.2	1	0.00076	0.001	0.005	0.000029
1,2-Dichloroethane	0.2	1	0.12	0.001	0.005	0.0012
1,2-Dichloropropane	0.2	1	0.16	0.001	0.005	0.0015
2-Butanone	1.3	5	1900	0.002	0.005	0.13696
2-Chloro-1,3-butadiene (chloroprene)	0.1	1	14	0.003	0.005	0.00106
2-Hexanone	0.5	5	1500	0.003	0.005	1.01
4-Methyl-2-pentanone	0.4	5	160	0.002	0.005	0.54437
Acetone	0.5	5	610	0.003	0.005	0.45337
Acrolein	4.2	10	0.042	0.024	0.05	0.0000144
Acrylonitrile	1.7	10	0.039	0.021	0.05	0.0000157
Allyl chloride (3-chloro-1-propene)	0.1	5	1800	0.001	0.005	0.000266
Benzene	0.2	1	0.34	0.001	0.005	0.0017
Bromodichloromethane	0.2	1	0.18	0.001	0.005	0.00113
Bromoform	0.2	1	8.5	0.001	0.005	0.038
Bromomethane	0.3	1	8.7	0.001	0.005	0.012
Carbon disulfide	0.1	1	84.1	0.001	0.005	0.09412
Carbon tetrachloride	0.4	1	0.17	0.001	0.005	0.0033
Chlorobenzene	0.2	1	10	0.001	0.005	0.06194
Chloroethane	0.3	1	4.6	0.005	0.005	0.33
Chloroform	0.2	1	6.2	0.001	0.005	0.027
Chloromethane	0.2	1	1.5	0.002	0.005	0.0000785
cis-1,2-Dichloroethene	0.2	1	5	0.001	0.005	0.02
cis-1,3-Dichloropropene	0.2	5	0.4	0.001	0.005	0.0003
Dibromochloromethane	0.2	1	0.13	0.001	0.005	0.02
Dibromomethane	0.2	1	61	0.001	0.005	0.0000859
Dichlorodifluoromethane	0.1	1	390	0.002	0.005	0.00133
Ethyl methacrylate	0.2	1	550	0.002	0.005	0.000602
Ethylbenzene	0.2	1	2.9	0.001	0.005	0.0001
Methacrylonitrile	0.9	20	1	0.016	0.1	0.0000297
Methyl iodide	0.1	1	0	0.003	0.005	NA[3]
Methyl methacrylate	0.8	1	1400	0.002	0.005	0.16756
Methylene chloride	2	4	4.3	0.001	0.005	0.0012
Pentachloroethane	0.1	5	56.4	0.004	0.005	0.68918
Styrene	0.2	1	56	0.001	0.005	0.18
Tetrachloroethene	0.1	1	0.66	0.001	0.005	0.0029
Toluene	0.2	1	253	0.008	0.005	0.59
Total Xylenes	0.6	5	117	0.003	0.005	1.88
trans-1,2-Dichloroethene	0.1	1	100	0.001	0.005	0.034
trans-1,3-Dichloropropene	0.2	1	0.4	0.001	0.005	0.0003
trans-1,4-Dichloro-2-butene	0.3	1	0.0012	0.002	0.005	0.00182
Trichloroethene	0.2	1	0.028	0.001	0.005	0.0028
Trichlorofluoromethane	0.2	1	1300	0.005	0.005	0.00307
Vinyl acetate	0.6	5	248	0.001	0.005	0.01295
Vinyl chloride	0.1	1	0.02	0.002	0.005	0.00067
Isobutanol	9.3	20	1800	0.072	0.1	2.3
Acetonitrile	1.7	10	100	0.002	0.05	420
Propionitrile	3.9	10	6080	0.002	0.05	NA[3]
1,4-Dioxane	9.1	20	6.1	0.091	0.1	0.0017

TABLE 1-4

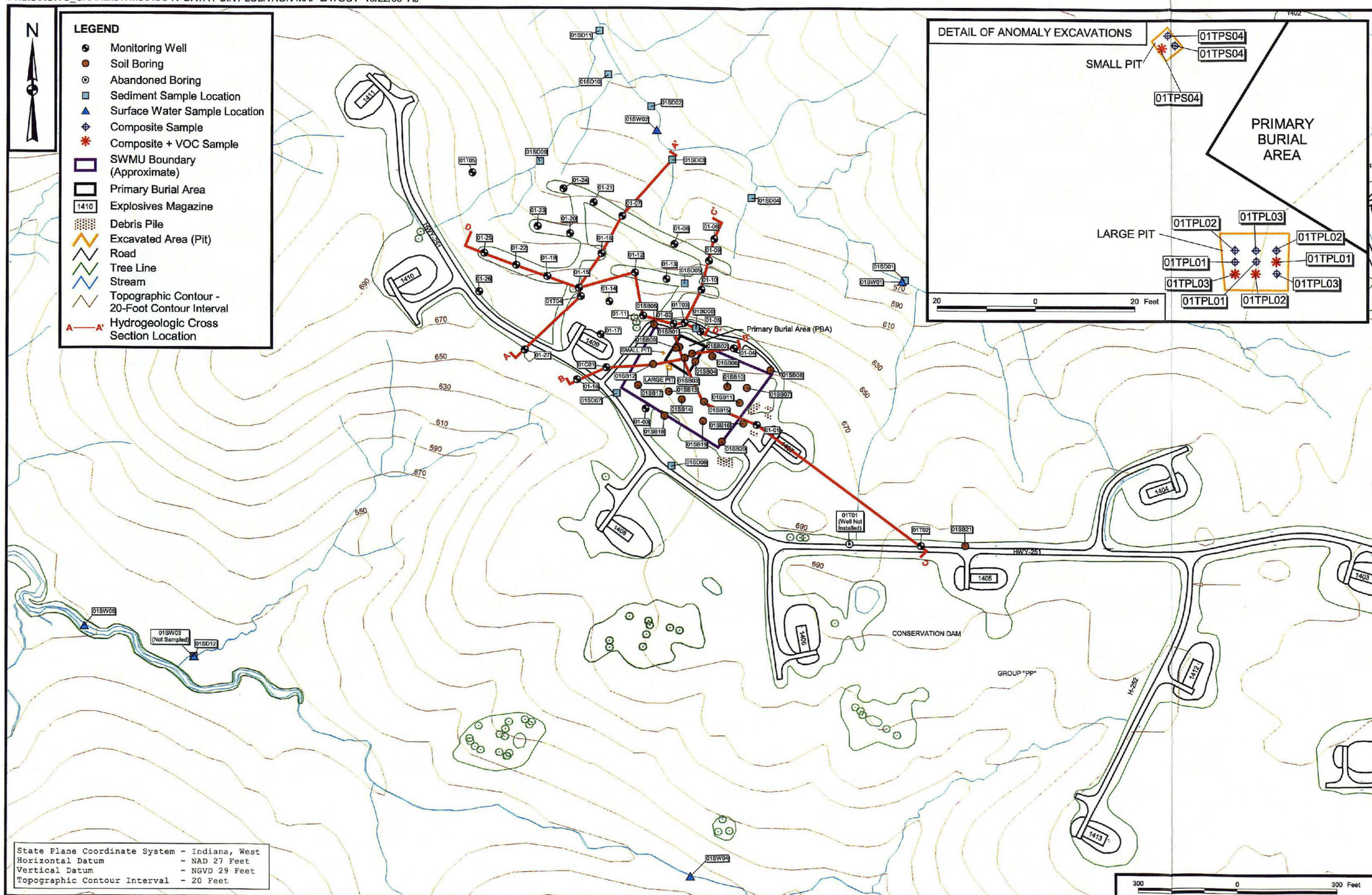
LABORATORY ANALYTICAL PARAMETERS, DETECTION AND REPORTING LIMITS, AND TARGET MDLs
NSWC CRANE, CRANE , INDIANA
PAGE 2 OF 2

Parameter	Aqueous Matrix			Solid Matrix		
	Laboratory MDL (ug/L)	Laboratory RL (ug/L)	Target MDL[1] (ug/L)	Laboratory MDL/MDA (mg/kg)	Laboratory RL (mg/kg)	Target MDL[1] (mg/kg)
NATURAL ATTENUATION PARAMETERS						
Acetylene (Microseeps)	200 ng/L	500 ng/L	NA[3]	ANR[2]	ANR[2]	ANR[2]
n-Butane (Microseeps)	4 ng/L	25 ng/L	NA[3]	ANR[2]	ANR[2]	ANR[2]
i-Butane (Microseeps)	3 ng/L	25 ng/L	NA[3]	ANR[2]	ANR[2]	ANR[2]
Ethane (Microseeps)	1 ng/L	5 ng/L	NA[3]	ANR[2]	ANR[2]	ANR[2]
Ethene (Microseeps)	3 ng/L	5 ng/L	NA[3]	ANR[2]	ANR[2]	ANR[2]
Methane (Microseeps)	0.002	0.015	NA[3]	ANR[2]	ANR[2]	ANR[2]
Propane (Microseeps)	2 ng/L	25 ng/L	NA[3]	ANR[2]	ANR[2]	ANR[2]
Propene (Microseeps)	11 ng/L	25 ng/L	NA[3]	ANR[2]	ANR[2]	ANR[2]
Chloride EPA 300.0	160	0.2	230000	ANR[2]	ANR[2]	ANR[2]
Hydrogen, dissolved (Microseeps)	0.029 nanomolar	0.03 nanomolar	NA[3]	ANR[2]	ANR[2]	ANR[2]
Nitrate + Nitrite as Nitrogen EPA 353.2	10	100	NA[3]	ANR[2]	ANR[2]	ANR[2]
Sulfate EPA 300.0	60	100	NA[3]	ANR[2]	ANR[2]	ANR[2]
Total Inorganic Carbon (Microseeps)	4000	4000	NA[3]	ANR[2]	ANR[2]	ANR[2]
Total Organic Carbon SW-846 9060/Lloyd Kahn	200	1000	NA[3]	74	500	NA[3]
Total Hardness EPA 130.2	NA[3]	1000	NA[3]	ANR[2]	ANR[2]	ANR[2]
Acetic (Microseeps)	8.7	70	NA[3]	ANR[2]	ANR[2]	ANR[2]
Butyric (Microseeps)	4.6	70	NA[3]	ANR[2]	ANR[2]	ANR[2]
n-Hexanoic (Microseeps)	20	100	NA[3]	ANR[2]	ANR[2]	ANR[2]
i-Hexanoic (Microseeps)	18	100	NA[3]	ANR[2]	ANR[2]	ANR[2]
Lactic (Microseeps)	14	70	NA[3]	ANR[2]	ANR[2]	ANR[2]
Pentanoic (Microseeps)	13	100	NA[3]	ANR[2]	ANR[2]	ANR[2]
i-Pentanoic (Microseeps)	19	100	NA[3]	ANR[2]	ANR[2]	ANR[2]
Propionic (Microseeps)	6.6	70	NA[3]	ANR[2]	ANR[2]	ANR[2]
Pyruvic (Microseeps)	12	70	NA[3]	ANR[2]	ANR[2]	ANR[2]
GAMMA RADIONUCLIDES, EPA 901.1 (Spectral lines in parentheses)						
Potassium-40 (1460)	ANR[2]	ANR[2]	ANR[2]	5 (pCi/g)	NA[4]	0.0445 (pCi/g)
Thallium-208 (583, 860)	ANR[2]	ANR[2]	ANR[2]	5 (pCi/g)	NA[4]	22600 (pCi/g)
Lead-210 (46)	ANR[2]	ANR[2]	ANR[2]	1 (pCi/g)	NA[4]	0.000187 (pCi/g)
Lead-212 (238)	ANR[2]	ANR[2]	ANR[2]	0.5 (pCi/g)	NA[4]	80.1 (pCi/g)
Lead-214 (295, 352)	ANR[2]	ANR[2]	ANR[2]	1 (pCi/g)	NA[4]	34900 (pCi/g)
Bismuth-212 (727)	ANR[2]	ANR[2]	ANR[2]	1 (pCi/g)	NA[4]	22400 (pCi/g)
Bismuth-214 (609, 1120, 1764)	ANR[2]	ANR[2]	ANR[2]	2 (pCi/g)	NA[4]	8190 (pCi/g)
Radium-226 (186)[5]	ANR[2]	ANR[2]	ANR[2]	1.0 (pCi/g)	NA[4]	0.000677 (pCi/g)
Actinium-228 (338, 911, 969)	ANR[2]	ANR[2]	ANR[2]	0.2 (pCi/g)	NA[4]	731 (pCi/g)
Thorium-234 (63, 92)	ANR[2]	ANR[2]	ANR[2]	1.0 (pCi/g)	NA[4]	15.3 (pCi/g)
Uranium-235 (143)	ANR[2]	ANR[2]	ANR[2]	0.08 (pCi/g)	NA[4]	0.00188 (pCi/g)
Cobalt-60 (1173, 1332)	ANR[2]	ANR[2]	ANR[2]	0.03 (pCi/g)	NA[4]	0.000902 (pCi/g)
Cesium-137 (662)	ANR[2]	ANR[2]	ANR[2]	0.03 (pCi/g)	NA[4]	0.00123 (pCi/g)
Europium-154 (123, 1274)	ANR[2]	ANR[2]	ANR[2]	0.02 (pCi/g)	NA[4]	0.0472 (pCi/g)
Europium-155 (87, 105)	ANR[2]	ANR[2]	ANR[2]	0.05 (pCi/g)	NA[4]	3.74 (pCi/g)
Protactinium-243 (1001)	ANR[2]	ANR[2]	ANR[2]	600 (pCi/g)	NA[4]	348 (pCi/g)

MDA = Minimum detectable activity (for radiochemical analyses).
MDL = Method detection limit (for chemical analyses).
Microseeps = Microseeps, Inc.
RL = Reporting limit
µg/L = Micrograms per liter.
mg/kg = Milligrams per kilogram.
mg/L = Milligrams per liter.
pCi/g = PicoCuries per gram.
pCi/L = PicoCuries per liter.

Shading indicates those chemicals for which the laboratory MDL (dark shading) or RL (light shading) exceeds the risk-based target level for the project.
1. Value is based on the minimum of EPA Region 9 Preliminary Remediation Goals, Region 5 Ecological Data Quality Levels, Federal Ambient Water Quality Criteria, and Maximum Contaminant Levels presented in Appendix A, Tables A-11 through A-14.
2. Analysis not required.
3. Not available.
4. Not applicable.
5. Reported value will not have been corrected for possible U-235 interferences.

P:\GIS\NSWC_CRANE\SWMU01.APR DATA POINT LOCATION MAP LAYOUT 10/22/03 AJ



CONTRACT NO. N0845

APPROVED BY T. JOHNSTON — DATE 10/22/03

APPROVED BY — DATE

DRAWING NO. FIGURE 1-1

REV 0

GEOLOGIC CROSS SECTION LOCATIONS AND HISTORICAL SAMPLING LOCATIONS
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

DEPARTMENT OF THE NAVY * SOUTHERN DIVISION, NAVAL FACILITIES ENGINEERING COMMAND

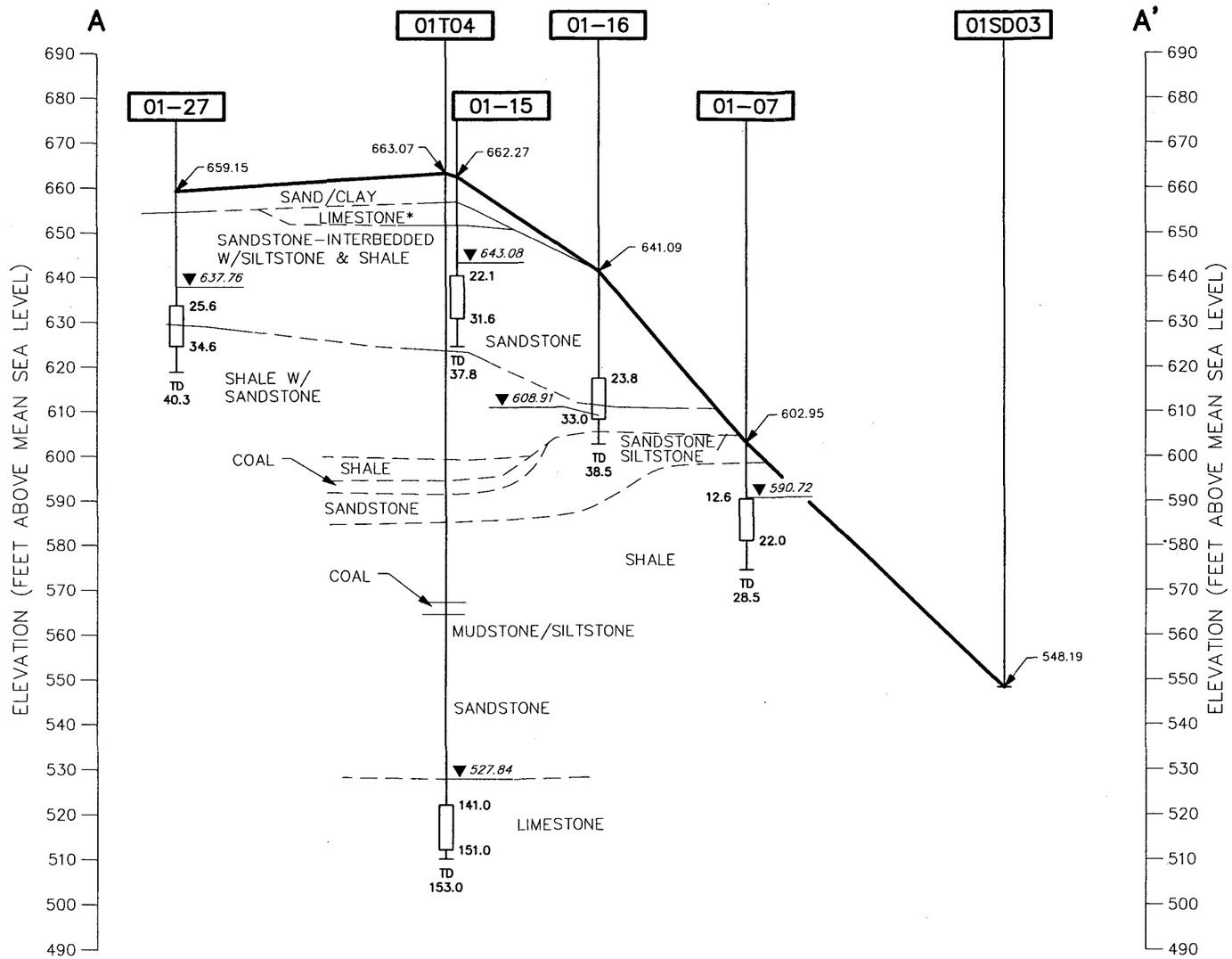
DRAWN BY A. JANOCHA — DATE 6/28/02

CHECKED BY J. SCHUBERT — DATE 10/22/03

COST/SCHED-AREA

SCALE AS NOTED

ACAD: 0845GX01.dwg 10/21/03 HJB PIT



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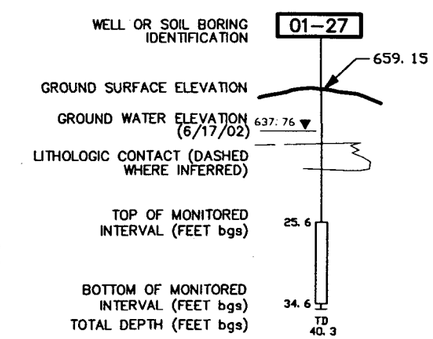


* = LIMESTONE LENS WAS OBSERVED IN BORING 01-15 BUT NOT IN 01T04. LIMESTONE LENS, THEREFORE, MAY NOT ACTUALLY BE PRESENT.

0 120 240
HORIZONTAL SCALE IN FEET

0 30 60
VERTICAL SCALE IN FEET

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

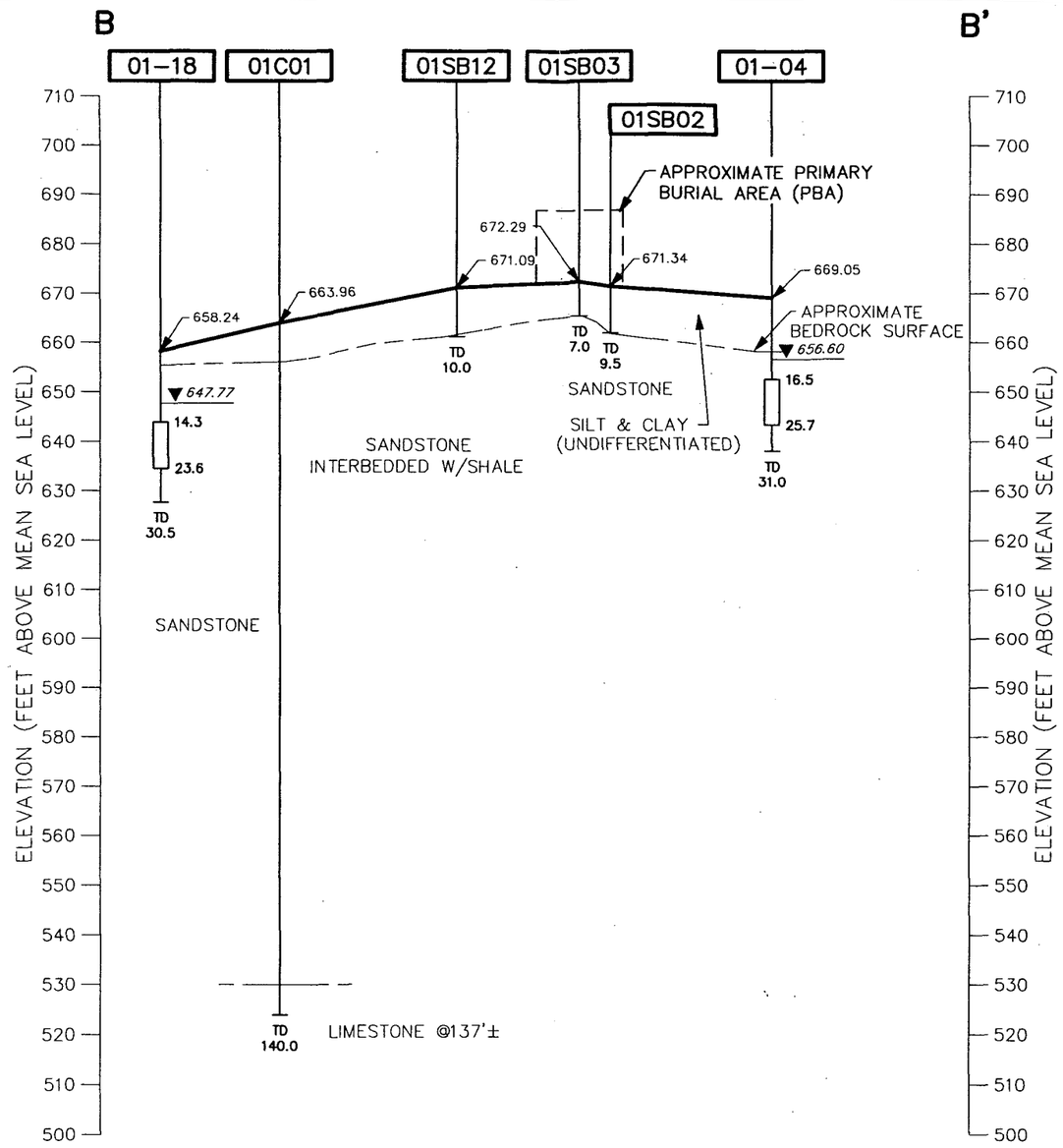
DRAWN BY HJB DATE 10/9/03
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

GENERALIZED HYDROGEOLIGIC CROSS SECTION A-A'
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

CONTRACT NO. 0845
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 1-2
REV. 0

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

ACAD: 0845GX02.dwg 10/09/03 HJB PIT



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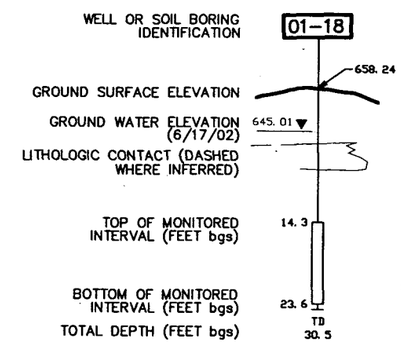
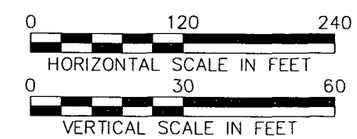




NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

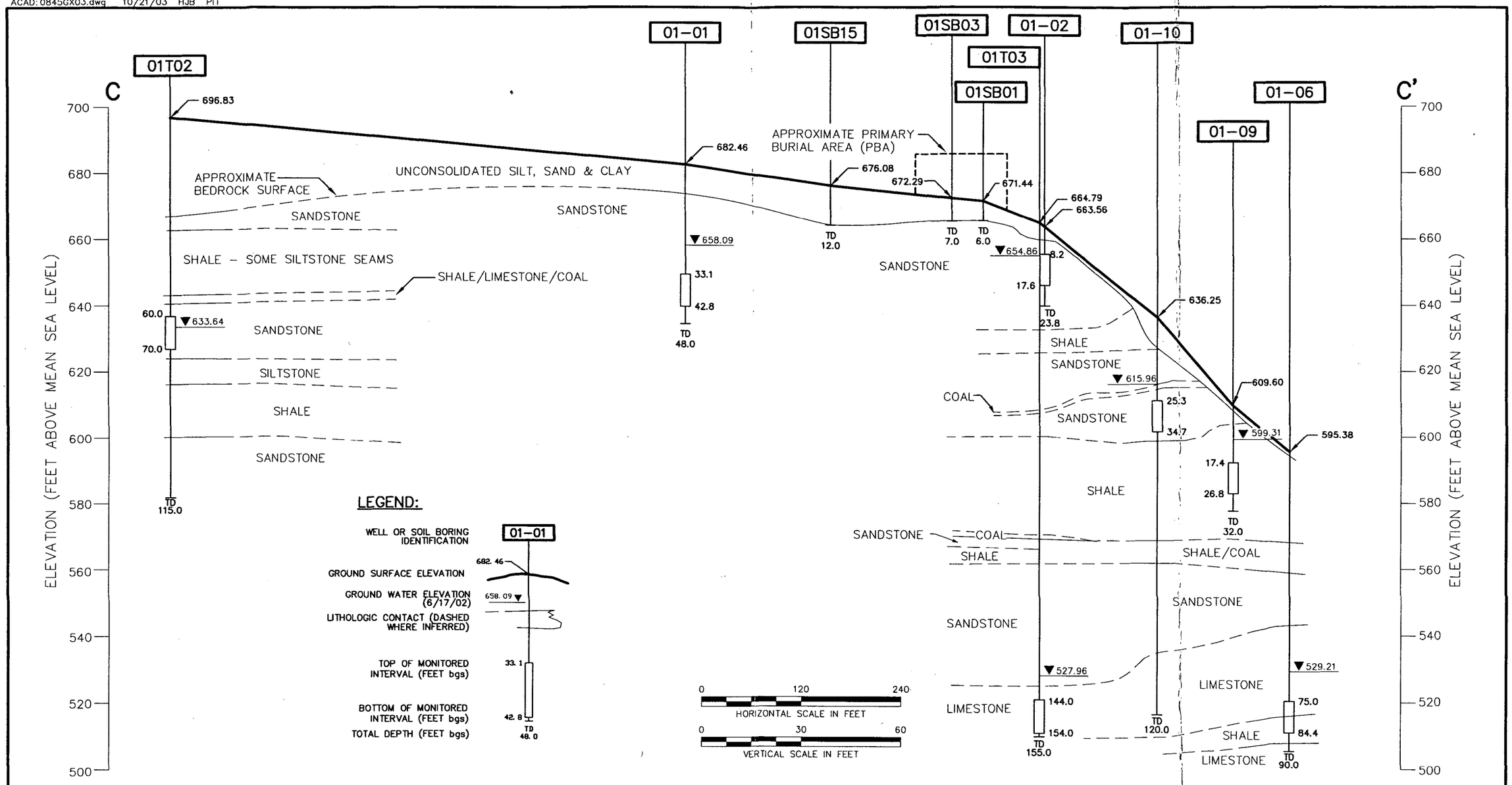
DRAWN BY HJB DATE 10/9/03
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

GENERALIZED HYDROGELOGIC CROSS-SECTION B-B'
SWMU 01 – MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

CONTRACT NO. 0845
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 1-3
REV. 0

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

ACAD: 0845GX03.dwg 10/21/03 HJB PIT



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJB DATE 10/9/03
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

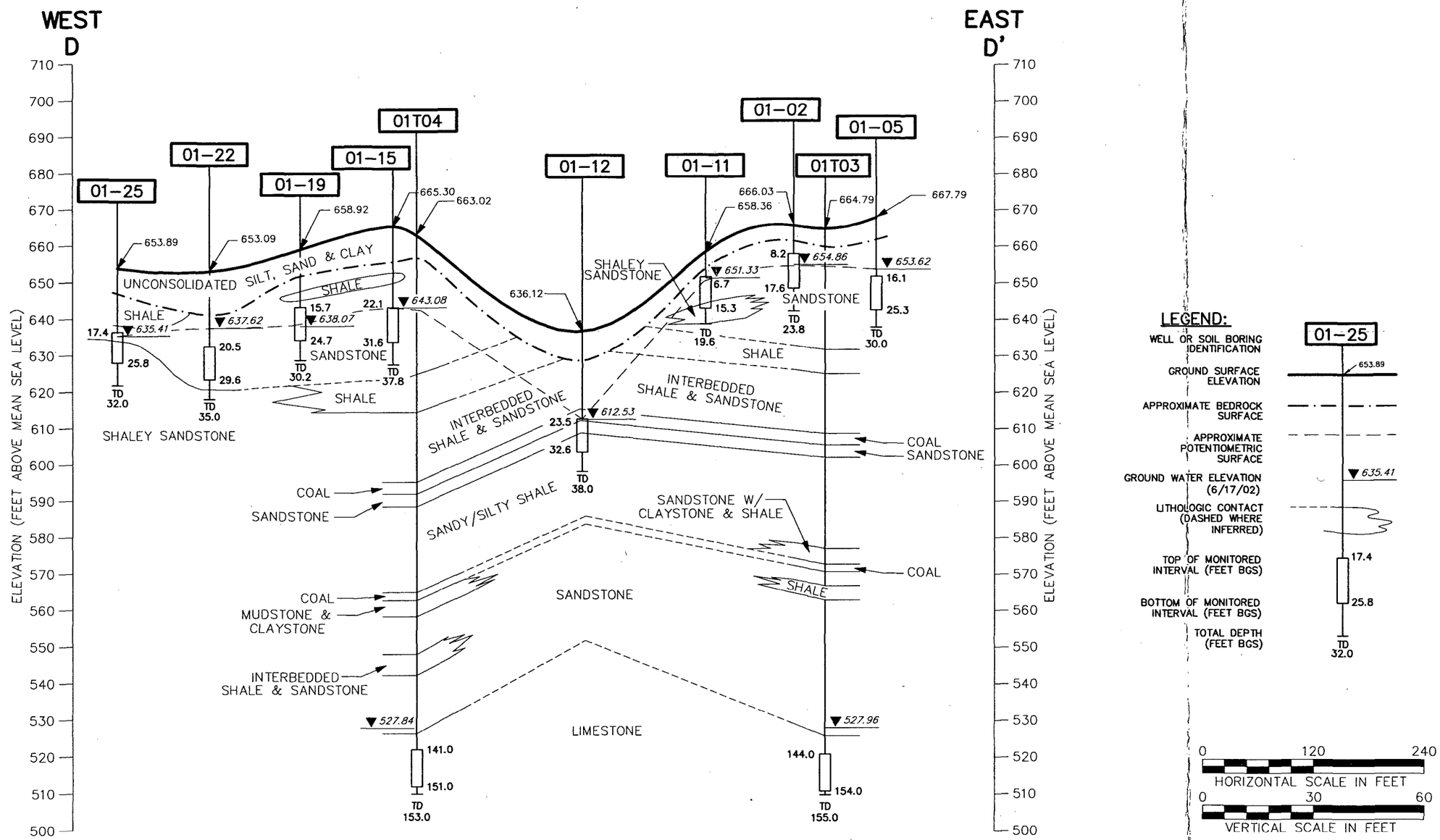
DEPARTMENT OF THE NAVY ★ SOUTHERN DIV FACILITIES ENGINEERING COMD ★

GENERALIZED HYDROGEOLOGIC CROSS SECTION C–C'
SWMU 01 – MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

CONTRACT NO. 0845
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 1–4
REV. 0

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

ACAD: 0845GX04.dwg 10/20/03 HJB PIT



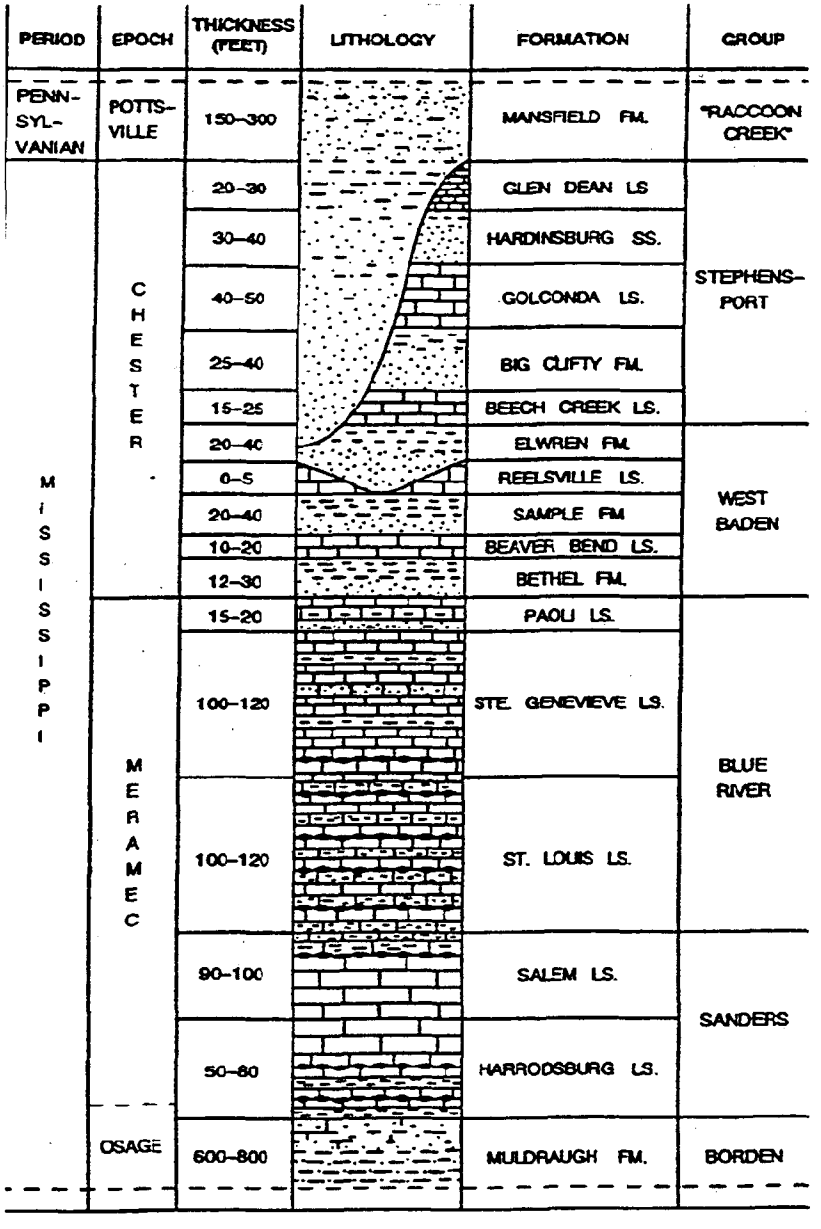
NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJB DATE 10/9/03
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

GENERALIZED HYDROGELOGIC CROSS SECTION D-D'
SWMU 01-MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

CONTRACT NO. 0845
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 1-5
REV. 0

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

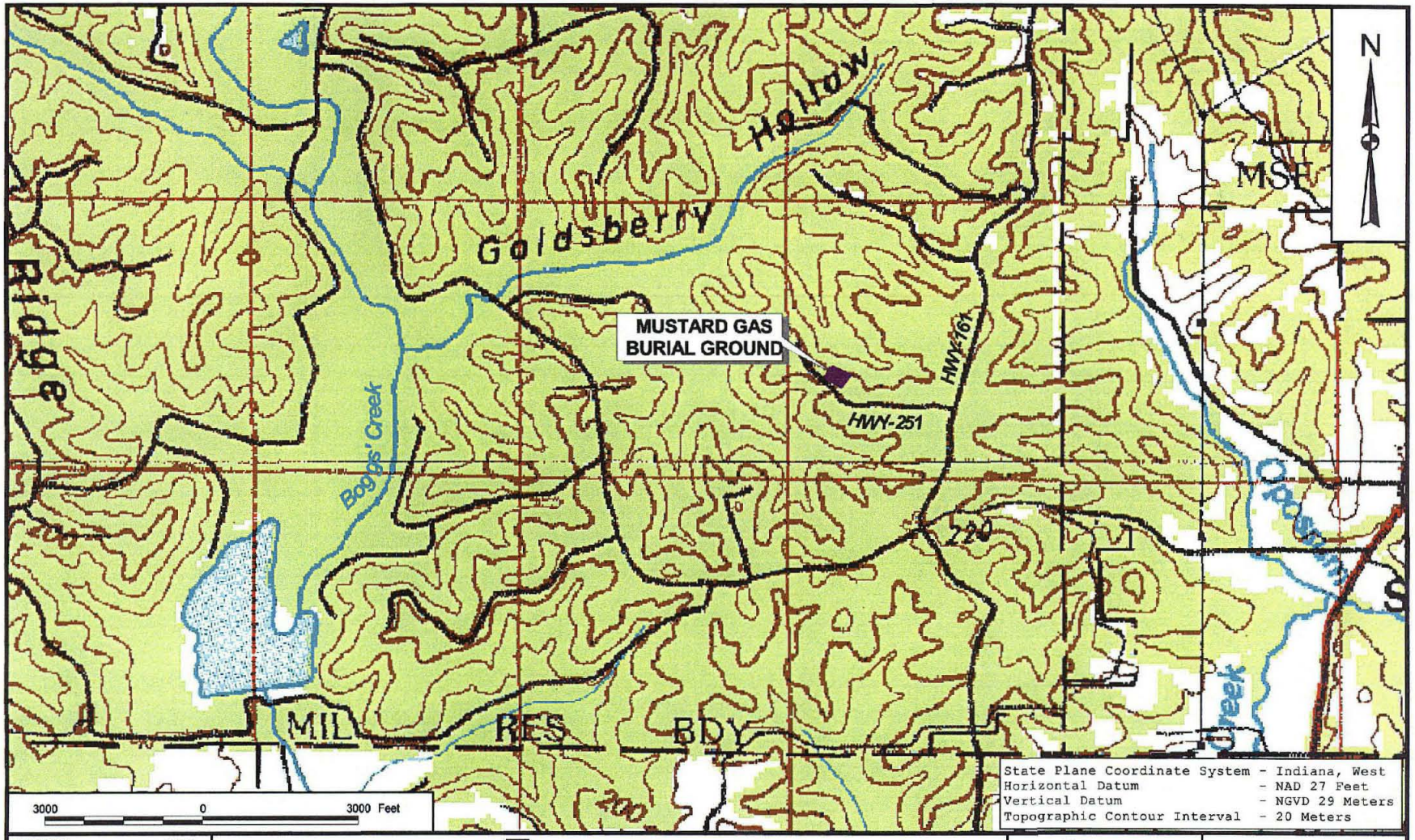


Source: Draft Report, RCRA Facility Investigation
Phase II Groundwater Release Assessment, SWMU 06/09
Demolition Area and Phase III Release
Characterization SWMU 07/09 Old Rifle Range
November 1995-Figure 11 by William L. Murphy and Roy Wade

Source: Palmer, 1969; Cited in Murphy and Wade, 1995

DRAWN BY J. LAMEY DATE 4/26/00	Tetra Tech NUS, Inc.	CONTRACT NUMBER N0485	OWNER NO. CTO 315
CHECKED BY J. SCHUBERT DATE 7/31/02	GENERAL STRATIGRAPHIC COLUMN SWMU 01 - MUSTARD GAS BURIAL GROUND NSWC CRANE CRANE, INDIANA	APPROVED BY T. JOHNSTON	DATE 10/10/03
COST/SCHEDULE-AREA		APPROVED BY —	DATE —
SCALE AS NOTED		DRAWING NO. FIGURE 1-6	REV 0

P:\GIS\NSWC_CRANE\SWMU01.APR STRATIGRAPHIC COLUMN 10/10/03 AJ

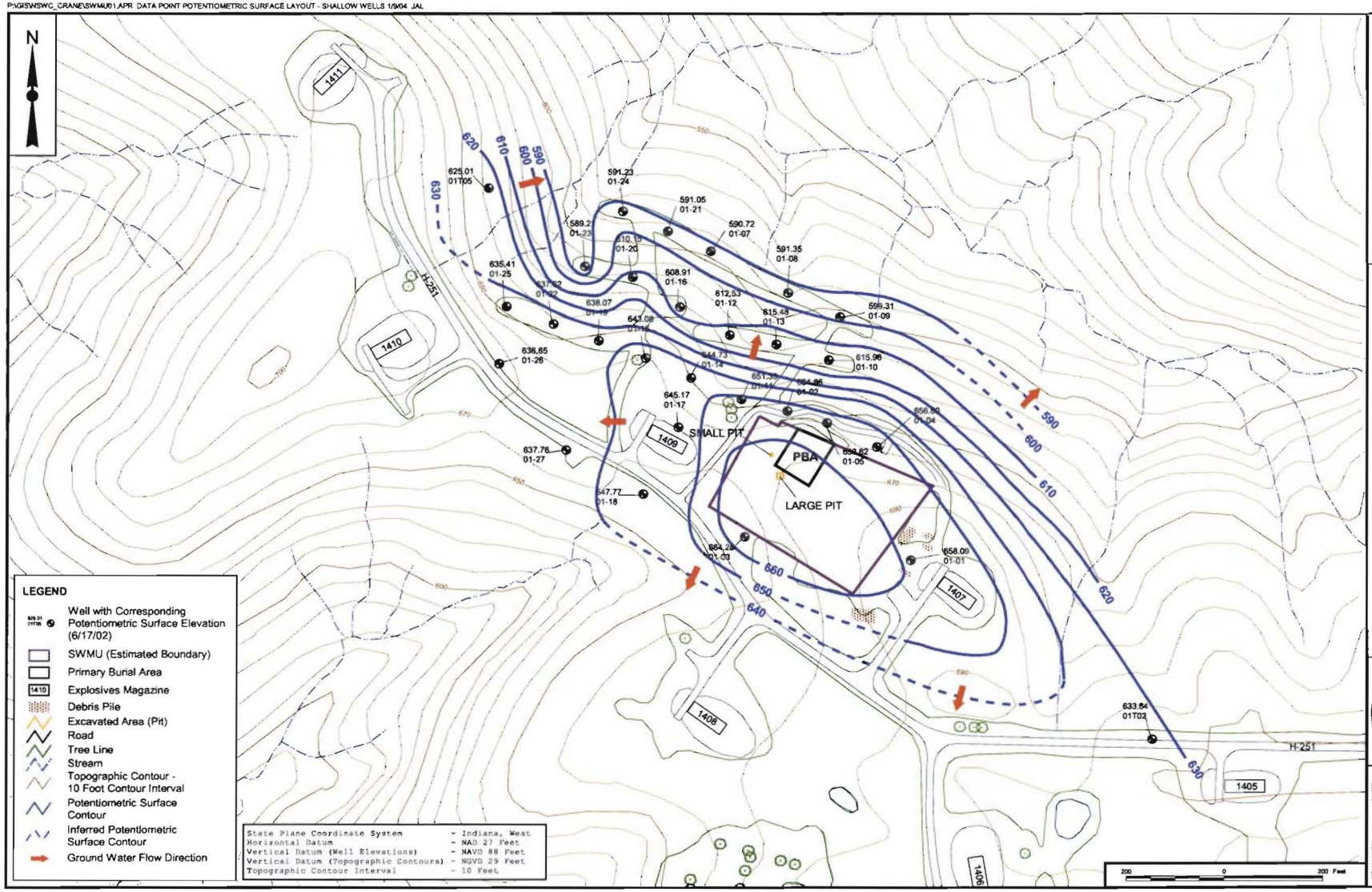


State Plane Coordinate System - Indiana, West
Horizontal Datum - NAD 27 Feet
Vertical Datum - NGVD 29 Meters
Topographic Contour Interval - 20 Meters

DRAWN BY J. LAMEY	DATE 2/9/00	Tetra Tech NUS, Inc.	CONTRACT NUMBER N0845 / OWNER NUMBER CTO 315
CHECKED BY J. SCHUBERT	DATE 10/22/03	PHYSICAL FEATURES AND SURFACE TOPOGRAPHY SWMU 01 - MUSTARD GAS BURIAL GROUND NSWC CRANE CRANE, INDIANA	APPROVED BY T. JOHNSTON / DATE 10/22/03
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 1-7 / REV 0

P:\GIS\NSWC_CRANE\SWMU01.APR SITE MAP-QUAD 10/22/03 AJ

P:\GIS\WSWC_CRANE\SWMU01.APR DATA POINT POTENTIOMETRIC SURFACE LAYOUT - SHALLOW WELLS 1/9/04 JAL



DRAWN BY A. JANOCHA	DATE 7/1/02	
CHECKED BY S. CONTI	DATE 7/19/02	
COST/SCHED-AREA		SCALE AS NOTED

CONTRACT NO. 0845

APPROVED BY T. JOHNSTON — DATE 7/31/02

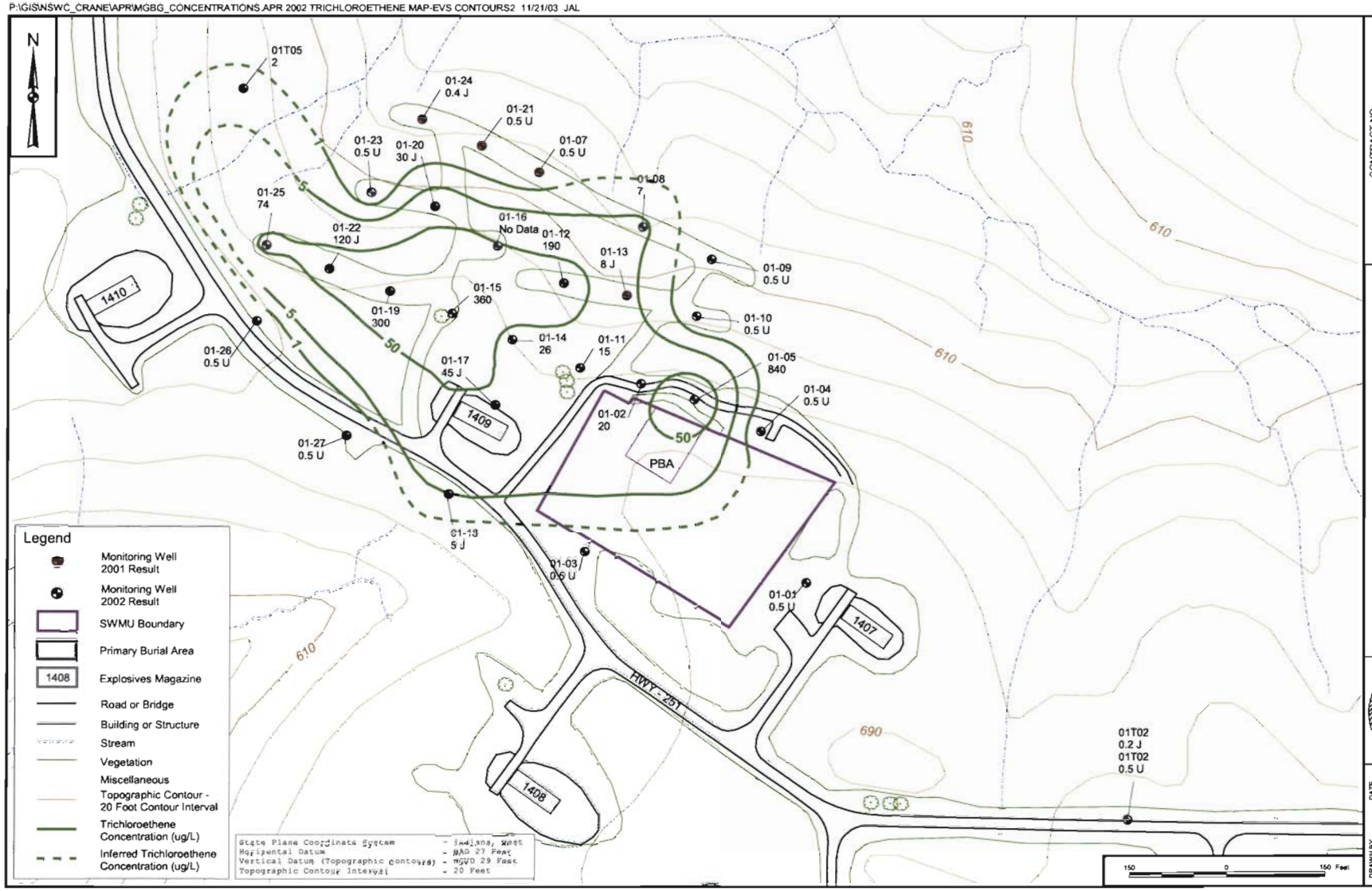
APPROVED BY ___ — DATE ___

DRAWING NO. FIGURE 1-8

REV 0

2002 POTENTIOMETRIC SURFACE MAP - SHALLOW WELLS
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

P:\GIS\NSWC_CRANE\APR\MGBG_CONCENTRATIONS.APR 2002 TRICHLOROETHENE MAP-EVS CONTOURS2 11/21/03 JAL



CONTRACT NO. N0845

APPROVED BY T. JOHNSTON — DATE 11/21/03

APPROVED BY ___ — DATE ___

DRAWING NO. FIGURE 1-9 — REV 0

TRICHLOROETHENE CONCENTRATIONS (UG/L) IN SHALLOW WELLS, 2002
SWMU 01 - MUSTARD GAS BURIAL GROUND
NAVAL SURFACE WARFARE CENTER CRANE
CRANE, INDIANA

DRAWN BY J. LAMEY — DATE 8/29/02

CHECKED BY T. JOHNSTON — DATE 12/13/02

CC:STRCH\B-AREA

SCALE AS NOTED

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

TtNUS, on behalf of the U.S. Navy, is responsible for the overall management, implementation of contract field activities, and preparation of the MGBG CMS. This section presents the project management and organization for this CMS at the MGBG at NSWC Crane. Personnel from the Navy will be actively involved and will coordinate with TtNUS personnel in a number of areas. Details concerning the identities of key individuals and their roles are provided in the U.S. EPA-approved Phase III RFI QAPP (TtNUS, 2001). Changes specific to this QAPP Addendum No. 1 are explained below.

It is intended that the individuals named in this QAPP Addendum No. 1 will perform the designated responsibilities to the extent that the specific person is available to perform the stated activities. The authorities and organizational relationships of key personnel are depicted on Figure 2-1. Corresponding addresses and telephone numbers of key personnel are listed by organization in Table 2-1.

All changes to personnel from the Phase III RFI QAPP are bolded in Table 2-1. The following personnel, originally specified in the Phase III RFI QAPP, are *not* required for the work governed by this QAPP Addendum No. 1:

- TtNUS personnel experienced in screening environmental media for unexploded ordnance (UXO)
- Personnel experienced in the handling of environmental samples containing mustard gas

Personnel qualified to conduct gamma spectrometric analyses at a fixed-base laboratory will be required if field screening indicates that radiation levels exceed background levels. In that case, the applicable personnel (Pace Analytical, formerly Southwest Laboratory of Oklahoma) are identified in the U.S. EPA-approved MGBG QAPP (TtNUS, 2001).

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TABLE 2-1

KEY MUSTARD GAS BURIAL GROUND PROJECT PERSONNEL NAMES, PHONE NUMBERS, AND ADDRESSES[1]
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

PERSON / TITLE / ORGANIZATION	ADDRESS	TELEPHONE
Peter Ramanauskas Project Manager U.S. EPA Region 5	U.S. EPA Region 5 DW-8J 77 West Jackson Blvd. Chicago, IL 60604	(312) 886-7890 FAX: (312) 353-4788
Allen Debus QA Coordinator U.S. EPA Region 5	U.S. EPA Region 5 77 West Jackson Blvd. Chicago, IL 60604	(312) 886-6186
Marty Harmless Office of Solid and Hazardous Waste Management IDEM	Office of Solid and Hazardous Waste Management 100 N. Senate Avenue Indianapolis, IN 46206-6015	(317) 234-0597
Doug Griffin Corrective Action Section Office of Land Quality Hazardous Waste Permits IDEM	Corrective Action Section Office of Land Quality Hazardous Waste Permits 100 N. Senate Avenue P. O. Box 6015 Indianapolis, IN 46206-6015	(317) 233-2710
Bill Gates Remedial Project Manager U.S. Navy SOUTHNAVFACENGCOM	NAVFAC EFD South Code ES32 P.O. Box 190010 N. Charleston, SC 29406	(843) 820-7360 FAX: (843) 820-7465
Tom Brent Environmental Site Manager NSWC Crane	NSWC Crane **Code RP3-TB** Bldg 3245 300 Highway 361 Crane, IN 47522-5001	(812) 854-6160 FAX: (812) 854-3981
Debbie Wroblewski Program Manager Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220-2745	(412) 921-8968 FAX: (412) 921-4040
Paul Frank Quality Assurance Manager Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220-2745	(412) 921-8950 FAX: (412) 921-4040
Matt Soltis Health and Safety Manager Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220-2745	(412) 921-8912 FAX: (412) 921-4040
Tom Johnston Task Order Manager Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220-2745	(412) 921-8615 FAX: (412) 921-4040

TABLE 2-1

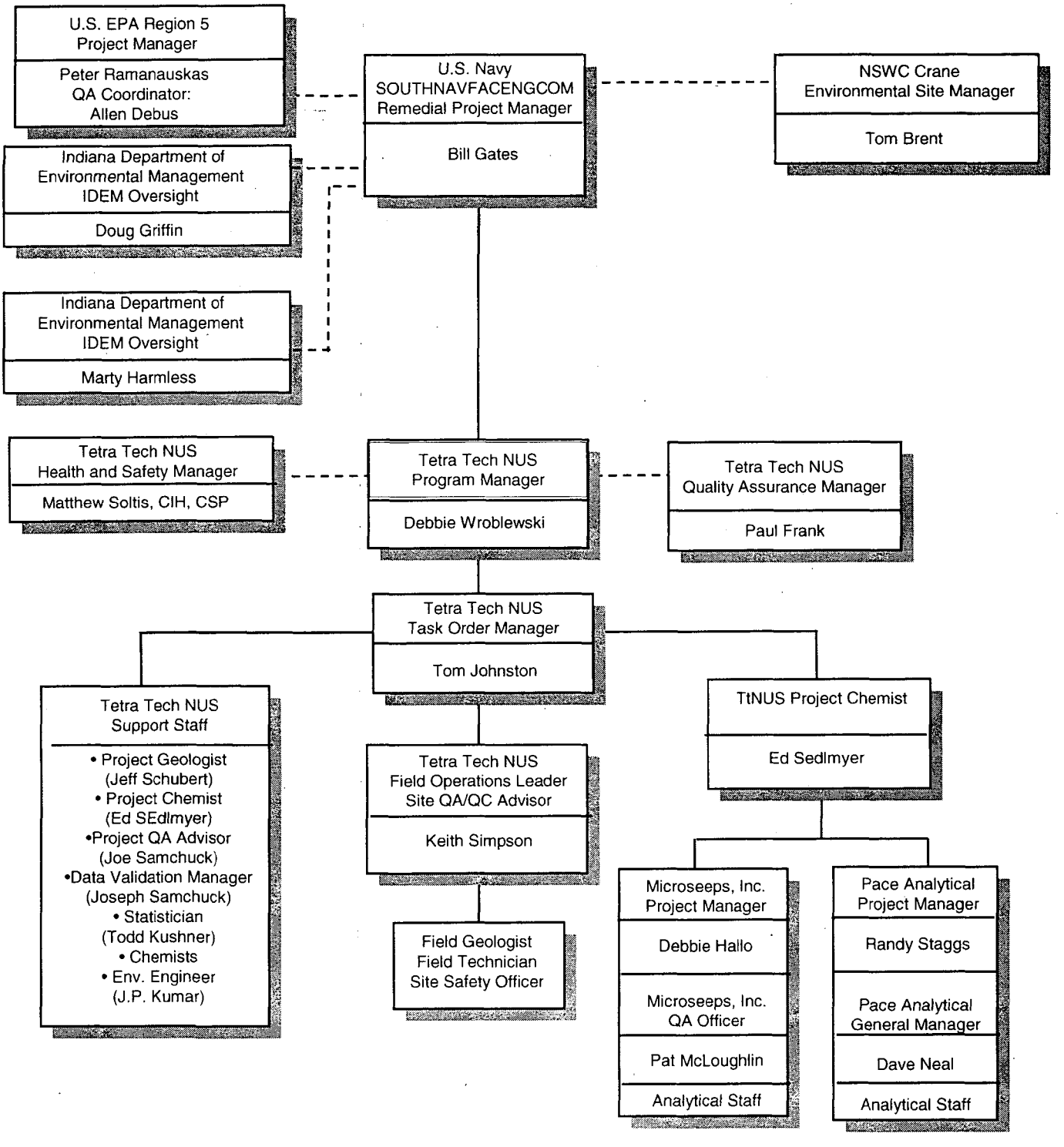
KEY MUSTARD GAS BURIAL GROUND PROJECT PERSONNEL NAMES, PHONE NUMBERS, AND ADDRESSES[1]
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA
PAGE 2 OF 2

PERSON / TITLE / ORGANIZATION	ADDRESS	TELEPHONE
Keith Simpson Field Operations Leader Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220-2745	(412) 921-8131 FAX: (412) 921-4040
Joseph Samchuck Data Validation Manager/Quality Assurance Advisor Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220-2745	(412) 921-8510 FAX: (412) 921-4040
Jeff Schubert Project Geologist Tetra Tech NUS	**Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220-2745**	**(412) 921-8794 FAX: (412) 921-4040**
Ed Sedlmyer Project Chemist Tetra Tech NUS	**Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220-2745**	**(412) 921-8704 FAX: (412) 921-4040**
Todd Kushner Statistician Tetra Tech NUS	**Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220-2745**	**(412) 921-8539 FAX: (412) 921-4040**
JP Kumar Chemical Engineer	**Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220**	**(412) 921-8825 FAX: (412) 921-4040**
Randy Staggs Project Manager Pace Analytical	**Pace Analytical (formerly S.W. Lab of OK) 1700 West Albany Broken Arrow, OK 74012**	**(918) 251-2858 FAX: (918) 251-2599**
Dave Neal Laboratory Director Pace Analytical	**Pace Analytical (formerly S.W. Lab of OK) 1700 West Albany Broken Arrow, OK 74012**	**(913) 599-5665 Ext. 226 Cell: (913)961-6325**
Debbie Hallo Customer Service Representative Microseeps, Inc.	**Microseeps, Inc. 220 William Pitt Way Pittsburgh PA 15238**	**(412) 826-5245 FAX: (412) 826-3433**
Pat McLoughlin QA Director Microseeps, Inc.	**Microseeps, Inc. 220 William Pitt Way Pittsburgh PA 15238**	**(412) 826-5245 FAX: (412) 826-3433**

1 Bolded text depicts changes from the Phase III RFI QAPP.

FIGURE 2-1

PROJECT ORGANIZATION CHART
SWMU 01 - MUSTARD GAS BURIAL GROUND
CORRECTIVE MEASURES STUDY
NSWC CRANE
CRANE, INDIANA



3.0 SAMPLING AND ANALYSIS PLAN

3.1 GENERAL APPROACH

The burial of HD bombs, thorium nitrate, and unknown research and development chemicals occurred at the MGBG between the 1940s and 1960s. Extensive geophysical surveys and exhumation of HD bombs occurred in 1974 and 1980. Based on interviews with base personnel and historical records, it is believed that no explosives or other UXO were ever buried in the MGBG nor has any ever been discovered there during the exhumations. It is also believed that all HD and demilitarized bombs have been exhumed from the MGBG. Although there is a remote possibility, some thorium or thorium compounds may still be present at the MGBG. During the recently completed Phase III RFI (TtNUS, 2003), soil samples collected throughout the MGBG showed no presence of UXO, HD, or elevated thorium concentrations.

In the early 1980s, 27 monitoring wells were installed around the MGBG, and a plume of chlorinated organic contaminants was discovered in the ground water, which was migrating primarily northwestward. However, during the recent RFI, only a trace of 1,1,2,2-PCA was detected in a single soil sample. Thus, the specific source area of the chlorinated VOCs migrating through the fractured bedrock is currently unknown.

This section describes locations and rationales for CMS sampling activities and the equipment and procedures to be used for collecting, handling, preserving, and shipping the samples to the analytical laboratories. Analytes to be evaluated in each environmental medium are listed in Tables 1-3 and 1-4. The text references SOPs (located in Appendix B) and the HASP (located in Appendix C), when applicable.

The field activities described in this QAPP Addendum include:

- Excavation of up to 10 trenches (i.e., test pits) in overburden soils to the top of the bedrock within and adjacent to the PBA to locate the primary source of VOCs in soils, if such a source is actually present.

- Use of a photoionization detector (PID) to screen soils as they are removed from the test pits. Any soil that exhibits detectable levels of VOCs will be sampled and analyzed for VOCs (up to six soil samples collected and analyzed for VOCs should be sufficient to support this effort).

- The VOC screening data from above will be used to select locations for two new shallow monitoring wells to be installed in or near the PBA.

- Measurement of gamma radiation levels of soils in the excavation backhoe bucket. If radiation levels exceed background radiation levels, soil samples will be submitted for gamma spectrometric analysis.

- Collection of ground water samples from 32 existing and two new monitoring wells.

- Measurement of water levels in all monitoring wells (synoptic survey).

- Survey of the locations of the two new monitoring wells and the test pits.

Prior to sampling, the Task Order Manager (TOM) will ensure that all field personnel read and understand the QAPP and HASP, the Field Operations Leader (FOL) will ensure that all required field equipment for non-health and safety operations is available and operational, and the Site Safety Officer (SSO) will ensure that all health and safety-related equipment is available and operational.

3.2 SAMPLE IDENTIFICATION SYSTEM

All samples will be properly labeled with an adhesive-backed sample label affixed to each sample container in accordance with SOP CTO315-01. The sample labels will include the following information: project name, project location, sample tracking number, sampling date, sampling time, type of analysis required, matrix type, preservative, initials of sampler, and the name of the analytical laboratory to which the sample will be submitted.

Each sample collected will be assigned a unique sample tracking number. The sample tracking number for soils is a four-segment, alphanumeric code beginning with the site designation ("01" represents SWMU 01) and followed by codes for the sample medium, sample location, and sample depth. The sample tracking number for the other media (surface water and ground water) is also a four-segment, alphanumeric code identifying the site ("01"), sample medium, sample location, and sampling round. For example, the first sample obtained from well 01T06 is designated as 01GWT0601. These numbering schemes are described in SOP CTO315-02. Previously assigned sample numbers (e.g., 01GWT0201 and 01GWT0202) will not be duplicated. Any other pertinent information regarding sample identification will be recorded in the field logbooks and on sample log sheets.

The sampling time recorded on the chain-of-custody form and labels for duplicate samples will be 0000 so that the duplicate samples are "blind" to the laboratory. Notes detailing the sample number, time, date, and type will be recorded on the sample log sheets and will document the location of the duplicate sample (sample log sheets are not provided to the laboratory).

Matrix spike and matrix spike duplicate (MS/MSD) samples will be designated on the field documentation forms and chain-of-custody form (see SOP CTO315-03).

3.3 SCREENING OF SOIL MATERIALS FOR METALLIC OBJECTS, GAMMA RADIATION, AND VOCs

Although the potential for encountering buried UXO is extremely low, caution will be used during all drilling or other intrusive activities.

All measurements made with the field screening instruments and visual observations concerning the soil materials brought to the surface will be recorded on test pit and/or borehole log sheets. Any encounters with metallic objects or discolored soil materials or any above-background measurements of VOCs or gross gamma radiation shall be immediately reported to the FOL and the SSO, and appropriate actions shall be taken as specified in the HASP.

Any soil material encountered during trenching activities will be sampled and analyzed for VOCs and/or radionuclides if above-background levels of VOCs or gamma radiation, respectively, are detected by the field screening instruments (Section 3.4.1). Any soil samples collected will be identified as to the trench location and depth from which it was obtained. All measurements made using the screening instruments and all visual observations will be recorded in the field log books. Thus, a complete record will be kept of materials and conditions that were encountered at each trench location.

Soil materials that may be contaminated with VOCs or radionuclides will be segregated from uncontaminated soils and managed as described in Section 3.11. When trenching and record-keeping at each trench location is completed, all uncontaminated soil materials excavated from the trench will be returned to the same trench and tamped down so that the ground surface is returned to approximately its original grade. The trench locations will be staked and surveyed and records will be maintained so that any soil material can be located and removed at a later date, if deemed necessary.

3.4 SAMPLING LOCATIONS, ANALYSES, AND RATIONALES

This section presents sampling locations, quality assurance (QA) samples to be collected, analyses to be performed, and rationales for the CMS sampling and analytical program. Details regarding the equipment and procedures for collecting, preserving, packaging, and shipping the samples are included in Sections 3.5 through 3.7 and the SOPs in Appendix B.

3.4.1 Surface and Subsurface Soils

A plume of ground water in shallow bedrock at the MGBG is contaminated with chlorinated VOCs (primarily 1,1,2,2-PCA and TCE) (see Figure 1-9, which shows only TCE). The highest concentrations of VOCs have been detected consistently in monitoring wells 01-02 and 01-05, which are located immediately north of the PBA (Figure 1-9). During the Phase III RFI, soil samples were collected throughout the MGBG and were analyzed for VOCs. However, only a trace (2 µg/kg) of 1,1,2,2-PCA was detected in a single soil sample. Thus, it is not clear whether there are any overburden soils in the PBA or surrounding area that contain VOCs. If VOCs are not present in overburden soil at concentrations greater than those observed to date, then the VOC mass is present almost entirely in the shallow bedrock in the vicinity of wells 01-02 and 01-05. These questions have significant implications for the formulation and evaluation of remedial alternatives during the CMS. Hence, the current trenching activities are being conducted to determine whether VOCs are present and where they are present in the overburden soils.

Soil trenching is being performed because the soil conditions and horizons in the sidewalls of a trench can be observed visually in more detail than can be observed in soil borings, lateral changes in soil materials can be observed in trenches, and a greater volume of soils can be screened for the presence of VOCs and radionuclides with the field instruments. In addition, the trenches (approximately 4 feet wide by 10 feet long) will extend to the top of bedrock. Personnel will make observations from outside the trenches.

A backhoe will be used for at least 1 day and possibly 2 days to dig trenches in the MGBG and PBA. A day of trenching will occur, starting near soil boring 01SB09 because 1,1,2,2-PCA was detected in that boring (chlorinated VOCs were not detected in any other soil boring). The intent will be to find a DNAPL source(s) in the soils. If no elevated PID or radiation readings are observed during the first day of trenching, and at least five trenches have been dug, then trenching activities will be terminated. However, if elevated readings are measured, or fewer than five trenches have been dug, then up to five more trenches will be excavated during a second day to delineate the extent of contaminated soil or to satisfy the FOL that no DNAPLs can reasonably be found in this manner. Trench alignments, depths, lengths,

etc. will be determined in the field based on conditions encountered. If potential contamination is encountered, the test trench(es) will be extended as necessary to delineate the lateral and vertical extent of contamination. The amount of time spent trenching will be decided by the FOL and will be based on whether VOCs are found or not, or to minimize generation of investigation-derived waste (IDW).

The area to be trenched is identified on Figure 3-1. The trenches [i.e., test pits (TP)] will be numbered in order of installation from 01TP01 to 01TPXX where XX represents the two-digit sequential trench number. The starting location for trenching will be near soil boring 01SB09 because 1,1,2,2-PCA and chloroform were previously detected in that boring.

As each trench is excavated, the soils will be screened for VOCs and gamma radiation then dumped in a limited area beside the trench. A geologist will observe the physical characteristics of the excavated soil (e.g., color, moisture content, and grain size distribution) and will scan the soils with a PID (SOP CTO315-04) and gross gamma scaler/ratemeter (SOP CTO315-05). All instrument readings and observations will be recorded on a TP log sheet.

If the field instruments indicate an elevated VOC or gamma radiation reading, the trenching will be temporarily halted and a soil sample will be collected. A sample will be collected for VOC analysis using EnCore™ samplers (SOP CTO315-08) if the PID indicates the presence of VOCs. A sample aliquot will be collected for radionuclide analysis if the gross gamma detector indicates an elevated level of radiation (SOP CTO315-05). Any soil samples collected will be identified using the soil trench number and the depth interval from which it was excavated; e.g., a soil sample collected from 4 to 6 feet deep in TP 3 would be labeled as sample number 01TP030406. The approximate lateral position within the trench, all measurement data, and other information related to the soil sample will be recorded on a soil sample log sheet (SOP CTO315-08). After the sample is collected, trenching will resume and will proceed to bedrock. If PID readings remain at background levels during the excavation of a trench, then a soil sample will still be collected from near the bottom of the trench for VOC analysis. After the trench bottom and one sidewall have been scraped clean by the excavator, the geologist will make a sketch of the trench and note any layering or other features observed.

The bottom and sides of the trench will be observed from outside the trench to determine whether water is seeping into the trench and from which side(s). These observations will be recorded in the field logbook. The backhoe will then replace any clean excavated soil back into the trench. The soil will be tamped down as it is replaced so the final grade of soil is returned as close as possible to the original grade. The backhoe will also smooth the surface so the area can be easily restored (i.e., seeded and mulched).

A sample will be collected from each trench during the trenching activities. The six samples collected from trenches and soil materials that displayed the highest PID readings will be sent to the laboratory and will be analyzed for VOCs. If fewer than six soil samples display PID readings above background, then one or more samples collected from trenches not having PID screening values above background will also be sent to the laboratory for VOC analysis. Thus, a total of six samples will ultimately be analyzed for VOCs. The samples selected for analysis that do not show elevated VOC readings will be selected by the FOL to most precisely bound any contaminated soil area. Up to six more samples may be collected for gamma spectrometric analysis (Table 3-2). These numbers of analyses should be sufficient to determine whether VOCs or radionuclide contaminants are present in the overburden soils at the MGBG, at what depths the contaminants occur, and the concentrations that might be present.

QA/quality control (QC) samples will be collected at frequencies listed in Table 3-2. One duplicate soil sample shall be collected for every 10 soil samples. Soil duplicates will be collected for those samples that have the greatest probability of containing contaminants (e.g., elevated levels of VOCs or radiation as indicated by the field screening readings). The duplicate samples should be placed in the same types of containers and handled in the same manner as the regular soil samples. The duplicate samples will be given unique QC sample IDs (see SOP CTO315-02). Because soil samples will be collected directly from the excavated soil with EnCore™ samplers, no other sampling equipment will be needed to collect the soil samples. Hence, no rinstate samples will be collected related to the soil samples. MS/MSD samples will be collected and analyzed in the fixed-base laboratory at a rate of 1 per every 20 soil VOC samples. For each cooler containing soil samples identified for VOC analysis (i.e., Encore™ samplers), a trip blank must also be stored in the cooler and continuously accompany the VOC samples until they have been analyzed. As samples are added to a cooler, the chain-of-custody form should be updated to include each new sample container (per SOP CTO315-03; see also Section 5.0). It is estimated that soil sampling will occur over a 1- to 2-day period and that all samples designated for VOC analyses will occupy the same cooler; therefore, one trip blank will be sent to the laboratory and analyzed for VOCs.

The width of each trench will be measured to the nearest half-foot or less and recorded on the field log. The location of the two ends of each soil trench will be marked with a wooden lath and flagging, and the trench location ID will be marked on the lath. In addition, a 2- by 2-inch wooden stake, 6 inches long, will be driven into the ground at the two ends of each trench. Each stake will have a piece of bright-colored flagging tacked onto its top and the trench location ID number indelibly marked on the side of the stake.

3.4.2 Ground Water

Between 1981 and 1984, the United States Army Corps of Engineers (USACE) installed 27 monitoring wells in bedrock in the vicinity of the MGBG (Figure 1-8). Ground water samples from select wells were collected and analyzed periodically between 1981 and 1986. One additional well (01CO1) was installed in 1993. Four additional wells (two shallow and two deep) were installed during the Phase III RFI in 2001 and 2002. Construction details for all 32 monitoring wells are summarized in Table 3-5.

Two new monitoring wells (01T06 and 01T07) will be installed within the MGBG (SOPs CTO315-07, -11, and -12) during this field effort to determine the ground water elevations and ground water quality near the center of the MGBG and under or adjacent to the PBA (Table 3-6). The wells will be installed in the first encountered water-bearing zone after the trenching activities have been performed. The tentative locations of the two new wells are shown on Figure 3-1. However, the locations of these wells may be adjusted depending on the results of the trenching activities. If trenching exposes soils that contain moderate concentrations of VOCs, the location of one or both wells will be moved immediately downgradient of the location where VOCs are detected in the soil. The objective will be to place the wells where the maximum lateral and vertical information can be obtained about VOC concentrations in ground water.

After the two new wells are installed, all 34 monitoring wells (32 existing and 2 new wells) will be sampled and analyzed for VOCs (Table 3-3). VOCs will be analyzed in every ground water sample because chlorinated VOCs were detected in most of the shallow wells prior to 1986 and more recently during the Phase III RFI.

During low-flow well sampling (SOP CTO315-14), the temperature, specific conductance, pH, dissolved oxygen, oxidation-reduction potential (ORP), and turbidity of the ground water will be measured (SOP CTO315-13) and recorded for each well (SOP CTO315-15).

One of the remedial alternatives to be evaluated during the CMS is monitored natural attenuation (MNA). Chemical data from eight monitoring wells have already been collected during the RFI to evaluate MNA (TtNUS, 2003). During this CMS field effort, 11 monitoring wells will be evaluated for geochemical conditions related to MNA (Table 3-3). Two of the wells (01-02 and 01-05) are located immediately north of the PBA and have historically had the highest concentrations of VOCs. Five of the wells (01-11, 01-14, 01-15, 01-19, 01-25, and 01T05) to be sampled for MNA parameters lie in a line extending from the PBA to the northwest. These wells lie near the centerline of the plume and have had significant concentrations of VOCs in the past. Data from these eight wells will be used to evaluate the ground water geochemical

conditions along the centerline of the plume and how these conditions vary with distance from the contaminant source. The other three monitoring wells to be sampled (01-01, 01-10, and 01-24) are located southeast, north, and northwest of the MGBG, respectively. These three wells are located near the periphery of the VOC plume and represent ground water geochemical conditions that exist surrounding the plume area.

The geochemical parameters that will be analyzed and used to evaluate the potential for MNA as a remedial option include 10 analytes or groups of analytes that will be analyzed in the fixed-base laboratory and 8 analytes that will be measured in the field within 4 hours of sample collection (Tables 3-1 and 3-3).

The total numbers of ground water samples to be analyzed for each analyte group are listed in Tables 3-1 and 3-4. The numbers of field QA/QC samples to be collected and analyzed are also listed in Table 3-4.

3.5 INVESTIGATION EQUIPMENT AND PROCEDURES

3.5.1 Backhoe Trenching for Soil Sampling

Soil trenching with a backhoe will be used to remove soil from the unconsolidated overburden. The procedures for soil logging and sampling are included in SOPs CTO315-07 and -08. As each bucket of soil is removed from a trench, it will be scanned for gross gamma levels and VOCs (SOPs CTO315-04 and -05) and placed on a tarp laid on the ground surface. The soil materials will be visually inspected and logged by the field geologist noting the soil texture, grain size (sand, silt, or clay), color (and any unusual discoloration), and moisture content. This information will be entered onto a TP log sheet.

If any soils are encountered that display an above-background reading with the PID, a soil sample will be collected for VOC analysis using three EnCoreTM samplers (SOP CTO315-08). The VOC samples will be collected from the soil materials that display the highest PID readings. If no PID readings are greater than background, three VOC samples will still be collected in order to verify whether or not VOCs are absent in the MGBG overburden soils. These soil VOC samples will be collected from near the bottom of trench 01TP01, and two other trenches which will be selected by the field geologist. The lateral and vertical locations of any soil samples within a trench will be estimated and recorded on the soil sample log sheet and the test pit log sheet.

If any soil samples exhibit radiation levels greater than background levels, a sample of soil will be collected, the location of the elevated reading will be noted, and the reading will be recorded. All results

will be recorded in the appropriate log book and/or on the appropriate field forms. Care must be taken to ensure that the background radiation measurements are representative of uncontaminated soils in the backhoe bucket.

For soil samples, the appropriate numbers and types of containers to be used for each sample aliquot are listed in Table 3-7. After the samples are properly containerized, labeled, tagged, and bagged (see SOP CTO315-01), they should be placed in a cooler containing ice until the samples can be properly packaged and prepared for shipment (SOP CTO315-17 and Section 3.7).

3.5.2 Inspection and Repair of Existing Monitoring Wells

Some of the existing wells may have broken casings, bent casings, missing caps, no locks, broken locks, and other problems since they were last sampled in 2002. Therefore, the existing wells will be located, inspected, and repaired if needed, at the beginning of this field effort. For example, broken or bent polyvinyl chloride (PVC) riser pipes above the ground surface will be sawed off, and new riser pipes will be added. Wells that cannot be repaired will not be sampled and will be properly abandoned. Caps and locks will be replaced if necessary. For damaged wells, the height of the casing above ground surface and the depth to the bottom of the well will be measured and recorded. This information will be compared to the boring logs and well construction logs to confirm that the wells are open through the screen interval. These activities are addressed in SOP CTO315-09. If the riser pipe is altered during well repairs, the repaired well will be resurveyed (see Section 3.9) to determine the new top-of-casing elevation.

3.5.3 Well Drilling

The approximate depths of the two new wells to be installed are listed in Table 3-6. Two holes, identified as 01T06 and 01T07 on Figure 3-1, will be cored through their entire length (2-inch diameter or larger). The lithology, fracture distribution, percent recovery, and other features of the rock core will be described by the field geologist. In addition, the rates of water produced during drilling will be carefully observed in order to identify rock zones that might be fractured and have above-average permeability characteristics. Procedures for drilling and logging a borehole in rock are included in SOP CTO315-10.

Because there is a possibility of encountering dense, non-aqueous phase liquid (DNAPL) in the bedrock or base of the overburden, the following procedures will be followed and precautions taken during drilling activities:

1. Be alert and constantly monitor for possible indicators of DNAPL presence:

- Sheen on drilling discharge water
- Unusual discoloration of water, especially if not attributed to suspended solids (i.e., drilling cuttings)
- High organic vapor readings/noticeable chemical/solvent odor in borehole discharge (air, water, cuttings, samples)
- Other potential indicators

Record in detail all borehole conditions encountered, observations made, and PID readings obtained during drilling operations, as per standard practice.

2. If observations indicate the potential presence of DNAPL, stop drilling immediately and obtain a sample of water/fluid from the bottom of the borehole, using a bottom-loading bailer. Visually examine the sample to determine whether phase separation/stratification of fluids is evident. Perform and document the results of DNAPL screening tests, such as:

- Add a small amount of Oil Red O dye to the sample and agitate - the dye is hydrophobic and will partition into a separate-phase liquid if present.

- Perform PID headspace analysis of the sample - readings of ≥20 ppm indicate possible DNAPL presence.

3. If these observations/tests further indicate **the potential for** (not necessarily confirmation of) DNAPL presence, terminate drilling operations immediately and notify the Task Order Manager and Geosciences Dept. Manager. Make every effort to minimize disturbance of the borehole environment, to minimize the potential for mobilizing the DNAPL. Do not drill any deeper than the depth zone where DNAPL is identified/suspected until the Project Manager, Geosciences Dept. Manager, Navy, and involved regulator(s) are all notified and agree to a follow-on course of action. Further advancement of the hole should be undertaken only with prior approval as described above and with extreme care to follow site-specific procedures developed for this situation. **It is extremely important to be aware of the incompatibility between various solvents and bentonite – in the presence of separate-phase (DNAPL) solvents, the swelling and sealing ability of bentonite is greatly diminished, thus the use of bentonite to seal off DNAPL zones can be ineffective.** If a borehole is to be advanced below a DNAPL zone, the DNAPL zone must be first isolated using a project-specific approved method (i.e., a steel casing grouted into place), and only with the prior approvals described above.

As each length of rock core is brought to the ground surface, the core will be extruded into Flute™ System fabric as described in SOP315-21. This fabric absorbs fluids from the surface of the core and is used to qualitatively determine whether non-aqueous phase liquids (NAPLs) are present in the core materials and at which specific locations (e.g., discrete fractures) it is present (SOP CTO315-21). The cores will be photographed and logged after the NAPL Flute™ test is completed. PID readings will be made of the fabric-covered core by making slits in the outer plastic liner and fabric, then inserting the PID probe through the slits.

After these two holes have been cored and logged, they will be enlarged to a diameter of approximately 6 inches.

3.5.4 Installation of Monitoring Wells

Two permanent monitoring wells will be installed. The well screens will be installed in the uppermost water-bearing sandstone, similar to nearby wells 01-02, 01-05, and 01-11 (See Figure 1-5). Therefore, the screens of the new wells will be at an elevation of approximately 645 to 655 feet above mean sea level. The rock cores will be examined in detail and any observed fractures and fracture density will be noted on the boring logs for each boring. The well screens will be positioned to intercept as many of the water-bearing fractures as possible. The wells will be constructed of 2-inch-diameter, Schedule 40, flush joint PVC riser pipe and screen (SOP CTO315-11). In each well, the screen will be 10 feet long and have a slot size of 0.02 inch (factory slotted). All riser pipe and screen sections will be new and certified clean. Each well will consist of 10 feet of slotted screen and enough solid riser pipe so that the riser will extend about 2.5 feet above the ground surface.

A sand filter pack will be placed around the annulus of the well screen from the bottom of the hole to 3 feet above the top of the well screen. Three feet of bentonite chips will be placed above the sandpack and will be allowed to wet and expand before grout is added to the hole. The remainder of the well annulus will be filled to the ground surface with a cement-bentonite grout mixture. A tremie pipe will be used to place grout in the well annulus to help ensure a good seal.

A black steel, outer protective casing will extend at least 2.5 feet below the ground surface to no more than 4 inches above the inner PVC well cap. The outer steel casing will have a hinged removable cap and a padlock. A 6-inch-thick, 4- by-4-feet concrete pad will be placed around the well at ground surface. In addition, four barrier posts will be installed at the corners of the concrete pad. Details regarding well

construction, sand pack and grout materials, the outer protective casing, the well pad, and the protective barrier posts are included in SOP CTO315-11.

3.5.5 Well Development

The two new monitoring wells will be developed in accordance with SOP CTO315-12 to remove fine sediment from inside and around the well screens. The method of well development can be either vigorous on-and-off pumping, or surge block and pumping. Field measurements of pH, specific conductance, temperature, and turbidity will be performed at 5- to 10-minute intervals on the water retrieved from the well, in accordance with SOP CTO315-12. Well development will continue until at least two times the amount of water added during drilling (if any) is removed from the well. After this initial purge, well development will continue until three consecutive readings of pH, specific conductance, and temperature are within 10 percent of each other, and three consecutive turbidity readings are within 5 nephelometric turbidity units (NTUs) of each other. If these criteria cannot be met after five well volumes of water have been removed, one additional well volume will be removed and well development will be considered complete.

All water removed from the well during the development process will be containerized and discharged to the sanitary sewer system for treatment and disposal at the NSWC wastewater treatment plant (SOP CTO315-20).

3.5.6 Water Quality Field Measurements

Field measurements of water quality parameters including pH, specific conductance, ORP, temperature, dissolved oxygen (DO), and turbidity will be performed on ground water in a flow-through cell attached to a pump discharge line. These measurements will be performed during well development (Section 3.5.5) and low-flow well sampling (Section 3.5.7). These field measurements (excluding turbidity) will be made using a YSI 6-Series Environmental Monitoring System or equivalent type of instrument. Turbidity measurements will be made using a LaMotte turbidity meter or equivalent. Calibration and measurements made with the field instruments will be in accordance with Section 6.1 and SOPs CTO315-13 and -14.

Each calibration of an instrument will be recorded on an equipment calibration log sheet. Water quality measurements along with date, time, instrument operator, and visual and other observations (e.g., weather conditions) will be recorded on well development logs (SOP CTO315-12), sample collection logs (SOP CTO315-15), or in field notebooks, as appropriate.

3.5.7 Low-Flow Sampling of Monitoring Wells

Low-flow sampling procedures will be used to collect ground water samples from existing and new wells (SOP CTO315-14). The depth to ground water in many of the wells is greater than 20 feet (Table 3-5); therefore, a compressed air bladder pump will be used to slowly pump ground water from the well at about 100 milliliters per minute (mL/min). Low-flow pumping will proceed until readings of water temperature, pH, specific conductance, DO, ORP, and turbidity stabilize. However, if the readings have not stabilized after 4 hours, sample collection will proceed. Appropriate sample bottles shall be filled directly from the pump discharge tube (see Tables 3-3 and 3-8). The bottles will be properly labeled, tagged, bagged, and placed in an ice-filled cooler as quickly as possible (SOPs CTO315-01 and -17). A ground water collection log sheet will be completed for each ground water sample collected (SOP CTO315-15).

All monitoring wells will be sampled for VOC analysis. Eleven of the wells will also be sampled and analyzed for field and laboratory MNA parameters (Table 3-3).

The wells will be sampled in order of least contaminated to most contaminated, based on historical data. This approach will lessen the possibility of incurring cross contamination between wells. After each ground water sample is collected, the pump will be decontaminated (SOP CTO 315-19). For every 10 ground water samples collected, a rinsate blank sample will be collected to ensure that decontamination of the pumps is effectively accomplished. The rinsate blank will be collected by pumping distilled water through the pump and placing the pump discharge water directly into sample containers. The appropriate sample containers and preservatives for each analyte group are listed in Table 3-8.

For each cooler containing samples identified for VOC analysis, a trip blank will be included in the cooler. The trip blank will accompany the VOC samples until they have been analyzed for VOCs. As samples are added to a cooler, the chain-of-custody form will be updated to include each new sample container (SOP CTO315-03).

3.5.8 Ground Water Level Measurements

When the two new wells have been installed and developed, water-levels will be measured in all wells. All water level measurements will be taken within a 24-hour period of consistent weather conditions using an electronic water level meter (per SOP CTO315-18). Water level elevations will be recorded to within a 0.01-foot accuracy from a marked reference point on the well riser pipe. Detailed procedures regarding water level measurements are included in SOP CTO315-18.

Water levels will be recorded on a TtNUS water level form. A blank water level form is provided in SOP CTO315-18 for reference purposes.

The water level meter and pump will be decontaminated between each well; decontamination procedures are addressed in SOP CTO315-19.

3.6 QUALITY CONTROL SAMPLES

This section focuses on field QC samples that will be collected as part of this environmental investigation. Field QC samples include field duplicates, source water blanks, equipment rinsate blanks, and trip blanks. Tables 3-2 and 3-4 present the types and numbers of required field QC samples to be collected for soil and ground water sampling activities, respectively, during the CMS field effort. Section 8.1 provides definitions and details for these and all other QC checks to be used during this investigation. Field QC sample requirements for field duplicates, source water blanks, equipment rinsate blanks, and trip blanks required for this project are described below. The frequencies of non-calibration QC checks are provided in Table 3-9.

Ambient Condition Blanks. There is no anticipated need to collect these blanks.

Field Duplicates. Field duplicates are obtained during a single act of sampling and are used to assess the overall precision of the sampling and analysis program. Duplicate samples will be collected at a rate of 1 for every 10 environmental samples of each type of environmental medium. All duplicate samples will be analyzed for the same parameters in the laboratory as their environmental sample counterparts. Duplicate samples will be preferentially collected where field evidence (e.g., PID reading, gross gamma readings, or odor) indicates that contamination is likely to be present in the environmental sample.

Equipment Rinsate Blanks. Equipment rinsate blanks will be obtained under representative field conditions by running analyte-free water through sample collection equipment after decontamination and placing it in the appropriate sample containers for analysis. Equipment rinsate blanks will be collected for non-dedicated equipment for all sampling rounds. No rinsate blanks are anticipated for soil sampling activities because samples for VOC analysis will be collected directly from the piles of excavated soil using EnCore™ samplers. For ground water samples, analyte-free water will be pumped through a decontaminated pump and tubing that will be used for ground water sampling.

Source Water Blanks. Source water blanks will be obtained by sampling each water source (e.g., potable water and distilled water) used for decontamination activities during the field investigation. Source water blanks will be used to determine if the water or the laboratory bottles are contributing to sample contamination. Source water blanks will be collected for each type of water used for decontamination and will be submitted at a frequency of one per sampling event. Source water blanks, as applicable, will be analyzed for the entire suite of parameters under investigation. It is anticipated that two source water blanks will be collected – one potable water sample and one sample of distilled water used for decontamination.

Trip Blanks. Trip blank samples are 40-milliliter (mL) glass vials that contain analyte-free water and are prepared by the analytical laboratory prior to the start of field activities. They should be stored in a sealed container until they are needed. During sampling activities, one trip blank shall be placed in each cooler that contains environmental samples destined for VOC analysis. The trip blank shall be properly labeled and added to the chain-of-custody form associated with the cooler (SOP CTO315-03). Trip blanks are only analyzed for VOCs.

Temperature Blanks. Temperature blanks are vials of water inserted into each cooler. The temperature of the temperature blank is measured prior to shipping the cooler to the laboratory and upon receipt at the laboratory to verify that samples were properly cooled during transit.

3.7 SAMPLE HANDLING, PACKAGING, AND SHIPPING

3.7.1 Sample Preservation

Preservation requirements for each of the chemicals of interest are provided in Tables 3-7 and 3-8. All soil samples require only to be cooled to 4°C ± 2°C; no chemical preservatives are necessary. Sample bottles for aqueous samples will contain the proper amounts and types of preservatives prior to being shipped to NSWC Crane (Table 3-8). The preservatives placed in the sample bottles will be certified to be free of analytes being tested in the samples. All samples will be promptly chilled with ice to 4°C ± 2°C and packaged in an insulated cooler (SOP CTO315-17). Each cooler will include a temperature blank. Ice will be sealed in containers to prevent water leakage. Samples will not be frozen.

3.7.2 Sample Labeling

Before samples are packaged, the sample labels and tags should be checked to ensure that all information on the label and tag is complete and correct (SOP CTO315-01). This information should also

be checked to ensure that it matches the information placed on the sample collection log sheets and the chain-of-custody form.

3.7.3 Sample Packaging

Each glass sample container will be placed in a bubble-wrap sleeve to protect it from breakage. The sample container will then be placed in a zip-lock bag to prevent cross-contamination or leakage (SOP CTO315-17). Only shipping containers that meet all applicable State and Federal standards for safe shipment will be used. Cube ice will be placed in plastic bags and placed around and between the samples in sufficient quantity to ensure that the samples remain chilled (4°C ± 2°C) during transport to the analytical laboratory.

The completed field chain-of-custody document will be signed, placed in a sealed plastic envelope, and taped to the top inside cover of the shipping container (SOP CTO315-03).

SOP CTO315-17 provides a detailed description of sample handling, packaging, and shipping procedures required for this project. The FOL will be responsible for ensuring the completion of the following forms:

- Sample Labels
- Chain-of-Custody Forms
- Custody Seals for Coolers
- Shipping Labels for Coolers
- Express Mail Air Bills

3.7.4 Sample Shipping

Shipping containers (i.e., coolers) will be sealed with nylon strapping tape in at least two places, and custody seals will be signed, dated, and affixed in a manner that will allow the receiver to quickly identify any tampering that may have occurred during transport to the laboratory (SOPs CTO315-03 and -17).

Shipment will be made by a public courier at the next scheduled pickup following completion of sample collection. Copies of the express mail air bills should be retained by the FOL for tracking purposes, if needed, and for communications with the laboratory. Air bills will be retained for the permanent record file.

3.7.5 Sample Custody

Custody of samples must be maintained and documented at all times as per SOP CTO315-03 beginning with the collection of samples in the field. Sample custody procedures are addressed in Section 5.0.

3.8 RECORD KEEPING

Standard forms, field notebooks, and a field log book will be used to record all sample collection activities, field measurements, observations concerning site conditions, and other project-related information. These records include sample log sheets, daily activity records, field logbooks, drilling and well completion log sheets, and field instrument calibration log sheets, among others. More details regarding record keeping are included in SOP CTO315-03.

3.8.1 Field Log Books

Bound, weatherproof field notebooks shall be maintained by sampling personnel. All information related to sampling and other field activities will be recorded in field notebooks. This information will include, but is not limited to, sampling time, weather conditions, unusual events, field measurements, and descriptions of photographs.

A bound, weatherproof logbook shall be maintained by the FOL. This book will contain a summary of each day's activities and will reference the field notebooks when applicable.

3.8.2 Drilling and Well Completion Logs

A drilling log will be completed for every drill hole installed during these field activities. A geologist will complete the borehole log, which will include information regarding date, time, personnel, drilling and sampling equipment, geologic materials encountered, fracture locations and density in bedrock (where appropriate), color, texture, odors, and readings made with screening instruments (see SOPs CTO315-04, -05, -07, and -10).

A well completion log will be completed for every monitoring well constructed. These logs will include information concerning the date, time of events, quantities of construction materials used, lengths and diameters of riser pipe and well screen placed in the well, and other information as described in SOP CTO315-11.

3.8.3 Well Development Log Sheets

During the development or redevelopment of each monitoring well, the date, time of events, development method and equipment, personnel present, amounts of water produced, measurements made by field water quality meters, and depths to water will be recorded on a well development log sheet, as described in SOP CTO315-12.

3.8.4 Equipment Calibration Logs

An equipment calibration log sheet will be used to record each time an instrument is calibrated or recalibrated and each time calibration is checked against a standard or background. The procedures and standards to be used for instrument calibration are summarized in Table 3-1 and discussed in Section 6.1.

3.8.5 Sample Collection Logs

One sample collection log sheet will be completed for every environmental sample, every duplicate sample, and every field blank sample collected during the field activities. Only the MS and MSD samples do not require their own individual sample collection log sheet.

3.8.6 Chain-of-Custody Forms

A chain-of-custody form will be completed for every cooler that contains samples being shipped to an off-site laboratory for analyses. These forms are a record of the people having custody of the samples from the time the samples are collected to the time they are analyzed and disposed (see SOP CTO315-03). The completed field chain-of-custody document will be signed, placed in a sealed plastic envelope, and taped to the top inside cover of the shipping container before it is shipped. A copy of the document will be retained by the FOL.

3.8.7 Shipping Forms/Airbills

Copies of all forms and/or airbills related to the shipment of coolers will be retained by the FOL to trace the shipment, if necessary, and to communicate with the receiving laboratory.

3.8.8 Permanent Record File

At completion of the field activities, the FOL shall submit to the TOM all field records, data, field notebooks, logbooks, chain-of-custody records, sample log sheets, daily activity logs, and other records concerning the project, including all of the forms and log sheets listed above. The FOL will check these records for legibility and completeness prior to submitting them to the TOM. These forms, data, and field notes will become part of the permanent project record.

3.9 SURVEYING

The horizontal and vertical locations of the two new monitoring wells, any reconstructed wells, and all TPs (stakes at both ends of each trench) will be surveyed. The horizontal location will be surveyed to the Indiana State Plane Coordinates within the nearest foot and referenced to the 1983 North American Datum (NAD83). The vertical elevations of the ground surface and top of casing will be measured to the nearest 0.1 foot and referred to the 1988 North American Vertical Datum (NAVD)

3.10 EQUIPMENT DECONTAMINATION

All re-usable equipment used to collect soil and ground water samples will be decontaminated in accordance with SOP CTO315-19. The backhoe bucket will be decontaminated after excavating at each location and prior to starting a new excavation. This will be accomplished by scraping and brushing as much dirt and debris as practicable from the bucket. All decontamination fluids will be containerized, transported to the sanitary sewer system, and treated in the NSWC Crane wastewater treatment plant prior to disposal (see SOP CTO315-20).

3.11 MANAGEMENT OF INVESTIGATION-DERIVED WASTE

It is anticipated that this investigation will generate the following types of potentially contaminated residues or investigation-derived waste (IDW):

- Personal protective equipment (PPE) and ground water sample tubing
- Well development and purge fluids
- Equipment decontamination fluids
- Waste soils and cuttings from well installation and test pitting (trenching)

IDW will be handled as described below:

PPE - All PPE will be double-bagged and placed in trash receptacles at the facility.

Well Development and Purge Fluids - All well development and purge fluids will be containerized. Development and purge fluids will be discharged to the NSWC Crane permitted sanitary sewer system for treatment and disposal.

Equipment Decontamination Fluids - All decontamination fluids will be combined with well development and purge fluids and handled in the same manner.

Waste Soils from Soil Borings and Trenches – For each drill hole and trench, the soils obtained from the holes will be scanned for VOCs and gross gamma radiation. If all readings from these screening instruments are at or less than background levels, the soil cuttings and excess core material will be spread on the ground surface or returned to the excavation in the case of trench soils, smoothed, and tamped for compaction.

If a field instrument indicates that contaminants are present in the excess soil materials, the excess soils from these holes will be placed in black plastic trash bags, labeled, and placed in 55-gallon sealable drums. The bags will be tagged and the drums will be clearly labeled regarding the dates, locations, and depths from where the soils originated and the personnel (including phone number) placing the soil in the drum. Also included will be the name and phone number for Mr. Tom Brent (see Table 2-1). The drums will be placed on palettes to elevate them above the ground. When analytical results are received from the laboratory concerning contaminant concentrations, decisions will be made as to how the soil materials will be disposed (SOP CTO315-20).

Tubing Used for Development, Purging, or Sampling - All tubing used to develop, purge, or sample a well will be double-bagged and placed in a trash receptacle at the facility.

3.12 SAFETY

Health and safety issues and concerns are critically important during any field investigation involving drilling, hazardous wastes, radioactive wastes, and chemical warfare agents. Sampling team members working at the site must be fully aware of the potential dangers involved with sampling activities, must be trained and prepared to deal with problems or health-related issues as they arise, and should minimize to the greatest possible extent the potential for exposure to harmful chemicals or accidents. To ensure that field activities are performed at a high level of safety, the elements as discussed in the following two

sections are included in the health and safety activities related to the sampling program addressed by this QAPP Addendum.

3.12.1 Health and Safety Plan

A separate HASP has been prepared describing specific health and safety requirements, concerns, and information related to the site activities (Appendix C). This document must be read and understood by each person working at the site. Each worker or visitor to the site must sign an acknowledgment that he or she has read and understands the HASP.

3.12.2 Health and Safety Training

All workers involved with the site investigations shall have successfully completed the training specified in Section 8.0 of the HASP. TtNUS and subcontractor personnel will supply OSHA documentation to the FOL before beginning work. Personnel who do not comply with this requirement must receive verbal approval to work from TtNUS corporate health and safety personnel.

3.12.3 Personal Protective Clothing and Equipment

Workers at the site must be part of a medical monitoring program and be medically approved to perform their duties without physical limitations. Protective clothing and equipment, as specified in the HASP, will be worn while performing site activities.

3.12.4 Safety Meetings

Safety meetings will be held among on-site workers in accordance with the HASP and whenever the SSO feels it is appropriate. The SSO will discuss safety issues related to activities being performed, and will make site workers aware of any new conditions that could potentially affect health or safety.

3.13 ORGANIZATION AND LOGISTICS OF FIELD INVESTIGATIONS

3.13.1 Personnel

The duties, responsibilities, and line of command for each person working on the project are described in Section 2.0 and displayed on Figure 2-1. Persons working on the project will be intimately familiar with their roles and responsibilities. In addition, they will be familiar with the mechanisms and procedures for coordinating tasks, improving communications, and reporting incidences or irregularities. The FOL is

responsible for coordinating all on-site personnel and activities. The SSO is responsible for health and safety monitoring and ensures that the HASP is adhered to during all field activities.

3.13.2 Subcontractors

Subcontractors will perform site activities involving drilling, well installation, and surveying. The FOL will direct all subcontractor activities.

3.13.3 Mobilization and Demobilization

Following approval of this QAPP Addendum No.1, TtNUS will begin mobilization activities. All field team members will review this QAPP Addendum (and associated HASP) prior to mobilization. In addition, a field team orientation meeting will be held to familiarize personnel with the scope of the field activities. Items to be presented during that meeting include:

- Identification of the QAPP, including the HASP (Appendix C) and applicable field SOPs (Appendix B).
- Site-specific safety concerns and requirements.
- Project objectives.
- Sampling designs and strategies for soil and ground water (including the relationship of soils data for this project to NSWC Crane background soil data).
- Site-specific particulars of field operations (e.g., locations of utilities, physical access to sampling location, communication mechanisms, lines of authority and responsibility, scheduling requirements, sample shipping concerns, etc.).
- Subcontractor coordination.
- Field decision authority.
- Site access requirements.
- Travel requirements.

The FOL will coordinate the mobilization activities for this project. The equipment required for the field activities will be mobilized from the TtNUS Pittsburgh office or the field office at NSWC Crane. The MGBG is in a fairly remote area of the base. As a result, electricity is not available on site. Therefore, power for electric pumps and all other electric-powered equipment, if required, will be supplied from portable gas-powered generators. It is anticipated that no portable gas-powered equipment will be used during field operations but if conditions arise that require such equipment, an application for their use will be made to the NSWC Crane Fire Department.

The FOL and crew will demobilize from the site upon completion of the field operations. All areas will be thoroughly checked; trash will be removed and disposed. All drums containing IDW will be checked to ensure that lids are secured and proper labels have been attached to the drums.

All areas disturbed by the drill rig, backhoe, or other vehicles or sampling activities will be smoothed, seeded, and mulched (with straw) to ensure that the disturbed areas are restored to satisfactory conditions.

3.13.4 Schedule

Approximately 20 working days have been scheduled to perform the CMS field activities at the site. The activities will be performed in approximately the following order:

1. Perform soil trenching and soil sampling activities
2. Drill, install, and develop two new monitoring wells
3. Sample all monitoring wells
4. Measure water levels in all monitoring wells
5. Survey two new monitoring wells and each trench location
6. Restore all disturbed areas

TABLE 3-1

FIELD SCREENING AND MEASUREMENTS
SWMU 01- MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Parameter	Equipment	SOP	Calibration
Volatile Organics	Perkin-Elmer Photovac 2020 Photoionization Detector	SOP CTO315-04	Per Manufacturer
pH; Temperature; Oxidation-reduction potential; Specific Conductance; Dissolved Oxygen (water-quality parameters)(1)	YSI 6-Series Environmental Monitoring System	SOP CTO315-13	Per Manufacturer
Turbidity (water-quality parameter)(1)	LaMotte Turbidity Meter	SOP CTO315-13	Per Manufacturer
Water Level Measurements	Heron Dipper-T (or equivalent)(2)	SOP CTO315-18	Per Manufacturer
Iron (+2), i.e., ferrous iron; Manganese (+2); Nitrite (as N); Sulfide	Hach Colorimeter (DR-850) and Test Kits	SOP CTO315-16	Per Manufacturer
Alkalinity; Carbon Dioxide; Dissolved Oxygen; Hydrogen Sulfide	CHEMetrics and Hach Test Kits	SOP CTO315-16	Per Manufacturer
Gross Gamma Radiation	Ludlum Model 2221 or Eberline Model ESP-1 scaler/ratemeter with 2" x 2" NaI detector	SOP CTO315-05	Per Manufacturer

1 Field measurements used to establish well stabilization prior to collecting ground water samples.
2 Any electronic water-level indicator with the capability of measuring to depths of 100 feet may be used.
SOP = Standard operating procedure.

TABLE 3-2

LISTING OF ENVIRONMENTAL SAMPLES, QA/QC SAMPLES, AND LABORATORY ANALYSES FOR SOILS[1]
SWMU 01 – MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Sample Location	Volatiles SW-846 8260B	Gamma Spectroscopy[2]
Environmental Samples[3]		
01TPaabbcc	1	-
01TPaabbcc	1	-
01TPaabbcc	1	-
01TPaabbcc	1	-
01TPaabbcc	1	-
01TPaabbcc	1	-
Field QA/QC Samples		
Field Duplicate[4]	1	-
Trip Blank[5]	1	-
Rinsate Blank[6]	0	-
Source Water Blank	0	-
Matrix Spike[7]	1	-
Matrix Spike Duplicate[8]	1	-

1 See Table 1-4 of this QAPP Addendum No. 1 for specific analysis requirements and analyte lists.

2 A soil sample will be collected for radionuclide analysis by gamma spectrometry only if a gross gamma screening measurement exceeds the background radiation level (SOP CTO315-05).

3 "aa" represents the two-digit number for the test pit number; "bb" and "cc" represent the depths below ground surface for the top and the bottom, respectively, of the sample interval.

4 Field duplicates will be collected at a frequency of 1 per every 10 samples per SWMU.

5 Trip blanks will be submitted for analysis at a frequency of one per cooler containing samples for VOC analysis. Because the number of sample coolers shipped may vary, the number of trip blanks is estimated.

6 Rinsate blanks will be collected at a frequency of 1 per every 10 samples, with a minimum of one per day of sampling per sampling device or instrument. These amounts are estimates and may vary.

7 Matrix spikes are collected for all organic and inorganic parameters at a frequency of 1 per every 20 field samples per matrix.

8 Matrix spike duplicates are collected for all organic parameters. Lab duplicates are analyzed for inorganic parameters in lieu of matrix spike duplicates. Matrix spike duplicates are collected at a frequency of 1 per every 20 field samples per matrix.

TABLE 3-3

GROUND WATER SAMPLES AND LABORATORY ANALYSES[1]
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample ID	Volatiles SW-846/8260B	Laboratory MNA Parameters									Field MNA Parameters[3]
			Nitrate + Nitrite (as N)	Chloride	Sulfate	Total Hardness (as CaCO3)	Dissolved Organic Gases[2]	Dissolved Hydrogen	Total Organic Carbon	Total Inorganic Carbon	Volatile Fatty Acids	
Ground Water Samples from Monitoring Wells												
01-01	01GW0103	1	1	1	1	1	1	1	1	1	1	1
01-02	01GW0203	1	1	1	1	1	1	1	1	1	1	1
01-03	01GW0303	1	-	-	-	-	-	-	-	-	-	-
01-04	01GW0403	1	-	-	-	-	-	-	-	-	-	-
01-05	01GW0503	1	1	1	1	1	1	1	1	1	1	1
01-06	01GW0603	1	-	-	-	-	-	-	-	-	-	-
01-07	01GW0702	1	-	-	-	-	-	-	-	-	-	-
01-08	01GW0803	1	-	-	-	-	-	-	-	-	-	-
01-09	01GW0903	1	-	-	-	-	-	-	-	-	-	-
01-10	01GW1003	1	1	1	1	1	1	1	1	1	1	1
01-11	01GW1103	1	1	1	1	1	1	1	1	1	1	1
01-12	01GW1202	1	-	-	-	-	-	-	-	-	-	-
01-13	01GW1302	1	-	-	-	-	-	-	-	-	-	-
01-14	01GW1403	1	1	1	1	1	1	1	1	1	1	1
01-15	01GW1503	1	1	1	1	1	1	1	1	1	1	1
01-16	01GW1601	1	-	-	-	-	-	-	-	-	-	-
01-17	01GW1702	1	-	-	-	-	-	-	-	-	-	-
01-18	01GW1802	1	-	-	-	-	-	-	-	-	-	-
01-19	01GW1902	1	1	1	1	1	1	1	1	1	1	1
01-20	01GW2002	1	-	-	-	-	-	-	-	-	-	-
01-21	01GW2102	1	-	-	-	-	-	-	-	-	-	-
01-22	01GW2202	1	-	-	-	-	-	-	-	-	-	-
01-23	01GW2303	1	-	-	-	-	-	-	-	-	-	-
01-24	01GW2402	1	1	1	1	1	1	1	1	1	1	1
01-25	01GW2503	1	1	1	1	1	1	1	1	1	1	1

TABLE 3-3

GROUND WATER SAMPLES AND LABORATORY ANALYSES[1]
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample ID	Volatiles SW-846/8260B	Laboratory MNA Parameters									Field MNA Parameters[3]
			Nitrate + Nitrite (as N)	Chloride	Sulfate	Total Hardness (as CaCO3)	Dissolved Organic Gases[2]	Dissolved Hydrogen	Total Organic Carbon	Total Inorganic Carbon	Volatile Fatty Acids	
01-26	01GW2603	1	-	-	-	-	-	-	-	-	-	-
01-27	01GW2702	1	-	-	-	-	-	-	-	-	-	-
01C01	01GWC0103	1	-	-	-	-	-	-	-	-	-	-
01T02	01GWT0204	1	-	-	-	-	-	-	-	-	-	-
01T03	01GWT0302	1	-	-	-	-	-	-	-	-	-	-
01T04	01GWT0402	1	-	-	-	-	-	-	-	-	-	-
01T05	01GWT0502	1	1	1	1	1	1	1	1	1	1	1
01T06	01GWT0601	1	-	-	-	-	-	-	-	-	-	-
01T07	01GWT0701	1	-	-	-	-	-	-	-	-	-	-
Total Ground Water Samples		34	11	11	11	11	11	11	11	11	11	11

1 See Table 1-4 of this QAPP Addendum No. 1 for specific analysis requirements and analyte lists.
2 Dissolved organic gases comprise acetylene, *n*-butane, *i*-butane, ethane, ethene, methane, propane, and propene.
3 Monitored Natural Attenuation (MNA) field parameters include field measurements of alkalinity, carbon dioxide, dissolved oxygen, hydrogen sulfide, iron (+2), manganese (+2), nitrite (as N), and sulfide (SOP CTO315-16).

TABLE 3-4

SUMMARY OF GROUND WATER ANALYSES[1] AND QA/QC SAMPLES
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Sample Type	Volatiles SW-846/8260B	Laboratory MNA Parameters									Field MNA Parameters[3]
		Nitrate + Nitrite (as N)	Chloride	Sulfate	Total Hardness (as CaCO3)	Dissolved Organic Gases[2]	Dissolved Hydrogen	Total Organic Carbon	Total Inorganic Carbon	Volatile Fatty Acids	
Total Ground Water Samples	**34**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**
Field Duplicate[4]	4	1	1	1	1	1	1	1	1	1	1
Trip Blank[5]	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rinsate Blank[6]	4	2	2	2	2	NA	NA	2	2	2	NA
Source Water Blank	1	1	1	1	1	NA	NA	1	1	1	NA
Matrix Spike[7]	2	1	1	1	NA	NA	NA	NA	NA	1	NA
Matrix Spike Duplicate[8]	2	NA	NA	NA	NA	NA	NA	NA	NA	1	NA

1 See Table 1-4 of this QAPP Addendum No. 1 for specific analysis requirements and analyte lists.
2 Dissolved organic gases include acetylene, butane, ethane, ethene, methane, propane, and propene.
3 Monitored Natural Attenuation (MNA) parameters include field measurements of dissolved oxygen, alkalinity, carbon dioxide, hardness, nitrite (as N), iron (+2), manganese (+2), sulfide, and hydrogen sulfide (SOP CTO315-16).
4 Field duplicates will be collected at a frequency of 1 per every 10 samples.
5 Trip blanks will be submitted for analysis at a frequency of one per cooler containing samples for volatile analysis. Because the number of sample coolers shipped may vary, the number of trip blanks are estimated.
6 Rinsate blanks will be collected at a frequency of 1 per every 10 samples, with a minimum of one per day of sampling per sampling device or instrument. These amounts are estimates and may vary.
7 Matrix spikes are collected for select organic and inorganic parameters at a frequency of 1 per every 20 field samples per matrix.
8 Matrix spike duplicates are collected for organic parameters only. Lab duplicates are analyzed for inorganic parameters in lieu of matrix spike duplicates. Matrix spike duplicates are collected at a frequency of 1 per every 20 field samples per matrix.

MNA - Monitored natural attenuation.
NA - Not applicable.

TABLE 3-5

MONITORING WELL CONSTRUCTION INFORMATION AND WATER LEVEL MEASUREMENTS
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Well Number	Installation Date	Ground Elevation (ft amsl)	Top of Riser Elevation (ft amsl)	Total Depth (ft bgs)[1]	Screened Interval				Aquifer	August 17, 2001		June 17, 2002	
					Top (ft bgs)	Bottom (ft bgs)	Top (ft amsl)	Bottom (ft amsl)		Depth to Water (ft btor)	Ground Water Elevation (ft amsl)	Depth to Water (ft btor)	Ground Water Elevation (ft amsl)
01-01	1981	682.46	685.22	48	33.14	42.77	649.32	639.69	Upper Pennyslvanian	28.9	656.32	27.13	658.09
01-02	1981	663.56	666.03	23.8	8.24	17.6	655.32	645.96	Upper Pennyslvanian	15.59	650.44	11.17	654.86
01-03	1981	666.85	669.55	18.6	3.99	13.41	662.86	653.44	Upper Pennyslvanian	12.83	656.72	5.27	664.28
01-04	1981	669.05	671.99	31	16.47	25.68	652.58	643.37	Upper Pennyslvanian	20.01	651.98	15.39	656.60
01-05	1981	665.07	667.79	30	16.18	25.3	648.89	639.77	Upper Pennyslvanian	17.83	649.96	14.17	653.62
01-06	11/10/1982	595.38	597.98	90	75.02	84.4	520.36	510.98	Lower Pennyslvanian	71.12	526.86	68.77	529.21
01-07	11/14/1982	602.95	605.43	28.5	12.61	21.99	590.34	580.96	Upper Pennyslvanian	17.55	587.88	14.71	590.72
01-08	11/15/1982	601.25	604.09	31	13.63	22.95	587.62	578.30	Upper Pennyslvanian	15.87	588.22	12.74	591.35
01-09	11/16/1982	609.6	612.23	32	17.4	26.78	592.20	582.82	Upper Pennyslvanian	20.54	591.69	12.92	599.31
01-10	11/30/1982	636.25	638.92	120	25.25	34.65	611.00	601.60	Upper Pennyslvanian	26.15	612.77	22.96	615.96
01-11	1/8/1983	655.49	658.36	19.6	6.72	15.35	648.77	640.14	Upper Pennyslvanian	11.17	647.19	7.03	651.33
01-12	1/19/1983	633.31	636.12	38	23.26	32.67	610.05	600.64	Upper Pennyslvanian	26.39	609.73	23.59	612.53
01-13	1/19/1983	634.17	637.06	35	19.97	29.42	614.20	604.75	Upper Pennyslvanian	24.67	612.39	21.58	615.48
01-14	1/25/1983	655.45	658.09	36	21.12	30.65	634.33	624.80	Upper Pennyslvanian	16.41	641.68	13.36	644.73
01-15	2/10/1983	662.27	665.3	37.8	22.1	31.6	640.17	630.67	Upper Pennyslvanian	28.56	636.74	22.22	643.08
01-16	2/11/1983	641.09	644.05	38.5	23.75	33	617.34	608.09	Upper Pennyslvanian	DRY	DRY	35.14	608.91
01-17	2/12/1983	662.12	664.61	39	23.25	32.55	638.87	629.57	Upper Pennyslvanian	22.26	642.35	19.44	645.17
01-18	6/17/1983	658.24	660.55	30.5	14.3	23.59	643.94	634.65	Upper Pennyslvanian	15.54	645.01	12.78	647.77
01-19	6/17/1983	656.44	658.92	30.2	15.7	24.7	640.74	631.74	Upper Pennyslvanian	22.04	636.88	20.85	638.07
01-20	6/20/1983	630.55	633.45	36.1	21.35	30.69	609.20	599.86	Upper Pennyslvanian	29.13	604.32	23.30	610.15

TABLE 3-5

MONITORING WELL CONSTRUCTION INFORMATION AND WATER LEVEL MEASUREMENTS
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Well Number	Installation Date	Ground Elevation (ft amsl)	Top of Riser Elevation (ft amsl)	Total Depth (ft bgs)(1)	Screened Interval				Aquifer	August 17, 2001		June 17, 2002	
					Top (ft bgs)	Bottom (ft bgs)	Top (ft amsl)	Bottom (ft amsl)		Depth to Water (ft btor)	Ground Water Elevation (ft amsl)	Depth to Water (ft btor)	Ground Water Elevation (ft amsl)
01-21	6/20/83	603.47	606.01	40.50	23.74	32.75	579.73	570.72	Upper Pennyslvanian	17.81	588.20	14.96	591.05
01-22	7/8/83	653.09	655.85	35.00	20.50	29.65	632.59	623.44	Upper Pennyslvanian	19.39	636.46	18.23	637.62
01-23	7/9/83	625.41	627.88	45.00	30.51	39.58	594.90	585.83	Upper Pennyslvanian	40.89	586.99	38.67	589.21
01-24	7/9/83	599.82	602.66	30.40	15.62	25.03	584.20	574.79	Upper Pennyslvanian	14.89	587.77	11.43	591.23
01-25	8/6/83	653.89	656.33	32.00	17.42	25.79	636.47	628.10	Upper Pennyslvanian	21.71	634.62	20.92	635.41
01-26	8/6/83	669.76	672.33	55.00	40.45	49.57	629.31	620.19	Upper Pennyslvanian	36.54	635.79	35.68	636.65
01-27	8/6/83	659.15	661.86	40.30	25.55	34.55	633.60	624.60	Upper Pennyslvanian	25.22	636.64	24.10	637.76
01C01	NA	663.96	666.23	NA	NA	NA	NA	NA	Lower Pennyslvanian	139.53	526.70	138.42	527.81
01T02	9/8/01	696.83	698.89	115.00	60.00	70.00	636.83	626.83	Upper Pennyslvanian	65.37	633.52	65.25	633.64
01T03	6/3/02	664.79	667.12	155.00	144.00	154.00	520.79	510.79	Lower Pennyslvanian	NI	NI	139.16	527.96
01T04	6/4/02	663.02	665.81	153.00	141.00	151.00	522.02	512.02	Lower Pennyslvanian	NI	NI	137.97	527.84
01T05	6/5/02	639.59	641.85	32.00	21.00	31.00	618.59	608.59	Upper Pennyslvanian	NI	NI	16.84	625.01

Notes:
1 = Total depth of boring, total depth of well may be less.
bgs = Below ground surface.
btor = Below top of riser.
amsl = Above mean sea level (NAVD88).
NA = Well construction data not available.
NI = Not installed at time of water level measurements.
* Well 01T01 was not installed because the hole did not produce enough water to yield representative ground water samples.

TABLE 3-6

PHYSICAL CHARACTERISTICS OF PROPOSED MONITORING WELLS
SWMU 01 – MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Monitoring Well Number	Approximate Ground Surface Elevation (feet amsl)	Approximate Total Depth (feet bgs)	Screen Length (feet)	Approximate Desired Well Screen Elevation[1]	
				Top (feet amsl)	Bottom (feet amsl)
01T06	TBD	30 to 45	10	TBD	TBD
01T07	TBD	30 to 45	10	TBD	TBD

amsl - Above mean sea level.
TBD - To be determined based on the exact well location and the depth that ground water is encountered during drilling.
bgs - Below ground surface.

1 Well screen elevations will vary depending on the ground surface elevation, the soil and rock types penetrated, and the distribution of fractures encountered in each boring.

TABLE 3-7

SUMMARY OF LABORATORY ANALYSES, CONTAINER TYPES AND VOLUMES, PRESERVATION REQUIREMENTS, AND HOLDING TIMES FOR SOILS SWMU 01 - MUSTARD GAS BURIAL GROUND NSWC CRANE CRANE, INDIANA

Parameter	Analyte/Methodology	Sample Container	Container Volume	Preservation	Maximum Holding Time[1]
Volatile Organic Compounds	SW-846 8260B	3 Encore™ samplers	Three 5-gram containers	Cool to 4 °C	48 hours to preservation; 14 days to analysis
Gamma Spectrometry	Pace Analytical (formerly SWLO) Method	Wide-mouth jar, Teflon-lined plastic cap	8 ounce	Cool to 4 °C	Within 180 days

1 All holding times are from date of collection.

SWLO - Southwest Laboratory of Oklahoma.

TABLE 3-8

SUMMARY OF LABORATORY ANALYSES, CONTAINER TYPES AND VOLUMES, PRESERVATION REQUIREMENTS, AND HOLDING TIMES FOR AQUEOUS SAMPLES SWMU 01 – MUSTARD GAS BURIAL GROUND NSWC CRANE CRANE, INDIANA

Parameter	Analyte/Methodology	Sample Container	Container Volume	Preservation	Maximum Holding Time[1]
Volatile Organic Compounds	SW-846 8260B	Glass, black phenolic plastic screw cap, Teflon-lined septum	40 mL (6 bottles each)	Cool to 4°C, dark, zero headspace, HCl to pH < 2	14 days to analysis
Nitrate + Nitrite (as N)	EPA Method 353.2	Polyethylene, plastic cap w/ plastic liner	500 mL	Cool to 4°C, H_2SO_4 to pH < 2	28 days to analysis
Chloride	EPA 300.0	Polyethylene, plastic cap w/ plastic liner	250 mL	Cool to 4°C	28 days to analysis
Sulfate	EPA 300.0	Polyethylene, plastic cap w/ plastic liner	250 mL	Cool to 4°C	28 days to analysis
Total Hardness (as $CaCO_3$)	EPA 130.2	Polyethylene, plastic cap w/ plastic liner	250 mL	Cool to 4°C, HNO_3 to pH < 2	180 days to analysis
Dissolved Organic Gases	Microseeps Inc. Method AM20Gax	Glass, aluminum crimp top vial	22 mL	Pressurize to 1 atmosphere	21 days to analysis
Dissolved Hydrogen	Microseeps Inc. Method AM20Gax	Glass, aluminum crimp top vial	22 mL	Pressurize to 1 atmosphere	21 days to analysis
Total Organic Carbon	SW-846 9060	Polyethylene, plastic cap w/ plastic liner	250 mL	Cool to 4°C	28 days to analysis
Total Inorganic Carbon	Microseeps Inc. Method AM21Gax	Amber glass, butyl rubber vial septum	40 mL	Cool to 4°C	14 days to analysis
Volatile Fatty Acids	Microseeps Inc. Method AM21Gax	Glass, black phenolic plastic screw cap, Teflon-lined septum vial	40 mL	Cool to 4°C	14 days to analysis

Note: Aqueous samples include ground water and aqueous QA samples.

1 All holding times are from date of collection.

HCl = Hydrochloric acid.

mL = milliliter.

H_2SO_4 = Sulfuric acid.

HNO_3 = Nitric acid.

TABLE 3-9

NON-CALIBRATION QUALITY CONTROL SAMPLE USAGE FREQUENCIES, ACCEPTANCE LIMITS, AND CORRECTIVE ACTIONS
SWMU 01 – MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

QC Sample Type	Collection Frequency	Acceptance Limit	Corrective Action
Field Duplicate	1 per 10 investigative samples collected.	Aqueous = 30% RPD Soil/Sediment = 50% RPD	Qualify data according to data validation requirements.
Equipment Rinsate Blank	1 per 10 investigative samples collected. For pre-cleaned, dedicated, and/or disposable equipment (i.e., pump tubing, etc.), one rinsate blank will be collected and analyzed at a frequency of one per lot or "batch blank" for a specific equipment type.	< RL (soil and water)	Identify source of contamination, if possible. Qualify data according to validation criteria. Qualify use of data if contamination appears to have adversely affected its usability.
Source Water Blank	1 per source of water used for sampling equipment decontamination.	< RL (soil and water)	Identify source of contamination, if possible. Qualify data according to validation criteria. Qualify use of data if contamination appears to have adversely affected its usability.
Trip Blank	1 per cooler containing samples for volatile organics analysis.	< RL (soil and water)	Identify source of volatiles contamination, if possible. Qualify data according to validation criteria. Qualify use of data if contamination appears to have adversely affected its usability.
Internal Standard	At least one internal standard per sample for GC/MS analysis.	Retention times stable to ±30 seconds; area counts stable to within factor of 2.	Laboratory action taken per analytical SOP. TtNUS action taken per validation protocols and Section 11.2.
Laboratory Control Sample	1 per 20 environmental samples per matrix.	See Tables 7-2 and 7-4	Laboratory action taken per analytical SOP. TtNUS action taken per validation protocols and Section 11.2.
Laboratory Duplicate	1 per 20 environmental samples analyzed for inorganic target analytes.	See Tables 7-1 and 7-3	Laboratory action taken per analytical SOP. TtNUS action taken per validation protocols and Section 11.2.
Laboratory Method Blank	1 per 20 environmental samples or per preparation batch, whichever is more frequent.	< RL (soil and water)	Laboratory action taken per analytical SOP. TtNUS action taken per validation protocols and Section 11.2.

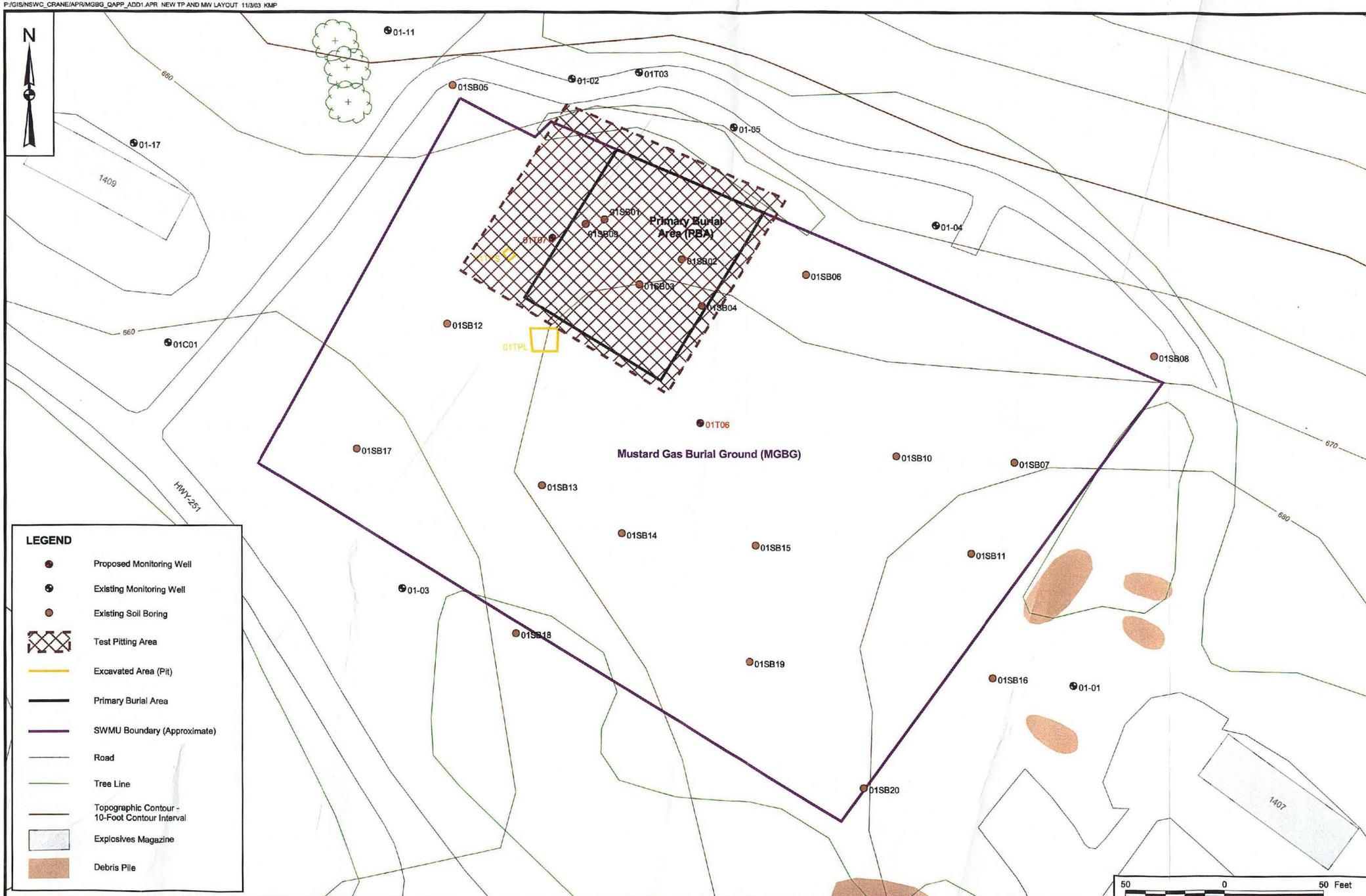
TABLE 3-9

NON-CALIBRATION QUALITY CONTROL SAMPLE USAGE FREQUENCIES, ACCEPTANCE LIMITS, AND CORRECTIVE ACTIONS
SWMU 01 – MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

QC Sample Type	Collection Frequency	Acceptance Limit	Corrective Action
Matrix Spike*	1 per 20 environmental samples.	See Tables 7-1 and 7-3	Laboratory action taken per analytical SOP. TtNUS action taken per validation protocols and Section 11.2.
Matrix Spike Duplicate*	1 per 20 environmental samples analyzed for organic target analytes.	See Tables 7-1 and 7-3	Laboratory action taken per analytical SOP. TtNUS action taken per validation protocols and Section 11.2.
Surrogate	At least one per sample for organic chromatographic analyses (GC and GC/MS).	See Tables 7-1 and 7-3	Laboratory action taken per analytical SOP. TtNUS action taken per validation protocols and Section 11.2.
Temperature Blank	One blank per sample cooler.	4°C ± 2°C	Laboratory action taken per analytical SOP. TtNUS action taken per validation protocols and Section 11.2.

* Matrix spikes and matrix spike duplicates are not analyzed in the field, but additional sample material must be collected in the field to ensure that the laboratory has enough material for spiking and duplicate analysis.
QC = Quality control.
RPD = Relative percent difference.
RL = Reporting limit.
FOL = Field Operations Leader.
GC/MS = Gas chromatograph/mass spectrometer.

P:/GIS/NSWC_CRANE/APR/MGBG_QAPP_ADD1.APR NEW TP AND MW LAYOUT 11/3/03 KMP



CONTRACT NO. N0845

APPROVED BY T. JOHNSTON — DATE 10/22/03

APPROVED BY — DATE

DRAWING NO. FIGURE 3-1

REV 0

TEST PITTING AREA AND TENTATIVE LOCATIONS OF TWO NEW MONITORING WELLS
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

DEPARTMENT OF THE NAVY - NAVAL FACILITIES ENGINEERING COMMAND - SOUTHERN DIVISION

DRAWN BY A. JANOCHA — DATE 10/12/03

CHECKED BY J. SCHUBERT — DATE 10/22/03

COST/SCHED-AREA

SCALE AS NOTED

4.0 CUSTODY PROCEDURES

Documented sample custody is one of several factors necessary for the admissibility of environmental data as evidence in a court of law. Custody procedures help to satisfy the two major requirements for admissibility: relevance and authenticity. Sample custody requirements are presented in Section 5.0 of the approved MGBG QAPP (TtNUS, 2001).

Pace Analytical (formerly Southwest Laboratory of Oklahoma) will analyze the samples generated under this QAPP Addendum No. 1 for all but the dissolved organic gases, dissolved hydrogen, volatile fatty acids, and field parameters. Microseeps, Inc. will perform analyses for the dissolved gases and volatile fatty acids on ground water samples. TtNUS personnel will conduct all field analyses.

The laboratory contact information, including shipping addresses, is provided in Table 2-1.

5.0 CALIBRATION PROCEDURES AND FREQUENCY

All instrumentation used to perform chemical measurements must be properly calibrated prior to use to obtain valid and usable results.

Some field equipment not listed in the approved MGBG QAPP will be used to measure parameters for evaluating the efficacy of natural attenuation at the MGBG. The necessary equipment lists are identified in the SOPs for field measurement, which are provided in Appendix B to this QAPP Addendum No. 1. The necessary analyte lists are presented in Table 1-3 of this QAPP Addendum No. 1.

Instruments used in the field and in the laboratory will be calibrated in accordance with the procedures governing the use of the instruments. Calibration procedures and frequency are described in Section 6.0 of the approved MGBG QAPP (TtNUS, 2001). The additional equipment for specific use in conjunction with this QAPP Addendum No. 1 will be calibrated in accordance with the corresponding SOPs. Chemical test kits do not necessarily require calibration, although when applicable, calibration check standards shall be analyzed in accordance with the test kit instructions. Applicability is indicated in the test kit instructions, and the check standards are provided with the test kit.

6.0 ANALYTICAL AND MEASUREMENT PROCEDURES

Field measurements and laboratory analytical procedures are presented in this section.

6.1 FIELD MEASUREMENT PROCEDURES

Parameters to be measured using field instrumentation include sample depth and sample location and the parameters listed in Table 3-1. Measurement of field parameters is governed by the applicable SOPs included in Appendix B. Some natural attenuation parameters will also be measured in the field using chemical test kits (Table 3-1).

6.2 LABORATORY ANALYTICAL AND MEASUREMENT PROCEDURES

The laboratory analytical procedures for all but the dissolved organic gases and hydrogen and volatile fatty acids will be performed by Pace Analytical (formerly, Southwest Laboratory of Oklahoma). This laboratory has successfully completed the laboratory evaluation process required as part of the Naval Facilities Engineering Service Center (NFESC) QA Program and described in the Department of Defense (DOD) Environmental Data Quality Systems Manual for Environmental Laboratories (DOD, 2002). The dissolved gases and volatile fatty acids analyses do not require Navy evaluation, and Microseeps has not been evaluated; however, a request for Navy evaluation is in the process of being submitted to the Navy. Table 6-1 provides a summary of the laboratory analytical methods and associated laboratory SOPs to be used during this investigation. Laboratory SOPs are included in Appendix I of the approved MGBG QAPP (TtNUS, 2001). Any SOPs that have been updated between the Phase III RFI and the generation of this QAPP are provided in Appendix D of this QAPP Addendum No. 1.

6.2.1 List of Project Target Compounds and Detection Limits

A list of the laboratory target analytes, project-specific, risk-based target levels, detection limits, and reporting limits (RLs) is provided in Table 1-4 of this QAPP Addendum No. 1. Data reporting conventions will be consistent with the Phase III reporting conventions as described in Section 1.4 of the EPA-approved MGBG QAPP (TtNUS, 2001).

6.2.2 List of Associated Quality Control Samples

Field and laboratory QC samples to be analyzed in support of this project are identified in Section 7.0 of this QAPP Addendum No. The analytical SOPs included in Appendix D of this QAPP Addendum No. 1

address minimum QC requirements for each associated analytical method. The SOPs include calibration QC requirements. Details on QC sample usage are provided in Section 7.0.

TABLE 6-1

SUMMARY OF ORGANIC, INORGANIC, AND MISCELLANEOUS
ANALYTICAL LABORATORY PROCEDURES
FOR SOLID AND AQUEOUS SAMPLES
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Analytical Parameter [1]	Preparation Method [2,3]	Analytical Method[2,3]	Preparation/Analytical SOP(s) [4]
VOLATILES – APPENDIX IX			
VOCs SW-846 8260B (Pace Analytical)	Aqueous SW-846 Method 5030 (25 mL purge) Solid SW-846 Method 5035 (5 g purge)	Aqueous SW-846 Method 8260B (25 mL purge) Solid SW-846 Method 8260B (5 g purge)	Aqueous SWL-OV-304 Solid SWL-OV-303
Gamma Spectrometry (contingent upon detecting radiation levels greater than background levels with hand-held screening instrument) (Pace Analytical)	Solid SWL-RD-125	Solid SWL-RD-125	Solid SWL-RD-125
NATURAL ATTENUATION PARAMETERS			
Chloride and Sulfate (Pace Analytical)	Aqueous EPA 300.0	Aqueous EPA 300.0	Aqueous SWL-IN-301
Total Hardness (Pace Analytical)	Aqueous EPA 130.2	Aqueous EPA 130.2	
Acetylene, Butane, Ethane, Ethene, Methane, Propane, and Propene, dissolved (Microseeps)	Aqueous Microseeps, Inc. Method	Aqueous Microseeps, Inc. Method	Aqueous SM9/AM20GAx
Hydrogen, dissolved (Microseeps)	Aqueous Microseeps, Inc. Method	Aqueous Microseeps, Inc. Method	Aqueous SM9/AM20GAx
Nitrate + Nitrite as Nitrogen (Pace Analytical)	Aqueous EPA 353.2	Aqueous EPA 353.2	Aqueous SWL-IN-304
TIC (Microseeps)	Aqueous Microseeps, Inc. Method	Aqueous Microseeps, Inc. Method	Aqueous DGPM-01/AM20GAx
TOC (Pace Analytical)	Aqueous SW-846 9060 Solid Lloyd Kahn	Aqueous SW-846 9060 Solid Lloyd Kahn	Aqueous SWL-IN-310 Solid SWL-IN-311

TABLE 6-1

SUMMARY OF ORGANIC, INORGANIC, AND MISCELLANEOUS ANALYTICAL LABORATORY PROCEDURES FOR SOLID AND AQUEOUS SAMPLES SWMU 01 - MUSTARD GAS BURIAL GROUND NSWC CRANE CRANE, INDIANA

Analytical Parameter [1]	Preparation Method [2,3]	Analytical Method[2,3]	Preparation/Analytical SOP(s) [4]
VFAs: Acetic, Propionic, Butyric, Pentanoic, *i*-pentanoic, Pyruvic, *i*-Hexanoic, *n*-Hexanoic, Lactic (Microseeps)	Aqueous Microseeps, Inc. Method	Aqueous Microseeps, Inc. Method	Aqueous DGPM-01/AM21GAx

TIC = Total inorganic carbon.
TOC = Total organic carbon.
VFAs = Volatile fatty acids.
VOCs = Volatile organic compounds.

1 Reference Table 1-4 of this document for the specific compounds.
2 U.S. EPA, 1986. Test methods for Evaluating Solid Wastes, Physical/Chemical Methods. SW-846, Third Edition and subsequent updates.
3 U.S. EPA Chemical Analyses of Water and Wastewater, March 1983.
4 Updated or revised Laboratory SOPs are included in Appendix D of this QAPP Addendum No. 1.

7.0 INTERNAL QUALITY CONTROL CHECKS

Field and laboratory QC samples will be analyzed routinely to evaluate overall data quality. Tables 3-2 and 3-4 of this QAPP Addendum No.1 present the number of QC samples anticipated to be collected in the field. Section 6.0 of the approved MGBG QAPP (TtNUS, 2001) addresses instrument calibrations, and Section 8.0 of the approved MGBG QAPP (TtNUS, 2001) describes field and laboratory QC sample types and level of effort associated with them for this project. The QC limits are presented in Tables 7-1 through 7-4 of this section. Tables of QC limits or portions thereof in Section 3.0 of the approved MGBG QAPP (TtNUS, 2001) that are not applicable to the sampling and analysis program of this QAPP Addendum No.1 are excluded.

Definitions and descriptions of various field and laboratory QC samples are presented in Section 8.0 of the approved QAPP (TtNUS, 2001) and, for convenience of the field crew, in Section 3.6 of this QAPP Addendum No. 1. Table 3-9 lists the frequencies at which non-calibration QC samples are collected and analyzed.

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TABLE 7-1

QUALITY CONTROL LIMITS[1]
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES AND SURROGATE SPIKES
VOLATILE ORGANIC COMPOUND ANALYSES
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Chemical	Solid Matrix		Aqueous Matrix	
	Accuracy (%R)	Precision (RPD)	Accuracy (%R)	Precision (RPD)
1,1,1-Trichloroethane	65-115	25	83-120	20
1,1,1,2-Tetrachloroethane	66-115	25	85-110	20
1,1,2,2-Tetrachloroethane	74-115	25	67-135	20
1,1,2-Trichloroethane	75-115	25	84-110	20
1,2,3-Trichloropropane	71-115	25	73-115	20
1,1-Dichloroethane	67-115	25	83-117	20
1,1-Dichloroethene	74-130	25	65-140	20
1,2-Dibromo-3-chloropropane	61-110	25	73-121	20
1,2-Dibromoethane	73-115	25	83-113	20
1,2-Dichloroethane	73-115	25	84-113	20
1,2-Dichloropropane	66-115	25	84-110	20
2-Butanone	54-115	25	58-134	20
2-Chloro-1,3-butadiene (chloroprene)	50-150[2]	25	50-150[2]	20
2-Hexanone	50-150[2]	25	89-119	20
4-Methyl-2-pentanone	67-117	25	72-123	20
Acetone	48-115	25	50-150[2]	20
Acrolein	50-150[2]	25	10-190	20
Acrylonitrile	50-150[2]	25	81-111	20
Allyl chloride (3-chloro-1-propene)	50-150[2]	25	50-150[2]	20
Benzene	64-125	25	83-112	20
Bromodichloromethane	68-115	25	86-111	20
Bromoform	66-115	25	84-113	20
Bromomethane	78-117	25	85-122	20
Carbon disulfide	64-117	25	50-150[2]	20
Carbon tetrachloride	61-115	25	57-147	20
Chlorobenzene	66-116	25	88-109	20
Chloroethane	84-125	25	81-117	20
Chloroform	69-115	25	82-114	20
Chloromethane	90-140	25	64-145	20
cis-1,2-Dichloroethene	70-115	25	83-112	20
cis-1,3-Dichloropropene	72-115	25	83-110	20
Dibromochloromethane	67-115	25	41-149	20

TABLE 7-1

QUALITY CONTROL LIMITS[1]
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES AND SURROGATE SPIKES
VOLATILE ORGANIC COMPOUND ANALYSES
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

	Solid Matrix		Aqueous Matrix	
Dibromomethane	73-115	25	86-109	20
Dichlorodifluoromethane	70-180	25	50-150[2]	20
Ethylbenzene	63-115	25	89-109	20
Ethyl methacrylate	50-150[2]	25	50-150[2]	20
Methacrylonitrile	50-150[2]	25	50-150[2]	20
Methylene chloride	61-100	25	10-190	20
Methyl iodide	50-150[2]	25	50-150[2]	20
Methyl methacrylate	50-150[2]	25	50-150[2]	20
Pentachloroethane	50-150[2]	25	50-150[2]	20
Styrene	63-115	25	90-104	20
Tetrachloroethene	60-115	25	68-120	20
Toluene	70-120	25	88-107	20
trans-1,2-Dichloroethene	67-118	25	77-121	20
trans-1,3-Dichloropropene	76-115	25	80-112	20
trans-1,4-Dichloro-2-butene	50-150[2]	25	83-125	20
Trichloroethene	67-120	25	76-117	20
Trichlorofluoromethane	72-115	25	92-97	20
Vinyl acetate	50-150[2]	25	50-150[2]	20
Vinyl chloride	80-133	25	73-131	20
Total Xylenes	59-115	25	92-103	20
isobutanol	50-150[2]	25	50-150[2]	20
acetonitrile	50-150[2]	25	50-150[2]	20
propionitrile	50-150[2]	25	50-150[2]	20
1,4,-dioxane	50-150[2]	25	50-150[2]	20
BROMOFLUORBENZENE (SU)	50-150[2]	NA	86-115	NA
1,2-DICHLOROETHANE-D4 (SU)	80-120	NA	80-120	NA
DIBROMOFLUOROMETHANE (SU)	80-120	NA	86-118	NA
TOLUENE-D8 (SU)	81-117	NA	88-110	NA

1 In-house QC limits provided by SWLO meet or exceed these limits.
2 Advisory limit; not computed statistically.

NA Not applicable
%R = Percent recovery
RPD = Relative percent difference
SU = Surrogate compound

TABLE 7-2

QUALITY CONTROL LIMITS[1]
LABORATORY CONTROL SAMPLES
VOLATILE ORGANIC COMPOUND ANALYSES
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Chemical	Solid Matrix	Aqueous Matrix
	Accuracy (%R)	Accuracy (%R)
1,1,1-Trichloroethane	65-115	83-120
1,1,1,2-Tetrachloroethane	66-115	85-110
1,1,2,2-Tetrachloroethane	74-115	67-135
1,1,2-Trichloroethane	75-115	84-110
1,2,3-Trichloropropane	71-115	73-115
1,1-Dichloroethane	67-115	83-117
1,1-Dichloroethene	74-130	65-140
1,2-Dibromo-3-chloropropane	61-110	73-121
1,2-Dibromoethane	73-115	83-113
1,2-Dichloroethane	73-115	84-113
1,2-Dichloropropane	66-115	84-110
2-Butanone	54-115	58-134
2-Chloro-1,3-butadiene (chloroprene)	50-150[2]	50-150[2]
2-Hexanone	50-150[2]	89-119
4-Methyl-2-pentanone	67-117	72-123
Acetone	48-115	50-150[2]
Acrolein	50-150[2]	10-190
Acrylonitrile	50-150[2]	81-111
Allyl chloride (3-chloro-1-propene)	50-150[2]	50-150[2]
Benzene	64-125	83-112
Bromodichloromethane	68-115	86-111
Bromoform	66-115	84-113
Bromomethane	78-117	85-122
Carbon disulfide	64-117	50-150[2]
Carbon tetrachloride	61-115	57-147
Chlorobenzene	66-116	88-109
Chloroethane	84-125	81-117
Chloroform	69-115	82-114
Chloromethane	90-140	64-145
cis-1,2-Dichloroethene	70-115	83-112
cis-1,3-Dichloropropene	72-115	83-110
Dibromochloromethane	67-115	41-149
Dibromomethane	73-115	86-109
Dichlorodifluoromethane	70-180	50-150
Ethylbenzene	63-115	89-109
Ethyl methacrylate	50-150[2]	50-150[2]
Methacrylonitrile	50-150[2]	50-150[2]
Methylene chloride	61-100	10-190
Methyl iodide	50-150[2]	50-150[2]
Methyl methacrylate	50-150[2]	50-150[2]

TABLE 7-2

QUALITY CONTROL LIMITS[1]
LABORATORY CONTROL SAMPLES
VOLATILE ORGANIC COMPOUND ANALYSES
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Chemical	Solid Matrix	Aqueous Matrix
	Accuracy (%R)	Accuracy (%R)
Pentachloroethane	50-150[2]	50-150[2]
Styrene	63-115	90-104
Tetrachloroethene	60-115	68-120
Toluene	70-120	88-107
trans-1,2-Dichloroethene	67-118	77-121
trans-1,3-Dichloropropene	76-115	80-112
trans-1,4-Dichloro-2-butene	50-150[2]	83-125
Trichloroethene	67-120	76-117
Trichlorofluoromethane	72-115	92-97
Vinyl acetate	50-150[2]	50-150[2]
Vinyl chloride	80-133	73-131
Total Xylenes	59-115	92-103
isobutanol	50-150[2]	50-150[2]
acetonitrile	50-150[2]	50-150[2]
propionitrile	50-150[2]	50-150[2]
1,4,-dioxane	50-150[2]	50-150[2]
Bromofluorbenzene (SU)	74-121	86-115
1,2-dichloroethane-d4 (SU)	80-120	80-120
Dibromofluoromethane (SU)	80-120	86-118
Toluene-d8 (SU)	81-117	88-110

1 In-house QC limits provided by SWLO meet or exceed these limits.
2 Advisory limit; not computed statistically.

NA Not applicable
%R = Percent recovery
RPD = Relative percent difference
SU = Surrogate compound

TABLE 7-3

QUALITY CONTROL LIMITS[1]
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES
NATURAL ATTENUATION PARAMETER ANALYSES
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Chemical	Solid Matrix		Aqueous Matrix	
	Accuracy (%R)	Precision (RPD)	Accuracy (%R)	Precision (RPD)
Chloride	NA	NA	75 – 125	20
Nitrate (EPA 300.0)	NA	NA	75 – 125	20
Sulfate (EPA 300.0)	NA	NA	75 – 125	20
Total Hardness (EPA 300.0)	NA	NA	75 – 125	25
Total Inorganic Carbon (SOP-AM20Gax)	NA	NA	75 – 125	20
Total Organic Carbon SW-846 9060	75 – 125	25	75 – 125	20
Potassium-40 (1460)	75 – 125	50	NA	NA
Thallium-208 (583, 860)	75 – 125	50	NA	NA
Lead-210 (46)	75 – 125	50	NA	NA
Lead-212 (238)	75 – 125	50	NA	NA
Lead-214 (295, 352)	75 – 125	50	NA	NA
Bismuth-212 (727)	75 – 125	50	NA	NA
Bismuth-214 (609, 1120, 1764)	75 – 125	50	NA	NA
Radium-226 (186) [4]	75 – 125	50	NA	NA
Actinium-228 (338, 911, 969)	75 – 125	50	NA	NA
Thorium-234 (63, 92)	75 – 125	50	NA	NA
Uranium-235 (143)	75 – 125	50	NA	NA
Cobalt-60 (1173, 1332)	75 – 125	50	NA	NA
Cesium-137 (662)	75 – 125	50	NA	NA
Europium-154 (123, 1274)	75 – 125	50	NA	NA
Europium-155 (87, 105)	75 – 125	50	NA	NA
Protactinium-243 (1001)	75 – 125	50	NA	NA
Acetylene	NA	NA	NA	NA
n-Butane	NA	NA	NA	NA
iso-Butane	NA	NA	NA	NA
Propane	NA	NA	NA	NA
Propene	NA	NA	NA	NA
Ethene	NA	NA	NA	NA
Ethane	NA	NA	NA	NA
Methane	NA	NA	NA	NA
Hydrogen	NA	NA	NA	NA
Acetic	NA	NA	75 – 125	20
Butyric	NA	NA	75 – 125	20
Hexanoic	NA	NA	75 – 125	20
i-Hexanoic	NA	NA	75 – 125	20
Lactic	NA	NA	75 – 125	20

TABLE 7-3

QUALITY CONTROL LIMITS[1]
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES
NATURAL ATTENUATION PARAMETER ANALYSES
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Chemical	Solid Matrix		Aqueous Matrix	
	Accuracy (%R)	Precision (RPD)	Accuracy (%R)	Precision (RPD)
Pentanoic	NA	NA	75 – 125	20
Iso-Pentanoic	NA	NA	75 – 125	20
Propionic	NA	NA	75 – 125	20
Pyruvic	NA	NA	75 – 125	20

1 In-house QC limits provided by SWLO meet or exceed these limits.
2 Advisory limit; not computed statistically.

NA Not applicable
%R = Percent recovery
RPD = Relative percent difference

TABLE 7-4

QUALITY CONTROL LIMITS[1]
LABORATORY CONTROL SAMPLES
NATURAL ATTENUATION PARAMETER ANALYSES
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Chemical	Solid Matrix		Aqueous Matrix	
	Accuracy (%R)	Precision (RPD)	Accuracy (%R)	Precision (RPD)
Chloride	NA	NA	80 – 120	NA
Nitrate (EPA 300.0)	NA	NA	80 – 120	NA
Sulfate (EPA 300.0)	NA	NA	80 – 120	NA
Total Hardness (EPA 300.0)	NA	NA	80 – 120	20%
Total Inorganic Carbon (SOP-AM20Gax)	NA	NA	80 – 120	NA
Total Organic Carbon SW-846 9060	80 – 120	NA	80 – 120	NA
Potassium-40 (1460)	75 – 125	50	NA	NA
Thallium-208 (583, 860)	75 – 125	50	NA	NA
Lead-210 (46)	75 – 125	50	NA	NA
Lead-212 (238)	75 – 125	50	NA	NA
Lead-214 (295, 352)	75 – 125	50	NA	NA
Bismuth-212 (727)	75 – 125	50	NA	NA
Bismuth-214 (609, 1120, 1764)	75 – 125	50	NA	NA
Radium-226 (186) [4]	75 – 125	50	NA	NA
Actinium-228 (338, 911, 969)	75 – 125	50	NA	NA
Thorium-234 (63, 92)	75 – 125	50	NA	NA
Uranium-235 (143)	75 – 125	50	NA	NA
Cobalt-60 (1173, 1332)	75 – 125	50	NA	NA
Cesium-137 (662)	75 – 125	50	NA	NA
Europium-154 (123, 1274)	75 – 125	50	NA	NA
Europium-155 (87, 105)	75 – 125	50	NA	NA
Protactinium-243 (1001)	75 – 125	50	NA	NA
Acetylene	NA	NA	75 – 125	20
n-Butane	NA	NA	75 – 125	20
iso-Butane	NA	NA	75 – 125	20
Propane	NA	NA	75 – 125	20
Propene	NA	NA	75 – 125	20
Ethene	NA	NA	75 – 125	20
Ethane	NA	NA	75 – 125	20
Methane	NA	NA	75 – 125	20
Hydrogen	NA	NA	75 – 125	20
Acetic	NA	NA	75 – 125	20
Butyric	NA	NA	75 – 125	20
Hexanoic	NA	NA	75 – 125	20
i-Hexanoic	NA	NA	75 – 125	20
Lactic	NA	NA	75 – 125	20

TABLE 7-4

QUALITY CONTROL LIMITS[1]
LABORATORY CONTROL SAMPLES
NATURAL ATTENUATION PARAMETER ANALYSES
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Chemical	Solid Matrix		Aqueous Matrix	
	Accuracy (%R)	Precision (RPD)	Accuracy (%R)	Precision (RPD)
Pentanoic	NA	NA	75 – 125	20
iso-Pentanoic	NA	NA	75 – 125	20
Propionic	NA	NA	75 – 125	20
Pyruvic	NA	NA	75 – 125	20

1 In-house QC limits provided by SWLO meet or exceed these limits.
2 Advisory limit; not computed statistically.

NA Not applicable
%R = Percent recovery
RPD = Relative percent difference

8.0 DATA REDUCTION, VALIDATION, AND REPORTING

8.1 GENERAL DATA REDUCTION

Section 9.0 of the approved MGBG QAPP (TtNUS, 2001) describes the procedures to be used for data reduction, validation, and reporting. The text in Section 9.0 of the MGBG QAPP (TtNUS, 2001) applies to Microseeps, Inc. for the ethane, ethene, hydrogen, methane, and volatile fatty acids analyses on ground water samples and to Pace Analytical (formerly Southwest Laboratory of Oklahoma) for all other analyses.

Field measurements in the field will be reported in the units indicated in Table 1-3 of this QAPP Addendum No. 1. Only the analyses listed in Table 1-3 of this QAPP Addendum No. 1 will be measured for this CMS.

The data analyses will be sufficient to assure stakeholders that any pertinent data gaps have been filled. All data reduction calculations for accuracy, precision, and completeness presented in Section 12.0 of the approved MGBG QAPP (TtNUS, 2001) apply to the CMS data. Additional data interpretation not addressed in the approved MGBG QAPP is described below.

8.2 CORRECTIVE MEASURES EVALUATIONS

Because uranium-235 quantified at 183.7 keV (yield = 54%) cannot be differentiated from Radium-226 (186.2 keV) in the gamma spectrometric analysis, the Ra-226 results will be corrected in the following manner:

> Uranium-235 will be quantified using the peak at 143.7 keV (yield = 10.5%) and this result will be subtracted from the radium-226 value that is quantified using the 186.2 keV energy (yield =3.28%). This correction will yield a corrected Ra-226 activity reflective of Ra-226 activity in the absence of uranium-235.

Corrective action remedy evaluation will begin with a screening of potentially applicable corrective measures alternatives for reduction of contaminant concentrations in ground water. The following corrective measures alternatives have been identified as potentially suitable:

- No further action (includes technical impracticability of remediating the contaminated ground water)
- Monitored natural attenuation

- Enhanced monitored natural attenuation
- Bedrock fracturing followed by chemical oxidation
- Pumping and treating the ground water contamination (in the source area only), with potential return to the water bearing unit, in a closed-loop recirculation/flushing system

From this list of potential corrective measures alternatives may be selected a shorter list of alternatives that appear to be feasible. Based on the initial screening, each potentially feasible corrective measures alternative will be evaluated in detail with regard to the following characteristics:

- Protection of human health and the environment.

- Attainment of media cleanup standards set by the implementing agency.

- Control of release sources so as to reduce or eliminate, to the extent practicable, further releases that may pose a threat to human health and the environment.

- Compliance with applicable standards for management of wastes.

- Other pertinent factors such as:

  - Long-term reliability and effectiveness, i.e., effectiveness of the remedy over the useful life of its components in being able to achieve and maintain reductions in contaminant levels that meet the applicable cleanup standards, including the magnitude and potential risk of residual contamination.

  - Reduction in the toxicity, mobility, or volume of wastes, i.e., an evaluation of the remedy's ability to eliminate or substantially reduce the future potential for releases or risks from exposure to ground water, based on the volume or mass of media treated and the degree and irreversibility of the process in removing and destroying contaminants while minimizing treatment residue.

  - Short-term effectiveness, i.e., the relative duration of the remedy until remedial objectives are attained and whether concerns for worker health, the environment, and nearby communities can be adequately addressed.

- Implementability as related to the technical, logistical, and administrative requirements for the remedy construction and its operation, including permitting and other legal requirements.

- Cost of implementation in terms of capital, operating, and present worth of future costs.

- State acceptance and community acceptance.

- MNA evaluations will be based on the "Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water," (U.S. EPA, 1998).

Final decisions concerning the effectiveness of the recommended remedy will be made in a partnership between the U.S. Navy and the U.S. EPA Region 5.

9.0 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits will be conducted periodically to ensure that work is being implemented in accordance with the approved QAPP and in an overall satisfactory manner. Section 10.0 of the approved MGBG QAPP (TtNUS, 2001) provides examples of pertinent audits.

10.0 PREVENTIVE MAINTENANCE PROCEDURES

Equipment used to collect samples will be maintained in accordance with the manufacturers' operation and maintenance manuals. Equipment and instruments will be calibrated in accordance with the procedures and at the frequencies presented in Section 5.0 of this QAPP Addendum No. 1. The preventive maintenance requirements for field and laboratory equipment are presented in Section 11.0 of the approved MGBG QAPP (TtNUS, 2001). These operations will occur in accordance with the applicable analytical SOPs of Appendix G to this QAPP Addendum No. 1.

11.0 CORRECTIVE ACTION

The TtNUS QA/QC program requires that any and all personnel noting conditions adverse to quality should report these conditions immediately to the TOM and Quality Assurance Manager (QAM). These parties, in turn, are charged with implementing appropriate corrective action in a timely manner. It is ultimately the responsibility of the QAM to document all findings and corrective actions taken and to monitor the effectiveness of the corrective measures performed. Corrective action requirements for field, laboratory, and data validation and for reporting non-conformances are presented in Section 13.0 of the approved MGBG QAPP (TtNUS, 2001).

12.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

QA reports to management will be provided in four primary formats during the course of this investigation: data validation reports, reports summarizing accomplishments and QA/QC issues during the field investigation, project-wide progress reports, and laboratory QA reports. The report frequencies, content, preparers, and recipients are summarized in Section 14.0 of the approved MGBG QAPP (TtNUS, 2001).

At the completion of this CMS a CMS report will be submitted to the EPA for review and concurrence.

REFERENCES

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TABLE A-1

SUMMARY OF ANALYTIC RESULTS - SURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB01	01SB02	01SB03	01SB04	01SB05	01SB06	01SB07	01SB08	01SB09	01SB10	01SB11	01SB12	01SB13	01SB14
Sample	01SS010002	01SS020002	01SS030002	01SS040002	01SS050002	01SS060002	01SS070002	01SS080002	01SS090002	01SS100002	01SS110002	01SS120002	01SS130002	01SS140002
Matrix	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil
Depth Range	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Soil Group	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Sample Date	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/27/2001	8/27/2001	8/21/2001	8/26/2001	8/27/2001	8/22/2001	8/25/2001	8/24/2001	8/24/2001
Volatile Organics (ug/kg)														
1,1,1,2-Tetrachloroethane	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	4 U	3 U
1,1,1-Trichloroethane	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	4 U	3 U
1,1,2,2-Tetrachloroethane	3 UJ	3 UJ	3 UJ	3 UJ	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	4 U	3 U
1,1,2-Trichloroethane	6 U	5 U	5 U	6 U	5 U	6 U	6 U	6 U	6 U	5 UJ	6 U	6 U	7 U	6 U
1,1-Dichloroethane	3 UJ	3 U	3 U	3 U	3 UJ	3 U	3 U	3 U	3 UJ	3 U	3 U	3 U	4 U	3 U
1,1-Dichloroethene	6 U	5 U	5 U	6 U	5 U	6 U	6 U	6 U	6 U	5 U	6 U	6 U	7 U	6 U
1,2,3-Trichloropropane	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ	3 U	3 U	3 U	3 UJ	3 U	3 U	3 U	4 U	3 U
1,2-Dibromo-3-Chloropropane	6 UJ	5 UJ	5 UJ	6 UJ	5 UJ	6 U	6 U	6 U	6 UJ	5 UJ	6 U	6 U	7 U	6 U
1,2-Dibromoethane	3 UJ	3 UJ	3 UJ	3 UJ	3 U	3 U	3 U	3 U	3 U	3 UJ	3 U	3 U	4 U	3 U
1,2-Dichloroethane	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	4 U	3 U
1,2-Dichloropropane	6 U	5 U	5 U	6 U	5 U	6 U	6 U	6 U	6 U	5 U	6 U	6 U	7 U	6 U
1,4-Dioxane	560 UR	540 UR	520 UR	590 UR	510 UR	560 UR	550 UR	570 UR	600 UR	530 UR	580 UR	630 UR	730 UR	650 UR
2-Butanone	6 UJ	5 UJ	5 UJ	6 UJ	5 UJ	38	6 U	6 U	6 UJ	5 UJ	6 U	6 UJ	71 J	6 UJ
2-Hexanone	6 UJ	5 UJ	5 UJ	6 UJ	5 UJ	6 U	6 U	6 UJ	6 UJ	5 UJ	6 UJ	6 U	7 U	6 U
3-Chloropropene	6 UJ	5 UJ	5 UJ	6 UJ	5 UJ	6 U	6 U	6 UJ	6 UJ	5 UJ	6 UJ	6 UJ	7 UJ	6 UJ
4-Methyl-2-Pentanone	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ	3 U	3 UJ	3 UJ	3 U	3 U	4 U	3 U
Acetone	6 UJ	5 UJ	5 UJ	6 UJ	5 UJ	680 UJ	130 J	6 UJ	6 UJ	5 UJ	6 UJ	6 U	650 U	6 UJ
Acetonitrile	220 UJ	220 UJ	210 UJ	240 UJ	200 UJ	220 UJ	220 UJ	230 UJ	240 UJ	210 UJ	230 UJ	250 UJ	290 UJ	260 UJ
Acrolein	56 UR	54 UR	52 UR	59 UR	51 UR	56 UR	55 UR	57 UR	60 UR	53 UR	58 UR	63 UR	73 UR	65 UR
Acrylonitrile	56 UJ	54 UJ	52 UJ	59 UJ	51 UJ	56 U	55 U	57 U	60 UJ	53 UJ	58 U	63 U	73 U	65 U
Benzene	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	4 U	3 U
Bromodichloromethane	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	4 U	3 U
Bromoform	3 UJ	3 U	3 UJ	3 U	3 U	3 U	3 U	3 U	3 U	3 UJ	3 U	3 U	4 U	3 U
Bromomethane	6 UJ	5 U	5 U	6 U	5 U	6 U	6 U	6 U	6 U	5 U	6 U	6 U	7 U	6 U
Carbon Disulfide	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	4 U	3 U
Carbon Tetrachloride	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ	4 UJ	3 UJ
Chlorobenzene	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	4 U	3 U
Chlorodibromomethane	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	4 U	3 U
Chloroethane	6 U	5 U	5 U	6 U	5 U	6 U	6 U	6 U	6 U	5 U	6 U	6 U	7 U	6 U
Chloroform	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	4 U	3 U
Chloromethane	6 U	5 U	5 U	6 U	5 U	6 U	6 U	6 UJ	6 U	5 U	6 UJ	6 U	7 U	6 U
Chloroprene	6 UJ	5 UJ	5 UJ	6 UJ	5 UJ	6 UJ	6 UJ	6 UJ	6 UJ	5 UJ	6 UJ	6 UJ	7 UJ	6 UJ
Cis-1,2-Dichloroethene	6 U	5 U	5 U	6 U	5 U	6 U	6 U	6 U	6 U	5 U	6 U	6 U	7 U	6 U
Cis-1,3-Dichloropropene	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	4 U	3 U
Dibromomethane	6 U	5 U	5 U	6 U	5 U	6 U	6 U	6 U	6 U	5 U	6 U	6 U	7 U	6 U
Dichlorodifluoromethane	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	4 U	3 U
Ethyl Methacrylate	6 UJ	5 UJ	5 UJ	6 UJ	5 U	6 U	6 U	6 U	6 U	5 UJ	6 U	6 U	7 UJ	6 UJ
Ethylbenzene	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	4 U	3 U
Isobutanol	220 UR	220 UR	210 UR	240 UR	200 UR	220 UR	220 UR	230 UR	240 UR	210 UR	230 UR	250 UR	290 UR	260 UR
Methacrylonitrile	110 UJ	110 UJ	100 UJ	120 UJ	100 UJ	110 UJ	110 UJ	110 U	120 UJ	110 UJ	120 U	130 UJ	150 UJ	130 UJ
Methyl Iodide	6 UJ	5 U	5 U	6 UJ	5 U	6 UJ	6 UJ	6 UJ	6 U	5 UJ	6 UJ	6 UJ	7 UJ	6 UJ
Methyl Methacrylate	6 UJ	5 UJ	5 UJ	6 U	5 UJ	6 U	6 U	6 U	6 UJ	5 UJ	6 U	6 U	7 U	6 U
Methylene Chloride	6 UJ	5 UJ	5 UJ	6 U	39 U	61 J	41 J	6 UJ	25 U	13 J	6 UJ	6 UJ	9	47
Pentachloroethane	6 UJ	5 UJ	5 UJ	6 UJ	5 UJ	6 U	6 U	6 UJ	6 UJ	5 UJ	6 UJ	6 UJ	7 UJ	6 UJ
Propionitrile	110 UR	110 UR	100 UR	120 UR	100 UR	110 UR	110 UR	110 UR	120 UR	110 UR	120 UR	130 UR	150 UR	130 UR
Styrene	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	4 U	3 U
Tetrachloroethene	3 UJ	3 UJ	3 UJ	3 UJ	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	4 U	3 U
Toluene	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 UJ	3 U	3 U	2 J	3 U
Total Xylenes	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	4 U	3 U
Trans-1,2-Dichloroethene	6 U	5 U	5 U	6 U	5 U	6 U	6 U	6 U	6 U	5 U	6 U	6 U	7 U	6 U
Trans-1,3-Dichloropropene	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	4 U	3 U

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-1

SUMMARY OF ANALYTIC RESULTS - SURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB01	01SB02	01SB03	01SB04	01SB05	01SB06	01SB07	01SB08	01SB09	01SB10	01SB11	01SB12	01SB13	01SB14
Sample	01SS010002	01SS020002	01SS030002	01SS040002	01SS050002	01SS060002	01SS070002	01SS080002	01SS090002	01SS100002	01SS110002	01SS120002	01SS130002	01SS140002
Matrix	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil
Depth Range	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Soil Group	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Sample Date	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/27/2001	8/27/2001	8/21/2001	8/26/2001	8/27/2001	8/22/2001	8/25/2001	8/24/2001	8/24/2001
Trans-1,4-Dichloro-2-Butene	6 U	5 U	5 U	6 UJ	5 U	6 U	6 U	6 U	6 U	5 UJ	6 U	6 U	7 U	6 U
Trichloroethene	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	4 U	3 U
Trichlorofluoromethane	6 U	5 U	5 U	6 U	5 U	6 UJ	6 UJ	6 U	6 U	5 UJ	6 U	6 U	7 U	6 U
Vinyl Acetate	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	4 U	3 U
Vinyl Chloride	6 U	5 U	5 U	6 U	5 U	6 U	6 U	6 U	6 U	5 U	6 U	6 U	7 U	6 U
Semivolatile Organics (ug/kg)														
1,2,4,5-Tetrachlorobenzene	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 U	390 U	420 U	470 U	420 U
1,2,4-Trichlorobenzene	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 U	390 U	420 U	470 U	420 U
1,2-Dichlorobenzene	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
1,3-Dichlorobenzene	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
1,4-Dichlorobenzene	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
1,4-Naphthoquinone	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 U	390 U	420 U	470 U	420 U
1,4-Phenylenediamine	1100 U	1000 U	1000 U	1000 U	1000 U	1100 UJ	990 UJ	950 UJ	1000 UJ	980 UJ	980 UJ	1000 U	1200 U	1000 U
1-Naphthylamine	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 U	390 U	420 U	470 U	420 U
2,2'-Oxybis(1-Chloropropane)	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
2,3,4,6-Tetrachlorophenol	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 U	390 U	420 U	470 U	420 U
2,4,5-Trichlorophenol	1100 U	1000 U	1000 U	1000 U	1000 U	1100 U	990 U	950 U	1000 U	980 U	980 U	1000 U	1200 U	1000 U
2,4,6-Trichlorophenol	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 U	390 U	420 U	470 U	420 U
2,4-Dichlorophenol	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 U	390 U	420 U	470 U	420 U
2,4-Dimethylphenol	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 U	390 U	420 U	470 U	420 U
2,4-Dinitrophenol	1100 U	1000 U	1000 U	1000 U	1000 U	1100 U	990 U	950 U	1000 U	980 UJ	980 U	1000 U	1200 U	1000 U
2,6-Dichlorophenol	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 U	390 U	420 U	470 U	420 U
2-Acetylaminofluorene	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
2-Chloronaphthalene	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
2-Chlorophenol	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
2-Methylnaphthalene	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
2-Methylphenol	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
2-Naphthylamine	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
2-Nitroaniline	550 U	500 U	500 U	500 U	500 U	550 U	500 U	480 U	500 U	490 U	490 U	500 U	600 U	500 U
2-Nitrophenol	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 U	390 U	420 U	470 U	420 U
2-Picoline	320 U	310 U	310 U	310 U	300 U	320 U	300 U	290 U	310 U	300 U	300 U	310 U	350 U	320 U
3,3'-Dichlorobenzidine	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 U	390 U	420 U	470 U	420 U
3,3'-Dimethylbenzidine	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 U	390 U	420 U	470 U	420 U
3-Methylcholanthrene	480 UJ	470 U	470 U	470 U	450 U	470 U	440 U	430 U	470 U	440 UJ	440 U	470 U	530 U	470 U
3-Methylphenol	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
3-Nitroaniline	1100 U	1000 U	1000 U	1000 U	1000 U	1100 U	990 U	950 U	1000 U	980 U	980 U	1000 U	1200 U	1000 U
4,6-Dinitro-2-Methylphenol	1100 U	1000 U	1000 U	1000 U	1000 U	1100 U	990 U	950 U	1000 U	980 U	980 U	1000 U	1200 U	1000 U
4-Aminobiphenyl	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
4-Bromophenyl Phenyl Ether	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 U	390 U	420 U	470 U	420 U
4-Chloro-3-Methylphenol	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 U	390 U	420 U	470 U	420 U
4-Chloroaniline	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 U	390 U	420 U	470 U	420 U
4-Chlorophenyl Phenyl Ether	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
4-Methylphenol	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
4-Nitroaniline	1100 U	1000 U	1000 U	1000 U	1000 U	1100 U	990 U	950 U	1000 U	980 U	980 U	1000 U	1200 U	1000 U
4-Nitrophenol	1100 U	1000 U	1000 U	1000 U	1000 U	1100 U	990 U	950 U	1000 U	980 U	980 U	1000 U	1200 U	1000 U
4-Nitroquinoline-1-Oxide	1100 UR	1000 UR	1000 UR	1000 UR	1000 UR	1100 UR	990 UR	950 UR	1000 UR	980 UR	980 UR	1000 UR	1200 UR	1000 UR
5-Nitro-O-Toluidine	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 U	390 U	420 U	470 U	420 U
7,12-Dimethylbenz(A)Anthracene	320 UJ	310 U	310 U	310 U	300 U	320 U	300 U	290 U	310 U	300 UJ	300 U	310 U	350 U	320 U
A,A-Dimethylphenethylamine	1100 U	1000 U	1000 U	1000 U	1000 U	1100 U	990 U	950 U	1000 U	980 U	980 U	1000 U	1200 U	1000 U
Acenaphthene	12.8 U	12.5 U	12.5 U	12.4 U	15.8	70.8	11.8 U	11.4 U	12.3 U	11.8 U	11.8 U	12.4 U	14 U	12.6 UJ
Acenaphthylene	12.8 U	12.5 U	12.5 U	12.4 UR	12.1 U	12.7 U	11.8 U	11.4 UJ	12.3 U	11.8 U	11.8 UJ	12.4 U	14 U	12.6 UJ
Acetophenone	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-1

SUMMARY OF ANALYTIC RESULTS - SURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB01	01SB02	01SB03	01SB04	01SB05	01SB06	01SB07	01SB08	01SB09	01SB10	01SB11	01SB12	01SB13	01SB14
Sample	01SS010002	01SS020002	01SS030002	01SS040002	01SS050002	01SS060002	01SS070002	01SS080002	01SS090002	01SS100002	01SS110002	01SS120002	01SS130002	01SS140002
Matrix	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil
Depth Range	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Soil Group	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Sample Date	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/27/2001	8/27/2001	8/21/2001	8/26/2001	8/27/2001	8/22/2001	8/25/2001	8/24/2001	8/24/2001
Aniline	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
Anthracene	12.8 U	12.5 U	12.5 U	12.4 U	12.1 U	12.7 U	11.8 U	11.4 UJ	12.3 U	11.8 U	11.8 UJ	12.4 U	14 U	12.6 UJ
Aramite	1100 U	1000 U	1000 U	1000 U	1000 U	1100 U	990 U	950 U	1000 U	980 U	980 U	1000 U	1200 U	1000 U
Benzo(A)Anthracene	12.8 U	12.5 U	12.5 U	12.4 U	12.1 U	12.7 U	11.8 U	11.4 U	12.3 U	11.8 U	11.8 U	12.4 U	14 U	12.6 UJ
Benzo(A)Pyrene	12.8 U	12.5 U	12.5 U	12.4 U	12.1 U	12.7 U	11.8 U	11.4 U	11.9 J	11.8 U	11.8 U	12.4 U	14 U	12.6 UJ
Benzo(B)Fluoranthene	12.8 U	12.5 U	12.5 U	12.4 U	12.1 U	12.7 U	11.8 U	11.4 U	12.3 U	11.8 U	11.8 U	12.4 U	14 U	12.6 UJ
Benzo(G,H,I)Perylene	12.8 U	12.5 U	12.5 U	12.4 U	12.1 U	12.7 U	11.8 U	11.4 U	11.8 J	11.8 U	11.8 U	12.4 U	14 U	12.6 UJ
Benzo(K)Fluoranthene	12.8 U	12.5 U	12.5 U	12.4 U	12.1 U	12.7 U	11.8 U	11.4 U	12.3 U	11.8 U	11.8 U	12.4 U	14 U	12.6 UJ
Benzyl Alcohol	270 U	270 U	270 U	270 U	270 U	270 U	270 U	270 U	270 U	270 U	270 U	270 U	270 U	270 U
Bis(2-Chloroethoxy)Methane	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 U	390 U	420 U	470 U	420 U
Bis(2-Chloroethyl)Ether	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
Bis(2-Ethylhexyl)Phthalate	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	420	200 U	89 J	210 U	240 U	210 U
Butyl Benzyl Phthalate	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
Chlorobenzilate	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 U	390 U	420 U	470 U	420 U
Chrysene	12.8 U	12.5 U	12.5 U	12.4 U	12.1 U	12.7 U	11.8 U	11.4 U	12.3 U	11.8 UJ	11.8 U	12.4 U	14 U	12.6 UJ
Di-N-Butyl Phthalate	220 U	210 U	210 U	210 U	200 U	210 UJ	200 UJ	190 U	210 U	200 UJ	200 U	210 U	240 U	210 UJ
Di-N-Octyl Phthalate	220 UJ	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 UJ	200 U	210 U	240 U	210 U
Diallate	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 U	390 U	420 U	470 U	420 U
Dibenzo(A,H)Anthracene	12.8 U	12.5 U	12.5 U	12.4 UJ	12.1 U	12.7 U	11.8 U	11.4 UJ	12.3 U	11.8 U	11.8 UJ	12.4 U	14 U	12.6 UJ
Dibenzofuran	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
Diethyl Phthalate	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
Dimethyl Phthalate	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
Diphenylamine	220 U	210 U	210 U	210 UJ	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
Ethyl Methane Sulfonate	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
Fluoranthene	12.8 U	12.5 U	12.5 U	12.4 U	12.1 U	12.7 U	11.8 U	11.4 U	3.98 J	11.8 U	11.8 U	12.4 U	14 U	12.6 UJ
Fluorene	12.8 U	12.5 U	12.5 U	12.4 U	12.1 U	12.7 U	11.8 U	11.4 U	12.3 U	11.8 U	11.8 U	12.4 U	14 U	12.6 UJ
Hexachlorobenzene	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 U	390 U	420 U	470 U	420 U
Hexachlorobutadiene	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 U	390 U	420 U	470 U	420 U
Hexachlorocyclopentadiene	430 U	410 U	420 U	410 UJ	400 U	420 U	400 U	380 U	410 U	390 UJ	390 U	420 U	470 U	420 U
Hexachloroethane	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
Hexachlorophene	17000 UJ	17000 UJ	17000 UJ	17000 U	16000 UJ	17000 UJ	16000 UJ	15000 UJ	17000 UJ	16000 UJ	16000 UJ	17000 U	19000 U	17000 U
Hexachloropropene	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 U	390 U	420 U	470 U	420 U
Indeno(1,2,3-CD)Pyrene	12.8 U	12.5 U	12.5 U	12.4 U	12.1 U	12.7 U	11.8 U	11.4 U	4.55 J	11.8 U	11.8 U	12.4 U	14 U	12.6 UJ
Isodrin	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 U	390 U	420 U	470 U	420 U
Isophorone	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
Isosafrole	430 U	410 U	420 U	410 U	46000	3200	400 U	380 U	410 U	390 U	2700	420 U	470 U	420 U
Kepone	1100 U	1000 U	1000 U	1000 U	1000 U	1100 U	990 U	950 U	1000 U	980 U	980 U	1000 U	1200 U	1000 U
Methapyrilene	1100 UR	1000 UR	1000 UR	1000 U	1000 UR	1100 UR	990 UR	950 U	1000 UR	980 UR	980 U	1000 UR	1200 UR	1000 UR
Methyl Methane Sulfonate	550 U	500 U	500 U	500 U	500 U	550 U	500 U	480 U	500 U	490 U	490 U	500 U	600 U	500 U
N-Nitroso-Di-N-Butylamine	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 U	390 U	420 U	470 U	420 U
N-Nitroso-Di-N-Propylamine	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
N-Nitrosodiethylamine	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
N-Nitrosodimethylamine	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
N-Nitrosomethylethylamine	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
N-Nitrosomorpholine	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
N-Nitrosopiperidine	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 U	390 U	420 U	470 U	420 U
N-Nitrosopyrrolidine	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
Naphthalene	12.8 U	12.5 U	12.5 U	12.4 UR	12.1 U	12.7 U	11.8 U	11.4 UR	12.3 U	11.8 U	11.8 UR	12.4 U	14 U	12.6 UJ
O,O,O-Triethyl Phosphorothioate	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 U	390 U	420 U	470 U	420 U
O-Toluidine	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
P-(Dimethylamino)Azobenzene	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 U	390 U	420 U	470 U	420 U
Pentachlorobenzene	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 U	390 U	420 U	470 U	420 U

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-1

SUMMARY OF ANALYTIC RESULTS - SURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB01	01SB02	01SB03	01SB04	01SB05	01SB06	01SB07	01SB08	01SB09	01SB10	01SB11	01SB12	01SB13	01SB14
Sample	01SS010002	01SS020002	01SS030002	01SS040002	01SS050002	01SS060002	01SS070002	01SS080002	01SS090002	01SS100002	01SS110002	01SS120002	01SS130002	01SS140002
Matrix	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil
Depth Range	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Soil Group	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Sample Date	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/27/2001	8/27/2001	8/21/2001	8/26/2001	8/27/2001	8/22/2001	8/25/2001	8/24/2001	8/24/2001
Pentachloronitrobenzene	1100 U	1000 U	1000 U	1000 U	1000 U	1100 U	990 U	950 U	1000 U	980 U	980 U	1000 U	1200 U	1000 U
Phenacetin	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 UJ	390 U	420 U	470 U	420 U
Phenanthrene	12.8 U	12.5 U	12.5 U	12.4 U	12.1 U	12.7 U	11.8 U	11.4 U	12.3 U	11.8 U	11.8 U	12.4 U	14 U	12.6 UJ
Phenol	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	210 U	200 U	200 U	210 U	240 U	210 U
Pronamide	430 UR	410 UR	420 UR	410 U	400 UR	420 UR	400 UR	380 UR	410 UR	390 UR	390 UR	420 UR	470 UR	420 U
Pyrene	12.8 U	12.5 U	12.5 U	14.6 J	12.1 U	12.7 U	11.8 U	11.4 U	12.3 U	11.8 U	11.8 U	12.4 U	14 U	12.6 UJ
Pyridine	220 U	220 U	220 U	220 U	220 U	220 U	220 U	220 U	220 U	220 U	220 U	220 U	240 U	220 U
Safrole	430 U	410 U	420 U	410 U	400 U	420 U	400 U	380 U	410 U	390 U	390 U	420 U	470 U	420 U
Energertics (ug/kg)														
1,3,5-Trinitrobenzene	476 U	476 U	476 U	500 U	500 U	476 U	454 U	476 U	476 U	500 U	500 U	476 U	500 U	476 U
1,3-Dinitrobenzene	476 U	476 U	476 U	500 U	500 U	476 U	454 U	476 U	476 U	500 U	500 U	476 U	500 U	476 U
2,4,6-Trinitrotoluene	476 U	476 U	476 U	500 U	500 U	476 U	454 U	476 U	476 U	500 U	500 U	476 U	500 U	476 U
2,4-Dinitrotoluene	476 U	476 U	476 U	500 U	500 U	476 U	454 U	476 U	476 U	500 U	500 U	476 U	500 U	476 U
2,6-Dinitrotoluene	476 U	476 U	476 U	500 U	500 U	476 U	454 U	476 U	476 U	500 U	500 U	476 U	500 U	476 U
2-Amino-4,6-Dinitrotoluene	476 U	476 U	476 U	500 U	500 U	476 U	454 U	476 U	476 U	500 U	500 U	476 U	500 U	476 U
2-Nitrotoluene	476 U	476 U	476 U	500 U	500 U	476 U	454 U	476 U	476 U	500 U	500 U	476 U	500 U	476 U
3-Nitrotoluene	476 U	476 U	476 U	500 U	500 U	476 U	454 U	476 U	476 U	500 U	500 U	476 U	500 U	476 U
4-Amino-2,6-Dinitrotoluene	476 U	476 U	476 U	500 U	500 U	476 U	454 U	476 U	476 U	500 U	500 U	476 U	500 U	476 U
4-Nitrotoluene	476 U	476 U	476 U	500 U	500 U	476 U	454 U	476 U	476 U	500 U	500 U	476 U	500 U	476 U
Hmx	476 U	476 U	476 U	500 U	500 U	476 U	454 U	476 U	476 U	500 U	500 U	476 U	500 U	476 U
Nitrobenzene	476 U	476 U	476 U	500 U	500 U	476 U	454 U	476 U	476 U	500 U	500 U	476 U	500 U	476 U
Rdx	476 U	476 U	476 U	500 U	500 U	476 U	454 U	476 U	476 U	500 U	500 U	476 U	500 U	476 U
Tetryl	476 U	476 U	476 U	500 U	500 U	476 U	454 U	476 U	476 U	500 U	500 U	476 U	500 U	476 U
Pesticides/PCBs (ug/kg)														
4,4'-DDD	3.2 U	3.1 U	3.1 U	3.1 U	3 U	3.2 U	2.9 U	2.9 UJ	3.1 U	3 U	2.9 U	3.1 U	3.5 U	3.1 U
4,4'-DDE	3.2 U	3.1 U	3.1 U	3.1 U	3 U	3.2 U	2.9 U	2.9 U	3.1 U	3 U	2.9 U	3.1 U	3.5 U	3.1 U
4,4'-DDT	3.2 UJ	3.1 UJ	3.1 UJ	3.1 U	3 UJ	3.2 U	2.9 U	2.9 U	3.1 UJ	3 U	2.9 U	3.1 U	3.5 U	3.1 U
Aldrin	1.7 U	1.6 U	1.6 U	1.6 U	1.6 U	1.7 U	1.5 U	1.5 U	1.6 U	1.5 U	1.5 U	1.6 U	1.8 U	1.6 U
Alpha-BHC	1.7 U	1.6 U	1.6 U	1.6 U	1.6 U	1.7 U	1.5 U	1.5 U	1.6 U	1.5 U	1.5 U	1.6 U	1.8 U	1.6 U
Alpha-Chlordane	1.7 U	1.6 U	1.6 U	1.6 U	1.6 U	1.7 U	1.5 U	1.5 U	1.6 U	1.5 U	1.5 U	1.6 U	1.8 U	1.6 U
Aroclor-1016	43 U	41 U	41 U	41 U	40 U	42 U	39 U	38 U	41 U	39 U	39 U	41 U	47 U	41 U
Aroclor-1221	43 U	41 U	41 U	41 U	40 U	42 U	39 U	38 U	41 U	39 U	39 U	41 U	47 U	41 U
Aroclor-1232	43 U	41 U	41 U	41 U	40 U	42 U	39 U	38 U	41 U	39 U	39 U	41 U	47 U	41 U
Aroclor-1242	43 U	41 U	41 U	41 U	40 U	42 U	39 U	38 U	41 U	39 U	39 U	41 U	47 U	41 U
Aroclor-1248	43 U	41 U	41 U	41 U	40 U	42 U	39 U	38 U	41 U	39 U	39 U	41 U	47 U	41 U
Aroclor-1254	43 U	41 U	41 U	41 U	40 U	42 U	39 U	38 U	41 U	39 U	39 U	41 U	47 U	41 U
Aroclor-1260	43 U	41 U	41 U	41 U	40 U	42 U	39 U	38 U	41 U	39 U	39 U	41 U	47 U	41 U
Beta-BHC	1.7 U	1.6 U	1.6 U	1.6 U	1.6 U	1.7 U	1.5 U	1.5 U	1.6 U	1.5 U	1.5 U	1.6 U	1.8 U	1.6 U
Delta-BHC	1.7 U	1.6 U	1.6 U	1.6 U	1.6 U	1.7 U	1.5 U	1.5 U	1.6 U	1.5 U	1.5 U	1.6 U	1.8 U	1.6 U
Dieldrin	3.2 U	3.1 U	3.1 U	3.1 U	3 U	3.2 U	2.9 U	2.9 U	3.1 U	3 U	2.9 U	3.1 U	3.5 U	3.1 U
Endosulfan I	1.7 U	1.6 U	1.6 U	1.6 U	1.6 U	1.7 U	1.5 U	1.5 U	1.6 U	1.5 U	1.5 U	1.6 U	1.8 U	1.6 U
Endosulfan II	3.2 UJ	3.1 UJ	3.1 UJ	3.1 U	3 U	3.2 U	2.9 U	2.9 U	3.1 UJ	3 U	2.9 U	3.1 U	3.5 U	3.1 U
Endosulfan Sulfate	3.2 U	3.1 U	3.1 U	3.1 U	3 U	3.2 U	2.9 U	2.9 U	3.1 U	3 U	2.9 U	3.1 U	3.5 U	3.1 U
Endrin	3.2 U	3.1 U	3.1 U	3.1 U	3 U	3.2 U	2.9 U	2.9 U	3.1 U	3 UJ	2.9 U	3.1 U	3.5 U	3.1 U
Endrin Aldehyde	3.2 U	3.1 U	3.1 U	3.1 U	3 U	3.2 UJ	2.9 UJ	2.9 U	3.1 U	3 UJ	2.9 U	3.1 U	3.5 U	3.1 U
Gamma-BHC (Lindane)	1.7 U	1.6 U	1.6 U	1.6 U	1.6 U	1.7 U	1.5 U	1.5 U	1.6 U	1.5 U	1.5 U	1.6 U	1.8 U	1.6 U
Gamma-Chlordane	5.6 R	1.6 U	1.6 U	0.55 J	1.6 U	1.7 U	1.5 U	1.5 U	1.6 U	3.4 R	1.5 U	0.62 J	0.89 J	0.9 J
Heptachlor	1.4 J	1.2 J	1.3 J	1.6 U	1.4 J	3.8 R	1.5 U	1.8	1.3 J	1.6	1.3 J	1.4 BU	1.5 BU	2 BU
Heptachlor Epoxide	1.7 U	1.6 U	1.6 U	1.6 U	1.6 U	1.7 U	1.5 U	1.5 U	1.6 U	1.5 U	1.5 U	1.6 U	1.8 U	1.6 U
Methoxychlor	17 U	16 U	16 U	16 U	16 U	17 U	15 U	15 U	16 U	15 U	15 U	16 U	18 U	16 U
Toxaphene	110 U	100 U	100 U	100 U	100 U	110 U	97 U	96 U	100 U	98 U	97 U	100 U	120 U	100 U
Herbicides (ug/kg)														

Calc = C[illegible]lated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = N[illegible]zed

TABLE A-1

SUMMARY OF ANALYTIC RESULTS - SURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB01	01SB02	01SB03	01SB04	01SB05	01SB06	01SB07	01SB08	01SB09	01SB10	01SB11	01SB12	01SB13	01SB14
Sample	01SS010002	01SS020002	01SS030002	01SS040002	01SS050002	01SS060002	01SS070002	01SS080002	01SS090002	01SS100002	01SS110002	01SS120002	01SS130002	01SS140002
Matrix	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil
Depth Range	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Soil Group	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Sample Date	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/27/2001	8/27/2001	8/21/2001	8/26/2001	8/27/2001	8/22/2001	8/25/2001	8/24/2001	8/24/2001
2,4,5-T	13 U	12 U	13 U	12 U	12 U	13 U	12 U	12 U	12 U	12 U	22 R	12 U	14 U	13 U
2,4,5-TP (Silvex)	13 U	12 U	13 U	12 U	12 U	13 U	12 U	12 UJ	12 U	12 U	15 J	12 U	14 U	13 U
2,4-D	36 R	38 J	35 J	87 U	85 U	100 R	83 U	81 U	87 U	83 U	82 U	87 U	130	88 U
Dinoseb	26 U	25 U	25 U	25 U	24 U	25 U	24 U	23 U	25 U	24 U	23 U	25 U	57 R	25 U
Pentachlorophenol	13 U	12 U	13 U	12 U	12 U	13 U	12 U	12 U	12 U	12 U	12 U	12 U	14 U	13 U
Inorganics (mg/kg)														
Aluminum	9670 J	13200 J	13200 J	14900 J	12300 J	13700	15900	14700 J	10100 J	19400	13400 J	12700 J	12700 J	16200 J
Antimony	1.7 J	0.53 U	0.66 U	0.88 U	0.50 U	0.61 U	1.3 U	0.81 U	0.60 U	1.4 U	0.67 U	0.20 UJ	0.62 U	0.48 U
Arsenic	7.0 J	10.9 J	10.3 J	9.0 J	7.9 J	7.7 J	8.8 J	7.6	7.2 J	9.3 J	8.0	6.9 J	7.1 J	8.9 J
Barium	69.2 J	82.8 J	45.1 J	66.4	56.6 J	157	71.8	130	75.5 J	66.0	104	122	109	69.6
Beryllium	0.50 J	0.52 J	0.40 J	0.63 J	0.41 J	0.96	0.30	0.88 J	0.47 J	0.21	0.88 J	1.0 J	0.79 J	0.63 J
Cadmium	0.42 J	0.04 UJ	0.04 UJ	0.49 J	0.15 J	0.05 U	0.05 U	0.01 U	0.27 J	0.22 J	0.01 U	0.25 J	0.30 J	0.17 J
Calcium	8440 J	5010 J	510 J	1480 J	891 J	1300 J	557 J	578 J	24100 J	27900 J	678 J	1190 J	3450 J	1010 J
Chromium	13.4	17.0	17.8	17.6 J	16.2	15.8	19.1	14.7	14.5	22.8	13.4	12.2 J	13.6 J	16.8 J
Cobalt	9.9	8.2	5.1	10.9 J	5.2	20.7	10.4	12.9 J	6.5	7.2	15.5 J	17.7 J	20.2 J	8.0 J
Copper	12.1 J	16.5 J	16.5 J	14.0 J	13.9 J	10.1	15.9	12.1 J	13.1 J	18.5	11.6 J	10.1 J	8.7 J	14.5 J
Iron	16300	24600	25500	23100	20300	18100	24000	19100	18300	24700	19000	15700	16300	23500
Lead	20.4	16.2	14.7	19.0	17.2	19.0	15.5	15.0 J	13.1	17.2	16.2 J	16.1	19.0	15.6
Magnesium	1820 J	3060 J	2470 J	2160 J	1900 J	1600 J	2380 J	1890 J	3790 J	5260 J	1760 J	1360 J	2340 J	2220 J
Manganese	588 J	453 J	232 J	420 J	305 J	2010	489	920 J	369 J	380	991 J	1230 J	1270 J	291 J
Mercury	0.04 J	0.05 J	0.06 J	0.05 J	0.05 J	0.05 J	0.05 J	0.05	0.07 J	0.07 J	0.06	0.03 U	0.05 U	0.05 U
Nickel	10.1	11.9	13.9	12.4 J	11.2	16.0	13.8	15.6	10.1	13.7	13.9	13.2 J	13.8 J	12.6 J
Potassium	668 J	587 J	755 J	817 J	596 J	709 J	837 J	849 J	540 J	1310 J	674 J	672 J	671 J	846 J
Selenium	0.62 J	0.88 J	1.2 J	1.4 U	0.79 J	0.69	1.3	0.49 J	0.58 J	1.1	0.51 J	0.99 U	1.0 U	1.0 U
Silver	0.39 U	0.36 U	0.36 U	0.37 U	0.35 U	0.35 U	0.16 U	0.02 U	0.37 U	0.15 U	0.02 U	0.37 U	0.43 U	0.38 U
Sodium	355 J	350 J	296 J	325 J	219 J	614	603	386 J	290 J	648	358 J	342 J	418 J	348 J
Strontium	11.3 J	11.5 J	7.0 J	8.8 J	8.5 J	11.2 J	10.3 J	9.4 J	24.7 J	33.5 J	8.4 J	8.8 J	10.1 J	9.0 J
Thallium	0.85	1.8	2.8	2.2 J	1.8	1.4	0.57 U	0.87 J	1.2	0.55 U	1.4 J	1.0 J	1.4 J	2.6 J
Thorium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thorium-Calc	2.53	4.00	3.88	6.44	3.90	3.96	4.3	3.25	4.69	4.89	4.5	5.44	3.14	1.90
Tin	24.5 U	22.7 U	23.1 U	23.7 U	22.3 U	2.5 U	2.5	3.9	23.4 U	2.6	3.8	23.6 U	27.0 U	23.8 U
Vanadium	23.8	32.1	30.3	32.2	28.9	31.9	37.5	30.7 J	24.5	44.5	28.5 J	26.8	26.9	31.7
Zinc	41.7 J	50.6 J	49.3 J	49.8 J	37.9 J	55.9	57.7	51.1	41.4 J	67.8	45.2	42.4 J	41.7 J	49.8 J
Miscellaneous Parameters														
1,4-Dithiane (ug/kg)	258 U	251 U	251 U	250 U	244 U	258 U	238 U	233 U	249 U	238 U	236 U	249 U	284 U	253 U
1,4-Oxathiane (ug/kg)	258 U	251 U	251 U	250 U	244 U	258 U	238 U	233 U	249 U	238 U	236 U	249 U	284 U	253 U
Bis(2-Chloroethyl)Sulfide (ug/kg)	258 U	251 U	251 U	250 U	244 U	258 U	238 U	233 U	249 U	238 U	236 U	249 U	284 U	253 U
Cation Exchange Capacity (meq/100g	13.9	NA	12.8	NA	12.2	NA	23.4 J	NA	NA	NA	NA	NA	24.4 J	NA
pH (S.U.)	7.8 J	NA	5.4 J	NA	5.2 J	NA	5	NA	NA	NA	NA	NA	5.8	NA
Total Organic Carbon (mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Radiologicals (pCi/g)														
Actinium-228	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bismuth-212	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bismuth-214	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cesium-137	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt-60	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Europium-154	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Europium-155	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead-210	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead-212	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead-214	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Potassium-40	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-1

SUMMARY OF ANALYTIC RESULTS - SURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB01	01SB02	01SB03	01SB04	01SB05	01SB06	01SB07	01SB08	01SB09	01SB10	01SB11	01SB12	01SB13	01SB14
Sample	01SS010002	01SS020002	01SS030002	01SS040002	01SS050002	01SS060002	01SS070002	01SS080002	01SS090002	01SS100002	01SS110002	01SS120002	01SS130002	01SS140002
Matrix	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil
Depth Range	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Soil Group	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Sample Date	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/27/2001	8/27/2001	8/21/2001	8/26/2001	8/27/2001	8/22/2001	8/25/2001	8/24/2001	8/24/2001
Protactinium-234	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Radium-226	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium-208	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thorium-228	0.257	0.433	0.388	0.730	0.357	0.417	0.467	0.320	0.480	0.502	0.458	0.623	0.337	0.227
Thorium-230	0.0178 J	0.052 J	0.0342 U	0.621 J	0.0345 U	0.0414	0.0490	0.385 J	0.0198 J	0.0688	0.473 J	0.474 J	0.0898 U	0.0554 U
Thorium-232	0.300	0.446	0.466	0.686	0.500	0.455	0.479	0.395	0.552	0.573	0.532	0.574	0.354	0.190
Thorium-234	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-235	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Calc = C[illegible]ted Value as descibed in Section 3.4.2.1 (TINUS, 2003).
NA = N[illegible]zed

TABLE A-1

SUMMARY OF ANALYTIC RESULTS - SURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB15	01SB16	01SB17	01SB18	01SB19	01SB20	01SB21	01TPL	01TPL	01TPL	01TPS	BG1SBA01
Sample	01SS150002	01SS160002	01SS170002	01SS180002	01SS190002	01SS200002	01SS210002	01TPL01	01TPL02	01TPL03	01TPS04	BG1SBA0101
Matrix	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil
Depth Range	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	1 - 1.5	1 - 1.5	1 - 1.5	1 - 1.5	0 - 1
Risk	Site	Site	Site	Site	Site	Site	SiteBackground	Site	Site	Site	Site	Basewide Background
Soil Group	3	3	3	3	3	3	3	3	3	3	3	3
Sample Date	8/22/2001	8/21/2001	8/24/2001	8/24/2001	8/24/2001	8/21/2001	8/21/2001	8/27/2001	8/27/2001	8/27/2001	8/27/2001	11/4/1999
Volatile Organics (ug/kg)												
1,1,1,2-Tetrachloroethane	3 U	3 U	5 U	4 U	4 U	3 U	NA	3 U	3 U	3 U	3 U	NA
1,1,1-Trichloroethane	3 U	3 U	5 U	4 U	4 U	3 U	NA	3 U	3 U	3 U	3 U	NA
1,1,2,2-Tetrachloroethane	3 U	3 U	5 U	4 U	4 U	3 U	NA	3 U	3 UJ	3 UJ	3 U	NA
1,1,2-Trichloroethane	6 U	5 U	10 U	8 U	7 U	6 U	NA	5 U	6 U	5 U	6 U	NA
1,1-Dichloroethane	3 U	3 U	5 U	4 U	4 U	3 U	NA	3 UJ	3 UJ	3 UJ	3 UJ	NA
1,1-Dichloroethene	6 U	5 U	10 U	8 U	7 U	6 U	NA	5 U	6 U	5 U	6 U	NA
1,2,3-Trichloropropane	3 U	3 U	5 U	4 U	4 U	3 U	NA	3 UJ	3 UJ	3 UJ	3 UJ	NA
1,2-Dibromo-3-Chloropropane	6 U	5 U	10 U	8 U	7 U	6 U	NA	5 UJ	6 UJ	5 UJ	6 UJ	NA
1,2-Dibromoethane	3 U	3 U	5 U	4 U	4 U	3 U	NA	3 U	3 UJ	3 UJ	3 U	NA
1,2-Dichloroethane	3 U	3 U	5 U	4 U	4 U	3 U	NA	3 U	3 U	3 U	3 U	NA
1,2-Dichloropropane	6 U	5 U	10 U	8 U	7 U	6 U	NA	5 U	6 U	5 U	6 U	NA
1,4-Dioxane	600 UR	530 UR	960 UR	840 UR	680 UR	580 UR	NA	520 UR	560 UR	550 UR	570 UR	NA
2-Butanone	6 U	5 U	10 UJ	8 UJ	7 UJ	6 U	NA	5 UJ	6 UJ	5 UJ	6 UJ	NA
2-Hexanone	6 UJ	5 U	10 U	8 U	7 U	6 U	NA	5 UJ	6 UJ	5 UJ	6 UJ	NA
3-Chloropropene	6 UJ	5 UJ	10 UJ	8 UJ	7 UJ	6 UJ	NA	5 UJ	6 UJ	5 UJ	6 UJ	NA
4-Methyl-2-Pentanone	3 U	3 U	5 U	4 U	4 U	3 U	NA	3 UJ	3 UJ	3 UJ	3 UJ	NA
Acetone	6 UJ	5 UJ	750 U	180	90	21 J	NA	5 UJ	6 UJ	5 UJ	6 UJ	NA
Acetonitrile	240 UJ	210 UJ	380 UJ	330 UJ	270 UJ	230 UJ	NA	210 UJ	230 UJ	220 UJ	230 UJ	NA
Acrolein	60 UR	53 UR	96 UR	84 UR	68 UR	58 UR	NA	52 UR	56 UR	55 UR	57 UR	NA
Acrylonitrile	60 U	53 U	96 U	84 U	68 U	58 U	NA	52 UJ	56 UJ	55 UJ	57 UJ	NA
Benzene	3 U	3 U	5 U	4 U	4 U	3 U	NA	3 U	3 U	3 U	3 U	NA
Bromodichloromethane	3 U	3 U	5 U	4 U	4 U	3 U	NA	3 U	3 U	3 U	3 U	NA
Bromoform	3 U	3 U	5 U	4 U	4 U	3 U	NA	3 U	3 UJ	3 UJ	3 U	NA
Bromomethane	6 U	5 U	10 U	8 U	7 U	6 U	NA	5 U	6 UJ	5 UJ	6 U	NA
Carbon Disulfide	3 U	3 U	6	4 U	4 U	3 U	NA	3 U	3 U	3 U	3 U	NA
Carbon Tetrachloride	3 UJ	3 UJ	5 UJ	4 UJ	4 UJ	3 UJ	NA	3 UJ	3 UJ	3 UJ	3 UJ	NA
Chlorobenzene	3 U	3 U	5 U	4 U	4 U	3 U	NA	3 U	3 U	3 U	3 U	NA
Chlorodibromomethane	3 U	3 U	5 U	4 U	4 U	3 U	NA	3 U	3 U	3 U	3 U	NA
Chloroethane	6 U	5 U	10 U	8 U	7 U	6 U	NA	5 U	6 U	5 U	6 U	NA
Chloroform	3 U	3 U	5 U	4 U	4 U	3 U	NA	3 U	3 U	3 U	3 U	NA
Chloromethane	6 UJ	5 UJ	10 U	8 U	7 U	6 UJ	NA	5 U	6 U	5 U	6 U	NA
Chloroprene	6 UJ	5 UJ	10 UJ	8 UJ	7 UJ	6 UJ	NA	5 UJ	6 UJ	5 UJ	6 UJ	NA
Cis-1,2-Dichloroethene	6 U	5 U	10 U	8 U	7 U	6 U	NA	5 U	6 U	5 U	6 U	NA
Cis-1,3-Dichloropropene	3 U	3 U	5 U	4 U	4 U	3 U	NA	3 U	3 U	3 U	3 U	NA
Dibromomethane	6 U	5 U	10 U	8 U	7 U	6 U	NA	5 U	6 U	5 U	6 U	NA
Dichlorodifluoromethane	3 U	3 U	5 U	4 U	4 U	3 U	NA	3 U	3 U	3 U	3 U	NA
Ethyl Methacrylate	6 U	5 U	10 U	8 U	7 U	6 U	NA	5 U	6 UJ	5 UJ	6 U	NA
Ethylbenzene	3 U	3 U	5 U	4 U	4 U	3 U	NA	3 U	3 U	3 U	3 U	NA
Isobutanol	240 UR	210 UR	380 UR	330 UR	270 UR	230 UR	NA	210 UR	230 UR	220 UR	230 UR	NA
Methacrylonitrile	120 U	110 U	190 UJ	170 UJ	140 UJ	120 U	NA	100 UJ	110 UJ	110 UJ	110 UJ	NA
Methyl Iodide	6 UJ	5 UJ	10 UJ	8 UJ	7 UJ	6 UJ	NA	5 U	6 UJ	5 UJ	6 U	NA
Methyl Methacrylate	6 U	5 U	10 U	8 U	7 U	6 U	NA	5 UJ	6 UJ	5 UJ	6 UJ	NA
Methylene Chloride	6 UJ	2 J	14 J	13 J	7 J	15 J	NA	5 UJ	6 UJ	5 UJ	26 U	NA
Pentachloroethane	6 UJ	5 UJ	10 UJ	8 UJ	7 UJ	6 UJ	NA	5 UJ	6 UJ	5 UJ	6 UJ	NA
Propionitrile	120 UR	110 UR	190 UR	170 UR	140 UR	120 UR	NA	100 UR	110 UR	110 UR	110 UR	NA
Styrene	3 U	3 U	5 U	4 U	4 U	3 U	NA	3 U	3 U	3 U	3 U	NA
Tetrachloroethene	3 U	3 U	5 U	4 U	4 U	3 U	NA	3 U	3 UJ	3 UJ	3 U	NA
Toluene	3 U	3 U	5 U	4 U	4 U	3 U	NA	3 U	3 U	3 U	3 U	NA
Total Xylenes	3 U	3 U	5 U	4 U	4 U	3 U	NA	3 U	3 U	3 U	3 U	NA
Trans-1,2-Dichloroethene	6 U	5 U	10 U	8 U	7 U	6 U	NA	5 U	6 U	5 U	6 U	NA
Trans-1,3-Dichloropropene	3 U	3 U	5 U	4 U	4 U	3 U	NA	3 U	3 U	3 U	3 U	NA

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-1

SUMMARY OF ANALYTIC RESULTS - SURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB15	01SB16	01SB17	01SB18	01SB19	01SB20	01SB21	01TPL	01TPL	01TPL	01TPS	BG1SBA01
Sample	01SS150002	01SS160002	01SS170002	01SS180002	01SS190002	01SS200002	01SS210002	01TPL01	01TPL02	01TPL03	01TPS04	BG1SBA0101
Matrix	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil
Depth Range	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	1 - 1.5	1 - 1.5	1 - 1.5	1 - 1.5	0 - 1
Risk	Site	Site	Site	Site	Site	Site	SiteBackground	Site	Site	Site	Site	Basewide Background
Soil Group	3	3	3	3	3	3	3	3	3	3	3	3
Sample Date	8/22/2001	8/21/2001	8/24/2001	8/24/2001	8/24/2001	8/21/2001	8/21/2001	8/27/2001	8/27/2001	8/27/2001	8/27/2001	11/4/1999
Trans-1,4-Dichloro-2-Butene	6 U	5 U	10 U	8 U	7 U	6 U	NA	5 U	6 U	5 U	6 U	NA
Trichloroethene	3 U	3 U	5 U	4 U	4 U	3 U	NA	3 U	3 U	3 U	3 U	NA
Trichlorofluoromethane	6 U	5 U	10 U	8 U	7 U	6 U	NA	5 U	6 U	5 U	6 U	NA
Vinyl Acetate	3 U	3 U	5 U	4 U	4 U	3 U	NA	3 U	3 U	3 U	3 U	NA
Vinyl Chloride	6 U	5 U	10 U	8 U	7 U	6 U	NA	5 U	6 U	5 U	6 U	NA
Semivolatile Organics (ug/kg)												
1,2,4,5-Tetrachlorobenzene	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 U	400 U	410 U	420 U	NA
1,2,4-Trichlorobenzene	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 U	400 U	410 U	420 U	NA
1,2-Dichlorobenzene	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
1,3-Dichlorobenzene	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
1,4-Dichlorobenzene	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
1,4-Naphthoquinone	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 U	400 U	410 U	420 U	NA
1,4-Phenylenediamine	990 UJ	1000 UJ	1300 U	940 U	1100 U	1000 UJ	NA	5000 UJ	1000 UJ	1000 UJ	1000 UJ	NA
1-Naphthylamine	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 U	400 U	410 U	420 U	NA
2,2'-Oxybis(1-Chloropropane)	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
2,3,4,6-Tetrachlorophenol	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 U	400 U	410 U	420 U	NA
2,4,5-Trichlorophenol	990 U	1000 U	1300 U	940 U	1100 U	1000 U	NA	5000 U	1000 U	1000 U	1000 U	NA
2,4,6-Trichlorophenol	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 U	400 U	410 U	420 U	NA
2,4-Dichlorophenol	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 U	400 U	410 U	420 U	NA
2,4-Dimethylphenol	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 U	400 U	410 U	420 U	NA
2,4-Dinitrophenol	990 U	1000 U	1300 U	940 U	1100 U	1000 U	NA	5000 U	1000 U	1000 U	1000 U	NA
2,6-Dichlorophenol	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 U	400 U	410 U	420 U	NA
2-Acetylaminofluorene	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 UJ	200 U	210 U	210 U	NA
2-Chloronaphthalene	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
2-Chlorophenol	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
2-Methylnaphthalene	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
2-Methylphenol	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
2-Naphthylamine	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
2-Nitroaniline	500 U	500 U	650 U	470 U	550 U	500 U	NA	2500 U	500 U	500 U	500 U	NA
2-Nitrophenol	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 U	400 U	410 U	420 U	NA
2-Picoline	300 U	310 U	260 U	280 U	320 U	310 U	NA	1600 U	300 U	310 U	310 U	NA
3,3'-Dichlorobenzidine	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 UJ	400 U	410 U	420 U	NA
3,3'-Dimethylbenzidine	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 UJ	400 U	410 U	420 U	NA
3-Methylcholanthrene	450 U	460 U	600 U	420 U	480 U	470 U	NA	2300 UJ	450 U	470 U	470 U	NA
3-Methylphenol	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
3-Nitroaniline	990 U	1000 U	1300 U	940 U	1100 U	1000 U	NA	5000 U	1000 U	1000 U	1000 U	NA
4,6-Dinitro-2-Methylphenol	990 U	1000 U	1300 U	940 U	1100 U	1000 U	NA	5000 U	1000 U	1000 U	1000 U	NA
4-Aminobiphenyl	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
4-Bromophenyl Phenyl Ether	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 U	400 U	410 U	420 U	NA
4-Chloro-3-Methylphenol	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 U	400 U	410 U	420 U	NA
4-Chloroaniline	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 U	400 U	410 U	420 U	NA
4-Chlorophenyl Phenyl Ether	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
4-Methylphenol	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
4-Nitroaniline	990 U	1000 U	1300 U	940 U	1100 U	1000 U	NA	5000 U	1000 U	1000 U	1000 U	NA
4-Nitrophenol	990 U	1000 U	1300 U	940 U	1100 U	1000 U	NA	5000 U	1000 U	1000 U	1000 U	NA
4-Nitroquinoline-1-Oxide	990 UR	1000 UR	1300 UR	940 UR	1100 UR	1000 UR	NA	5000 UR	1000 UR	1000 UR	1000 UR	NA
5-Nitro-O-Toluidine	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 U	400 U	410 U	420 U	NA
7,12-Dimethylbenz(A)Anthracene	300 U	310 U	260 J	280 U	320 U	310 U	NA	1500 UJ	300 U	310 U	310 U	NA
A,A-Dimethylphenethylamine	990 U	1000 U	1300 U	940 U	1100 U	1000 U	NA	5000 U	1000 U	1000 U	1000 U	NA
Acenaphthene	12.1 U	12.3 U	15.8 U	11.2 UJ	12.5 UJ	12.4 U	NA	12.3 U	12.1 U	12.5 U	12.4 U	NA
Acenaphthylene	12.1 UJ	12.3 U	15.8 U	11.2 UJ	12.5 UJ	12.4 U	NA	12.3 U	12.1 U	12.5 U	12.4 U	NA
Acetophenone	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = N[illegible]zed

TABLE A-1

SUMMARY OF ANALYTIC RESULTS - SURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB15	01SB16	01SB17	01SB18	01SB19	01SB20	01SB21	01TPL	01TPL	01TPL	01TPS	BG1SBA01
Sample	01SS150002	01SS160002	01SS170002	01SS180002	01SS190002	01SS200002	01SS210002	01TPL01	01TPL02	01TPL03	01TPS04	BG1SBA0101
Matrix	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil
Depth Range	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	1 - 1.5	1 - 1.5	1 - 1.5	1 - 1.5	0 - 1
Risk	Site	Site	Site	Site	Site	Site	SiteBackground	Site	Site	Site	Site	Basewide Background
Soil Group	3	3	3	3	3	3	3	3	3	3	3	3
Sample Date	8/22/2001	8/21/2001	8/24/2001	8/24/2001	8/24/2001	8/21/2001	8/21/2001	8/27/2001	8/27/2001	8/27/2001	8/27/2001	11/4/1999
Aniline	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
Anthracene	12.1 UJ	12.3 U	15.8 U	11.2 UJ	12.5 UJ	12.4 U	NA	12.3 U	12.1 U	12.5 U	12.4 U	NA
Aramite	990 U	1000 U	1300 U	940 U	1100 U	1000 U	NA	5000 U	1000 U	1000 U	1000 U	NA
Benzo(A)Anthracene	12.1 U	12.3 U	15.8 U	11.2 UJ	12.5 UJ	12.4 U	NA	12.3 U	12.1 U	12.5 U	12.4 U	NA
Benzo(A)Pyrene	12.1 U	12.3 U	15.8 U	11.2 UJ	12.5 UJ	12.4 U	NA	5.85 J	12.1 U	12.5 U	12.4 U	NA
Benzo(B)Fluoranthene	12.1 U	12.3 U	15.8 U	11.2 UJ	12.5 UJ	12.4 U	NA	12.3 U	12.1 U	12.5 U	12.4 U	NA
Benzo(G,H,I)Perylene	12.1 U	12.3 U	15.8 U	11.2 UJ	12.5 UJ	12.4 U	NA	9.3 J	12.1 U	12.5 U	12.4 U	NA
Benzo(K)Fluoranthene	12.1 U	12.3 U	15.8 U	11.2 UJ	12.5 UJ	12.4 U	NA	14.1 J	12.1 U	12.5 U	12.4 U	NA
Benzyl Alcohol	270 U	270 U	270 U	270 U	270 U	270 U	NA	1400 U	270 U	270 U	270 U	NA
Bis(2-Chloroethoxy)Methane	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 U	400 U	410 U	420 U	NA
Bis(2-Chloroethyl)Ether	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
Bis(2-Ethylhexyl)Phthalate	200 U	210 U	270 U	83 J	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
Butyl Benzyl Phthalate	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 UJ	200 U	210 U	210 U	NA
Chlorobenzilate	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 UJ	400 U	410 U	420 U	NA
Chrysene	12.1 U	12.3 U	15.8 U	11.2 UJ	12.5 UJ	12.4 U	NA	12.3 U	12.1 U	12.5 U	12.4 U	NA
Di-N-Butyl Phthalate	200 U	210 U	270 UJ	190 UJ	210 UJ	210 U	NA	1000 U	200 U	210 U	210 U	NA
Di-N-Octyl Phthalate	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 UJ	200 U	210 U	210 U	NA
Diallate	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 U	400 U	410 U	420 U	NA
Dibenzo(A,H)Anthracene	12.1 UJ	12.3 U	15.8 U	11.2 UJ	12.5 UJ	12.4 U	NA	5.76 J	12.1 U	12.5 U	12.4 U	NA
Dibenzofuran	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
Diethyl Phthalate	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
Dimethyl Phthalate	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
Diphenylamine	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
Ethyl Methane Sulfonate	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
Fluoranthene	12.1 U	12.3 U	15.8 U	11.2 UJ	12.5 UJ	12.4 U	NA	4.39 J	12.1 U	12.5 U	12.4 U	NA
Fluorene	12.1 U	12.3 U	15.8 U	11.2 UJ	12.5 UJ	12.4 U	NA	12.3 U	12.1 U	12.5 U	12.4 U	NA
Hexachlorobenzene	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 U	400 U	410 U	420 U	NA
Hexachlorobutadiene	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 U	400 U	410 U	420 U	NA
Hexachlorocyclopentadiene	400 UJ	410 U	540 U	380 U	420 U	420 U	NA	2000 U	400 U	410 U	420 U	NA
Hexachloroethane	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
Hexachlorophene	16000 UJ	16000 UJ	21000 U	15000 U	17000 U	17000 UJ	NA	80000 UJ	16000 UJ	17000 UJ	17000 UJ	NA
Hexachloropropene	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 U	400 U	410 U	420 U	NA
Indeno(1,2,3-CD)Pyrene	12.1 U	12.3 U	15.8 U	11.2 UJ	12.5 UJ	12.4 U	NA	4.52 J	12.1 U	12.5 U	12.4 U	NA
Isodrin	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 U	400 U	410 U	420 U	NA
Isophorone	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
Isosafrole	400 U	410 U	540 U	410	420 U	400 J	NA	2000 U	400 U	410 U	150 J	NA
Kepone	990 U	1000 U	1300 U	940 U	1100 U	1000 U	NA	5000 UJ	1000 U	1000 U	1000 U	NA
Methapyrilene	990 U	1000 U	1300 UR	940 UR	1100 U	1000 U	NA	5000 UR	1000 UR	1000 UR	1000 UR	NA
Methyl Methane Sulfonate	500 U	500 U	650 U	470 U	550 U	500 U	NA	2500 U	500 U	500 U	500 U	NA
N-Nitroso-Di-N-Butylamine	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 U	400 U	410 U	420 U	NA
N-Nitroso-Di-N-Propylamine	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
N-Nitrosodiethylamine	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
N-Nitrosodimethylamine	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
N-Nitrosomethylethylamine	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
N-Nitrosomorpholine	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
N-Nitrosopiperidine	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 U	400 U	410 U	420 U	NA
N-Nitrosopyrrolidine	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
Naphthalene	12.1 UR	12.3 U	15.8 U	11.2 UJ	12.5 UJ	12.4 U	NA	12.3 U	12.1 U	12.5 U	12.4 U	NA
O,O,O-Triethyl Phosphorothioate	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 U	400 U	410 U	420 U	NA
O-Toluidine	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
P-(Dimethylamino)Azobenzene	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 U	400 U	410 U	420 U	NA
Pentachlorobenzene	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 U	400 U	410 U	420 U	NA

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-1

SUMMARY OF ANALYTIC RESULTS - SURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB15	01SB16	01SB17	01SB18	01SB19	01SB20	01SB21	01TPL	01TPL	01TPL	01TPS	BG1SBA01
Sample	01SS150002	01SS160002	01SS170002	01SS180002	01SS190002	01SS200002	01SS210002	01TPL01	01TPL02	01TPL03	01TPS04	BG1SBA0101
Matrix	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil
Depth Range	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	1 - 1.5	1 - 1.5	.1 - 1.5	1 - 1.5	0 - 1
Risk	Site	Site	Site	Site	Site	Site	SiteBackground	Site	Site	Site	Site	Basewide Background
Soil Group	3	3	3	3	3	3	3	3	3	3	3	3
Sample Date	8/22/2001	8/21/2001	8/24/2001	8/24/2001	8/24/2001	8/21/2001	8/21/2001	8/27/2001	8/27/2001	8/27/2001	8/27/2001	11/4/1999
Pentachloronitrobenzene	990 U	1000 U	1300 U	940 U	1100 U	1000 U	NA	5000 U	1000 U	1000 U	1000 U	NA
Phenacetin	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 U	400 U	410 U	420 U	NA
Phenanthrene	12.1 U	12.3 U	15.8 U	11.2 UJ	12.5 UJ	12.4 UR	NA	12.3 U	12.1 U	12.5 U	12.4 U	NA
Phenol	200 U	210 U	270 U	190 U	210 U	210 U	NA	1000 U	200 U	210 U	210 U	NA
Pronamide	400 UR	410 UR	540 U	380 U	420 U	420 UR	NA	2000 UR	400 UR	410 UR	420 UR	NA
Pyrene	12.1 U	12.3 U	15.8 U	11.2 UJ	12.5 UJ	12.4 U	NA	4.1 J	12.1 U	12.5 U	12.4 U	NA
Pyridine	220 U	220 U	270 U	220 U	220 U	220 U	NA	1100 U	220 U	220 U	220 U	NA
Safrole	400 U	410 U	540 U	380 U	420 U	420 U	NA	2000 U	400 U	410 U	420 U	NA
Energertics (ug/kg)												
1,3,5-Trinitrobenzene	500 U	476 U	476 U	476 U	476 U	500 U	NA	NA	NA	NA	NA	NA
1,3-Dinitrobenzene	500 U	476 U	476 U	476 U	476 U	500 U	NA	NA	NA	NA	NA	NA
2,4,6-Trinitrotoluene	500 U	476 U	476 U	476 U	476 U	500 U	NA	NA	NA	NA	NA	NA
2,4-Dinitrotoluene	500 U	476 U	476 U	476 U	476 U	500 U	NA	NA	NA	NA	NA	NA
2,6-Dinitrotoluene	500 U	476 U	476 U	476 U	476 U	500 U	NA	NA	NA	NA	NA	NA
2-Amino-4,6-Dinitrotoluene	500 U	476 U	476 U	476 U	476 U	500 U	NA	NA	NA	NA	NA	NA
2-Nitrotoluene	500 U	476 U	476 U	476 U	476 U	500 U	NA	NA	NA	NA	NA	NA
3-Nitrotoluene	500 U	476 U	476 U	476 U	476 U	500 U	NA	NA	NA	NA	NA	NA
4-Amino-2,6-Dinitrotoluene	500 U	476 U	476 U	476 U	476 U	500 U	NA	NA	NA	NA	NA	NA
4-Nitrotoluene	500 U	476 U	476 U	476 U	476 U	500 U	NA	NA	NA	NA	NA	NA
Hmx	500 U	476 U	476 U	476 U	476 U	500 U	NA	NA	NA	NA	NA	NA
Nitrobenzene	500 U	476 U	476 U	476 U	476 U	500 U	NA	NA	NA	NA	NA	NA
Rdx	500 U	476 U	476 U	476 U	476 U	500 U	NA	NA	NA	NA	NA	NA
Tetryl	500 U	476 U	476 U	476 U	476 U	500 U	NA	NA	NA	NA	NA	NA
Pesticides/PCBs (ug/kg)												
4,4'-DDD	3 U	3 U	4 U	2.8 U	3.2 U	3.1 U	NA	NA	NA	NA	NA	NA
4,4'-DDE	3 UJ	3 U	4 U	2.8 U	3.2 U	3.1 U	NA	NA	NA	NA	NA	NA
4,4'-DDT	3 U	3 U	4 U	2.8 U	3.2 U	3.1 U	NA	NA	NA	NA	NA	NA
Aldrin	1.6 U	1.6 U	2.1 U	1.5 U	1.7 U	1.6 U	NA	NA	NA	NA	NA	NA
Alpha-BHC	1.6 U	1.6 U	2.1 U	1.5 U	1.7 U	1.6 U	NA	NA	NA	NA	NA	NA
Alpha-Chlordane	1.6 U	1.6 U	2.1 U	1.5 U	1.7 U	1.6 U	NA	NA	NA	NA	NA	NA
Aroclor-1016	40 U	40 U	53 U	37 U	42 U	41 U	NA	NA	NA	NA	NA	NA
Aroclor-1221	40 U	40 U	53 U	37 U	42 U	41 U	NA	NA	NA	NA	NA	NA
Aroclor-1232	40 U	40 U	53 U	37 U	42 U	41 U	NA	NA	NA	NA	NA	NA
Aroclor-1242	40 U	40 U	53 U	37 U	42 U	41 U	NA	NA	NA	NA	NA	NA
Aroclor-1248	40 U	40 U	53 U	37 U	42 U	41 U	NA	NA	NA	NA	NA	NA
Aroclor-1254	40 U	40 U	53 U	37 U	42 U	41 U	NA	NA	NA	NA	NA	NA
Aroclor-1260	40 U	40 U	53 U	37 U	42 U	41 U	NA	NA	NA	NA	NA	NA
Beta-BHC	1.6 U	1.6 U	2.1 U	1.5 U	1.7 U	1.6 U	NA	NA	NA	NA	NA	NA
Delta-BHC	1.6 UJ	1.6 U	2.1 U	1.5 U	1.7 U	1.6 U	NA	NA	NA	NA	NA	NA
Dieldrin	3 U	3 U	4 U	2.8 U	3.2 U	3.1 U	NA	NA	NA	NA	NA	NA
Endosulfan I	1.6 U	1.6 U	2.1 U	1.5 U	1.7 U	1.6 U	NA	NA	NA	NA	NA	NA
Endosulfan II	3 U	3 U	4 U	2.8 U	3.2 U	3.1 U	NA	NA	NA	NA	NA	NA
Endosulfan Sulfate	3 U	3 U	4 U	2.8 U	3.2 U	3.1 U	NA	NA	NA	NA	NA	NA
Endrin	3 U	3 U	4 U	2.8 U	3.2 U	3.1 U	NA	NA	NA	NA	NA	NA
Endrin Aldehyde	3 U	3 U	4 U	2.8 U	3.2 U	3.1 U	NA	NA	NA	NA	NA	NA
Gamma-BHC (Lindane)	1.6 U	1.6 U	2.1 U	1.5 U	1.7 U	1.6 U	NA	NA	NA	NA	NA	NA
Gamma-Chlordane	3 R	1.6 U	1.1 J	0.71 J	0.81 J	1.6 U	NA	NA	NA	NA	NA	NA
Heptachlor	2	1.4 J	2.4 BU	1 BU	1.2 BU	2.4	NA	NA	NA	NA	NA	NA
Heptachlor Epoxide	1.6 U	1.6 U	2.1 U	1.5 U	1.7 U	1.6 U	NA	NA	NA	NA	NA	NA
Methoxychlor	16 U	16 U	21 U	15 U	17 U	16 U	NA	NA	NA	NA	NA	NA
Toxaphene	100 U	100 U	130 U	94 U	110 U	100 U	NA	NA	NA	NA	NA	NA
Herbicides (ug/kg)												

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-1

SUMMARY OF ANALYTIC RESULTS - SURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB15	01SB16	01SB17	01SB18	01SB19	01SB20	01SB21	01TPL	01TPL	01TPL	01TPS	BG1SBA01
Sample	01SS150002	01SS160002	01SS170002	01SS180002	01SS190002	01SS200002	01SS210002	01TPL01	01TPL02	01TPL03	01TPS04	BG1SBA0101
Matrix	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil
Depth Range	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	1 - 1.5	1 - 1.5	1 - 1.5	1 - 1.5	0 - 1
Risk	Site	Site	Site	Site	Site	Site	SiteBackground	Site	Site	Site	Site	Basewide Background
Soil Group	3	3	3	3	3	3	3	3	3	3	3	3
Sample Date	8/22/2001	8/21/2001	8/24/2001	8/24/2001	8/24/2001	8/21/2001	8/21/2001	8/27/2001	8/27/2001	8/27/2001	8/27/2001	11/4/1999
2,4,5-T	12 U	12 U	16 U	11 U	13 U	13 U	NA	NA	NA	NA	NA	NA
2,4,5-TP (Silvex)	5.9 J	12 U	16 U	11 U	13 U	13 U	NA	NA	NA	NA	NA	NA
2,4-D	85 U	86 U	210	69 J	90 U	88 U	NA	NA	NA	NA	NA	NA
Dinoseb	24 U	25 U	32 U	23 U	26 U	25 U	NA	NA	NA	NA	NA	NA
Pentachlorophenol	12 U	12 U	16 U	11 U	13 U	13 U	NA	NA	NA	NA	NA	NA
Inorganics (mg/kg)												
Aluminum	17200 J	12200	15300 J	9400 J	12400 J	13800	NA	9820 J	9900 J	9570 J	12400 J	8070 J
Antimony	0.89 U	0.51 U	0.36 U	0.49 U	0.55 U	0.54 U	NA	0.34 U	0.45 U	0.40 U	0.28 U	0.53 U
Arsenic	9.1	8.3	10.8 J	6.0 J	7.9 J	7.5	NA	6.9 J	6.4 J	6.2 J	7.1 J	7.9
Barium	76.2	104	169	49.9	42.9	112	NA	117 J	118 J	114 J	131 J	76.6 J
Beryllium	0.59 U	0.72 J	1.0 J	0.45 J	0.38 J	0.78 J	NA	0.93 J	0.77 J	0.86 J	0.72 J	1.4 U
Cadmium	0.01 U	0.05 UJ	1.3 J	0.09 J	0.15 J	0.05 UJ	NA	0.14 J	0.05 J	0.04 UJ	0.11 J	0.29 U
Calcium	1050 J	2520	1450 J	421 J	579 J	946	NA	12600 J	18800 J	4810 J	1120 J	5 U
Chromium	19.3	13.9	24.3 J	12.1 J	15.9 J	14.1	NA	12.8	13.1	11.5	14.0	21.7 J
Cobalt	8.3 J	11.6	18.8 J	8.8 J	3.2 J	20.3	NA	22.3	19.0	16.2	18.6	18
Copper	17.6 J	12.6 J	12.6 J	8.1 J	12.3 J	10.9 J	NA	7.4 J	7.9 J	9.1 J	10.5 J	9.8
Iron	23500	19900	24600	17200	22800	18000	NA	15400	14600	15000	17600	36200 J
Lead	12.9 J	16.5	20.0	11.4	11.0	18.1	NA	21.6	17.6	17.8	16.3	21.5 J
Magnesium	2380 J	1780	1930 J	1050 J	1850 J	1570	NA	1540 J	1830 J	1190 J	1500 J	620 J
Manganese	382 J	629	1420 J	427 J	114 J	1220	NA	1720 J	1540 J	1290 J	1070 J	1950 J
Mercury	0.07	0.07 U	0.04 U	0.04 U	0.10 U	0.05 U	NA	0.04 J	0.03 J	0.04 J	0.04 J	0.05
Nickel	12.2	11.7	16.0 J	6.9 J	8.1 J	13.4	NA	12.1	11.1	10.9	13.9	20 J
Potassium	823 J	668 J	853 J	436 J	575 J	846 J	NA	503 J	519 J	479 J	676 J	644
Selenium	0.62 J	0.38 U	1.5 U	0.68 U	0.87 U	0.49	NA	0.76 J	0.72 J	0.74 J	0.70 J	0.82 U
Silver	0.05 U	0.15 U	0.46 U	0.34 U	0.37 U	0.16 U	NA	0.37 U	0.36 U	0.37 U	0.36 U	0.05 J
Sodium	384 J	304	452 J	329 J	426 J	400	NA	336 J	283 J	351 J	297 J	2.4 U
Strontium	10.4 J	11.9 J	13.7 J	5.0 J	6.8 J	8.8 J	NA	15.9 J	20.2 J	9.5 J	12.8 J	NA
Thallium	1.5 J	1.6	2.5 J	1.9 J	2.7 J	1.6	NA	0.69	0.61 U	0.62 U	0.99	0.19 J
Thorium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thorium-Calc	4.04	4.58	4.2	3.57	3.56	3.70	3.59	4.73	3.76	4.11	4.32	NA
Tin	3.8	3.1	29.2 U	21.6 U	23.4 U	3.4	NA	23.2 U	23.1 U	23.7 U	22.8 U	0.63 U
Vanadium	35.7 J	28.1	36.2	24.8	30.4	28.6	NA	24.8	23.6	22.8	29.2	30.7 J
Zinc	50.9	42.5	54.9 J	25.1 J	34.3 J	45.3	NA	41.2 J	35.5 J	38.6 J	46.3 J	37.6 J
Miscellaneous Parameters												
1,4-Dithiane (ug/kg)	244 U	247 U	323 U	227 U	256 U	252 U	NA	247 U	243 U	250 U	247 U	NA
1,4-Oxathiane (ug/kg)	244 U	247 U	323 U	227 U	256 U	252 U	NA	247 U	243 U	250 U	247 U	NA
Bis(2-Chloroethyl)Sulfide (ug/kg)	244 U	247 U	323 U	227 U	256 U	252 U	NA	247 U	243 U	250 U	247 U	NA
Cation Exchange Capacity (meq/100g	NA	NA	NA	NA	NA	11.2	NA	NA	NA	NA	NA	NA
pH (S.U.)	NA	NA	NA	NA	NA	5.0 J	NA	7.5 J	NA	NA	NA	NA
Total Organic Carbon (mg/kg)	NA	NA	NA	NA	NA	NA	619 U	NA	NA	NA	NA	NA
Total Radiologicals (pCi/g)												
Actinium-228	NA	NA	NA	NA	NA	NA	NA	NA	0.92	0.97	NA	NA
Bismuth-212	NA	NA	NA	NA	NA	NA	NA	NA	0.91	0.94	NA	NA
Bismuth-214	NA	NA	NA	NA	NA	NA	NA	NA	0.68	0.74	NA	NA
Cesium-137	NA	NA	NA	NA	NA	NA	NA	NA	0.0359 U	0.09	NA	NA
Cobalt-60	NA	NA	NA	NA	NA	NA	NA	NA	0.0146 U	0.0162 U	NA	NA
Europium-154	NA	NA	NA	NA	NA	NA	NA	NA	0.0127 U	0.0129 U	NA	NA
Europium-155	NA	NA	NA	NA	NA	NA	NA	NA	0.0964 U	0.232 U	NA	NA
Lead-210	NA	NA	NA	NA	NA	NA	NA	NA	0.47	0.52	NA	NA
Lead-212	NA	NA	NA	NA	NA	NA	NA	NA	0.83	0.86	NA	NA
Lead-214	NA	NA	NA	NA	NA	NA	NA	NA	0.71	0.69	NA	NA
Potassium-40	NA	NA	NA	NA	NA	NA	NA	NA	9.94	9.76	NA	NA

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-1

SUMMARY OF ANALYTIC RESULTS - SURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB15	01SB16	01SB17	01SB18	01SB19	01SB20	01SB21	01TPL	01TPL	01TPL	01TPS	BG1SBA01
Sample	01SS150002	01SS160002	01SS170002	01SS180002	01SS190002	01SS200002	01SS210002	01TPL01	01TPL02	01TPL03	01TPS04	BG1SBA0101
Matrix	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil
Depth Range	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	1 - 1.5	1 - 1.5	1 - 1.5	1 - 1.5	0 - 1
Risk	Site	Site	Site	Site	Site	Site	SiteBackground	Site	Site	Site	Site	Basewide Background
Soil Group	3	3	3	3	3	3	3	3	3	3	3	3
Sample Date	8/22/2001	8/21/2001	8/24/2001	8/24/2001	8/24/2001	8/21/2001	8/21/2001	8/27/2001	8/27/2001	8/27/2001	8/27/2001	11/4/1999
Protactinium-234	NA	NA	NA	NA	NA	NA	NA	NA	3.12 U	2.73 U	NA	NA
Radium-226	NA	NA	NA	NA	NA	NA	NA	NA	1.56	1.68	NA	NA
Thallium-208	NA	NA	NA	NA	NA	NA	NA	NA	0.77	0.81	NA	NA
Thorium-228	0.387	0.490	0.427	0.416	0.299	0.436	0.431	0.483	0.377	0.353	0.449	NA
Thorium-230	0.562 J	0.475	0.0395 U	0.0345 U	0.0848 U	0.578	0.0764	0.0278 J	0.0179 J	0.023 J	0.0215 J	NA
Thorium-232	0.501	0.518	0.497	0.370	0.485	0.379	0.359	0.557	0.451	0.552	0.501	NA
Thorium-234	NA	NA	NA	NA	NA	NA	NA	NA	1.00	1.73	NA	NA
Uranium-235	NA	NA	NA	NA	NA	NA	NA	NA	0.12	0.14	NA	NA

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-1

SUMMARY OF ANALYTIC RESULTS - SURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	BG1SBA04	BG1SBP04	BG1SBP06	BG1SBP07	BG1SBP08	BG1SBP09	BG3SBA01	BG3SBA03
Sample	BG1SBA0401	BG1SBP0401	BG1SBP0601	BG1SBP0701	BG1SBP0801	BG1SBP0901	BG3SBA0101	BG3SBA0301
Matrix	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil
Depth Range	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
Risk	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background
Soil Group	3	3	3	3	3	3	3	3
Sample Date	11/5/1999	11/6/1999	11/5/1999	11/5/1999	11/6/1999	11/6/1999	11/2/1999	11/3/1999
Volatile Organics (ug/kg)								
1,1,1,2-Tetrachloroethane	NA	NA	NA	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	NA	NA	NA	NA	NA	NA	NA	NA
1,1,2,2-Tetrachloroethane	NA	NA	NA	NA	NA	NA	NA	NA
1,1,2-Trichloroethane	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethane	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3-Trichloropropane	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dibromo-3-Chloropropane	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dibromoethane	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloropropane	NA	NA	NA	NA	NA	NA	NA	NA
1,4-Dioxane	NA	NA	NA	NA	NA	NA	NA	NA
2-Butanone	NA	NA	NA	NA	NA	NA	NA	NA
2-Hexanone	NA	NA	NA	NA	NA	NA	NA	NA
3-Chloropropene	NA	NA	NA	NA	NA	NA	NA	NA
4-Methyl-2-Pentanone	NA	NA	NA	NA	NA	NA	NA	NA
Acetone	NA	NA	NA	NA	NA	NA	NA	NA
Acetonitrile	NA	NA	NA	NA	NA	NA	NA	NA
Acrolein	NA	NA	NA	NA	NA	NA	NA	NA
Acrylonitrile	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	NA	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	NA	NA	NA	NA	NA	NA	NA	NA
Bromoform	NA	NA	NA	NA	NA	NA	NA	NA
Bromomethane	NA	NA	NA	NA	NA	NA	NA	NA
Carbon Disulfide	NA	NA	NA	NA	NA	NA	NA	NA
Carbon Tetrachloride	NA	NA	NA	NA	NA	NA	NA	NA
Chlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA
Chlorodibromomethane	NA	NA	NA	NA	NA	NA	NA	NA
Chloroethane	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	NA	NA	NA	NA	NA	NA	NA	NA
Chloromethane	NA	NA	NA	NA	NA	NA	NA	NA
Chloroprene	NA	NA	NA	NA	NA	NA	NA	NA
Cis-1,2-Dichloroethene	NA	NA	NA	NA	NA	NA	NA	NA
Cis-1,3-Dichloropropene	NA	NA	NA	NA	NA	NA	NA	NA
Dibromomethane	NA	NA	NA	NA	NA	NA	NA	NA
Dichlorodifluoromethane	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl Methacrylate	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	NA	NA	NA	NA	NA	NA	NA	NA
Isobutanol	NA	NA	NA	NA	NA	NA	NA	NA
Methacrylonitrile	NA	NA	NA	NA	NA	NA	NA	NA
Methyl Iodide	NA	NA	NA	NA	NA	NA	NA	NA
Methyl Methacrylate	NA	NA	NA	NA	NA	NA	NA	NA
Methylene Chloride	NA	NA	NA	NA	NA	NA	NA	NA
Pentachloroethane	NA	NA	NA	NA	NA	NA	NA	NA
Propionitrile	NA	NA	NA	NA	NA	NA	NA	NA
Styrene	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	NA	NA	NA	NA	NA	NA	NA	NA
Toluene	NA	NA	NA	NA	NA	NA	NA	NA
Total Xylenes	NA	NA	NA	NA	NA	NA	NA	NA
Trans-1,2-Dichloroethene	NA	NA	NA	NA	NA	NA	NA	NA
Trans-1,3-Dichloropropene	NA	NA	NA	NA	NA	NA	NA	NA

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-1

SUMMARY OF ANALYTIC RESULTS - SURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	BG1SBA04	BG1SBP04	BG1SBP06	BG1SBP07	BG1SBP08	BG1SBP09	BG3SBA01	BG3SBA03
Sample	BG1SBA0401	BG1SBP0401	BG1SBP0601	BG1SBP0701	BG1SBP0801	BG1SBP0901	BG3SBA0101	BG3SBA0301
Matrix	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil
Depth Range	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
Risk	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background
Soil Group	3	3	3	3	3	3	3	3
Sample Date	11/5/1999	11/6/1999	11/5/1999	11/5/1999	11/6/1999	11/6/1999	11/2/1999	11/3/1999
Trans-1,4-Dichloro-2-Butene	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethene	NA	NA	NA	NA	NA	NA	NA	NA
Trichlorofluoromethane	NA	NA	NA	NA	NA	NA	NA	NA
Vinyl Acetate	NA	NA	NA	NA	NA	NA	NA	NA
Vinyl Chloride	NA	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organics (ug/kg)								
1,2,4,5-Tetrachlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA
1,2,4-Trichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA
1,3-Dichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA
1,4-Dichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA
1,4-Naphthoquinone	NA	NA	NA	NA	NA	NA	NA	NA
1,4-Phenylenediamine	NA	NA	NA	NA	NA	NA	NA	NA
1-Naphthylamine	NA	NA	NA	NA	NA	NA	NA	NA
2,2'-Oxybis(1-Chloropropane)	NA	NA	NA	NA	NA	NA	NA	NA
2,3,4,6-Tetrachlorophenol	NA	NA	NA	NA	NA	NA	NA	NA
2,4,5-Trichlorophenol	NA	NA	NA	NA	NA	NA	NA	NA
2,4,6-Trichlorophenol	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dichlorophenol	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dimethylphenol	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dinitrophenol	NA	NA	NA	NA	NA	NA	NA	NA
2,6-Dichlorophenol	NA	NA	NA	NA	NA	NA	NA	NA
2-Acetylaminofluorene	NA	NA	NA	NA	NA	NA	NA	NA
2-Chloronaphthalene	NA	NA	NA	NA	NA	NA	NA	NA
2-Chlorophenol	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylphenol	NA	NA	NA	NA	NA	NA	NA	NA
2-Naphthylamine	NA	NA	NA	NA	NA	NA	NA	NA
2-Nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA
2-Nitrophenol	NA	NA	NA	NA	NA	NA	NA	NA
2-Picoline	NA	NA	NA	NA	NA	NA	NA	NA
3,3'-Dichlorobenzidine	NA	NA	NA	NA	NA	NA	NA	NA
3,3'-Dimethylbenzidine	NA	NA	NA	NA	NA	NA	NA	NA
3-Methylcholanthrene	NA	NA	NA	NA	NA	NA	NA	NA
3-Methylphenol	NA	NA	NA	NA	NA	NA	NA	NA
3-Nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA
4,6-Dinitro-2-Methylphenol	NA	NA	NA	NA	NA	NA	NA	NA
4-Aminobiphenyl	NA	NA	NA	NA	NA	NA	NA	NA
4-Bromophenyl Phenyl Ether	NA	NA	NA	NA	NA	NA	NA	NA
4-Chloro-3-Methylphenol	NA	NA	NA	NA	NA	NA	NA	NA
4-Chloroaniline	NA	NA	NA	NA	NA	NA	NA	NA
4-Chlorophenyl Phenyl Ether	NA	NA	NA	NA	NA	NA	NA	NA
4-Methylphenol	NA	NA	NA	NA	NA	NA	NA	NA
4-Nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA
4-Nitrophenol	NA	NA	NA	NA	NA	NA	NA	NA
4-Nitroquinoline-1-Oxide	NA	NA	NA	NA	NA	NA	NA	NA
5-Nitro-O-Toluidine	NA	NA	NA	NA	NA	NA	NA	NA
7,12-Dimethylbenz(A)Anthracene	NA	NA	NA	NA	NA	NA	NA	NA
A,A-Dimethylphenethylamine	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthene	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthylene	NA	NA	NA	NA	NA	NA	NA	NA
Acetophenone	NA	NA	NA	NA	NA	NA	NA	NA

Calc = [illegible]lated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = [illegible]lyzed

TABLE A-1

SUMMARY OF ANALYTIC RESULTS - SURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	BG1SBA04	BG1SBP04	BG1SBP06	BG1SBP07	BG1SBP08	BG1SBP09	BG3SBA01	BG3SBA03
Sample	BG1SBA0401	BG1SBP0401	BG1SBP0601	BG1SBP0701	BG1SBP0801	BG1SBP0901	BG3SBA0101	BG3SBA0301
Matrix	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil
Depth Range	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
Risk	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background
Soil Group	3	3	3	3	3	3	3	3
Sample Date	11/5/1999	11/6/1999	11/5/1999	11/5/1999	11/6/1999	11/6/1999	11/2/1999	11/3/1999
Aniline	NA	NA	NA	NA	NA	NA	NA	NA
Anthracene	NA	NA	NA	NA	NA	NA	NA	NA
Aramite	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(A)Anthracene	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(A)Pyrene	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(B)Fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(G,H,I)Perylene	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(K)Fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA
Benzyl Alcohol	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-Chloroethoxy)Methane	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-Chloroethyl)Ether	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-Ethylhexyl)Phthalate	NA	NA	NA	NA	NA	NA	NA	NA
Butyl Benzyl Phthalate	NA	NA	NA	NA	NA	NA	NA	NA
Chlorobenzilate	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA	NA	NA
Di-N-Butyl Phthalate	NA	NA	NA	NA	NA	NA	NA	NA
Di-N-Octyl Phthalate	NA	NA	NA	NA	NA	NA	NA	NA
Diallate	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(A,H)Anthracene	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzofuran	NA	NA	NA	NA	NA	NA	NA	NA
Diethyl Phthalate	NA	NA	NA	NA	NA	NA	NA	NA
Dimethyl Phthalate	NA	NA	NA	NA	NA	NA	NA	NA
Diphenylamine	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl Methane Sulfonate	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorobutadiene	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorocyclopentadiene	NA	NA	NA	NA	NA	NA	NA	NA
Hexachloroethane	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorophene	NA	NA	NA	NA	NA	NA	NA	NA
Hexachloropropene	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-CD)Pyrene	NA	NA	NA	NA	NA	NA	NA	NA
Isodrin	NA	NA	NA	NA	NA	NA	NA	NA
Isophorone	NA	NA	NA	NA	NA	NA	NA	NA
Isosafrole	NA	NA	NA	NA	NA	NA	NA	NA
Kepone	NA	NA	NA	NA	NA	NA	NA	NA
Methapyrilene	NA	NA	NA	NA	NA	NA	NA	NA
Methyl Methane Sulfonate	NA	NA	NA	NA	NA	NA	NA	NA
N-Nitroso-Di-N-Butylamine	NA	NA	NA	NA	NA	NA	NA	NA
N-Nitroso-Di-N-Propylamine	NA	NA	NA	NA	NA	NA	NA	NA
N-Nitrosodiethylamine	NA	NA	NA	NA	NA	NA	NA	NA
N-Nitrosodimethylamine	NA	NA	NA	NA	NA	NA	NA	NA
N-Nitrosomethylethylamine	NA	NA	NA	NA	NA	NA	NA	NA
N-Nitrosomorpholine	NA	NA	NA	NA	NA	NA	NA	NA
N-Nitrosopiperidine	NA	NA	NA	NA	NA	NA	NA	NA
N-Nitrosopyrrolidine	NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene	NA	NA	NA	NA	NA	NA	NA	NA
O,O,O-Triethyl Phosphorothioate	NA	NA	NA	NA	NA	NA	NA	NA
O-Toluidine	NA	NA	NA	NA	NA	NA	NA	NA
P-(Dimethylamino)Azobenzene	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-1

SUMMARY OF ANALYTIC RESULTS - SURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	BG1SBA04	BG1SBP04	BG1SBP06	BG1SBP07	BG1SBP08	BG1SBP09	BG3SBA01	BG3SBA03
Sample	BG1SBA0401	BG1SBP0401	BG1SBP0601	BG1SBP0701	BG1SBP0801	BG1SBP0901	BG3SBA0101	BG3SBA0301
Matrix	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil
Depth Range	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
Risk	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background
Soil Group	3	3	3	3	3	3	3	3
Sample Date	11/5/1999	11/6/1999	11/5/1999	11/5/1999	11/6/1999	11/6/1999	11/2/1999	11/3/1999
Pentachloronitrobenzene	NA	NA	NA	NA	NA	NA	NA	NA
Phenacetin	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA	NA	NA
Phenol	NA	NA	NA	NA	NA	NA	NA	NA
Pronamide	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA	NA	NA
Pyridine	NA	NA	NA	NA	NA	NA	NA	NA
Safrole	NA	NA	NA	NA	NA	NA	NA	NA
Energertics (ug/kg)								
1,3,5-Trinitrobenzene	NA	NA	NA	NA	NA	NA	NA	NA
1,3-Dinitrobenzene	NA	NA	NA	NA	NA	NA	NA	NA
2,4,6-Trinitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dinitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA
2,6-Dinitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA
2-Amino-4,6-Dinitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA
2-Nitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA
3-Nitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA
4-Amino-2,6-Dinitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA
4-Nitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA
Hmx	NA	NA	NA	NA	NA	NA	NA	NA
Nitrobenzene	NA	NA	NA	NA	NA	NA	NA	NA
Rdx	NA	NA	NA	NA	NA	NA	NA	NA
Tetryl	NA	NA	NA	NA	NA	NA	NA	NA
Pesticides/PCBs (ug/kg)								
4,4'-DDD	NA	NA	NA	NA	NA	NA	NA	NA
4,4'-DDE	NA	NA	NA	NA	NA	NA	NA	NA
4,4'-DDT	NA	NA	NA	NA	NA	NA	NA	NA
Aldrin	NA	NA	NA	NA	NA	NA	NA	NA
Alpha-BHC	NA	NA	NA	NA	NA	NA	NA	NA
Alpha-Chlordane	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1016	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1221	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1232	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1242	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1248	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1254	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1260	NA	NA	NA	NA	NA	NA	NA	NA
Beta-BHC	NA	NA	NA	NA	NA	NA	NA	NA
Delta-BHC	NA	NA	NA	NA	NA	NA	NA	NA
Dieldrin	NA	NA	NA	NA	NA	NA	NA	NA
Endosulfan I	NA	NA	NA	NA	NA	NA	NA	NA
Endosulfan II	NA	NA	NA	NA	NA	NA	NA	NA
Endosulfan Sulfate	NA	NA	NA	NA	NA	NA	NA	NA
Endrin	NA	NA	NA	NA	NA	NA	NA	NA
Endrin Aldehyde	NA	NA	NA	NA	NA	NA	NA	NA
Gamma-BHC (Lindane)	NA	NA	NA	NA	NA	NA	NA	NA
Gamma-Chlordane	NA	NA	NA	NA	NA	NA	NA	NA
Heptachlor	NA	NA	NA	NA	NA	NA	NA	NA
Heptachlor Epoxide	NA	NA	NA	NA	NA	NA	NA	NA
Methoxychlor	NA	NA	NA	NA	NA	NA	NA	NA
Toxaphene	NA	NA	NA	NA	NA	NA	NA	NA
Herbicides (ug/kg)								

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-1

SUMMARY OF ANALYTIC RESULTS - SURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	BG1SBA04	BG1SBP04	BG1SBP06	BG1SBP07	BG1SBP08	BG1SBP09	BG3SBA01	BG3SBA03
Sample	BG1SBA0401	BG1SBP0401	BG1SBP0601	BG1SBP0701	BG1SBP0801	BG1SBP0901	BG3SBA0101	BG3SBA0301
Matrix	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil
Depth Range	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
Risk	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background
Soil Group	3	3	3	3	3	3	3	3
Sample Date	11/5/1999	11/6/1999	11/5/1999	11/5/1999	11/6/1999	11/6/1999	11/2/1999	11/3/1999
2,4,5-T	NA	NA	NA	NA	NA	NA	NA	NA
2,4,5-TP (Silvex)	NA	NA	NA	NA	NA	NA	NA	NA
2,4-D	NA	NA	NA	NA	NA	NA	NA	NA
Dinoseb	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorophenol	NA	NA	NA	NA	NA	NA	NA	NA
Inorganics (mg/kg)								
Aluminum	6920 J	12200	14800 J	6770 J	17400	9300	8240 J	9600 J
Antimony	0.37 U	0.72 U	0.61 U	0.26 U	1.8 U	3.2 U	0.71 U	0.71 U
Arsenic	4	5.2 J	6.8 J	2.4 J	8.5 J	4.7 J	3.7	4.8
Barium	59.1 J	72.2 J	66.7 J	46.1 J	75 J	77.1 J	74.3 J	105 J
Beryllium	0.35 U	0.68 U	0.6 U	0.96 U	0.56 U	0.84 U	0.64 U	0.69 U
Cadmium	0.3 U	0.26 J	0.45 J	0.19 J	0.61	0.1 J	0.2 U	0.29 U
Calcium	896 J	255	405 J	115 J	418	278	334	957 J
Chromium	10.2 J	13.7 J	17.6 J	8.5 J	19.9 J	13.3 J	9.2 J	15 J
Cobalt	6	15.1	10.4	10.2	8.5	13.1	8.8	14.4
Copper	8.8	9.8	12.2	5.4	17.1	9.4	6.5	8 J
Iron	12100 J	15600 J	19700 J	12300 J	23400 J	15900 J	9340 J	16900 J
Lead	9.4 J	13.6 J	13 J	10.7 J	13.8 J	13.7 J	12.3 J	19 J
Magnesium	967 J	1430 J	1910 J	712 J	2250 J	988 J	876 J	1310 J
Manganese	417 J	577 J	389 J	606 J	268 J	1480 J	721 J	1560 J
Mercury	0.05 U	0.05 U	0.05 U	0.05	0.04	0.05 U	0.05 U	0.05
Nickel	10.3 J	13.1 J	14.6 J	13.2 J	15.9 J	15.2 J	8.8 J	13.2 J
Potassium	607 J	831	1110 J	418 J	1490	889	584	1060
Selenium	0.45 U	0.63	0.55	0.58	0.51	0.64	0.64 U	1 U
Silver	0.05 J	0.11 J	0.1 J	0.05 J	0.1 J	0.05 J	0.05 J	0.06 J
Sodium	2.5 U	16.1 J	22.6 U	2.41 U	18.1 J	14.2 J	2.5 U	2.9 U
Strontium	13.7 J	9.4 J	13.7 J	8.7 J	10.7 J	12.7 J	7.4 J	10.1 J
Thallium	0.1 J	0.21 J	0.25 J	0.14 J	0.25 J	0.2 J	0.15 J	0.17 J
Thorium	6.3 J	7.5 J	8.4 J	5.9 J	8.5 J	7.9 J	4.8 J	6.4 J
Thorium-Calc	NA	NA	NA	NA	NA	NA	NA	NA
Tin	0.53 U	0.67 U	0.61 U	0.51 U	0.8 U	0.6 U	0.66 U	0.82 U
Vanadium	17.5 J	28.4 J	34.6 J	17.1 J	40 J	20.4 J	16.9	23.5
Zinc	24.4 J	41.4 J	43.1 J	32.7 J	52.6 J	36.2 J	34.1 J	37.7 J
Miscellaneous Parameters								
1,4-Dithiane (ug/kg)	NA	NA	NA	NA	NA	NA	NA	NA
1,4-Oxathiane (ug/kg)	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-Chloroethyl)Sulfide (ug/kg)	NA	NA	NA	NA	NA	NA	NA	NA
Cation Exchange Capacity (meq/100g	NA	NA	NA	NA	NA	NA	NA	NA
pH (S.U.)	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon (mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA
Total Radiologicals (pCi/g)								
Actinium-228	NA	NA	NA	NA	NA	NA	NA	NA
Bismuth-212	NA	NA	NA	NA	NA	NA	NA	NA
Bismuth-214	NA	NA	NA	NA	NA	NA	NA	NA
Cesium-137	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt-60	NA	NA	NA	NA	NA	NA	NA	NA
Europium-154	NA	NA	NA	NA	NA	NA	NA	NA
Europium-155	NA	NA	NA	NA	NA	NA	NA	NA
Lead-210	NA	NA	NA	NA	NA	NA	NA	NA
Lead-212	NA	NA	NA	NA	NA	NA	NA	NA
Lead-214	NA	NA	NA	NA	NA	NA	NA	NA
Potassium-40	NA	NA	NA	NA	NA	NA	NA	NA

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-1

SUMMARY OF ANALYTIC RESULTS - SURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	BG1SBA04	BG1SBP04	BG1SBP06	BG1SBP07	BG1SBP08	BG1SBP09	BG3SBA01	BG3SBA03
Sample	BG1SBA0401	BG1SBP0401	BG1SBP0601	BG1SBP0701	BG1SBP0801	BG1SBP0901	BG3SBA0101	BG3SBA0301
Matrix	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil
Depth Range	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
Risk	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background
Soil Group	3	3	3	3	3	3	3	3
Sample Date	11/5/1999	11/6/1999	11/5/1999	11/5/1999	11/6/1999	11/6/1999	11/2/1999	11/3/1999
Protactinium-234	NA	NA	NA	NA	NA	NA	NA	NA
Radium-226	NA	NA	NA	NA	NA	NA	NA	NA
Thallium-208	NA	NA	NA	NA	NA	NA	NA	NA
Thorium-228	NA	NA	NA	NA	NA	NA	NA	NA
Thorium-230	NA	NA	NA	NA	NA	NA	NA	NA
Thorium-232	NA	NA	NA	NA	NA	NA	NA	NA
Thorium-234	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-235	NA	NA	NA	NA	NA	NA	NA	NA

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-1

SUMMARY OF ANALYTIC RESULTS - SURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	BG3SBA05	BG3SBM02	BG3SBM04	BG3SBM06	BG3SBM07	BG3SBM08
Sample	BG3SBA0501	BG3SBM0201	BG3SBM0401	BG3SBM0601	BG3SBM0701	BG3SBM0801
Matrix	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil
Depth Range	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
Risk	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background
Soil Group	3	3	3	3	3	3
Sample Date	11/4/1999	11/2/1999	11/3/1999	11/2/1999	11/3/1999	11/3/1999
Volatile Organics (ug/kg)						
1,1,1,2-Tetrachloroethane	NA	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	NA	NA	NA	NA	NA	NA
1,1,2,2-Tetrachloroethane	NA	NA	NA	NA	NA	NA
1,1,2-Trichloroethane	NA	NA	NA	NA	NA	NA
1,1-Dichloroethane	NA	NA	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	NA	NA	NA	NA
1,2,3-Trichloropropane	NA	NA	NA	NA	NA	NA
1,2-Dibromo-3-Chloropropane	NA	NA	NA	NA	NA	NA
1,2-Dibromoethane	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	NA	NA	NA	NA	NA	NA
1,2-Dichloropropane	NA	NA	NA	NA	NA	NA
1,4-Dioxane	NA	NA	NA	NA	NA	NA
2-Butanone	NA	NA	NA	NA	NA	NA
2-Hexanone	NA	NA	NA	NA	NA	NA
3-Chloropropene	NA	NA	NA	NA	NA	NA
4-Methyl-2-Pentanone	NA	NA	NA	NA	NA	NA
Acetone	NA	NA	NA	NA	NA	NA
Acetonitrile	NA	NA	NA	NA	NA	NA
Acrolein	NA	NA	NA	NA	NA	NA
Acrylonitrile	NA	NA	NA	NA	NA	NA
Benzene	NA	NA	NA	NA	NA	NA
Bromodichloromethane	NA	NA	NA	NA	NA	NA
Bromoform	NA	NA	NA	NA	NA	NA
Bromomethane	NA	NA	NA	NA	NA	NA
Carbon Disulfide	NA	NA	NA	NA	NA	NA
Carbon Tetrachloride	NA	NA	NA	NA	NA	NA
Chlorobenzene	NA	NA	NA	NA	NA	NA
Chlorodibromomethane	NA	NA	NA	NA	NA	NA
Chloroethane	NA	NA	NA	NA	NA	NA
Chloroform	NA	NA	NA	NA	NA	NA
Chloromethane	NA	NA	NA	NA	NA	NA
Chloroprene	NA	NA	NA	NA	NA	NA
Cis-1,2-Dichloroethene	NA	NA	NA	NA	NA	NA
Cis-1,3-Dichloropropene	NA	NA	NA	NA	NA	NA
Dibromomethane	NA	NA	NA	NA	NA	NA
Dichlorodifluoromethane	NA	NA	NA	NA	NA	NA
Ethyl Methacrylate	NA	NA	NA	NA	NA	NA
Ethylbenzene	NA	NA	NA	NA	NA	NA
Isobutanol	NA	NA	NA	NA	NA	NA
Methacrylonitrile	NA	NA	NA	NA	NA	NA
Methyl Iodide	NA	NA	NA	NA	NA	NA
Methyl Methacrylate	NA	NA	NA	NA	NA	NA
Methylene Chloride	NA	NA	NA	NA	NA	NA
Pentachloroethane	NA	NA	NA	NA	NA	NA
Propionitrile	NA	NA	NA	NA	NA	NA
Styrene	NA	NA	NA	NA	NA	NA
Tetrachloroethene	NA	NA	NA	NA	NA	NA
Toluene	NA	NA	NA	NA	NA	NA
Total Xylenes	NA	NA	NA	NA	NA	NA
Trans-1,2-Dichloroethene	NA	NA	NA	NA	NA	NA
Trans-1,3-Dichloropropene	NA	NA	NA	NA	NA	NA

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-1

SUMMARY OF ANALYTIC RESULTS - SURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	BG3SBA05	BG3SBM02	BG3SBM04	BG3SBM06	BG3SBM07	BG3SBM08
Sample	BG3SBA0501	BG3SBM0201	BG3SBM0401	BG3SBM0601	BG3SBM0701	BG3SBM0801
Matrix	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil
Depth Range	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
Risk	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background
Soil Group	3	3	3	3	3	3
Sample Date	11/4/1999	11/2/1999	11/3/1999	11/2/1999	11/3/1999	11/3/1999
Trans-1,4-Dichloro-2-Butene	NA	NA	NA	NA	NA	NA
Trichloroethene	NA	NA	NA	NA	NA	NA
Trichlorofluoromethane	NA	NA	NA	NA	NA	NA
Vinyl Acetate	NA	NA	NA	NA	NA	NA
Vinyl Chloride	NA	NA	NA	NA	NA	NA
Semivolatile Organics (ug/kg)						
1,2,4,5-Tetrachlorobenzene	NA	NA	NA	NA	NA	NA
1,2,4-Trichlorobenzene	NA	NA	NA	NA	NA	NA
1,2-Dichlorobenzene	NA	NA	NA	NA	NA	NA
1,3-Dichlorobenzene	NA	NA	NA	NA	NA	NA
1,4-Dichlorobenzene	NA	NA	NA	NA	NA	NA
1,4-Naphthoquinone	NA	NA	NA	NA	NA	NA
1,4-Phenylenediamine	NA	NA	NA	NA	NA	NA
1-Naphthylamine	NA	NA	NA	NA	NA	NA
2,2'-Oxybis(1-Chloropropane)	NA	NA	NA	NA	NA	NA
2,3,4,6-Tetrachlorophenol	NA	NA	NA	NA	NA	NA
2,4,5-Trichlorophenol	NA	NA	NA	NA	NA	NA
2,4,6-Trichlorophenol	NA	NA	NA	NA	NA	NA
2,4-Dichlorophenol	NA	NA	NA	NA	NA	NA
2,4-Dimethylphenol	NA	NA	NA	NA	NA	NA
2,4-Dinitrophenol	NA	NA	NA	NA	NA	NA
2,6-Dichlorophenol	NA	NA	NA	NA	NA	NA
2-Acetylaminofluorene	NA	NA	NA	NA	NA	NA
2-Chloronaphthalene	NA	NA	NA	NA	NA	NA
2-Chlorophenol	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	NA	NA	NA	NA	NA	NA
2-Methylphenol	NA	NA	NA	NA	NA	NA
2-Naphthylamine	NA	NA	NA	NA	NA	NA
2-Nitroaniline	NA	NA	NA	NA	NA	NA
2-Nitrophenol	NA	NA	NA	NA	NA	NA
2-Picoline	NA	NA	NA	NA	NA	NA
3,3'-Dichlorobenzidine	NA	NA	NA	NA	NA	NA
3,3'-Dimethylbenzidine	NA	NA	NA	NA	NA	NA
3-Methylcholanthrene	NA	NA	NA	NA	NA	NA
3-Methylphenol	NA	NA	NA	NA	NA	NA
3-Nitroaniline	NA	NA	NA	NA	NA	NA
4,6-Dinitro-2-Methylphenol	NA	NA	NA	NA	NA	NA
4-Aminobiphenyl	NA	NA	NA	NA	NA	NA
4-Bromophenyl Phenyl Ether	NA	NA	NA	NA	NA	NA
4-Chloro-3-Methylphenol	NA	NA	NA	NA	NA	NA
4-Chloroaniline	NA	NA	NA	NA	NA	NA
4-Chlorophenyl Phenyl Ether	NA	NA	NA	NA	NA	NA
4-Methylphenol	NA	NA	NA	NA	NA	NA
4-Nitroaniline	NA	NA	NA	NA	NA	NA
4-Nitrophenol	NA	NA	NA	NA	NA	NA
4-Nitroquinoline-1-Oxide	NA	NA	NA	NA	NA	NA
5-Nitro-O-Toluidine	NA	NA	NA	NA	NA	NA
7,12-Dimethylbenz(A)Anthracene	NA	NA	NA	NA	NA	NA
A,A-Dimethylphenethylamine	NA	NA	NA	NA	NA	NA
Acenaphthene	NA	NA	NA	NA	NA	NA
Acenaphthylene	NA	NA	NA	NA	NA	NA
Acetophenone	NA	NA	NA	NA	NA	NA

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = [illegible]lyzed

TABLE A-1

SUMMARY OF ANALYTIC RESULTS - SURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	BG3SBA05	BG3SBM02	BG3SBM04	BG3SBM06	BG3SBM07	BG3SBM08
Sample	BG3SBA0501	BG3SBM0201	BG3SBM0401	BG3SBM0601	BG3SBM0701	BG3SBM0801
Matrix	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil
Depth Range	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
Risk	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background
Soil Group	3	3	3	3	3	3
Sample Date	11/4/1999	11/2/1999	11/3/1999	11/2/1999	11/3/1999	11/3/1999
Aniline	NA	NA	NA	NA	NA	NA
Anthracene	NA	NA	NA	NA	NA	NA
Aramite	NA	NA	NA	NA	NA	NA
Benzo(A)Anthracene	NA	NA	NA	NA	NA	NA
Benzo(A)Pyrene	NA	NA	NA	NA	NA	NA
Benzo(B)Fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(G,H,I)Perylene	NA	NA	NA	NA	NA	NA
Benzo(K)Fluoranthene	NA	NA	NA	NA	NA	NA
Benzyl Alcohol	NA	NA	NA	NA	NA	NA
Bis(2-Chloroethoxy)Methane	NA	NA	NA	NA	NA	NA
Bis(2-Chloroethyl)Ether	NA	NA	NA	NA	NA	NA
Bis(2-Ethylhexyl)Phthalate	NA	NA	NA	NA	NA	NA
Butyl Benzyl Phthalate	NA	NA	NA	NA	NA	NA
Chlorobenzilate	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA
Di-N-Butyl Phthalate	NA	NA	NA	NA	NA	NA
Di-N-Octyl Phthalate	NA	NA	NA	NA	NA	NA
Diallate	NA	NA	NA	NA	NA	NA
Dibenzo(A,H)Anthracene	NA	NA	NA	NA	NA	NA
Dibenzofuran	NA	NA	NA	NA	NA	NA
Diethyl Phthalate	NA	NA	NA	NA	NA	NA
Dimethyl Phthalate	NA	NA	NA	NA	NA	NA
Diphenylamine	NA	NA	NA	NA	NA	NA
Ethyl Methane Sulfonate	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA	NA	NA
Hexachlorobenzene	NA	NA	NA	NA	NA	NA
Hexachlorobutadiene	NA	NA	NA	NA	NA	NA
Hexachlorocyclopentadiene	NA	NA	NA	NA	NA	NA
Hexachloroethane	NA	NA	NA	NA	NA	NA
Hexachlorophene	NA	NA	NA	NA	NA	NA
Hexachloropropene	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-CD)Pyrene	NA	NA	NA	NA	NA	NA
Isodrin	NA	NA	NA	NA	NA	NA
Isophorone	NA	NA	NA	NA	NA	NA
Isosafrole	NA	NA	NA	NA	NA	NA
Kepone	NA	NA	NA	NA	NA	NA
Methapyrilene	NA	NA	NA	NA	NA	NA
Methyl Methane Sulfonate	NA	NA	NA	NA	NA	NA
N-Nitroso-Di-N-Butylamine	NA	NA	NA	NA	NA	NA
N-Nitroso-Di-N-Propylamine	NA	NA	NA	NA	NA	NA
N-Nitrosodiethylamine	NA	NA	NA	NA	NA	NA
N-Nitrosodimethylamine	NA	NA	NA	NA	NA	NA
N-Nitrosomethylethylamine	NA	NA	NA	NA	NA	NA
N-Nitrosomorpholine	NA	NA	NA	NA	NA	NA
N-Nitrosopiperidine	NA	NA	NA	NA	NA	NA
N-Nitrosopyrrolidine	NA	NA	NA	NA	NA	NA
Naphthalene	NA	NA	NA	NA	NA	NA
O,O,O-Triethyl Phosphorothioate	NA	NA	NA	NA	NA	NA
O-Toluidine	NA	NA	NA	NA	NA	NA
P-(Dimethylamino)Azobenzene	NA	NA	NA	NA	NA	NA
Pentachlorobenzene	NA	NA	NA	NA	NA	NA

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-1

SUMMARY OF ANALYTIC RESULTS - SURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	BG3SBA05	BG3SBM02	BG3SBM04	BG3SBM06	BG3SBM07	BG3SBM08
Sample	BG3SBA0501	BG3SBM0201	BG3SBM0401	BG3SBM0601	BG3SBM0701	BG3SBM0801
Matrix	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil
Depth Range	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
Risk	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background
Soil Group	3	3	3	3	3	3
Sample Date	11/4/1999	11/2/1999	11/3/1999	11/2/1999	11/3/1999	11/3/1999
Pentachloronitrobenzene	NA	NA	NA	NA	NA	NA
Phenacetin	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA
Phenol	NA	NA	NA	NA	NA	NA
Pronamide	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA
Pyridine	NA	NA	NA	NA	NA	NA
Safrole	NA	NA	NA	NA	NA	NA
Energertics (ug/kg)						
1,3,5-Trinitrobenzene	NA	NA	NA	NA	NA	NA
1,3-Dinitrobenzene	NA	NA	NA	NA	NA	NA
2,4,6-Trinitrotoluene	NA	NA	NA	NA	NA	NA
2,4-Dinitrotoluene	NA	NA	NA	NA	NA	NA
2,6-Dinitrotoluene	NA	NA	NA	NA	NA	NA
2-Amino-4,6-Dinitrotoluene	NA	NA	NA	NA	NA	NA
2-Nitrotoluene	NA	NA	NA	NA	NA	NA
3-Nitrotoluene	NA	NA	NA	NA	NA	NA
4-Amino-2,6-Dinitrotoluene	NA	NA	NA	NA	NA	NA
4-Nitrotoluene	NA	NA	NA	NA	NA	NA
Hmx	NA	NA	NA	NA	NA	NA
Nitrobenzene	NA	NA	NA	NA	NA	NA
Rdx	NA	NA	NA	NA	NA	NA
Tetryl	NA	NA	NA	NA	NA	NA
Pesticides/PCBs (ug/kg)						
4,4'-DDD	NA	NA	NA	NA	NA	NA
4,4'-DDE	NA	NA	NA	NA	NA	NA
4,4'-DDT	NA	NA	NA	NA	NA	NA
Aldrin	NA	NA	NA	NA	NA	NA
Alpha-BHC	NA	NA	NA	NA	NA	NA
Alpha-Chlordane	NA	NA	NA	NA	NA	NA
Aroclor-1016	NA	NA	NA	NA	NA	NA
Aroclor-1221	NA	NA	NA	NA	NA	NA
Aroclor-1232	NA	NA	NA	NA	NA	NA
Aroclor-1242	NA	NA	NA	NA	NA	NA
Aroclor-1248	NA	NA	NA	NA	NA	NA
Aroclor-1254	NA	NA	NA	NA	NA	NA
Aroclor-1260	NA	NA	NA	NA	NA	NA
Beta-BHC	NA	NA	NA	NA	NA	NA
Delta-BHC	NA	NA	NA	NA	NA	NA
Dieldrin	NA	NA	NA	NA	NA	NA
Endosulfan I	NA	NA	NA	NA	NA	NA
Endosulfan II	NA	NA	NA	NA	NA	NA
Endosulfan Sulfate	NA	NA	NA	NA	NA	NA
Endrin	NA	NA	NA	NA	NA	NA
Endrin Aldehyde	NA	NA	NA	NA	NA	NA
Gamma-BHC (Lindane)	NA	NA	NA	NA	NA	NA
Gamma-Chlordane	NA	NA	NA	NA	NA	NA
Heptachlor	NA	NA	NA	NA	NA	NA
Heptachlor Epoxide	NA	NA	NA	NA	NA	NA
Methoxychlor	NA	NA	NA	NA	NA	NA
Toxaphene	NA	NA	NA	NA	NA	NA
Herbicides (ug/kg)						

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-1

SUMMARY OF ANALYTIC RESULTS - SURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	BG3SBA05	BG3SBM02	BG3SBM04	BG3SBM06	BG3SBM07	BG3SBM08
Sample	BG3SBA0501	BG3SBM0201	BG3SBM0401	BG3SBM0601	BG3SBM0701	BG3SBM0801
Matrix	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil
Depth Range	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
Risk	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background
Soil Group	3	3	3	3	3	3
Sample Date	11/4/1999	11/2/1999	11/3/1999	11/2/1999	11/3/1999	11/3/1999
2,4,5-T	NA	NA	NA	NA	NA	NA
2,4,5-TP (Silvex)	NA	NA	NA	NA	NA	NA
2,4-D	NA	NA	NA	NA	NA	NA
Dinoseb	NA	NA	NA	NA	NA	NA
Pentachlorophenol	NA	NA	NA	NA	NA	NA
Inorganics (mg/kg)						
Aluminum	9800 J	10400	9900	9320	12300	8450
Antimony	0.41 U	0.38 U	5.6 J	0.44 U	1.4 J	0.36 U
Arsenic	8	5.9 J	5.5 J	7.8 J	10.2 J	4.6 J
Barium	128 J	71.8 J	118 J	153 J	143 J	65.2 J
Beryllium	0.73 U	0.65 U	0.94 U	0.77 U	1.2 U	0.61 U
Cadmium	0.28 U	3.6 J	1.2 J	0.83 J	0.72 J	0.83 J
Calcium	595 J	303 J	424 J	35300 J	286 J	370 J
Chromium	11.1 J	17.8 J	12.2 J	13.1 J	16.4 J	17.6 J
Cobalt	8.7	15.2	13.5	13.7	27.1	8.4
Copper	7.5	7.6	8.1 J	7.6	7.1 J	7.9 J
Iron	10700 J	15700	12400	15000	20900	13200
Lead	12.3 J	16.6 J	14.2 J	17.8 J	20.6 J	14.3 J
Magnesium	1000 J	1210 J	1310 J	1330 J	1110 J	1040 J
Manganese	1430 J	851 J	1380 J	1690 J	3040 J	666 J
Mercury	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05
Nickel	12.8 J	11.2 J	13.8 J	14.2 J	13.6 J	10.2 J
Potassium	821	688	801	1340	791	630
Selenium	0.73 U	0.98 U	0.94 U	1 U	1.3 U	0.72 U
Silver	0.06 J	0.05 J	0.06 J	0.06 J	0.06 J	0.06 J
Sodium	2.8 U	9.4 J	2.8 U	23.7 J	13.7 U	4.4 U
Strontium	9.9 J	8.6 J	13.3 J	63.2 J	11.1 J	7.4 J
Thallium	0.22 J	0.16 J	0.22 J	0.18 J	0.22 J	0.17 J
Thorium	5.3 J	7.1 J	7.3 J	5.9 J	7.8 J	5.8 J
Thorium-Calc	NA	NA	NA	NA	NA	NA
Tin	0.56 U	0.65 U	0.59 U	1.2 U	1.2 U	0.52 U
Vanadium	19.4 J	26.9	23.1	21.6	37.4	22.3
Zinc	30.2 U	35.1 J	37.2 J	40.2 J	60.2 J	28.1 J
Miscellaneous Parameters						
1,4-Dithiane (ug/kg)	NA	NA	NA	NA	NA	NA
1,4-Oxathiane (ug/kg)	NA	NA	NA	NA	NA	NA
Bis(2-Chloroethyl)Sulfide (ug/kg)	NA	NA	NA	NA	NA	NA
Cation Exchange Capacity (meq/100g	NA	NA	NA	NA	NA	NA
pH (S.U.)	NA	NA	NA	NA	NA	NA
Total Organic Carbon (mg/kg)	NA	NA	NA	NA	NA	NA
Total Radiologicals (pCi/g)						
Actinium-228	NA	NA	NA	NA	NA	NA
Bismuth-212	NA	NA	NA	NA	NA	NA
Bismuth-214	NA	NA	NA	NA	NA	NA
Cesium-137	NA	NA	NA	NA	NA	NA
Cobalt-60	NA	NA	NA	NA	NA	NA
Europium-154	NA	NA	NA	NA	NA	NA
Europium-155	NA	NA	NA	NA	NA	NA
Lead-210	NA	NA	NA	NA	NA	NA
Lead-212	NA	NA	NA	NA	NA	NA
Lead-214	NA	NA	NA	NA	NA	NA
Potassium-40	NA	NA	NA	NA	NA	NA

Calc = Calculated Value as descibed in Section 3.4.2.1 (TINUS, 2003).
NA = Not Analyzed

TABLE A-1

SUMMARY OF ANALYTIC RESULTS - SURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	BG3SBA05	BG3SBM02	BG3SBM04	BG3SBM06	BG3SBM07	BG3SBM08
Sample	BG3SBA0501	BG3SBM0201	BG3SBM0401	BG3SBM0601	BG3SBM0701	BG3SBM0801
Matrix	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil
Depth Range	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
Risk	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background
Soil Group	3	3	3	3	3	3
Sample Date	11/4/1999	11/2/1999	11/3/1999	11/2/1999	11/3/1999	11/3/1999
Protactinium-234	NA	NA	NA	NA	NA	NA
Radium-226	NA	NA	NA	NA	NA	NA
Thallium-208	NA	NA	NA	NA	NA	NA
Thorium-228	NA	NA	NA	NA	NA	NA
Thorium-230	NA	NA	NA	NA	NA	NA
Thorium-232	NA	NA	NA	NA	NA	NA
Thorium-234	NA	NA	NA	NA	NA	NA
Uranium-235	NA	NA	NA	NA	NA	NA

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB01	01SB02	01SB02	01SB03	01SB04	01SB04	01SB05	01SB05	01SB06	01SB06
Sample	01SB010206	01SB020206	01SB020610	01SB030206	01SB040206	01SB040610	01SB050206	01SB050610	01SB060206	01SB060610
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	2 - 6	2 - 6	6 - 9.5	2 - 6	2 - 6	6 - 10	2 - 6	6 - 8.5	2 - 6	6 - 10
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Soil Group	8	8	8	8	8	8	8	8	8	8
Sample Date	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/27/2001	8/27/2001
Volatile Organics (ug/kg)										
1,1,1,2-Tetrachloroethane	3 U	3 U	3 U	3 U	2 U	3 U	3 U	3 U	3 U	3 U
1,1,1-Trichloroethane	3 U	3 U	3 U	3 U	2 U	3 U	3 U	3 U	3 U	3 U
1,1,2,2-Tetrachloroethane	3 UJ	3 UJ	3 UJ	3 U	2 UJ	3 UJ	3 U	3 UJ	3 U	3 U
1,1,2-Trichloroethane	6 U	5 U	5 U	5 U	4 U	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethane	3 UJ	3 U	3 U	3 UJ	2 U	3 U	3 UJ	3 UJ	3 U	3 U
1,1-Dichloroethene	6 U	5 U	5 U	5 U	4 U	5 U	5 U	5 U	5 U	5 U
1,2,3-Trichloropropane	3 UJ	3 UJ	3 UJ	3 UJ	2 UJ	3 UJ	3 UJ	3 UJ	3 U	3 U
1,2-Dibromo-3-Chloropropane	6 UJ	5 UJ	5 UJ	5 UJ	4 UJ	5 UJ	5 UJ	5 UJ	5 U	5 U
1,2-Dibromoethane	3 UJ	3 UJ	3 UJ	3 U	2 UJ	3 UJ	3 U	3 UJ	3 U	3 U
1,2-Dichloroethane	3 U	3 U	3 U	3 U	2 U	3 U	3 U	3 U	3 U	3 U
1,2-Dichloropropane	6 U	5 U	5 U	5 U	4 U	5 U	5 U	5 U	5 U	5 U
1,4-Dioxane	570 UR	510 UR	500 UR	530 UR	450 UR	460 UR	540 UR	490 UR	530 UR	500 UR
2-Butanone	6 UJ	5 UJ	5 UJ	5 UJ	4 UJ	5 UJ	5 UJ	5 UJ	5 U	5 U
2-Hexanone	6 UJ	5 UJ	5 UJ	5 UJ	4 UJ	5 UJ	5 UJ	5 UJ	5 U	5 U
3-Chloropropene	6 UJ	5 UJ	5 UJ	5 UJ	4 UJ	5 UJ	5 UJ	5 UJ	5 U	5 U
4-Methyl-2-Pentanone	3 UJ	3 UJ	3 UJ	3 UJ	2 UJ	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ
Acetone	6 UJ	5 UJ	5 UJ	5 UJ	4 UJ	5 UJ	5 UJ	5 UJ	32 J	9 J
Acetonitrile	230 UJ	200 UJ	200 UJ	210 UJ	180 UJ	180 UJ	220 UJ	200 UJ	210 UJ	200 UJ
Acrolein	57 UR	51 UR	50 UR	53 UR	45 UR	46 UR	54 UR	49 UR	53 UR	50 UR
Acrylonitrile	57 UJ	51 UJ	50 UJ	53 UJ	45 UJ	46 UJ	54 UJ	49 UJ	53 U	50 U
Benzene	3 U	3 U	3 U	3 U	2 U	3 U	3 U	3 U	3 U	3 U
Bromodichloromethane	3 U	3 U	3 U	3 U	2 U	3 U	3 U	3 U	3 U	3 U
Bromofor	3 UJ	3 UJ	3 UJ	3 U	2 U	3 U	3 U	3 UJ	3 U	3 U
Bromomethane	6 UJ	5 U	5 U	5 U	4 U	5 U	5 U	5 UJ	5 U	5 U
Carbon Disulfide	3 U	3 U	3 U	3 U	2 U	3 U	3 U	3 U	3 U	3 U
Carbon Tetrachloride	3 UJ	3 UJ	3 UJ	3 UJ	2 UJ	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ
Chlorobenzene	3 U	3 U	3 U	3 U	2 U	3 U	3 U	3 U	3 U	3 U
Chlorodibromomethane	3 U	3 U	3 U	3 U	2 U	3 U	3 U	3 U	3 U	3 U
Chloroethane	6 U	5 U	5 U	5 U	4 U	5 U	5 U	5 U	5 U	5 U
Chlorofor	3 U	3 U	3 U	3 U	2 U	3 U	3 U	3 U	3 U	3 U
Chloromethane	6 U	5 U	5 U	5 U	4 U	5 U	5 U	5 U	5 U	5 U
Chloroprene	6 UJ	5 UJ	5 UJ	5 UJ	4 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ
Cis-1,2-Dichloroethene	6 U	5 U	5 U	5 U	4 U	5 U	5 U	5 U	5 U	5 U
Cis-1,3-Dichloropropene	3 U	3 U	3 U	3 U	2 U	3 U	3 U	3 U	3 U	3 U
Dibromomethane	6 U	5 U	5 U	5 U	4 U	5 U	5 U	5 U	5 U	5 U
Dichlorodifluoromethane	3 U	3 U	3 U	3 U	2 U	3 U	3 U	3 U	3 U	3 U
Ethyl Methacrylate	6 UJ	5 UJ	5 UJ	5 U	4 UJ	5 UJ	5 U	5 UJ	5 U	5 U
Ethylbenzene	3 U	3 U	3 U	3 U	2 U	3 U	3 U	3 U	3 U	3 U
Isobutanol	230 UR	200 UR	200 UR	210 UR	180 UR	180 UR	220 UR	200 UR	210 UR	200 UR
Methacrylonitrile	110 UJ	100 UJ	100 UJ	110 UJ	90 UJ	91 UJ	110 UJ	99 UJ	110 UJ	100 UJ
Methyl Iodide	6 UJ	5 U	5 U	5 U	4 UJ	5 UJ	5 U	5 UJ	5 UJ	5 UJ
Methyl Methacrylate	6 UJ	5 UJ	5 UJ	5 UJ	4 U	5 U	5 UJ	5 UJ	5 U	5 U
Methylene Chloride	40 BU	20 U	6 U	9 U	3 J	5 U	54 U	48 BU	58 J	46 J
Pentachloroethane	6 UJ	5 UJ	5 UJ	5 UJ	4 UJ	5 UJ	5 UJ	5 UJ	5 U	5 U
Propionitrile	110 UR	100 UR	100 UR	110 UR	90 UR	91 UR	110 UR	99 UR	110 UR	100 UR
Styrene	3 U	3 U	3 U	3 U	2 U	3 U	3 U	3 U	3 U	3 U
Tetrachloroethene	3 UJ	3 UJ	3 UJ	3 U	2 UJ	3 UJ	3 U	3 UJ	3 U	3 U
Toluene	3 U	3 U	3 U	3 U	2 U	3 U	3 U	3 U	3 U	3 U
Total Xylenes	3 U	3 U	3 U	3 U	2 U	3 U	3 U	3 U	3 U	3 U
Trans-1,2-Dichloroethene	6 U	5 U	5 U	5 U	4 U	5 U	5 U	5 U	5 U	5 U

Calc = Calculated Value as descibed in Section 3.4.2.1 (TINUS, 2003).
NA = Not Analyzed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB01	01SB02	01SB02	01SB03	01SB04	01SB04	01SB05	01SB05	01SB06	01SB06
Sample	01SB010206	01SB020206	01SB020610	01SB030206	01SB040206	01SB040610	01SB050206	01SB050610	01SB060206	01SB060610
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	2 - 6	2 - 6	6 - 9.5	2 - 6	2 - 6	6 - 10	2 - 6	6 - 8.5	2 - 6	6 - 10
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Soil Group	8	8	8	8	8	8	8	8	8	8
Sample Date	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/27/2001	8/27/2001
Trans-1,3-Dichloropropene	3 U	3 U	3 U	3 U	2 U	3 U	3 U	3 U	3 U	3 U
Trans-1,4-Dichloro-2-Butene	6 U	5 U	5 U	5 U	4 UJ	5 UJ	5 U	5 U	5 U	5 U
Trichloroethene	3 U	3 U	3 U	3 U	2 U	3 U	3 U	3 U	3 U	3 U
Trichlorofluoromethane	6 U	5 U	5 U	5 U	4 U	5 U	5 U	5 U	5 UJ	5 UJ
Vinyl Acetate	3 U	3 U	3 U	3 U	2 U	3 U	3 U	3 U	3 U	3 U
Vinyl Chloride	6 U	5 U	5 U	5 U	4 U	5 U	5 U	5 U	5 U	5 U
Semivolatile Organics (ug/kg)										
1,2,4,5-Tetrachlorobenzene	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
1,2,4-Trichlorobenzene	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
1,2-Dichlorobenzene	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
1,3-Dichlorobenzene	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
1,4-Dichlorobenzene	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
1,4-Naphthoquinone	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
1,4-Phenylenediamine	990 UJ	1000 UJ	910 UJ	1000 UJ	920 U	920 U	890 UJ	940 UJ	990 UJ	1000 UJ
1-Naphthylamine	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
2,2'-Oxybis(1-Chloropropane)	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
2,3,4,6-Tetrachlorophenol	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
2,4,5-Trichlorophenol	990 U	1000 U	910 U	1000 U	920 U	920 U	890 U	940 U	990 U	1000 U
2,4,6-Trichlorophenol	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
2,4-Dichlorophenol	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
2,4-Dimethylphenol	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
2,4-Dinitrophenol	990 U	1000 U	910 U	1000 U	920 U	920 U	890 U	940 U	990 U	1000 U
2,6-Dichlorophenol	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
2-Acetylaminofluorene	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
2-Chloronaphthalene	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
2-Chlorophenol	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
2-Methylnaphthalene	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
2-Methylphenol	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
2-Naphthylamine	200 U	200 U	190 U	210 U	190 U	190 U	190 U	190 U	200 U	200 U
2-Nitroaniline	500 U	500 U	460 U	500 U	460 U	460 U	450 U	470 U	500 U	500 U
2-Nitrophenol	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
2-Picoline	300 U	300 U	270 U	310 U	280 U	280 U	270 U	280 U	300 U	300 U
3,3'-Dichlorobenzidine	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
3,3'-Dimethylbenzidine	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
3-Methylcholanthrene	440 U	450 U	410 U	470 U	410 U	410 U	400 U	420 U	450 U	450 U
3-Methylphenol	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
3-Nitroaniline	990 U	1000 U	910 U	1000 U	920 U	920 U	890 U	940 U	990 U	1000 U
4,6-Dinitro-2-Methylphenol	990 U	1000 U	910 U	1000 U	920 U	920 U	890 U	940 U	990 U	1000 U
4-Aminobiphenyl	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
4-Bromophenyl Phenyl Ether	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
4-Chloro-3-Methylphenol	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
4-Chloroaniline	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
4-Chlorophenyl Phenyl Ether	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
4-Methylphenol	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
4-Nitroaniline	990 U	1000 U	910 U	1000 U	920 U	920 U	890 U	940 U	990 U	1000 U
4-Nitrophenol	990 U	1000 U	910 U	1000 U	920 U	920 U	890 U	940 U	990 U	1000 U
4-Nitroquinoline-1-Oxide	990 UR	1000 UR	910 UR	1000 UR	920 UR	920 UR	890 UR	940 UR	990 UR	1000 UR
5-Nitro-O-Toluidine	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
7,12-Dimethylbenz(A)Anthracene	300 U	300 U	270 U	310 U	280 U	280 U	270 U	280 U	300 U	300 U
A,A-Dimethylphenethylamine	990 U	1000 U	910 U	1000 U	920 U	920 U	890 U	940 U	990 U	1000 U
Acenaphthene	11.7 U	12.1 U	10.9 U	12.3 U	11 U	11 U	10.7 U	11.2 U	30.3	4.34 J

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = N[illegible]lyzed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB01	01SB02	01SB02	01SB03	01SB04	01SB04	01SB05	01SB05	01SB06	01SB06
Sample	01SB010206	01SB020206	01SB020610	01SB030206	01SB040206	01SB040610	01SB050206	01SB050610	01SB060206	01SB060610
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	2 - 6	2 - 6	6 - 9.5	2 - 6	2 - 6	6 - 10	2 - 6	6 - 8.5	2 - 6	6 - 10
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Soil Group	8	8	8	8	8	8	8	8	8	8
Sample Date	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/27/2001	8/27/2001
Acenaphthylene	11.7 U	12.1 U	10.9 U	12.3 U	11 U	11 U	10.7 U	11.2 U	12 U	12 U
Acetophenone	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
Aniline	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
Anthracene	11.7 U	12.1 U	10.9 U	12.3 U	11 U	11 U	10.7 U	11.2 U	12 U	12 U
Aramite	990 U	1000 U	910 U	1000 U	920 U	920 U	890 U	940 U	990 U	1000 U
Benzo(A)Anthracene	11.7 U	12.1 U	10.9 U	12.3 U	11 U	11 U	10.7 U	11.2 U	12 U	12 U
Benzo(A)Pyrene	11.7 U	12.1 U	10.9 U	12.3 U	11 U	11 U	10.7 U	11.2 U	12 U	12 U
Benzo(B)Fluoranthene	11.7 U	12.1 U	10.9 U	12.3 U	11 U	11 U	10.7 U	11.2 U	12 U	12 U
Benzo(G,H,I)Perylene	11.7 U	12.1 U	10.9 U	12.3 U	11 U	11 U	10.7 U	11.2 U	12 U	12 U
Benzo(K)Fluoranthene	11.7 U	12.1 U	10.9 U	12.3 U	11 U	11 U	10.7 U	11.2 U	12 U	12 U
Benzyl Alcohol	270 U	270 U	270 U	270 U	270 U	270 U	270 U	270 U	270 U	270 U
Bis(2-Chloroethoxy)Methane	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
Bis(2-Chloroethyl)Ether	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
Bis(2-Ethylhexyl)Phthalate	200 U	200 U	180 U	210 U	190 U	190 U	180 U	110 J	200 U	200 U
Butyl Benzyl Phthalate	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
Chlorobenzilate	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
Chrysene	11.7 U	12.1 U	10.9 U	12.3 U	11 U	11 U	10.7 U	11.2 U	12 U	12 U
Di-N-Butyl Phthalate	200 U	200 U	180 U	210 U	190 UJ	190 U	180 U	190 U	200 UJ	200 UJ
Di-N-Octyl Phthalate	200 U	200 U	190 U	210 U	190 U	190 U	190 U	190 U	200 U	200 U
Diallate	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
Dibenzo(A,H)Anthracene	11.7 U	12.1 U	10.9 U	12.3 U	11 U	11 U	10.7 U	11.2 U	12 U	12 U
Dibenzofuran	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
Diethyl Phthalate	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
Dimethyl Phthalate	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
Diphenylamine	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
Ethyl Methane Sulfonate	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
Fluoranthene	11.7 U	12.1 U	10.9 U	12.3 U	11 U	11 U	10.7 U	11.2 U	12 U	12 U
Fluorene	11.7 U	12.1 U	10.9 U	12.3 U	11 U	11 U	10.7 U	11.2 U	12 U	12 U
Hexachlorobenzene	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
Hexachlorobutadiene	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
Hexachlorocyclopentadiene	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
Hexachloroethane	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
Hexachlorophene	16000 UJ	16000 UJ	14000 UJ	17000 UJ	15000 U	15000 U	14000 UJ	15000 UJ	16000 UJ	16000 UJ
Hexachloropropene	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
Indeno(1,2,3-CD)Pyrene	11.7 U	12.1 U	10.9 U	12.3 U	11 U	11 U	10.7 U	11.2 U	12 U	12 U
Isodrin	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
Isophorone	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
Isosafrole	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
Kepone	990 U	1000 U	910 U	1000 U	920 U	920 U	890 U	940 U	990 U	1000 U
Methapyrilene	990 UR	1000 UR	910 UR	1000 UR	920 U	920 U	890 UR	940 UR	990 UR	1000 UR
Methyl Methane Sulfonate	500 U	500 U	460 U	500 U	460 U	460 U	450 U	470 U	500 U	500 U
N-Nitroso-Di-N-Butylamine	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
N-Nitroso-Di-N-Propylamine	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
N-Nitrosodiethylamine	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
N-Nitrosodimethylamine	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
N-Nitrosomethylethylamine	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
N-Nitrosomorpholine	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
N-Nitrosopiperidine	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
N-Nitrosopyrrolidine	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
Naphthalene	11.7 U	8.85 J	10.9 U	8.52 J	11 U	11 U	10.7 U	11.2 U	12 U	12 U
O,O,O-Triethyl Phosphorothioate	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U

Calc = Calculated Value as descibed in Section 3.4.2.1 (TINUS, 2003).
NA = Not Analyzed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB01	01SB02	01SB02	01SB03	01SB04	01SB04	01SB05	01SB05	01SB06	01SB06
Sample	01SB010206	01SB020206	01SB020610	01SB030206	01SB040206	01SB040610	01SB050206	01SB050610	01SB060206	01SB060610
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	2 - 6	2 - 6	6 - 9.5	2 - 6	2 - 6	6 - 10	2 - 6	6 - 8.5	2 - 6	6 - 10
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Soil Group	8	8	8	8	8	8	8	8	8	8
Sample Date	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/27/2001	8/27/2001
O-Toluidine	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
P-(Dimethylamino)Azobenzene	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
Pentachlorobenzene	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
Pentachloronitrobenzene	990 U	1000 U	910 U	1000 U	920 U	920 U	890 U	940 U	990 U	1000 U
Phenacetin	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
Phenanthrene	11.7 U	12.1 U	10.9 U	12.3 U	11 U	11 U	10.7 U	11.2 U	12 U	12 U
Phenol	200 U	200 U	180 U	210 U	190 U	190 U	180 U	190 U	200 U	200 U
Pronamide	400 UR	400 UR	360 UR	410 UR	370 U	370 U	360 UR	370 UR	400 UR	400 UR
Pyrene	11.7 U	12.1 U	10.9 U	12.3 U	11 U	11 U	10.7 U	11.2 U	12 U	12 U
Pyridine	220 U	220 U	220 U	220 U	220 U	220 U	220 U	220 U	220 U	220 U
Safrole	400 U	400 U	360 U	410 U	370 U	370 U	360 U	370 U	400 U	400 U
Energertics (ug/kg)										
1,3,5-Trinitrobenzene	476 U	500 U	476 U	476 U	476 U	476 U	454 U	476 U	454 U	476 U
1,3-Dinitrobenzene	476 U	500 U	476 U	476 U	476 U	476 U	454 U	476 U	454 U	476 U
2,4,6-Trinitrotoluene	476 U	500 U	476 U	476 U	476 U	476 U	454 U	476 U	454 U	476 U
2,4-Dinitrotoluene	476 U	500 U	476 U	476 U	476 U	476 U	454 U	476 U	454 U	476 U
2,6-Dinitrotoluene	476 U	500 U	476 U	476 U	476 U	476 U	454 U	476 U	454 U	476 U
2-Amino-4,6-Dinitrotoluene	476 U	500 U	476 U	476 U	476 U	476 U	454 U	476 U	454 U	476 U
2-Nitrotoluene	476 U	500 U	476 U	476 U	476 U	476 U	454 U	476 U	454 U	476 U
3-Nitrotoluene	476 U	500 U	476 U	476 U	476 U	476 U	454 U	476 U	454 U	476 U
4-Amino-2,6-Dinitrotoluene	476 U	500 U	476 U	476 U	476 U	476 U	454 U	476 U	454 U	476 U
4-Nitrotoluene	476 U	500 U	476 U	476 U	476 U	476 U	454 U	476 U	454 U	476 U
HMX	476 U	500 U	476 U	476 U	476 U	476 U	454 U	476 U	454 U	476 U
Nitrobenzene	476 U	500 U	476 U	476 U	476 U	476 U	454 U	476 U	454 U	476 U
RDX	476 U	500 U	476 U	476 U	476 U	476 U	454 U	476 U	454 U	476 U
Tetryl	476 U	500 U	476 U	476 U	476 U	476 U	454 U	476 U	454 U	476 U
Pesticides/PCBs (ug/kg)										
4,4'-DDD	3 U	3 U	NA	3.1 U	2.8 U	NA	2.7 U	NA	3 U	NA
4,4'-DDE	3 U	3 U	NA	3.1 U	2.8 U	NA	2.7 U	NA	3 U	NA
4,4'-DDT	3 UJ	3 UJ	NA	3.1 UJ	2.8 U	NA	2.7 UJ	NA	3 U	NA
Aldrin	1.5 U	1.6 U	NA	1.6 U	1.4 U	NA	1.4 U	NA	1.5 U	NA
Alpha-BHC	1.5 U	1.6 U	NA	1.6 U	1.4 U	NA	1.4 U	NA	1.5 U	NA
Alpha-Chlordane	1.5 U	1.6 U	NA	1.6 U	1.4 U	NA	1.4 U	NA	1.5 U	NA
Aroclor-1016	39 U	40 U	NA	41 U	36 U	NA	35 U	NA	39 U	NA
Aroclor-1221	39 U	40 U	NA	41 U	36 U	NA	35 U	NA	39 U	NA
Aroclor-1232	39 U	40 U	NA	41 U	36 U	NA	35 U	NA	39 U	NA
Aroclor-1242	39 U	40 U	NA	41 U	36 U	NA	35 U	NA	39 U	NA
Aroclor-1248	39 U	40 U	NA	41 U	36 U	NA	35 U	NA	39 U	NA
Aroclor-1254	39 U	40 U	NA	41 U	36 U	NA	35 U	NA	39 U	NA
Aroclor-1260	39 U	40 U	NA	41 U	36 U	NA	35 U	NA	39 U	NA
Beta-BHC	1.5 U	1.6 U	NA	1.6 U	1.4 U	NA	1.4 U	NA	1.5 U	NA
Delta-BHC	1.5 U	1.6 U	NA	1.6 U	1.4 U	NA	1.4 U	NA	1.5 U	NA
Dieldrin	3 U	3 U	NA	3.1 U	2.8 U	NA	2.7 U	NA	3 U	NA
Endosulfan I	1.5 U	1.6 U	NA	1.6 U	1.4 U	NA	1.4 U	NA	1.5 U	NA
Endosulfan II	3 UJ	3 UJ	NA	3.1 UJ	2.8 U	NA	2.7 U	NA	3 U	NA
Endosulfan Sulfate	3 U	3 U	NA	3.1 U	2.8 U	NA	2.7 U	NA	3 U	NA
Endrin	3 U	3 U	NA	3.1 U	2.8 U	NA	2.7 U	NA	3 U	NA
Endrin Aldehyde	3 U	3 U	NA	3.1 U	2.8 U	NA	2.7 U	NA	3 UJ	NA
Gamma-BHC (Lindane)	1.5 U	1.6 U	NA	1.6 U	1.4 U	NA	1.4 U	NA	1.5 U	NA
Gamma-Chlordane	1.5 U	1.6 U	NA	1.6 U	1.4 U	NA	1.4 U	NA	1.5 U	NA
Heptachlor	1.4 J	1.2 J	NA	1.2 J	1.2 BU	NA	0.96 J	NA	1 J	NA

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB01	01SB02	01SB02	01SB03	01SB04	01SB04	01SB05	01SB05	01SB06	01SB06
Sample	01SB010206	01SB020206	01SB020610	01SB030206	01SB040206	01SB040610	01SB050206	01SB050610	01SB060206	01SB060610
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	2 - 6	2 - 6	6 - 9.5	2 - 6	2 - 6	6 - 10	2 - 6	6 - 8.5	2 - 6	6 - 10
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Soil Group	8	8	8	8	8	8	8	8	8	8
Sample Date	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/27/2001	8/27/2001
Heptachlor Epoxide	1.5 U	1.6 U	NA	1.6 U	1.4 U	NA	1.4 U	NA	1.5 U	NA
Methoxychlor	15 U	16 U	NA	16 U	14 U	NA	14 U	NA	15 U	NA
Toxaphene	99 U	100 U	NA	100 U	92 U	NA	89 U	NA	99 U	NA
Herbicides (ug/kg)										
2,4,5-T	12 U	12 U	NA	12 U	11 U	NA	11 U	NA	12 U	NA
2,4,5-TP (Silvex)	12 U	12 U	NA	12 U	11 U	NA	11 U	NA	12 U	NA
2,4-D	83 U	85 U	NA	87 U	77 U	NA	75 U	NA	84 U	NA
Dinoseb	24 U	24 U	NA	25 U	22 U	NA	21 U	NA	24 U	NA
Pentachlorophenol	12 U	12 U	NA	12 U	11 U	NA	11 U	NA	12 U	NA
Inorganics (mg/kg)										
Aluminum	8350 J	7610 J	3180 J	9130 J	8280 J	4100 J	4890 J	3730 J	18100	7010
Antimony	0.23 U	0.19 UJ	0.54 U	0.65 U	0.36 U	0.43 U	0.46 U	0.25 U	1.3 U	0.52 U
Arsenic	3.2 J	2.9 J	0.36 U	4.8 J	4.7 J	0.88 U	5.1 J	2.3 U	7.7 J	2.0 J
Barium	64.9 J	35.5 J	58.2 J	38.1 J	30.9	52.0	15.7 J	14.9 J	52.8	28.3
Beryllium	0.37 J	0.38 J	1.2 J	0.45 J	0.38 J	1.1 J	0.34 J	0.42 J	0.38	1.5
Cadmium	0.04 J	0.76	0.03 UJ	1.1	0.21 J	0.35 J	0.03 UJ	0.03 UJ	0.05 U	0.05 U
Calcium	43200 J	485 J	487 J	553 J	461 J	540 J	121 J	69.6 J	629 J	673 J
Chromium	12.2	11.5	8.7	14.6	12.7 J	10.7 J	9.0	7.7	24.0	21.3
Cobalt	2.6	3.4	25.8	3.5	2.9 J	14.6 J	5.5	4.3	8.0	22.3
Copper	10.6 J	10.2 J	12.8 J	11.3 J	9.5 J	13.1 J	6.8 J	7.6 J	14.2	17.5
Iron	12400	13900	30800	18300	15000	24800 J	18000	13200	27700	22400
Lead	8.3	18.6	15.4	36.9	9.9	10.6	6.2	7.9	16.0	12.6
Magnesium	4670 J	1320 J	1030 J	1480 J	1390 J	1130 J	395 J	311 J	1830 J	1530 J
Manganese	69.6 J	70.1 J	379 J	107 J	86.4 J	270 J	133 J	100 J	251	408
Mercury	0.02 UJ	0.02 UJ	0.02 UJ	0.02 UJ	0.02 U	0.02 U	0.02 J	0.02 J	0.07 J	0.03 J
Nickel	6.5	8.3	32.7	7.2	7.5 J	26.6 J	11.2	9.2	11.5	39.3
Potassium	358 J	420 J	488 J	371 J	393 J	752 J	305 J	427 J	792 J	1190 J
Selenium	0.12 J	0.21 J	0.85 J	0.45 J	0.45 U	0.90 U	0.32 J	0.28 J	1.7	0.71
Silver	0.36 U	0.37 U	0.32 U	0.37 U	0.33 U	0.33 U	0.31 U	0.34 U	0.15 U	0.16 U
Sodium	365 J	392 J	357 J	411 J	332 J	347 J	240 J	251 J	657	755
Strontium	46.0 J	5.7 J	4.0 J	6.9 J	5.6 J	4.8 J	2.0 J	1.3 J	11.6 J	12.5 J
Thallium	0.84	1.0	2.7	1.5	1.7 J	2.7	1.7	1.1	0.55 U	0.58 U
Thorium-Calc	3.79	3.6	5.18	3.82	6.43	5.05	2.20	3.07	4.80	6.94
Tin	22.5 U	23.1 U	20.1 U	23.5 U	21.1 U	21.0 U	19.9 U	21.4 U	2.4	2.3 U
Vanadium	18.7	18.7	9.2	27.7	21.6	9.4	13.8	8.9	42.6	14.7
Zinc	31.3 J	23.9 J	70.9 J	22.1 J	23.1 J	62.0 J	49.8 J	29.4 J	43.6	72.1
Miscellaneous Parameters										
1,4-Dithiane (ug/kg)	237 U	244 U	218 U	249 U	222 U	221 U	216 U	225 U	241 U	242 U
1,4-Oxathiane (ug/kg)	237 U	244 U	218 U	249 U	222 U	221 U	216 U	225 U	241 U	242 U
Bis(2-Chloroethyl)Sulfide (ug/kg)	237 U	244 U	218 U	249 U	222 U	221 U	216 U	225 U	241 U	242 U
Cation Exchange Capacity (meq/100g)	12.9	NA	NA	18.2	NA	NA	20.1	18.7	NA	NA
pH (S.U.)	7.1 J	NA	NA	5.1 J	NA	NA	4.4 J	5.1 J	NA	NA
Total Organic Carbon (mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Radiologicals (pCi/g)										
Actinium-228	1.11	1.27	NA	1.07	1.01	NA	NA	NA	NA	NA
Bismuth-212	1.30	1.07	NA	1.13	0.98	NA	NA	NA	NA	NA
Bismuth-214	0.87	0.85	NA	0.73	0.73	NA	NA	NA	NA	NA
Cesium-137	0.00857 U	0.0104 U	NA	0.00668 U	0.0086 U	NA	NA	NA	NA	NA
Cobalt-60	0.0148 U	0.0284 U	NA	0.0139 U	0.0124 U	NA	NA	NA	NA	NA
Europium-154	0.029 U	0.0469 U	NA	0.0218 U	0.0363 U	NA	NA	NA	NA	NA
Europium-155	0.242 U	0.09	NA	0.244 U	0.08	NA	NA	NA	NA	NA

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB01	01SB02	01SB02	01SB03	01SB04	01SB04	01SB05	01SB05	01SB06	01SB06
Sample	01SB010206	01SB020206	01SB020610	01SB030206	01SB040206	01SB040610	01SB050206	01SB050610	01SB060206	01SB060610
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	2 - 6	2 - 6	6 - 9.5	2 - 6	2 - 6	6 - 10	2 - 6	6 - 8.5	2 - 6	6 - 10
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Soil Group	8	8	8	8	8	8	8	8	8	8
Sample Date	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/27/2001	8/27/2001
Lead-210	0.45	0.57	NA	0.65	0.36	NA	NA	NA	NA	NA
Lead-212	1.00	1.13	NA	1.00	0.95	NA	NA	NA	NA	NA
Lead-214	0.87	0.83	NA	0.72	0.75	NA	NA	NA	NA	NA
Potassium-40	5.98	9.23	NA	9.05	8.48	NA	NA	NA	NA	NA
Protactinium-234	2.58 U	3.21 U	NA	2.75 U	3.17 U	NA	NA	NA	NA	NA
Radium-226	1.79	1.90	NA	1.68	1.66	NA	NA	NA	NA	NA
Thallium-208	0.91	1.04	NA	0.94	0.91	NA	NA	NA	NA	NA
Thorium-228	0.359	0.393	0.477	0.343	0.781	0.494	0.207	0.332	0.512	0.654
Thorium-230	0.0522 U	0.0646 U	0.0661 J	0.113 J	0.485 J	0.520 J	0.0386 J	0.0332 J	0.0536 U	0.140
Thorium-232	0.475	0.400	0.663	0.497	0.633	0.618	0.276	0.343	0.543	0.872
Thorium-234	1.10	1.14	NA	1.88	1.00	NA	NA	NA	NA	NA
Uranium-235	0.144 U	0.191 U	NA	0.102 U	0.207 U	NA	NA	NA	NA	NA

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = [illegible]lyzed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB07	01SB08	01SB08	01SB09	01SB10	01SB11	01SB11	01SB12	01SB12	01SB13
Sample	01SB070206	01SB080206	01SB080610	01SB090206	01SB100206	01SB110206	01SB110610	01SB120206	01SB120610	01SB130206
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	2 - 5	2 - 6	6 - 10	2 - 6	2 - 6	2 - 6	6 - 10	2 - 6	6 - 10	2 - 6
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Soil Group	8	8	9	8	8	8	8	8	9	8
Sample Date	8/27/2001	8/21/2001	8/21/2001	8/27/2001	8/27/2001	8/22/2001	8/22/2001	8/25/2001	8/25/2001	8/24/2001
Volatile Organics (ug/kg)										
1,1,1,2-Tetrachloroethane	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
1,1,1-Trichloroethane	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
1,1,2,2-Tetrachloroethane	3 U	3 U	3 U	2 J	3 UJ	3 U	3 U	3 U	3 U	3 U
1,1,2-Trichloroethane	6 U	5 U	5 U	5 U	5 U	6 U	5 U	5 U	5 U	6 U
1,1-Dichloroethane	3 U	3 U	3 U	3 UJ	3 U	3 U	3 U	3 U	3 U	3 U
1,1-Dichloroethene	6 U	5 U	5 U	5 U	5 U	6 U	5 U	5 U	5 U	6 U
1,2,3-Trichloropropane	3 U	3 U	3 U	3 UJ	3 UJ	3 U	3 U	3 U	3 U	3 U
1,2-Dibromo-3-Chloropropane	6 U	5 U	5 U	5 UJ	5 UJ	6 U	5 U	5 U	5 U	6 U
1,2-Dibromoethane	3 U	3 U	3 U	3 U	3 UJ	3 U	3 U	3 U	3 U	3 U
1,2-Dichloroethane	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
1,2-Dichloropropane	6 U	5 U	5 U	5 U	5 U	6 U	5 U	5 U	5 U	6 U
1,4-Dioxane	600 UR	530 UR	540 UR	480 UR	470 UR	580 UR	510 UR	450 UR	480 UR	570 UR
2-Butanone	6 U	5 U	5 U	5 UJ	5 UJ	6 U	5 U	5 UJ	5 UJ	6 UJ
2-Hexanone	6 U	5 UJ	5 UJ	5 UJ	5 UJ	6 UJ	5 UJ	5 U	5 U	6 U
3-Chloropropene	6 U	5 UJ	5 UJ	5 UJ	5 UJ	6 UJ	5 UJ	5 UJ	5 UJ	6 UJ
4-Methyl-2-Pentanone	3 UJ	3 U	3 U	3 UJ	3 UJ	3 U	3 U	3 U	3 U	3 U
Acetone	29 J	5 UJ	5 UJ	5 UJ	5 UJ	6 UJ	5 UJ	6	5 U	36
Acetonitrile	240 UJ	210 UJ	220 UJ	190 UJ	190 UJ	230 UJ	210 UJ	180 UJ	190 UJ	230 UJ
Acrolein	60 UR	53 UR	54 UR	48 UR	47 UR	58 UR	51 UR	45 UR	48 UR	57 UR
Acrylonitrile	60 U	53 U	54 U	48 UJ	47 UJ	58 U	51 U	45 U	48 U	57 U
Benzene	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Bromodichloromethane	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Bromofor	3 U	3 U	3 U	3 U	3 UJ	3 U	3 U	3 U	3 U	3 U
Bromomethane	6 U	5 U	5 U	5 U	5 U	6 U	5 U	5 U	5 U	6 U
Carbon Disulfide	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Carbon Tetrachloride	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ
Chlorobenzene	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Chlorodibromomethane	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Chloroethane	6 U	5 U	5 U	5 U	5 U	6 U	5 U	5 U	5 U	6 U
Chlorofor	3 U	3 U	3 U	4 J	3 U	3 U	3 U	3 U	3 U	3 U
Chloromethane	6 U	5 UJ	5 UJ	5 U	5 U	6 UJ	5 UJ	5 U	5 U	6 U
Chloroprene	6 UJ	5 UJ	5 UJ	5 UJ	5 UJ	6 UJ	5 UJ	5 UJ	5 UJ	6 UJ
Cis-1,2-Dichloroethene	6 U	5 U	5 U	5 U	5 U	6 U	5 U	5 U	5 U	6 U
Cis-1,3-Dichloropropene	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Dibromomethane	6 U	5 U	5 U	5 U	5 U	6 U	5 U	5 U	5 U	6 U
Dichlorodifluoromethane	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Ethyl Methacrylate	6 U	5 U	5 U	5 U	5 UJ	6 U	5 U	5 U	5 U	6 UJ
Ethylbenzene	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Isobutanol	240 UR	210 UR	220 UR	190 UR	190 UR	230 UR	210 UR	180 UR	190 UR	230 UR
Methacrylonitrile	120 UJ	110 U	110 U	95 UJ	94 UJ	120 U	100 U	91 UJ	96 UJ	110 UJ
Methyl Iodide	6 UJ	5 UJ	5 UJ	5 U	5 U	6 UJ	5 UJ	5 UJ	5 UJ	6 UJ
Methyl Methacrylate	6 U	5 U	5 U	5 UJ	5 UJ	6 U	5 U	5 U	5 U	6 U
Methylene Chloride	86 J	21 J	16 J	45 U	50 J	26 J	15 J	15 J	13 J	10
Pentachloroethane	6 U	5 UJ	5 UJ	5 UJ	5 UJ	6 UJ	5 UJ	5 UJ	5 UJ	6 UJ
Propionitrile	120 UR	110 UR	110 UR	95 UR	94 UR	120 UR	100 UR	91 UR	96 UR	110 UR
Styrene	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Tetrachloroethene	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Toluene	3 U	3 U	3 U	3 U	3 UJ	3 U	3 U	3 U	3 U	3 U
Total Xylenes	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Trans-1,2-Dichloroethene	6 U	5 U	5 U	5 U	5 U	6 U	5 U	5 U	5 U	6 U

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB07	01SB08	01SB08	01SB09	01SB10	01SB11	01SB11	01SB12	01SB12	01SB13
Sample	01SB070206	01SB080206	01SB080610	01SB090206	01SB100206	01SB110206	01SB110610	01SB120206	01SB120610	01SB130206
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	2 - 5	2 - 6	6 - 10	2 - 6	2 - 6	2 - 6	6 - 10	2 - 6	6 - 10	2 - 6
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Soil Group	8	8	9	8	8	8	8	8	9	8
Sample Date	8/27/2001	8/21/2001	8/21/2001	8/27/2001	8/27/2001	8/22/2001	8/22/2001	8/25/2001	8/25/2001	8/24/2001
Trans-1,3-Dichloropropene	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Trans-1,4-Dichloro-2-Butene	6 U	5 U	5 U	5 U	5 UJ	6 U	5 U	5 U	5 U	6 U
Trichloroethene	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Trichlorofluoromethane	6 UJ	5 U	5 U	5 U	5 UJ	6 U	5 U	5 U	5 U	6 U
Vinyl Acetate	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Vinyl Chloride	6 U	5 U	5 U	5 U	5 U	6 U	5 U	5 U	5 U	6 U
Semivolatile Organics (ug/kg)										
1,2,4,5-Tetrachlorobenzene	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
1,2,4-Trichlorobenzene	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
1,2-Dichlorobenzene	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
1,3-Dichlorobenzene	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
1,4-Dichlorobenzene	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
1,4-Naphthoquinone	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
1,4-Phenylenediamine	1100 UJ	970 UJ	960 UJ	970 UJ	970 UJ	960 UJ	950 UJ	930 U	920 U	1100 U
1-Naphthylamine	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
2,2'-Oxybis(1-Chloropropane)	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
2,3,4,6-Tetrachlorophenol	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
2,4,5-Trichlorophenol	1100 U	970 U	960 U	970 U	970 U	960 U	950 U	930 U	920 U	1100 U
2,4,6-Trichlorophenol	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
2,4-Dichlorophenol	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
2,4-Dimethylphenol	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
2,4-Dinitrophenol	1100 U	970 U	960 U	970 U	970 U	960 U	950 U	930 U	920 U	1100 U
2,6-Dichlorophenol	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
2-Acetylaminofluorene	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
2-Chloronaphthalene	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
2-Chlorophenol	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
2-Methylnaphthalene	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
2-Methylphenol	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
2-Naphthylamine	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
2-Nitroaniline	550 U	490 U	480 U	490 U	490 U	480 U	480 U	470 U	460 U	550 U
2-Nitrophenol	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
2-Picoline	340 U	290 U	290 U	290 U	290 U	300 U	290 U	280 U	280 U	320 U
3,3'-Dichlorobenzidine	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
3,3'-Dimethylbenzidine	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
3-Methylcholanthrene	510 U	430 U	430 U	430 U	430 U	430 U	430 U	420 U	410 U	480 U
3-Methylphenol	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
3-Nitroaniline	1100 U	970 U	960 U	970 U	970 U	960 U	950 U	930 U	920 U	1100 U
4,6-Dinitro-2-Methylphenol	1100 U	970 U	960 U	970 U	970 U	960 U	950 U	930 U	920 U	1100 U
4-Aminobiphenyl	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
4-Bromophenyl Phenyl Ether	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
4-Chloro-3-Methylphenol	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
4-Chloroaniline	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
4-Chlorophenyl Phenyl Ether	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
4-Methylphenol	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
4-Nitroaniline	1100 U	970 U	960 U	970 U	970 U	960 U	950 U	930 U	920 U	1100 U
4-Nitrophenol	1100 U	970 U	960 U	970 U	970 U	960 U	950 U	930 U	920 U	1100 U
4-Nitroquinoline-1-Oxide	1100 UR	970 UR	960 UR	970 UR	970 UR	960 UR	950 UR	930 UR	920 UR	1100 UR
5-Nitro-O-Toluidine	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
7,12-Dimethylbenz(A)Anthracene	340 U	290 U	290 U	290 U	290 U	300 U	290 U	280 U	280 U	320 U
A,A-Dimethylphenethylamine	1100 U	970 UJ	960 UJ	970 U	970 U	960 UJ	950 U	930 U	920 U	1100 U
Acenaphthene	13.5 U	11.6 U	11.3 U	11.6 U	11.6 U	11.8 U	11.3 U	11.1 U	11 U	12.7 UJ

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = [illegible]lyzed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB07	01SB08	01SB08	01SB09	01SB10	01SB11	01SB11	01SB12	01SB12	01SB13
Sample	01SB070206	01SB080206	01SB080610	01SB090206	01SB100206	01SB110206	01SB110610	01SB120206	01SB120610	01SB130206
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	2 - 5	2 - 6	6 - 10	2 - 6	2 - 6	2 - 6	6 - 10	2 - 6	6 - 10	2 - 6
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Soil Group	8	8	9	8	8	8	8	8	9	8
Sample Date	8/27/2001	8/21/2001	8/21/2001	8/27/2001	8/27/2001	8/22/2001	8/22/2001	8/25/2001	8/25/2001	8/24/2001
Acenaphthylene	13.5 U	11.6 UJ	11.3 UJ	11.6 U	11.6 U	11.8 UJ	11.3 UJ	11.1 U	11 U	12.7 UJ
Acetophenone	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
Aniline	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
Anthracene	13.5 U	11.6 UJ	11.3 UJ	11.6 U	11.6 U	11.8 UJ	11.3 UJ	11.1 U	11 U	12.7 UJ
Aramite	1100 U	970 U	960 U	970 U	970 U	960 U	950 U	930 U	920 U	1100 U
Benzo(A)Anthracene	13.5 U	11.6 U	11.3 U	11.6 U	11.6 U	11.8 U	11.3 U	11.1 U	11 U	12.7 UJ
Benzo(A)Pyrene	13.5 U	11.6 U	11.3 U	11.6 U	11.6 U	11.8 U	11.3 U	11.1 U	11 U	12.7 UJ
Benzo(B)Fluoranthene	13.5 U	11.6 U	11.3 U	11.6 U	11.6 U	11.8 U	11.3 U	11.1 U	11 U	12.7 UJ
Benzo(G,H,I)Perylene	13.5 U	11.6 U	11.3 U	11.6 U	11.6 U	11.8 U	11.3 U	11.1 U	11 U	12.7 UJ
Benzo(K)Fluoranthene	13.5 U	11.6 U	11.3 U	11.6 U	11.6 U	11.8 U	11.3 U	11.1 U	11 U	12.7 UJ
Benzyl Alcohol	270 U	270 U	270 U	270 U	270 U	270 U	270 U	270 U	270 U	270 U
Bis(2-Chloroethoxy)Methane	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
Bis(2-Chloroethyl)Ether	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
Bis(2-Ethylhexyl)Phthalate	230 U	200 U	190 U	5600	200 U	200 U	190 U	190 U	190 U	210 U
Butyl Benzyl Phthalate	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
Chlorobenzilate	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
Chrysene	13.5 U	11.6 U	11.3 U	11.6 U	11.6 U	11.8 U	11.3 U	11.1 U	11 U	12.7 UJ
Di-N-Butyl Phthalate	230 UJ	200 U	190 U	200 U	200 UJ	200 U	190 U	190 UJ	190 UJ	210 UJ
Di-N-Octyl Phthalate	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
Diallate	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
Dibenzo(A,H)Anthracene	13.5 U	11.6 UJ	11.3 UJ	11.6 U	11.6 U	11.8 UJ	11.3 UJ	11.1 U	11 U	12.7 UJ
Dibenzofuran	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
Diethyl Phthalate	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
Dimethyl Phthalate	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
Diphenylamine	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
Ethyl Methane Sulfonate	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
Fluoranthene	13.5 U	11.6 U	11.3 U	11.6 U	11.6 U	11.8 U	11.3 U	11.1 U	11 U	12.7 UJ
Fluorene	13.5 U	11.6 U	11.3 U	11.6 U	11.6 U	11.8 U	11.3 U	11.1 U	11 U	12.7 UJ
Hexachlorobenzene	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
Hexachlorobutadiene	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
Hexachlorocyclopentadiene	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
Hexachloroethane	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
Hexachlorophene	18000 UJ	15000 UJ	15000 UJ	15000 UJ	15000 UJ	15000 UJ	15000 UJ	15000 U	15000 U	17000 U
Hexachloropropene	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
Indeno(1,2,3-CD)Pyrene	13.5 U	11.6 U	11.3 U	11.6 U	11.6 U	11.8 U	11.3 U	11.1 U	11 U	12.7 UJ
Isodrin	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
Isophorone	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
Isosafrole	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
Kepone	1100 U	970 U	960 U	970 U	970 U	960 U	950 U	930 U	920 U	1100 U
Methapyrilene	1100 UR	970 U	960 U	970 UR	970 UR	960 U	950 U	930 U	920 U	1100 U
Methyl Methane Sulfonate	550 U	490 U	480 U	490 U	490 U	480 U	480 U	470 U	460 U	550 U
N-Nitroso-Di-N-Butylamine	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
N-Nitroso-Di-N-Propylamine	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
N-Nitrosodiethylamine	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
N-Nitrosodimethylamine	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
N-Nitrosomethylethylamine	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
N-Nitrosomorpholine	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
N-Nitrosopiperidine	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
N-Nitrosopyrrolidine	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
Naphthalene	13.5 U	11.6 UR	11.3 UR	10.2 J	11.6 U	11.8 UR	11.3 UR	11.1 U	11 U	12.7 UJ
O,O,O-Triethyl Phosphorothioate	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB07	01SB08	01SB08	01SB09	01SB10	01SB11	01SB11	01SB12	01SB12	01SB13
Sample	01SB070206	01SB080206	01SB080610	01SB090206	01SB100206	01SB110206	01SB110610	01SB120206	01SB120610	01SB130206
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	2 - 5	2 - 6	6 - 10	2 - 6	2 - 6	2 - 6	6 - 10	2 - 6	6 - 10	2 - 6
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Soil Group	8	8	9	8	8	8	8	8	9	8
Sample Date	8/27/2001	8/21/2001	8/21/2001	8/27/2001	8/27/2001	8/22/2001	8/22/2001	8/25/2001	8/25/2001	8/24/2001
O-Toluidine	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
P-(Dimethylamino)Azobenzene	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
Pentachlorobenzene	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
Pentachloronitrobenzene	1100 U	970 U	960 U	970 U	970 U	960 U	950 U	930 U	920 U	1100 U
Phenacetin	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
Phenanthrene	13.5 U	11.6 U	11.3 U	11.6 U	11.6 U	11.8 U	11.3 U	11.1 U	11 U	12.7 UJ
Phenol	230 U	200 U	190 U	200 U	200 U	200 U	190 U	190 U	190 U	210 U
Pronamide	460 UR	390 UR	380 UR	390 UR	390 UR	390 UR	380 UR	370 U	370 U	420 U
Pyrene	13.5 U	11.6 U	11.3 U	11.6 U	11.6 U	11.8 U	11.3 U	11.1 U	11 U	12.7 UJ
Pyridine	230 U	220 U	220 U	220 U	220 U	220 U	220 U	220 U	220 U	220 U
Safrole	460 U	390 U	380 U	390 U	390 U	390 U	380 U	370 U	370 U	420 U
Energetics (ug/kg)										
1,3,5-Trinitrobenzene	476 U	500 U	476 U	476 U	476 U	500 U	500 U	500 U	476 U	476 U
1,3-Dinitrobenzene	476 U	500 U	476 U	476 U	476 U	500 U	500 U	500 U	476 U	476 U
2,4,6-Trinitrotoluene	476 U	500 U	476 U	476 U	476 U	500 U	500 U	500 U	476 U	476 U
2,4-Dinitrotoluene	476 U	500 U	476 U	476 U	476 U	500 U	500 U	500 U	476 U	476 U
2,6-Dinitrotoluene	476 U	500 U	476 U	476 U	476 U	500 U	500 U	500 U	476 U	476 U
2-Amino-4,6-Dinitrotoluene	476 U	500 U	476 U	476 U	476 U	500 U	500 U	500 U	476 U	476 U
2-Nitrotoluene	476 U	500 U	476 U	476 U	476 U	500 U	500 U	500 U	476 U	476 U
3-Nitrotoluene	476 U	500 U	476 U	476 U	476 U	500 U	500 U	500 U	476 U	476 U
4-Amino-2,6-Dinitrotoluene	476 U	500 U	476 U	476 U	476 U	500 U	500 U	500 U	476 U	476 U
4-Nitrotoluene	476 U	500 U	476 U	476 U	476 U	500 U	500 U	500 U	476 U	476 U
HMX	476 U	70.6 J	476 U	476 U	476 U	500 U	500 U	500 U	476 U	476 U
Nitrobenzene	476 U	500 U	476 U	476 U	476 U	500 U	500 U	500 U	476 U	476 U
RDX	476 U	500 U	476 U	476 U	476 U	500 U	500 U	500 U	476 U	476 U
Tetryl	476 U	500 U	476 U	476 U	476 U	500 U	500 U	500 U	476 U	476 U
Pesticides/PCBs (ug/kg)										
4,4'-DDD	3.4 U	2.9 U	NA	2.9 U	2.9 U	2.9 U	NA	2.8 U	NA	3.2 U
4,4'-DDE	3.4 U	2.9 U	NA	2.9 U	2.9 U	2.9 U	NA	2.8 U	NA	3.2 U
4,4'-DDT	3.4 U	2.9 U	NA	2.9 UJ	2.9 U	2.9 U	NA	2.8 U	NA	3.2 U
Aldrin	1.8 U	1.5 U	NA	1.5 U	1.5 U	1.5 U	NA	1.5 U	NA	1.7 U
Alpha-BHC	1.8 U	1.5 U	NA	1.5 U	1.5 U	1.5 U	NA	1.5 U	NA	1.7 U
Alpha-Chlordane	1.8 U	1.5 U	NA	1.5 U	1.5 U	1.5 U	NA	1.5 U	NA	1.7 U
Aroclor-1016	45 U	38 U	NA	38 U	38 U	39 U	NA	37 U	NA	42 U
Aroclor-1221	45 U	38 U	NA	38 U	38 U	39 U	NA	37 U	NA	42 U
Aroclor-1232	45 U	38 U	NA	38 U	38 U	39 U	NA	37 U	NA	42 U
Aroclor-1242	45 U	38 U	NA	38 U	38 U	39 U	NA	37 U	NA	42 U
Aroclor-1248	45 U	38 U	NA	38 U	38 U	39 U	NA	37 U	NA	42 U
Aroclor-1254	45 U	38 U	NA	38 U	38 U	39 U	NA	37 U	NA	42 U
Aroclor-1260	45 U	38 U	NA	38 U	38 U	39 U	NA	37 U	NA	42 U
Beta-BHC	1.8 U	1.5 U	NA	1.5 U	1.5 U	1.5 U	NA	1.5 U	NA	1.7 U
Delta-BHC	1.8 U	1.5 U	NA	1.5 U	1.5 U	1.5 U	NA	1.5 U	NA	1.7 U
Dieldrin	3.4 U	2.9 U	NA	2.9 U	2.9 U	2.9 U	NA	2.8 U	NA	3.2 U
Endosulfan I	1.8 U	1.5 U	NA	1.5 U	1.5 U	1.5 U	NA	1.5 U	NA	1.7 U
Endosulfan II	3.4 U	2.9 U	NA	2.9 U	2.9 U	2.9 U	NA	2.8 U	NA	3.2 U
Endosulfan Sulfate	3.4 U	2.9 U	NA	2.9 U	2.9 U	2.9 U	NA	2.8 U	NA	3.2 U
Endrin	3.4 U	2.9 U	NA	2.9 U	2.9 U	2.9 U	NA	2.8 U	NA	3.2 U
Endrin Aldehyde	3.4 UJ	2.9 U	NA	2.9 U	2.9 UJ	2.9 U	NA	2.8 U	NA	3.2 U
Gamma-BHC (Lindane)	1.8 U	1.5 U	NA	1.5 U	1.5 U	1.5 U	NA	1.5 U	NA	1.7 U
Gamma-Chlordane	1.8 U	1.5 U	NA	1.5 U	1.5 U	1.5 U	NA	0.82 J	NA	2.6 J
Heptachlor	1.5 J	1.6 J	NA	1.2 J	0.94 J	1.5 J	NA	1 BU	NA	1.5 BU

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = N[illegible]yzed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB07	01SB08	01SB08	01SB09	01SB10	01SB11	01SB11	01SB12	01SB12	01SB13
Sample	01SB070206	01SB080206	01SB080610	01SB090206	01SB100206	01SB110206	01SB110610	01SB120206	01SB120610	01SB130206
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	2 - 5	2 - 6	6 - 10	2 - 6	2 - 6	2 - 6	6 - 10	2 - 6	6 - 10	2 - 6
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Soil Group	8	8	9	8	8	8	8	8	9	8
Sample Date	8/27/2001	8/21/2001	8/21/2001	8/27/2001	8/27/2001	8/22/2001	8/22/2001	8/25/2001	8/25/2001	8/24/2001
Heptachlor Epoxide	1.8 U	1.5 U	NA	1.5 U	1.5 U	1.5 U	NA	1.5 U	NA	1.7 U
Methoxychlor	18 U	15 U	NA	15 U	15 U	15 U	NA	15 U	NA	17 U
Toxaphene	110 U	96 U	NA	96 U	96 U	97 U	NA	93 U	NA	110 U
Herbicides (ug/kg)										
2,4,5-T	14 U	12 U	NA	12 U	12 U	12 U	NA	11 U	NA	13 U
2,4,5-TP (Silvex)	14 U	12 UJ	NA	12 U	12 U	12 UJ	NA	11 U	NA	13 U
2,4-D	96 U	81 U	NA	81 U	81 U	82 U	NA	78 U	NA	90 U
Dinoseb	27 U	23 U	NA	23 U	23 U	23 U	NA	22 U	NA	26 U
Pentachlorophenol	14 U	12 U	NA	12 U	12 U	12 U	NA	11 U	NA	13 U
Inorganics (mg/kg)										
Aluminum	12700	7030 J	4290 J	10100 J	14200	11900 J	4530 J	8210 J	4330 J	9510 J
Antimony	1.3 U	0.48 U	1.6 U	0.41 U	0.95 U	0.44 U	0.55 U	0.40 U	0.18 U	0.29 U
Arsenic	6.7 J	4.2	0.48 J	4.1 J	2.7 J	8.1	3.1	3.4 J	1.7 U	5.3 J
Barium	55.4	26.3	23.6	34.8 J	51.2	44.0	28.1	27.9	52.2	39.7
Beryllium	0.24	0.31 U	1.6 J	0.55 J	0.24	0.42 U	0.32 U	0.33 J	0.47 J	0.35 J
Cadmium	0.05 U	0.01 U	0.01 U	0.03 UJ	0.04 U	0.01 U	0.01 U	0.16 J	0.16	0.04 J
Calcium	549 J	262 J	362 J	901 J	10000 J	332 J	557 J	305 J	485 J	263 J
Chromium	18.7	10.4	15.0	14.9	17.6	15.9	10.3	11.3 J	8.5 J	12.7 J
Cobalt	5.5	2.0 J	16.8 J	2.6	4.0	4.0 J	1.3 J	3.0 J	3.9 J	3.4 J
Copper	14.4	9.4 J	25.3 J	10.7 J	11.4	12.7 J	9.1 J	7.4 J	7.8 J	10.8 J
Iron	24400	12600	71500	15800	15700	23600	16200	12800	8750	17800
Lead	12.2	8.0 J	7.6 J	10.3	10.5	11.9 J	9.6 J	10.5	9.8	9.2
Magnesium	2350 J	826 J	395 J	1210 J	1840 J	1750 J	512 J	1120 J	663 J	1630 J
Manganese	250	45.4 J	329 J	20.3 J	137	180 J	21.7 J	157 J	20.9 J	131 J
Mercury	0.02 J	0.04	0.03	0.02 J	0.02 J	0.06	0.03	0.03 J	0.02 U	0.03 U
Nickel	11.5	4.5	24.9	6.7	8.8	8.1	3.2	5.6 J	8.2 J	8.2 J
Potassium	617 J	441 J	754 J	353 J	615 J	553 J	207 J	381 J	449 J	504 J
Selenium	1.4	0.31 J	1.3 J	0.36 J	1.1	0.41 J	0.34 J	0.48 U	0.18 U	0.55 U
Silver	0.17 U	0.05 U	0.06 U	0.34 U	0.14 U	0.08 U	0.05 U	0.32 U	0.33 U	0.38 U
Sodium	567	359 J	379 J	342 J	706	336 J	343 J	329 J	379 J	391 J
Strontium	10.2 J	5.0 J	4.4 J	9.9 J	17.5 J	6.1 J	4.1 J	5.2 J	4.9 J	5.4 J
Thallium	0.63 U	1.1 J	5.3 J	1.5	0.53 U	2.1	1.4 J	1.1 J	1.0	1.8 J
Thorium-Calc	4.22	3.44	2.93	3.98	5.22	3.34	4.84	4.74	4.48	3.41
Tin	2.5 U	3.6	4.0	21.8 U	2.8	3.3	2.3	20.4 U	21.1 U	24.0 U
Vanadium	32.9	18.3 J	15.9 J	26.8	28.1	29.4 J	20.5 J	20.9	10.2	22.2
Zinc	46.9	18.1	129	16.2 J	43.3	34.2	15.0	17.6 J	26.1 J	31.7 J
Miscellaneous Parameters										
1,4-Dithiane (ug/kg)	274 U	232 U	231 U	232 U	233 U	236 U	230 U	224 U	222 U	255 U
1,4-Oxathiane (ug/kg)	274 U	232 U	231 U	232 U	233 U	236 U	230 U	224 U	222 U	255 U
Bis(2-Chloroethyl)Sulfide (ug/kg)	274 U	232 U	231 U	232 U	233 U	236 U	230 U	224 U	222 U	255 U
Cation Exchange Capacity (meq/100g)	19.2 J	NA	NA	NA	NA	NA	NA	NA	NA	14.8 J
pH (S.U.)	5	NA	NA	NA	NA	NA	NA	NA	NA	4.8
Total Organic Carbon (mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Radiologicals (pCi/g)										
Actinium-228	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bismuth-212	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bismuth-214	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cesium-137	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt-60	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Europium-154	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Europium-155	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB07	01SB08	01SB08	01SB09	01SB10	01SB11	01SB11	01SB12	01SB12	01SB13
Sample	01SB070206	01SB080206	01SB080610	01SB090206	01SB100206	01SB110206	01SB110610	01SB120206	01SB120610	01SB130206
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	2 - 5	2 - 6	6 - 10	2 - 6	2 - 6	2 - 6	6 - 10	2 - 6	6 - 10	2 - 6
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Soil Group	8	8	9	8	8	8	8	8	9	8
Sample Date	8/27/2001	8/21/2001	8/21/2001	8/27/2001	8/27/2001	8/22/2001	8/22/2001	8/25/2001	8/25/2001	8/24/2001
Lead-210	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead-212	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead-214	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Potassium-40	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Protactinium-234	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Radium-226	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium-208	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thorium-228	0.355	0.242	0.400	0.400	0.537	0.319	0.502	0.504	0.507	0.291
Thorium-230	0.164	0.334 J	0.385 J	0.0427 U	0.111	0.434 J	0.637 J	0.394 U	0.360 U	0.421 J
Thorium-232	0.574	0.514	0.245	0.475	0.612	0.416	0.562	0.538	0.479	0.459
Thorium-234	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-235	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB13	01SB14	01SB14	01SB15	01SB15	01SB16	01SB16	01SB17	01SB17	01SB18
Sample	01SB130610	01SB140206	01SB140610	01SB150206	01SB150610	01SB160206	01SB160610	01SB170206	01SB170610	01SB180206
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	6 - 10	2 - 6	6 - 8	2 - 6	6 - 10	2 - 6	6 - 10	2 - 6	6 - 9.7	2 - 6
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Soil Group	8	8	8	8	8	8	9	8	8	8
Sample Date	8/24/2001	8/24/2001	8/24/2001	8/22/2001	8/22/2001	8/21/2001	8/21/2001	8/24/2001	8/24/2001	8/24/2001
Volatile Organics (ug/kg)										
1,1,1,2-Tetrachloroethane	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
1,1,1-Trichloroethane	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
1,1,2,2-Tetrachloroethane	3 U	3 UJ	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
1,1,2-Trichloroethane	6 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	6 U
1,1-Dichloroethane	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
1,1-Dichloroethene	6 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	6 U
1,2,3-Trichloropropane	3 U	3 UJ	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
1,2-Dibromo-3-Chloropropane	6 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 U	6 U
1,2-Dibromoethane	3 U	3 UJ	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
1,2-Dichloroethane	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
1,2-Dichloropropane	6 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	6 U
1,4-Dioxane	550 UR	540 UR	500 UR	530 UR	510 UR	500 UR	530 UR	500 UR	500 UR	580 UR
2-Butanone	6 UJ	5 UJ	5 UJ	5 U	5 U	5 U	5 UJ	5 UJ	5 UJ	6 UJ
2-Hexanone	6 U	5 UJ	5 U	5 UJ	5 UJ	5 U	5 U	5 U	5 U	6 U
3-Chloropropene	6 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	6 UJ
4-Methyl-2-Pentanone	3 U	3 UJ	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Acetone	17	5 UJ	5 U	5 UJ	5 UJ	5 UJ	5 UJ	11	14	26
Acetonitrile	220 UJ	220 UJ	200 UJ	210 UJ	200 UJ	200 UJ	210 UJ	200 UJ	200 UJ	230 UJ
Acrolein	55 UR	54 UR	50 UR	53 UR	51 UR	50 UR	53 UR	50 UR	50 UR	58 UR
Acrylonitrile	55 U	54 UJ	50 U	53 U	51 U	50 U	53 U	50 U	50 U	58 U
Benzene	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Bromodichloromethane	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Bromofor	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Bromomethane	6 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	6 U
Carbon Disulfide	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 UJ	3 U
Carbon Tetrachloride	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ
Chlorobenzene	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Chlorodibromomethane	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Chloroethane	6 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	6 U
Chlorofor	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Chloromethane	6 U	5 U	5 U	5 UJ	5 UJ	5 UJ	5 U	5 U	5 U	6 U
Chloroprene	6 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	6 UJ
Cis-1,2-Dichloroethene	6 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	6 U
Cis-1,3-Dichloropropene	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Dibromomethane	6 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	6 U
Dichlorodifluoromethane	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Ethyl Methacrylate	6 UJ	5 UJ	5 UJ	5 U	5 U	5 U	5 UJ	5 U	5 U	6 U
Ethylbenzene	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Isobutanol	220 UR	220 UR	200 UR	210 UR	200 UR	200 UR	210 UR	200 UR	200 UR	230 UR
Methacrylonitrile	110 UJ	110 UJ	99 UJ	110 U	100 U	100 U	110 UJ	100 UJ	100 UJ	120 UJ
Methyl Iodide	6 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	6 UJ
Methyl Methacrylate	6 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	6 U
Methylene Chloride	5 J	5 J	47	14 J	16 J	13 J	11 J	7 J	4 J	7 J
Pentachloroethane	6 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	6 UJ
Propionitrile	110 UR	110 UR	99 UR	110 UR	100 UR	100 UR	110 UR	100 UR	100 UR	120 UR
Styrene	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Tetrachloroethene	3 U	3 UJ	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Toluene	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Total Xylenes	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Trans-1,2-Dichloroethene	6 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	6 U

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB13	01SB14	01SB14	01SB15	01SB15	01SB16	01SB16	01SB17	01SB17	01SB18
Sample	01SB130610	01SB140206	01SB140610	01SB150206	01SB150610	01SB160206	01SB160610	01SB170206	01SB170610	01SB180206
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	6 - 10	2 - 6	6 - 8	2 - 6	6 - 10	2 - 6	6 - 10	2 - 6	6 - 9.7	2 - 6
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Soil Group	8	8	8	8	8	8	9	8	8	8
Sample Date	8/24/2001	8/24/2001	8/24/2001	8/22/2001	8/22/2001	8/21/2001	8/21/2001	8/24/2001	8/24/2001	8/24/2001
Trans-1,3-Dichloropropene	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Trans-1,4-Dichloro-2-Butene	6 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 U	6 U
Trichloroethene	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Trichlorofluoromethane	6 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	6 U
Vinyl Acetate	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Vinyl Chloride	6 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	6 U
Semivolatile Organics (ug/kg)										
1,2,4,5-Tetrachlorobenzene	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
1,2,4-Trichlorobenzene	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
1,2-Dichlorobenzene	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
1,3-Dichlorobenzene	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
1,4-Dichlorobenzene	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
1,4-Naphthoquinone	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
1,4-Phenylenediamine	1000 U	960 U	950 U	990 UJ	990 UJ	1000 U	980 UJ	890 U	960 U	1000 U
1-Naphthylamine	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
2,2'-Oxybis(1-Chloropropane)	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
2,3,4,6-Tetrachlorophenol	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
2,4,5-Trichlorophenol	1000 U	960 U	950 U	990 U	990 U	1000 U	980 U	890 U	960 U	1000 U
2,4,6-Trichlorophenol	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
2,4-Dichlorophenol	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
2,4-Dimethylphenol	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
2,4-Dinitrophenol	1000 U	960 U	950 U	990 U	990 U	1000 U	980 U	890 U	960 U	1000 U
2,6-Dichlorophenol	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
2-Acetylaminofluorene	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
2-Chloronaphthalene	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
2-Chlorophenol	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
2-Methylnaphthalene	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
2-Methylphenol	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
2-Naphthylamine	200 U	200 U	190 U	200 U	200 U	200 U	200 U	190 U	190 U	210 U
2-Nitroaniline	500 U	480 U	480 U	500 U	500 U	500 U	490 U	450 U	480 U	500 U
2-Nitrophenol	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
2-Picoline	300 U	290 U	290 U	300 U	300 U	300 U	300 U	320 U	290 U	300 U
3,3'-Dichlorobenzidine	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
3,3'-Dimethylbenzidine	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
3-Methylcholanthrene	450 U	430 U	430 U	450 U	440 U	450 U	440 U	400 U	430 U	460 U
3-Methylphenol	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
3-Nitroaniline	1000 U	960 U	950 U	990 U	990 U	1000 U	980 U	890 U	960 U	1000 U
4,6-Dinitro-2-Methylphenol	1000 U	960 U	950 U	990 U	990 U	1000 U	980 U	890 U	960 U	1000 U
4-Aminobiphenyl	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
4-Bromophenyl Phenyl Ether	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
4-Chloro-3-Methylphenol	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
4-Chloroaniline	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
4-Chlorophenyl Phenyl Ether	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
4-Methylphenol	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
4-Nitroaniline	1000 U	960 U	950 U	990 U	990 U	1000 U	980 U	890 U	960 U	1000 U
4-Nitrophenol	1000 U	960 U	950 U	990 U	990 U	1000 U	980 U	890 U	960 U	1000 U
4-Nitroquinoline-1-Oxide	1000 UR	960 UR	950 UR	990 UR	990 UR	1000 UR	980 UR	890 U	960 UR	1000 UR
5-Nitro-O-Toluidine	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
7,12-Dimethylbenz(A)Anthracene	300 U	290 U	290 U	300 U	300 U	300 U	300 U	320 U	290 U	300 U
A,A-Dimethylphenethylamine	1000 U	960 U	950 U	990 UJ	990 U	1000 U	980 U	890 U	960 U	1000 U
Acenaphthene	11.9 U	14.2	11.4 U	11.9 U	12 U	12 U	11.8 U	12.7 U	11.4 UR	12 U

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB13	01SB14	01SB14	01SB15	01SB15	01SB16	01SB16	01SB17	01SB17	01SB18
Sample	01SB130610	01SB140206	01SB140610	01SB150206	01SB150610	01SB160206	01SB160610	01SB170206	01SB170610	01SB180206
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	6 - 10	2 - 6	6 - 8	2 - 6	6 - 10	2 - 6	6 - 10	2 - 6	6 - 9.7	2 - 6
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Soil Group	8	8	8	8	8	8	9	8	8	8
Sample Date	8/24/2001	8/24/2001	8/24/2001	8/22/2001	8/22/2001	8/21/2001	8/21/2001	8/24/2001	8/24/2001	8/24/2001
Acenaphthylene	11.9 U	11.6 U	11.4 U	11.9 UJ	12 UJ	12 U	11.8 U	12.7 U	11.4 UR	12 U
Acetophenone	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
Aniline	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
Anthracene	11.9 U	11.6 U	11.4 U	11.9 UJ	12 UJ	12 U	11.8 U	12.7 U	11.4 UR	12 U
Aramite	1000 U	960 U	950 U	990 U	990 U	1000 U	980 U	890 U	960 U	1000 U
Benzo(A)Anthracene	11.9 U	11.6 U	11.4 U	11.9 U	12 U	12 U	11.8 U	12.7 U	11.4 UR	12 U
Benzo(A)Pyrene	11.9 U	11.6 U	11.4 U	11.9 U	12 U	12 U	11.8 U	12.7 U	11.4 UR	12 U
Benzo(B)Fluoranthene	11.9 U	11.6 U	11.4 U	11.9 U	12 U	12 U	11.8 U	12.7 U	11.4 UR	12 U
Benzo(G,H,I)Perylene	11.9 U	11.6 U	11.4 U	11.9 U	12 U	12 U	11.8 U	12.7 U	11.4 UR	12 U
Benzo(K)Fluoranthene	11.9 U	11.6 U	11.4 U	11.9 U	12 U	12 U	11.8 U	12.7 U	11.4 UR	12 U
Benzyl Alcohol	270 U	270 U	270 U	270 U	270 U	270 U	270 U	270 U	270 U	270 U
Bis(2-Chloroethoxy)Methane	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
Bis(2-Chloroethyl)Ether	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
Bis(2-Ethylhexyl)Phthalate	200 U	200 U	190 U	200 U	200 U	200 U	97 J	180 U	190 U	210 U
Butyl Benzyl Phthalate	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
Chlorobenzilate	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
Chrysene	11.9 U	11.6 U	11.4 U	11.9 U	12 U	12 U	11.8 U	12.7 U	11.4 UR	12 U
Di-N-Butyl Phthalate	200 UJ	200 UJ	190 UJ	200 U	200 U	200 U	200 U	180 UJ	190 U	210 UJ
Di-N-Octyl Phthalate	200 U	200 U	190 U	200 U	200 U	200 U	200 U	190 U	190 U	210 U
Diallate	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
Dibenzo(A,H)Anthracene	11.9 U	11.6 U	11.4 U	11.9 UJ	12 UJ	12 U	11.8 U	12.7 U	11.4 UR	12 U
Dibenzofuran	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
Diethyl Phthalate	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
Dimethyl Phthalate	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
Diphenylamine	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
Ethyl Methane Sulfonate	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
Fluoranthene	11.9 U	11.6 U	11.4 U	11.9 U	12 U	12 U	11.8 U	12.7 U	11.4 UR	12 U
Fluorene	11.9 U	11.6 U	11.4 U	11.9 U	12 U	12 U	11.8 U	12.7 U	11.4 UR	12 U
Hexachlorobenzene	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
Hexachlorobutadiene	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
Hexachlorocyclopentadiene	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
Hexachloroethane	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
Hexachlorophene	16000 U	15000 U	15000 U	16000 UJ	16000 UJ	16000 UJ	16000 UJ	14000 U	15000 U	16000 U
Hexachloropropene	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
Indeno(1,2,3-CD)Pyrene	11.9 U	11.6 U	11.4 U	11.9 U	12 U	12 U	11.8 U	12.7 U	11.4 UR	12 U
Isodrin	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
Isophorone	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
Isosafrole	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
Kepone	1000 U	960 U	950 U	990 U	990 U	1000 U	980 U	890 U	960 U	1000 U
Methapyrilene	1000 U	960 U	950 U	990 U	990 U	1000 U	980 U	890 U	960 U	1000 U
Methyl Methane Sulfonate	500 U	480 U	480 U	500 U	500 U	500 U	490 U	450 U	480 U	500 U
N-Nitroso-Di-N-Butylamine	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
N-Nitroso-Di-N-Propylamine	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
N-Nitrosodiethylamine	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
N-Nitrosodimethylamine	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
N-Nitrosomethylethylamine	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
N-Nitrosomorpholine	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
N-Nitrosopiperidine	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
N-Nitrosopyrrolidine	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
Naphthalene	11.9 U	11.6 U	11.4 U	11.9 UR	12 UR	12 UR	11.8 UR	12.7 U	11.4 UR	12 U
O,O,O-Triethyl Phosphorothioate	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB13	01SB14	01SB14	01SB15	01SB15	01SB16	01SB16	01SB17	01SB17	01SB18
Sample	01SB130610	01SB140206	01SB140610	01SB150206	01SB150610	01SB160206	01SB160610	01SB170206	01SB170610	01SB180206
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	6 - 10	2 - 6	6 - 8	2 - 6	6 - 10	2 - 6	6 - 10	2 - 6	6 - 9.7	2 - 6
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Soil Group	8	8	8	8	8	8	9	8	8	8
Sample Date	8/24/2001	8/24/2001	8/24/2001	8/22/2001	8/22/2001	8/21/2001	8/21/2001	8/24/2001	8/24/2001	8/24/2001
O-Toluidine	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
P-(Dimethylamino)Azobenzene	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
Pentachlorobenzene	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
Pentachloronitrobenzene	1000 U	960 U	950 U	990 U	990 U	1000 U	980 U	890 U	960 U	1000 U
Phenacetin	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
Phenanthrene	11.9 U	11.6 U	11.4 U	11.9 U	12 U	12 U	11.8 U	12.7 U	11.4 UR	12 U
Phenol	200 U	200 U	190 U	200 U	200 U	200 U	200 U	180 U	190 U	210 U
Pronamide	400 U	390 U	380 U	400 UR	400 UR	400 UR	390 UR	360 U	380 U	410 U
Pyrene	11.9 U	11.6 U	11.4 U	11.9 U	12 U	12 U	11.8 U	12.7 U	11.4 UR	12 U
Pyridine	220 U	220 U	220 U	220 U	220 U	220 U	220 U	220 U	220 U	220 U
Safrole	400 U	390 U	380 U	400 U	400 U	400 U	390 U	360 U	380 U	410 U
Energertics (ug/kg)										
1,3,5-Trinitrobenzene	454 U	476 U	476 U	476 U	476 U	476 U	454 U	454 U	476 U	476 U
1,3-Dinitrobenzene	454 U	476 U	476 U	476 U	476 U	476 U	454 U	454 U	476 U	476 U
2,4,6-Trinitrotoluene	454 U	476 U	476 U	476 U	476 U	476 U	454 U	454 U	476 U	476 U
2,4-Dinitrotoluene	454 U	476 U	476 U	476 U	476 U	476 U	454 U	454 U	476 U	476 U
2,6-Dinitrotoluene	454 U	476 U	476 U	476 U	476 U	476 U	454 U	454 U	476 U	476 U
2-Amino-4,6-Dinitrotoluene	454 U	476 U	476 U	476 U	476 U	476 U	454 U	454 U	476 U	476 U
2-Nitrotoluene	454 U	476 U	476 U	476 U	476 U	476 U	454 U	454 U	476 U	476 U
3-Nitrotoluene	454 U	476 U	476 U	476 U	476 U	476 U	454 U	454 U	476 U	476 U
4-Amino-2,6-Dinitrotoluene	454 U	476 U	476 U	476 U	476 U	476 U	454 U	454 U	476 U	476 U
4-Nitrotoluene	454 U	476 U	476 U	476 U	476 U	476 U	454 U	454 U	476 U	476 U
HMX	454 U	476 U	476 U	476 U	476 U	476 U	454 U	454 U	476 U	476 U
Nitrobenzene	454 U	476 U	476 U	476 U	476 U	476 U	454 U	454 U	476 U	476 U
RDX	454 U	476 U	476 U	476 U	476 U	476 U	454 U	454 U	476 U	476 U
Tetryl	454 U	476 U	476 U	476 U	476 U	476 U	454 U	454 U	476 U	476 U
Pesticides/PCBs (ug/kg)										
4,4'-DDD	NA	2.9 U	NA	3 U	NA	3 U	NA	3.2 U	NA	3 U
4,4'-DDE	NA	2.9 U	NA	3 U	NA	3 U	NA	3.2 U	NA	3 U
4,4'-DDT	NA	2.9 U	NA	3 U	NA	3 U	NA	3.2 U	NA	3 U
Aldrin	NA	1.5 U	NA	1.6 U	NA	1.6 U	NA	1.7 U	NA	1.6 U
Alpha-BHC	NA	1.5 U	NA	1.6 U	NA	1.6 U	NA	1.7 U	NA	1.6 U
Alpha-Chlordane	NA	1.5 U	NA	1.6 U	NA	1.6 U	NA	1.7 U	NA	1.6 U
Aroclor-1016	NA	38 U	NA	40 U	NA	40 U	NA	42 U	NA	40 U
Aroclor-1221	NA	38 U	NA	40 U	NA	40 U	NA	42 U	NA	40 U
Aroclor-1232	NA	38 U	NA	40 U	NA	40 U	NA	42 U	NA	40 U
Aroclor-1242	NA	38 U	NA	40 U	NA	40 U	NA	42 U	NA	40 U
Aroclor-1248	NA	38 U	NA	40 U	NA	40 U	NA	42 U	NA	40 U
Aroclor-1254	NA	38 U	NA	40 U	NA	40 U	NA	42 U	NA	40 U
Aroclor-1260	NA	38 U	NA	40 U	NA	40 U	NA	42 U	NA	40 U
Beta-BHC	NA	1.5 U	NA	1.6 U	NA	1.6 U	NA	1.7 U	NA	1.6 U
Delta-BHC	NA	1.5 U	NA	1.6 U	NA	1.6 U	NA	1.7 U	NA	1.6 U
Dieldrin	NA	2.9 U	NA	3 U	NA	3 U	NA	3.2 U	NA	3 U
Endosulfan I	NA	1.5 U	NA	1.6 U	NA	1.6 U	NA	1.7 U	NA	1.6 U
Endosulfan II	NA	2.9 U	NA	3 U	NA	3 U	NA	3.2 U	NA	3 U
Endosulfan Sulfate	NA	2.9 U	NA	3 U	NA	3 U	NA	3.2 U	NA	3 U
Endrin	NA	2.9 U	NA	3 U	NA	3 U	NA	3.2 U	NA	3 U
Endrin Aldehyde	NA	2.9 U	NA	3 U	NA	3 U	NA	3.2 U	NA	3 U
Gamma-BHC (Lindane)	NA	1.5 U	NA	1.6 U	NA	1.6 U	NA	1.7 U	NA	1.6 U
Gamma-Chlordane	NA	0.64 J	NA	1.6 U	NA	3 J	NA	0.65 J	NA	0.98 J
Heptachlor	NA	1.4 BU	NA	2 J	NA	1.9	NA	2.1 BU	NA	1 BU

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB13	01SB14	01SB14	01SB15	01SB15	01SB16	01SB16	01SB17	01SB17	01SB18
Sample	01SB130610	01SB140206	01SB140610	01SB150206	01SB150610	01SB160206	01SB160610	01SB170206	01SB170610	01SB180206
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	6 - 10	2 - 6	6 - 8	2 - 6	6 - 10	2 - 6	6 - 10	2 - 6	6 - 9.7	2 - 6
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Soil Group	8	8	8	8	8	8	9	8	8	8
Sample Date	8/24/2001	8/24/2001	8/24/2001	8/22/2001	8/22/2001	8/21/2001	8/21/2001	8/24/2001	8/24/2001	8/24/2001
Heptachlor Epoxide	NA	1.5 U	NA	1.6 U	NA	1.6 U	NA	1.7 U	NA	1.6 U
Methoxychlor	NA	15 U	NA	16 U	NA	16 U	NA	17 U	NA	16 U
Toxaphene	NA	96 U	NA	99 U	NA	99 U	NA	110 U	NA	100 U
Herbicides (ug/kg)										
2,4,5-T	NA	12 U	NA	12 U	NA	12 U	NA	13 U	NA	12 U
2,4,5-TP (Silvex)	NA	12 U	NA	12 UJ	NA	12 U	NA	13 U	NA	12 U
2,4-D	NA	81 U	NA	84 U	NA	85 U	NA	90 U	NA	85 U
Dinoseb	NA	23 U	NA	24 U	NA	24 U	NA	26 U	NA	24 U
Pentachlorophenol	NA	12 U	NA	12 U	NA	12 U	NA	13 U	NA	12 U
Inorganics (mg/kg)										
Aluminum	4090 J	7630 J	3270 J	8610 J	4280 J	9900	5760	10600 J	6800 J	4700 J
Antimony	0.19 UJ	0.29 U	0.25 U	0.23 U	0.23 U	0.51 U	0.51 U	0.61 U	0.18 UJ	0.25 U
Arsenic	2.0 U	2.8 J	1.7 U	4.7	0.85	4.4	7.8	7.2 J	1.2 U	1.8 U
Barium	34.3	30.8	21.4	36.3	41.7	32.7	34.1	43.7	300	31.4
Beryllium	0.36 J	0.34 J	0.22 U	0.38 U	0.69 J	0.27 U	0.33 U	0.38 J	0.58 J	0.34 J
Cadmium	0.04	0.04 J	0.05	0.01 U	0.01 U	0.05 UJ	0.59 J	0.20 J	0.04	0.04 U
Calcium	475 J	314 J	251 J	350 J	1080 J	3250	834	393 J	912 J	223 J
Chromium	7.5 J	12.1 J	6.9 J	15.5	6.4 J	12.7	9.8	12.7 J	8.7 J	8.0 J
Cobalt	2.2 J	2.4 J	1.7 J	3.4 J	8.1 J	2.7 J	1.4 J	4.5 J	4.3 J	2.6 J
Copper	7.5 J	6.7 J	4.3 J	9.6 J	9.5 J	9.8 J	7.6 J	12.8 J	6.8 J	9.4 J
Iron	8200	11700	6540	19500	9730 J	17400	12000	18800	4940	8540
Lead	8.8	12.0	6.1	12.0 J	5.8 J	10.3	18.0	12.8	9.8	8.4
Magnesium	640 J	945 J	477 J	1430 J	1150 J	1760	617	1900 J	1300 J	683 J
Manganese	12.8 J	114 J	23.3 J	155 J	32.2 J	66.4	12.3	177 J	12.9 J	15.6 J
Mercury	0.02 U	0.02 U	0.02 U	0.04	0.03	0.05 U	0.03 U	0.02 U	0.02 U	0.02 U
Nickel	6.0 J	4.9 J	4.0 J	6.8	12.1	6.0	3.4	9.1 J	10.5 J	6.8 J
Potassium	531 J	329 J	359 J	356 J	488 J	417 J	254 J	574 J	550 J	570 J
Selenium	0.52 U	0.52 U	0.28 U	0.28 UJ	0.28 U	0.38 U	0.38 U	0.65 U	0.22 U	0.35 U
Silver	0.36 U	0.35 U	0.34 U	0.02 U	0.02 U	0.15 U	0.15 U	0.38 U	0.34 U	0.35 U
Sodium	349 J	318 J	329 J	360 J	351 J	356	355	379 J	441 J	385 J
Strontium	4.1 J	5.1 J	3.2 J	4.7 J	5.3 J	7.8 J	5.2 J	6.4 J	11.3 J	3.5 J
Thallium	0.86	1.3 J	1.1	1.4 J	1.0	2.2	1.4	1.8 J	0.75	1.1
Thorium-Calc	3.12	3.59	3.38	3.08	4.84	3.50	4.59	3.51	4.11	4.7
Tin	22.6 U	22.1 U	21.4 U	3.4	3.6	2.7	2.3 U	23.9 U	21.8 U	22.3 U
Vanadium	10.4	21.7	7.4	25.2 J	7.2 J	22.4	16.1	26.4	7.1	10.1
Zinc	20.6 J	15.7 J	18.0 J	26.8	31.8	22.8	11.2	36.8 J	29.0 J	25.6 J
Miscellaneous Parameters										
1,4-Dithiane (ug/kg)	240 U	233 U	230 U	240 U	242 U	243 U	238 U	256 U	229 U	244 U
1,4-Oxathiane (ug/kg)	240 U	233 U	230 U	240 U	242 U	243 U	238 U	256 U	229 U	244 U
Bis(2-Chloroethyl)Sulfide (ug/kg)	240 U	233 U	230 U	240 U	242 U	243 U	238 U	256 U	229 U	244 U
Cation Exchange Capacity (meq/100g)	11 J	NA	NA	NA	NA	NA	NA	NA	NA	NA
pH (S.U.)	5.7	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon (mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Radiologicals (pCi/g)										
Actinium-228	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bismuth-212	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bismuth-214	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cesium-137	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt-60	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Europium-154	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Europium-155	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB13	01SB14	01SB14	01SB15	01SB15	01SB16	01SB16	01SB17	01SB17	01SB18
Sample	01SB130610	01SB140206	01SB140610	01SB150206	01SB150610	01SB160206	01SB160610	01SB170206	01SB170610	01SB180206
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	6 - 10	2 - 6	6 - 8	2 - 6	6 - 10	2 - 6	6 - 10	2 - 6	6 - 9.7	2 - 6
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Soil Group	8	8	8	8	8	8	9	8	8	8
Sample Date	8/24/2001	8/24/2001	8/24/2001	8/22/2001	8/22/2001	8/21/2001	8/21/2001	8/24/2001	8/24/2001	8/24/2001
Lead-210	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead-212	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead-214	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Potassium-40	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Protactinium-234	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Radium-226	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium-208	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thorium-228	0.298	0.331	0.378	0.308	0.627	0.266	0.535	0.360	0.480	0.452
Thorium-230	0.284 J	0.0540 U	0.257 J	0.539 J	0.474 J	0.438	0.349	0.0428 U	0.0683 U	0.265 J
Thorium-232	0.388	0.458	0.365	0.369	0.438	0.503	0.474	0.413	0.424	0.583
Thorium-234	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-235	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Calc = [illegible]lated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = [illegible]yzed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB18	01SB19	01SB19	01SB20	01SB20	01SB21	01SB21	BG1SBP01	BG1SBP02
Sample	01SB180610	01SB190206	01SB190610	01SB200206	01SB200610	01SB210206	01SB210610	BG1SBP0103	BG1SBP0204
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	6 - 8	2 - 6	6 - 8	2 - 6	6 - 8	0 - 2	6 - 10	2 - 3	3 - 4
Risk	Site	Site	Site	Site	Site	Site Background	Site Background	Basewide Background	Basewide Background
Soil Group	8	8	9	8	8	8	9	8	8
Sample Date	8/24/2001	8/24/2001	8/24/2001	8/21/2001	8/21/2001	8/21/2001	8/21/2001	11/6/1999	11/6/1999
Volatile Organics (ug/kg)									
1,1,1,2-Tetrachloroethane	3 U	4 U	3 U	3 U	3 U	NA	NA	NA	NA
1,1,1-Trichloroethane	3 U	4 U	3 U	3 U	3 U	NA	NA	NA	NA
1,1,2,2-Tetrachloroethane	3 U	4 U	3 U	3 U	3 U	NA	NA	NA	NA
1,1,2-Trichloroethane	6 U	7 U	6 U	5 U	5 U	NA	NA	NA	NA
1,1-Dichloroethane	3 U	4 U	3 U	3 U	3 U	NA	NA	NA	NA
1,1-Dichloroethene	6 U	7 U	6 U	5 U	5 U	NA	NA	NA	NA
1,2,3-Trichloropropane	3 U	4 U	3 U	3 U	3 U	NA	NA	NA	NA
1,2-Dibromo-3-Chloropropane	6 U	7 U	6 U	5 U	5 U	NA	NA	NA	NA
1,2-Dibromoethane	3 U	4 U	3 U	3 U	3 U	NA	NA	NA	NA
1,2-Dichloroethane	3 U	4 U	3 U	3 U	3 U	NA	NA	NA	NA
1,2-Dichloropropane	6 U	7 U	6 U	5 U	5 U	NA	NA	NA	NA
1,4-Dioxane	590 UR	730 UR	620 UR	500 UR	530 UR	NA	NA	NA	NA
2-Butanone	6 UJ	7 UJ	6 UJ	5 U	5 U	NA	NA	NA	NA
2-Hexanone	6 U	7 U	6 U	5 U	5 U	NA	NA	NA	NA
3-Chloropropene	6 UJ	7 UJ	6 UJ	5 UJ	5 UJ	NA	NA	NA	NA
4-Methyl-2-Pentanone	3 U	4 U	3 U	3 U	3 U	NA	NA	NA	NA
Acetone	42	20	31	5 UJ	5 UJ	NA	NA	NA	NA
Acetonitrile	230 UJ	290 UJ	250 UJ	200 UJ	210 UJ	NA	NA	NA	NA
Acrolein	59 UR	73 UR	62 UR	50 UR	53 UR	NA	NA	NA	NA
Acrylonitrile	59 U	73 U	62 U	50 U	53 U	NA	NA	NA	NA
Benzene	3 U	4 U	3 U	3 U	3 U	NA	NA	NA	NA
Bromodichloromethane	3 U	4 U	3 U	3 U	3 U	NA	NA	NA	NA
Bromofor	3 U	4 U	3 U	3 U	3 U	NA	NA	NA	NA
Bromomethane	6 U	7 U	6 U	5 U	5 U	NA	NA	NA	NA
Carbon Disulfide	3 U	4 U	3 U	3 U	3 U	NA	NA	NA	NA
Carbon Tetrachloride	3 UJ	4 UJ	3 UJ	3 UJ	3 UJ	NA	NA	NA	NA
Chlorobenzene	3 U	4 U	3 U	3 U	3 U	NA	NA	NA	NA
Chlorodibromomethane	3 U	4 U	3 U	3 U	3 U	NA	NA	NA	NA
Chloroethane	6 U	7 U	6 U	5 U	5 U	NA	NA	NA	NA
Chlorofor	3 U	4 U	3 U	3 U	3 U	NA	NA	NA	NA
Chloromethane	6 U	7 U	6 U	5 UJ	5 UJ	NA	NA	NA	NA
Chloroprene	6 UJ	7 UJ	6 UJ	5 UJ	5 UJ	NA	NA	NA	NA
Cis-1,2-Dichloroethene	6 U	7 U	6 U	5 U	5 U	NA	NA	NA	NA
Cis-1,3-Dichloropropene	3 U	4 U	3 U	3 U	3 U	NA	NA	NA	NA
Dibromomethane	6 U	7 U	6 U	5 U	5 U	NA	NA	NA	NA
Dichlorodifluoromethane	3 U	4 U	3 U	3 U	3 U	NA	NA	NA	NA
Ethyl Methacrylate	6 U	7 U	6 U	5 U	5 U	NA	NA	NA	NA
Ethylbenzene	3 U	4 U	3 U	3 U	3 U	NA	NA	NA	NA
Isobutanol	230 UR	290 UR	250 UR	200 UR	210 UR	NA	NA	NA	NA
Methacrylonitrile	120 UJ	150 UJ	120 UJ	100 U	110 U	NA	NA	NA	NA
Methyl Iodide	6 UJ	7 UJ	6 UJ	5 UJ	5 UJ	NA	NA	NA	NA
Methyl Methacrylate	6 U	7 U	6 U	5 U	5 U	NA	NA	NA	NA
Methylene Chloride	6 J	7 J	5 J	12 J	9 J	NA	NA	NA	NA
Pentachloroethane	6 UJ	7 UJ	6 UJ	5 UJ	5 UJ	NA	NA	NA	NA
Propionitrile	120 UR	150 UR	120 UR	100 UR	110 UR	NA	NA	NA	NA
Styrene	3 U	4 U	3 U	3 U	3 U	NA	NA	NA	NA
Tetrachloroethene	3 U	4 U	3 U	3 U	3 U	NA	NA	NA	NA
Toluene	3 U	4 U	3 U	3 U	3 U	NA	NA	NA	NA
Total Xylenes	3 U	4 U	3 U	3 U	3 U	NA	NA	NA	NA
Trans-1,2-Dichloroethene	6 U	7 U	6 U	5 U	5 U	NA	NA	NA	NA

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB18	01SB19	01SB19	01SB20	01SB20	01SB21	01SB21	BG1SBP01	BG1SBP02
Sample	01SB180610	01SB190206	01SB190610	01SB200206	01SB200610	01SB210206	01SB210610	BG1SBP0103	BG1SBP0204
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	6 - 8	2 - 6	6 - 8	2 - 6	6 - 8	0 - 2	6 - 10	2 - 3	3 - 4
Risk	Site	Site	Site	Site	Site	Site Background	Site Background	Basewide Background	Basewide Background
Soil Group	8	8	9	8	8	8	9	8	8
Sample Date	8/24/2001	8/24/2001	8/24/2001	8/21/2001	8/21/2001	8/21/2001	8/21/2001	11/6/1999	11/6/1999
Trans-1,3-Dichloropropene	3 U	4 U	3 U	3 U	3 U	NA	NA	NA	NA
Trans-1,4-Dichloro-2-Butene	6 U	7 U	6 U	5 U	5 U	NA	NA	NA	NA
Trichloroethene	3 U	4 U	3 U	3 U	3 U	NA	NA	NA	NA
Trichlorofluoromethane	6 U	7 U	6 U	5 U	5 U	NA	NA	NA	NA
Vinyl Acetate	3 U	4 U	3 U	3 U	3 U	NA	NA	NA	NA
Vinyl Chloride	6 U	7 U	6 U	5 U	5 U	NA	NA	NA	NA
Semivolatile Organics (ug/kg)									
1,2,4,5-Tetrachlorobenzene	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
1,2,4-Trichlorobenzene	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
1,2-Dichlorobenzene	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
1,3-Dichlorobenzene	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
1,4-Dichlorobenzene	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
1,4-Naphthoquinone	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
1,4-Phenylenediamine	1000 U	1200 U	970 U	1000 U	1000 U	NA	NA	NA	NA
1-Naphthylamine	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
2,2'-Oxybis(1-Chloropropane)	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
2,3,4,6-Tetrachlorophenol	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
2,4,5-Trichlorophenol	1000 U	1200 U	970 U	1000 U	1000 U	NA	NA	NA	NA
2,4,6-Trichlorophenol	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
2,4-Dichlorophenol	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
2,4-Dimethylphenol	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
2,4-Dinitrophenol	1000 U	1200 U	970 U	1000 U	1000 U	NA	NA	NA	NA
2,6-Dichlorophenol	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
2-Acetylaminofluorene	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
2-Chloronaphthalene	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
2-Chlorophenol	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
2-Methylnaphthalene	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
2-Methylphenol	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
2-Naphthylamine	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
2-Nitroaniline	500 U	600 U	490 U	500 U	500 U	NA	NA	NA	NA
2-Nitrophenol	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
2-Picoline	310 U	370 U	300 U	300 U	310 U	NA	NA	NA	NA
3,3'-Dichlorobenzidine	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
3,3'-Dimethylbenzidine	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
3-Methylcholanthrene	470 U	550 U	440 U	450 U	460 U	NA	NA	NA	NA
3-Methylphenol	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
3-Nitroaniline	1000 U	1200 U	970 U	1000 U	1000 U	NA	NA	NA	NA
4,6-Dinitro-2-Methylphenol	1000 U	1200 U	970 U	1000 U	1000 U	NA	NA	NA	NA
4-Aminobiphenyl	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
4-Bromophenyl Phenyl Ether	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
4-Chloro-3-Methylphenol	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
4-Chloroaniline	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
4-Chlorophenyl Phenyl Ether	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
4-Methylphenol	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
4-Nitroaniline	1000 U	1200 U	970 U	1000 U	1000 U	NA	NA	NA	NA
4-Nitrophenol	1000 U	1200 U	970 U	1000 U	1000 U	NA	NA	NA	NA
4-Nitroquinoline-1-Oxide	1000 UR	1200 UR	970 U	1000 UR	1000 UR	NA	NA	NA	NA
5-Nitro-O-Toluidine	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
7,12-Dimethylbenz(A)Anthracene	310 U	370 U	300 U	300 U	310 U	NA	NA	NA	NA
A,A-Dimethylphenethylamine	1000 U	1200 U	970 U	1000 U	1000 U	NA	NA	NA	NA
Acenaphthene	12.3 U	14.8 U	11.8 U	11.7 U	12.1 U	NA	NA	NA	NA

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB18	01SB19	01SB19	01SB20	01SB20	01SB21	01SB21	BG1SBP01	BG1SBP02
Sample	01SB180610	01SB190206	01SB190610	01SB200206	01SB200610	01SB210206	01SB210610	BG1SBP0103	BG1SBP0204
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	6 - 8	2 - 6	6 - 8	2 - 6	6 - 8	0 - 2	6 - 10	2 - 3	3 - 4
Risk	Site	Site	Site	Site	Site	Site Background	Site Background	Basewide Background	Basewide Background
Soil Group	8	8	9	8	8	8	9	8	8
Sample Date	8/24/2001	8/24/2001	8/24/2001	8/21/2001	8/21/2001	8/21/2001	8/21/2001	11/6/1999	11/6/1999
Acenaphthylene	12.3 U	14.8 U	11.8 U	11.7 U	12.1 U	NA	NA	NA	NA
Acetophenone	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
Aniline	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
Anthracene	12.3 U	14.8 U	11.8 U	11.7 U	41.5	NA	NA	NA	NA
Aramite	1000 U	1200 U	970 U	1000 U	1000 U	NA	NA	NA	NA
Benzo(A)Anthracene	12.3 U	14.8 U	11.8 U	11.7 U	153 J	NA	NA	NA	NA
Benzo(A)Pyrene	12.3 U	14.8 U	11.8 U	11.7 U	181 J	NA	NA	NA	NA
Benzo(B)Fluoranthene	12.3 U	14.8 U	11.8 U	11.7 U	318 J	NA	NA	NA	NA
Benzo(G,H,I)Perylene	12.3 U	14.8 U	11.8 U	11.7 U	160 J	NA	NA	NA	NA
Benzo(K)Fluoranthene	12.3 U	14.8 U	11.8 U	11.7 U	12.1 U	NA	NA	NA	NA
Benzyl Alcohol	270 U	270 U	270 U	270 U	270 U	NA	NA	NA	NA
Bis(2-Chloroethoxy)Methane	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
Bis(2-Chloroethyl)Ether	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
Bis(2-Ethylhexyl)Phthalate	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
Butyl Benzyl Phthalate	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
Chlorobenzilate	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
Chrysene	12.3 U	14.8 U	11.8 U	11.7 U	108 J	NA	NA	NA	NA
Di-N-Butyl Phthalate	210 UJ	250 UJ	200 UJ	200 U	210 U	NA	NA	NA	NA
Di-N-Octyl Phthalate	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
Diallate	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
Dibenzo(A,H)Anthracene	12.3 U	14.8 U	11.8 U	11.7 U	12.1 U	NA	NA	NA	NA
Dibenzofuran	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
Diethyl Phthalate	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
Dimethyl Phthalate	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
Diphenylamine	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
Ethyl Methane Sulfonate	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
Fluoranthene	12.3 U	14.8 U	11.8 U	11.7 U	540 J	NA	NA	NA	NA
Fluorene	12.3 U	14.8 U	11.8 U	11.7 U	22.3	NA	NA	NA	NA
Hexachlorobenzene	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
Hexachlorobutadiene	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
Hexachlorocyclopentadiene	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
Hexachloroethane	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
Hexachlorophene	17000 U	20000 U	16000 U	16000 UJ	16000 UJ	NA	NA	NA	NA
Hexachloropropene	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
Indeno(1,2,3-CD)Pyrene	12.3 U	14.8 U	11.8 U	11.7 U	68.1	NA	NA	NA	NA
Isodrin	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
Isophorone	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
Isosafrole	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
Kepone	1000 U	1200 U	970 U	1000 U	1000 U	NA	NA	NA	NA
Methapyrilene	1000 U	1200 U	970 U	1000 U	1000 U	NA	NA	NA	NA
Methyl Methane Sulfonate	500 U	600 U	490 U	500 U	500 U	NA	NA	NA	NA
N-Nitroso-Di-N-Butylamine	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
N-Nitroso-Di-N-Propylamine	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
N-Nitrosodiethylamine	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
N-Nitrosodimethylamine	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
N-Nitrosomethylethylamine	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
N-Nitrosomorpholine	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
N-Nitrosopiperidine	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
N-Nitrosopyrrolidine	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
Naphthalene	12.3 U	14.8 U	11.8 U	11.7 UR	12.1 UR	NA	NA	NA	NA
O,O,O-Triethyl Phosphorothioate	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA

Calc = Calculated Value as descibed in Section 3.4.2.1 (TINUS, 2003).
NA = Not Analyzed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB18	01SB19	01SB19	01SB20	01SB20	01SB21	01SB21	BG1SBP01	BG1SBP02
Sample	01SB180610	01SB190206	01SB190610	01SB200206	01SB200610	01SB210206	01SB210610	BG1SBP0103	BG1SBP0204
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	6 - 8	2 - 6	6 - 8	2 - 6	6 - 8	0 - 2	6 - 10	2 - 3	3 - 4
Risk	Site	Site	Site	Site	Site	Site Background	Site Background	Basewide Background	Basewide Background
Soil Group	8	8	9	8	8	8	9	8	8
Sample Date	8/24/2001	8/24/2001	8/24/2001	8/21/2001	8/21/2001	8/21/2001	8/21/2001	11/6/1999	11/6/1999
O-Toluidine	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
P-(Dimethylamino)Azobenzene	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
Pentachlorobenzene	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
Pentachloronitrobenzene	1000 U	1200 U	970 U	1000 U	1000 U	NA	NA	NA	NA
Phenacetin	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
Phenanthrene	12.3 U	14.8 U	11.8 U	11.7 U	278 J	NA	NA	NA	NA
Phenol	210 U	250 U	200 U	200 U	210 U	NA	NA	NA	NA
Pronamide	420 U	490 U	390 U	400 UR	410 UR	NA	NA	NA	NA
Pyrene	12.3 U	14.8 U	11.8 U	11.7 U	306 J	NA	NA	NA	NA
Pyridine	220 U	250 U	220 U	220 U	220 U	NA	NA	NA	NA
Safrole	420 U	490 U	390 U	400 U	410 U	NA	NA	NA	NA
Energetics (ug/kg)									
1,3,5-Trinitrobenzene	454 U	476 U	476 U	500 U	500 U	NA	NA	NA	NA
1,3-Dinitrobenzene	454 U	476 U	476 U	500 U	500 U	NA	NA	NA	NA
2,4,6-Trinitrotoluene	454 U	476 U	476 U	500 U	500 U	NA	NA	NA	NA
2,4-Dinitrotoluene	454 U	476 U	476 U	500 U	500 U	NA	NA	NA	NA
2,6-Dinitrotoluene	454 U	476 U	476 U	500 U	500 U	NA	NA	NA	NA
2-Amino-4,6-Dinitrotoluene	454 U	476 U	476 U	500 U	500 U	NA	NA	NA	NA
2-Nitrotoluene	454 U	476 U	476 U	500 U	500 U	NA	NA	NA	NA
3-Nitrotoluene	454 U	476 U	476 U	500 U	500 U	NA	NA	NA	NA
4-Amino-2,6-Dinitrotoluene	454 U	476 U	476 U	500 U	500 U	NA	NA	NA	NA
4-Nitrotoluene	454 U	476 U	476 U	500 U	500 U	NA	NA	NA	NA
HMX	454 U	476 U	476 U	500 U	500 U	NA	NA	NA	NA
Nitrobenzene	454 U	476 U	476 U	500 U	500 U	NA	NA	NA	NA
RDX	454 U	476 U	476 U	500 U	500 U	NA	NA	NA	NA
Tetryl	454 U	476 U	476 U	500 U	500 U	NA	NA	NA	NA
Pesticides/PCBs (ug/kg)									
4,4'-DDD	NA	3.7 U	NA	3 U	NA	NA	NA	NA	NA
4,4'-DDE	NA	3.7 U	NA	3 U	NA	NA	NA	NA	NA
4,4'-DDT	NA	3.7 U	NA	3 U	NA	NA	NA	NA	NA
Aldrin	NA	1.9 U	NA	1.6 U	NA	NA	NA	NA	NA
Alpha-BHC	NA	1.9 U	NA	1.6 U	NA	NA	NA	NA	NA
Alpha-Chlordane	NA	1.9 U	NA	1.6 U	NA	NA	NA	NA	NA
Aroclor-1016	NA	49 U	NA	39 U	NA	NA	NA	NA	NA
Aroclor-1221	NA	49 U	NA	39 U	NA	NA	NA	NA	NA
Aroclor-1232	NA	49 U	NA	39 U	NA	NA	NA	NA	NA
Aroclor-1242	NA	49 U	NA	39 U	NA	NA	NA	NA	NA
Aroclor-1248	NA	49 U	NA	39 U	NA	NA	NA	NA	NA
Aroclor-1254	NA	49 U	NA	39 U	NA	NA	NA	NA	NA
Aroclor-1260	NA	49 U	NA	39 U	NA	NA	NA	NA	NA
Beta-BHC	NA	1.9 U	NA	1.6 U	NA	NA	NA	NA	NA
Delta-BHC	NA	1.9 U	NA	1.6 U	NA	NA	NA	NA	NA
Dieldrin	NA	3.7 U	NA	3 U	NA	NA	NA	NA	NA
Endosulfan I	NA	1.9 U	NA	1.6 U	NA	NA	NA	NA	NA
Endosulfan II	NA	3.7 U	NA	3 U	NA	NA	NA	NA	NA
Endosulfan Sulfate	NA	3.7 U	NA	3 U	NA	NA	NA	NA	NA
Endrin	NA	3.7 U	NA	3 U	NA	NA	NA	NA	NA
Endrin Aldehyde	NA	3.7 U	NA	3 U	NA	NA	NA	NA	NA
Gamma-BHC (Lindane)	NA	1.9 U	NA	1.6 U	NA	NA	NA	NA	NA
Gamma-Chlordane	NA	1.9 U	NA	1.6 U	NA	NA	NA	NA	NA
Heptachlor	NA	1.3 BU	NA	1.4 J	NA	NA	NA	NA	NA

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB18	01SB19	01SB19	01SB20	01SB20	01SB21	01SB21	BG1SBP01	BG1SBP02
Sample	01SB180610	01SB190206	01SB190610	01SB200206	01SB200610	01SB210206	01SB210610	BG1SBP0103	BG1SBP0204
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	6 - 8	2 - 6	6 - 8	2 - 6	6 - 8	0 - 2	6 - 10	2 - 3	3 - 4
Risk	Site	Site	Site	Site	Site	Site Background	Site Background	Basewide Background	Basewide Background
Soil Group	8	8	9	8	8	8	9	8	8
Sample Date	8/24/2001	8/24/2001	8/24/2001	8/21/2001	8/21/2001	8/21/2001	8/21/2001	11/6/1999	11/6/1999
Heptachlor Epoxide	NA	1.9 U	NA	1.6 U	NA	NA	NA	NA	NA
Methoxychlor	NA	19 U	NA	16 U	NA	NA	NA	NA	NA
Toxaphene	NA	120 U	NA	99 U	NA	NA	NA	NA	NA
Herbicides (ug/kg)									
2,4,5-T	NA	15 U	NA	12 U	NA	NA	NA	NA	NA
2,4,5-TP (Silvex)	NA	15 U	NA	12 U	NA	NA	NA	NA	NA
2,4-D	NA	100 U	NA	84 U	NA	NA	NA	NA	NA
Dinoseb	NA	30 U	NA	24 U	NA	NA	NA	NA	NA
Pentachlorophenol	NA	15 U	NA	12 U	NA	NA	NA	NA	NA
Inorganics (mg/kg)									
Aluminum	4490 J	12500 J	1420 J	11700	10100	NA	NA	15700	15300
Antimony	0.20 UJ	0.65 U	0.25 U	0.49 U	0.51 U	NA	NA	0.97 U	0.77 U
Arsenic	2.3 U	3.5 J	20.2 J	5.0 J	1.5 J	NA	NA	8 J	8.5 J
Barium	40.1	85.1	11.3	35.3	47.6	NA	NA	55.4 J	79.5 J
Beryllium	0.43 J	0.52 J	0.22 U	0.48 U	0.76 J	NA	NA	0.52 U	0.56 U
Cadmium	0.05	0.07 J	0.20	0.05 UJ	0.05 UJ	NA	NA	0.29 J	0.36 J
Calcium	385 J	510 J	222 J	271	427	NA	NA	199	543
Chromium	11.0 J	15.3 J	6.8 J	18.6	14.6	NA	NA	21.3 J	21.6 J
Cobalt	8.2 J	2.3 J	0.60 U	4.3	5.5	NA	NA	9.1	6.8
Copper	8.9 J	9.1 J	6.5 J	11.3 J	13.4 J	NA	NA	18	20.4
Iron	7420	19100	7360	26100	25400	NA	NA	24500 J	24600 J
Lead	10.5	12.1	8.4	14.7	11.6	NA	NA	13.7 J	11.1 J
Magnesium	909 J	1240 J	193 J	1380	1050	NA	NA	2390 J	2870 J
Manganese	109 J	48.1 J	8.6 J	172	36.8	NA	NA	301 J	222 J
Mercury	0.02 U	0.02 U	0.02 U	0.03 U	0.03 U	NA	NA	0.14	0.05 U
Nickel	12.1 J	5.8 J	1.6 J	7.5	10.4	NA	NA	14.6 J	13.4 J
Potassium	594 J	382 J	233 J	488 J	460 J	NA	NA	1170	1290
Selenium	0.33 U	0.55 U	0.31 U	0.37 U	0.40	NA	NA	0.43 J	0.56
Silver	0.38 U	0.43 U	0.36 U	0.15 U	0.15 U	NA	NA	0.05 J	0.05 J
Sodium	426 J	446 J	321 J	399	456	NA	NA	10 J	76.8
Strontium	4.3 J	6.7 J	2.1 J	5.3 J	7.1 J	NA	NA	10.3 J	19.2 J
Thallium	0.99	1.7 J	0.94	2.1	2.6	NA	NA	0.24 J	0.25 J
Thorium-Calc	3.85	2.44	3.92	1.87	4.28	3.53	4.11	NA	NA
Tin	23.9 U	27.0 U	22.5 U	3.3	3.2	NA	NA	0.74 U	0.82 U
Vanadium	8.2	28.1	10.3	32.1	21.3	NA	NA	37.8 J	38.2 J
Zinc	37.0 J	20.4 J	9.3 J	26.7	42.6	NA	NA	45.2 J	47.8 J
Miscellaneous Parameters									
1,4-Dithiane (ug/kg)	252 U	299 U	237 U	240 U	248 U	NA	NA	NA	NA
1,4-Oxathiane (ug/kg)	252 U	299 U	237 U	240 U	248 U	NA	NA	NA	NA
Bis(2-Chloroethyl)Sulfide (ug/kg)	252 U	299 U	237 U	240 U	248 U	NA	NA	NA	NA
Cation Exchange Capacity (meq/100g)	NA	NA	NA	11.5	20.1	NA	NA	NA	NA
pH (S.U.)	NA	NA	NA	5.0 J	5.1 J	NA	NA	NA	NA
Total Organic Carbon (mg/kg)	NA	NA	NA	NA	NA	608 U	589 U	NA	NA
Total Radiologicals (pCi/g)									
Actinium-228	NA	NA	NA	NA	NA	NA	NA	1.41 J	1.46 J
Bismuth-212	NA	NA	NA	NA	NA	NA	NA	1.98 J	1.58 J
Bismuth-214	NA	NA	NA	NA	NA	NA	NA	1.2 J	1.32 J
Cesium-137	NA	NA	NA	NA	NA	NA	NA	0.06 UJ	0.0591 UJ
Cobalt-60	NA	NA	NA	NA	NA	NA	NA	0.04 UJ	0.0397 UJ
Europium-154	NA	NA	NA	NA	NA	NA	NA	0.04 UJ	0.0225 UJ
Europium-155	NA	NA	NA	NA	NA	NA	NA	0.07 J	0.08 J

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB18	01SB19	01SB19	01SB20	01SB20	01SB21	01SB21	BG1SBP01	BG1SBP02
Sample	01SB180610	01SB190206	01SB190610	01SB200206	01SB200610	01SB210206	01SB210610	BG1SBP0103	BG1SBP0204
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	6 - 8	2 - 6	6 - 8	2 - 6	6 - 8	0 - 2	6 - 10	2 - 3	3 - 4
Risk	Site	Site	Site	Site	Site	Site Background	Site Background	Basewide Background	Basewide Background
Soil Group	8	8	9	8	8	8	9	8	8
Sample Date	8/24/2001	8/24/2001	8/24/2001	8/21/2001	8/21/2001	8/21/2001	8/21/2001	11/6/1999	11/6/1999
Lead-210	NA	NA	NA	NA	NA	NA	NA	0.74 J	0.9 J
Lead-212	NA	NA	NA	NA	NA	NA	NA	1.38 J	1.40 J
Lead-214	NA	NA	NA	NA	NA	NA	NA	1.13 J	1.29 J
Potassium-40	NA	NA	NA	NA	NA	NA	NA	18.1 J	20.3 J
Protactinium-234	NA	NA	NA	NA	NA	NA	NA	6.26 UJ	7.54 UJ
Radium-226	NA	NA	NA	NA	NA	NA	NA	2.09 J	2.04 J
Thallium-208	NA	NA	NA	NA	NA	NA	NA	1.13 J	1.22 J
Thorium-228	0.467	0.226	0.485	0.167	0.392	0.387	0.450	NA	NA
Thorium-230	0.0747 U	0.0148 U	0.126 U	0.0418	0.136	0.289	0.254	NA	NA
Thorium-232	0.380	0.310	0.378	0.245	0.549	0.389	0.455	NA	NA
Thorium-234	NA	NA	NA	NA	NA	NA	NA	1.2 J	2.1 J
Uranium-235	NA	NA	NA	NA	NA	NA	NA	0.198 UJ	0.348 UJ

Calc = C[illegible]ted Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = N[illegible]zed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	BG1SBP02	BG1SBP03	BG1SBP04	BG1SBP05	BG1SBP06	BG1SBP08	BG1SBP10	BG1SBP08
Sample	BG1SBP0206	BG1SBP0305	BG1SBP0406	BG1SBP0505	BG1SBP0603	BG1SBP0804	BG1SBP1004	BG1SBP0806
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	5 - 6	4 - 5	5 - 6	4 - 5	2 - 3	3 - 4	3 - 4	5 - 6
Risk	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background
Soil Group	8	8	8	8	8	8	8	9
Sample Date	11/6/1999	11/6/1999	11/6/1999	11/5/1999	11/5/1999	11/6/1999	11/5/1999	11/6/1999
Volatile Organics (ug/kg)								
1,1,1,2-Tetrachloroethane	NA	NA	NA	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	NA	NA	NA	NA	NA	NA	NA	NA
1,1,2,2-Tetrachloroethane	NA	NA	NA	NA	NA	NA	NA	NA
1,1,2-Trichloroethane	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethane	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3-Trichloropropane	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dibromo-3-Chloropropane	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dibromoethane	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloropropane	NA	NA	NA	NA	NA	NA	NA	NA
1,4-Dioxane	NA	NA	NA	NA	NA	NA	NA	NA
2-Butanone	NA	NA	NA	NA	NA	NA	NA	NA
2-Hexanone	NA	NA	NA	NA	NA	NA	NA	NA
3-Chloropropene	NA	NA	NA	NA	NA	NA	NA	NA
4-Methyl-2-Pentanone	NA	NA	NA	NA	NA	NA	NA	NA
Acetone	NA	NA	NA	NA	NA	NA	NA	NA
Acetonitrile	NA	NA	NA	NA	NA	NA	NA	NA
Acrolein	NA	NA	NA	NA	NA	NA	NA	NA
Acrylonitrile	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	NA	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	NA	NA	NA	NA	NA	NA	NA	NA
Bromofor	NA	NA	NA	NA	NA	NA	NA	NA
Bromomethane	NA	NA	NA	NA	NA	NA	NA	NA
Carbon Disulfide	NA	NA	NA	NA	NA	NA	NA	NA
Carbon Tetrachloride	NA	NA	NA	NA	NA	NA	NA	NA
Chlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA
Chlorodibromomethane	NA	NA	NA	NA	NA	NA	NA	NA
Chloroethane	NA	NA	NA	NA	NA	NA	NA	NA
Chlorofor	NA	NA	NA	NA	NA	NA	NA	NA
Chloromethane	NA	NA	NA	NA	NA	NA	NA	NA
Chloroprene	NA	NA	NA	NA	NA	NA	NA	NA
Cis-1,2-Dichloroethene	NA	NA	NA	NA	NA	NA	NA	NA
Cis-1,3-Dichloropropene	NA	NA	NA	NA	NA	NA	NA	NA
Dibromomethane	NA	NA	NA	NA	NA	NA	NA	NA
Dichlorodifluoromethane	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl Methacrylate	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	NA	NA	NA	NA	NA	NA	NA	NA
Isobutanol	NA	NA	NA	NA	NA	NA	NA	NA
Methacrylonitrile	NA	NA	NA	NA	NA	NA	NA	NA
Methyl Iodide	NA	NA	NA	NA	NA	NA	NA	NA
Methyl Methacrylate	NA	NA	NA	NA	NA	NA	NA	NA
Methylene Chloride	NA	NA	NA	NA	NA	NA	NA	NA
Pentachloroethane	NA	NA	NA	NA	NA	NA	NA	NA
Propionitrile	NA	NA	NA	NA	NA	NA	NA	NA
Styrene	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	NA	NA	NA	NA	NA	NA	NA	NA
Toluene	NA	NA	NA	NA	NA	NA	NA	NA
Total Xylenes	NA	NA	NA	NA	NA	NA	NA	NA
Trans-1,2-Dichloroethene	NA	NA	NA	NA	NA	NA	NA	NA

Calc = Calculated Value as descibed in Section 3.4.2.1 (TINUS, 2003).
NA = Not Analyzed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	BG1SBP02	BG1SBP03	BG1SBP04	BG1SBP05	BG1SBP06	BG1SBP08	BG1SBP10	BG1SBP08
Sample	BG1SBP0206	BG1SBP0305	BG1SBP0406	BG1SBP0505	BG1SBP0603	BG1SBP0804	BG1SBP1004	BG1SBP0806
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	5 - 6	4 - 5	5 - 6	4 - 5	2 - 3	3 - 4	3 - 4	5 - 6
Risk	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background
Soil Group	8	8	8	8	8	8	8	9
Sample Date	11/6/1999	11/6/1999	11/6/1999	11/5/1999	11/5/1999	11/6/1999	11/5/1999	11/6/1999
Trans-1,3-Dichloropropene	NA	NA	NA	NA	NA	NA	NA	NA
Trans-1,4-Dichloro-2-Butene	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethene	NA	NA	NA	NA	NA	NA	NA	NA
Trichlorofluoromethane	NA	NA	NA	NA	NA	NA	NA	NA
Vinyl Acetate	NA	NA	NA	NA	NA	NA	NA	NA
Vinyl Chloride	NA	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organics (ug/kg)								
1,2,4,5-Tetrachlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA
1,2,4-Trichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA
1,3-Dichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA
1,4-Dichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA
1,4-Naphthoquinone	NA	NA	NA	NA	NA	NA	NA	NA
1,4-Phenylenediamine	NA	NA	NA	NA	NA	NA	NA	NA
1-Naphthylamine	NA	NA	NA	NA	NA	NA	NA	NA
2,2'-Oxybis(1-Chloropropane)	NA	NA	NA	NA	NA	NA	NA	NA
2,3,4,6-Tetrachlorophenol	NA	NA	NA	NA	NA	NA	NA	NA
2,4,5-Trichlorophenol	NA	NA	NA	NA	NA	NA	NA	NA
2,4,6-Trichlorophenol	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dichlorophenol	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dimethylphenol	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dinitrophenol	NA	NA	NA	NA	NA	NA	NA	NA
2,6-Dichlorophenol	NA	NA	NA	NA	NA	NA	NA	NA
2-Acetylaminofluorene	NA	NA	NA	NA	NA	NA	NA	NA
2-Chloronaphthalene	NA	NA	NA	NA	NA	NA	NA	NA
2-Chlorophenol	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylphenol	NA	NA	NA	NA	NA	NA	NA	NA
2-Naphthylamine	NA	NA	NA	NA	NA	NA	NA	NA
2-Nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA
2-Nitrophenol	NA	NA	NA	NA	NA	NA	NA	NA
2-Picoline	NA	NA	NA	NA	NA	NA	NA	NA
3,3'-Dichlorobenzidine	NA	NA	NA	NA	NA	NA	NA	NA
3,3'-Dimethylbenzidine	NA	NA	NA	NA	NA	NA	NA	NA
3-Methylcholanthrene	NA	NA	NA	NA	NA	NA	NA	NA
3-Methylphenol	NA	NA	NA	NA	NA	NA	NA	NA
3-Nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA
4,6-Dinitro-2-Methylphenol	NA	NA	NA	NA	NA	NA	NA	NA
4-Aminobiphenyl	NA	NA	NA	NA	NA	NA	NA	NA
4-Bromophenyl Phenyl Ether	NA	NA	NA	NA	NA	NA	NA	NA
4-Chloro-3-Methylphenol	NA	NA	NA	NA	NA	NA	NA	NA
4-Chloroaniline	NA	NA	NA	NA	NA	NA	NA	NA
4-Chlorophenyl Phenyl Ether	NA	NA	NA	NA	NA	NA	NA	NA
4-Methylphenol	NA	NA	NA	NA	NA	NA	NA	NA
4-Nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA
4-Nitrophenol	NA	NA	NA	NA	NA	NA	NA	NA
4-Nitroquinoline-1-Oxide	NA	NA	NA	NA	NA	NA	NA	NA
5-Nitro-O-Toluidine	NA	NA	NA	NA	NA	NA	NA	NA
7,12-Dimethylbenz(A)Anthracene	NA	NA	NA	NA	NA	NA	NA	NA
A,A-Dimethylphenethylamine	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthene	NA	NA	NA	NA	NA	NA	NA	NA

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not analyzed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	BG1SBP02	BG1SBP03	BG1SBP04	BG1SBP05	BG1SBP06	BG1SBP08	BG1SBP10	BG1SBP08
Sample	BG1SBP0206	BG1SBP0305	BG1SBP0406	BG1SBP0505	BG1SBP0603	BG1SBP0804	BG1SBP1004	BG1SBP0806
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	5 - 6	4 - 5	5 - 6	4 - 5	2 - 3	3 - 4	3 - 4	5 - 6
Risk	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background
Soil Group	8	8	8	8	8	8	8	9
Sample Date	11/6/1999	11/6/1999	11/6/1999	11/5/1999	11/5/1999	11/6/1999	11/5/1999	11/6/1999
Acenaphthylene	NA	NA	NA	NA	NA	NA	NA	NA
Acetophenone	NA	NA	NA	NA	NA	NA	NA	NA
Aniline	NA	NA	NA	NA	NA	NA	NA	NA
Anthracene	NA	NA	NA	NA	NA	NA	NA	NA
Aramite	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(A)Anthracene	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(A)Pyrene	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(B)Fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(G,H,I)Perylene	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(K)Fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA
Benzyl Alcohol	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-Chloroethoxy)Methane	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-Chloroethyl)Ether	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-Ethylhexyl)Phthalate	NA	NA	NA	NA	NA	NA	NA	NA
Butyl Benzyl Phthalate	NA	NA	NA	NA	NA	NA	NA	NA
Chlorobenzilate	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA	NA	NA
Di-N-Butyl Phthalate	NA	NA	NA	NA	NA	NA	NA	NA
Di-N-Octyl Phthalate	NA	NA	NA	NA	NA	NA	NA	NA
Diallate	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(A,H)Anthracene	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzofuran	NA	NA	NA	NA	NA	NA	NA	NA
Diethyl Phthalate	NA	NA	NA	NA	NA	NA	NA	NA
Dimethyl Phthalate	NA	NA	NA	NA	NA	NA	NA	NA
Diphenylamine	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl Methane Sulfonate	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorobutadiene	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorocyclopentadiene	NA	NA	NA	NA	NA	NA	NA	NA
Hexachloroethane	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorophene	NA	NA	NA	NA	NA	NA	NA	NA
Hexachloropropene	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-CD)Pyrene	NA	NA	NA	NA	NA	NA	NA	NA
Isodrin	NA	NA	NA	NA	NA	NA	NA	NA
Isophorone	NA	NA	NA	NA	NA	NA	NA	NA
Isosafrole	NA	NA	NA	NA	NA	NA	NA	NA
Kepone	NA	NA	NA	NA	NA	NA	NA	NA
Methapyrilene	NA	NA	NA	NA	NA	NA	NA	NA
Methyl Methane Sulfonate	NA	NA	NA	NA	NA	NA	NA	NA
N-Nitroso-Di-N-Butylamine	NA	NA	NA	NA	NA	NA	NA	NA
N-Nitroso-Di-N-Propylamine	NA	NA	NA	NA	NA	NA	NA	NA
N-Nitrosodiethylamine	NA	NA	NA	NA	NA	NA	NA	NA
N-Nitrosodimethylamine	NA	NA	NA	NA	NA	NA	NA	NA
N-Nitrosomethylethylamine	NA	NA	NA	NA	NA	NA	NA	NA
N-Nitrosomorpholine	NA	NA	NA	NA	NA	NA	NA	NA
N-Nitrosopiperidine	NA	NA	NA	NA	NA	NA	NA	NA
N-Nitrosopyrrolidine	NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene	NA	NA	NA	NA	NA	NA	NA	NA
O,O,O-Triethyl Phosphorothioate	NA	NA	NA	NA	NA	NA	NA	NA

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	BG1SBP02	BG1SBP03	BG1SBP04	BG1SBP05	BG1SBP06	BG1SBP08	BG1SBP10	BG1SBP08
Sample	BG1SBP0206	BG1SBP0305	BG1SBP0406	BG1SBP0505	BG1SBP0603	BG1SBP0804	BG1SBP1004	BG1SBP0806
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	5 - 6	4 - 5	5 - 6	4 - 5	2 - 3	3 - 4	3 - 4	5 - 6
Risk	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background
Soil Group	8	8	8	8	8	8	8	9
Sample Date	11/6/1999	11/6/1999	11/6/1999	11/5/1999	11/5/1999	11/6/1999	11/5/1999	11/6/1999
O-Toluidine	NA	NA	NA	NA	NA	NA	NA	NA
P-(Dimethylamino)Azobenzene	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA
Pentachloronitrobenzene	NA	NA	NA	NA	NA	NA	NA	NA
Phenacetin	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA	NA	NA
Phenol	NA	NA	NA	NA	NA	NA	NA	NA
Pronamide	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA	NA	NA
Pyridine	NA	NA	NA	NA	NA	NA	NA	NA
Safrole	NA	NA	NA	NA	NA	NA	NA	NA
Energetics (ug/kg)								
1,3,5-Trinitrobenzene	NA	NA	NA	NA	NA	NA	NA	NA
1,3-Dinitrobenzene	NA	NA	NA	NA	NA	NA	NA	NA
2,4,6-Trinitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dinitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA
2,6-Dinitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA
2-Amino-4,6-Dinitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA
2-Nitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA
3-Nitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA
4-Amino-2,6-Dinitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA
4-Nitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA
HMX	NA	NA	NA	NA	NA	NA	NA	NA
Nitrobenzene	NA	NA	NA	NA	NA	NA	NA	NA
RDX	NA	NA	NA	NA	NA	NA	NA	NA
Tetryl	NA	NA	NA	NA	NA	NA	NA	NA
Pesticides/PCBs (ug/kg)								
4,4'-DDD	NA	NA	NA	NA	NA	NA	NA	NA
4,4'-DDE	NA	NA	NA	NA	NA	NA	NA	NA
4,4'-DDT	NA	NA	NA	NA	NA	NA	NA	NA
Aldrin	NA	NA	NA	NA	NA	NA	NA	NA
Alpha-BHC	NA	NA	NA	NA	NA	NA	NA	NA
Alpha-Chlordane	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1016	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1221	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1232	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1242	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1248	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1254	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1260	NA	NA	NA	NA	NA	NA	NA	NA
Beta-BHC	NA	NA	NA	NA	NA	NA	NA	NA
Delta-BHC	NA	NA	NA	NA	NA	NA	NA	NA
Dieldrin	NA	NA	NA	NA	NA	NA	NA	NA
Endosulfan I	NA	NA	NA	NA	NA	NA	NA	NA
Endosulfan II	NA	NA	NA	NA	NA	NA	NA	NA
Endosulfan Sulfate	NA	NA	NA	NA	NA	NA	NA	NA
Endrin	NA	NA	NA	NA	NA	NA	NA	NA
Endrin Aldehyde	NA	NA	NA	NA	NA	NA	NA	NA
Gamma-BHC (Lindane)	NA	NA	NA	NA	NA	NA	NA	NA
Gamma-Chlordane	NA	NA	NA	NA	NA	NA	NA	NA
Heptachlor	NA	NA	NA	NA	NA	NA	NA	NA

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	BG1SBP02	BG1SBP03	BG1SBP04	BG1SBP05	BG1SBP06	BG1SBP08	BG1SBP10	BG1SBP08
Sample	BG1SBP0206	BG1SBP0305	BG1SBP0406	BG1SBP0505	BG1SBP0603	BG1SBP0804	BG1SBP1004	BG1SBP0806
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	5 - 6	4 - 5	5 - 6	4 - 5	2 - 3	3 - 4	3 - 4	5 - 6
Risk	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background
Soil Group	8	8	8	8	8	8	8	9
Sample Date	11/6/1999	11/6/1999	11/6/1999	11/5/1999	11/5/1999	11/6/1999	11/5/1999	11/6/1999
Heptachlor Epoxide	NA	NA	NA	NA	NA	NA	NA	NA
Methoxychlor	NA	NA	NA	NA	NA	NA	NA	NA
Toxaphene	NA	NA	NA	NA	NA	NA	NA	NA
Herbicides (ug/kg)								
2,4,5-T	NA	NA	NA	NA	NA	NA	NA	NA
2,4,5-TP (Silvex)	NA	NA	NA	NA	NA	NA	NA	NA
2,4-D	NA	NA	NA	NA	NA	NA	NA	NA
Dinoseb	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorophenol	NA	NA	NA	NA	NA	NA	NA	NA
Inorganics (mg/kg)								
Aluminum	16200	9070	10500	13800 J	13200 J	12500	10900 J	5430
Antimony	0.68 U	0.4 U	0.48 U	11.3 J	0.42 U	1.2 U	0.31 U	0.76 U
Arsenic	6 J	5.6 J	1.4 J	2.5 J	5.9 J	6.4 J	5.3 J	2.9 J
Barium	73.6 J	25.1 J	52.6 J	83.4 J	36.9 J	56.1 J	49.1 J	24.8 J
Beryllium	1.2 U	1 U	0.93 U	0.7 U	0.49 U	0.55 U	0.42 U	0.28 U
Cadmium	0.64	0.1 J	0.05 U	0.05 J	0.2 J	0.35 J	0.28 J	0.14 J
Calcium	650	85.2 J	835	970 J	340 J	144	333 J	53.6 J
Chromium	27.1 J	19.6 J	14.7 J	19.1 J	24.7 J	14.2 J	17 J	7.7 J
Cobalt	12.5	12.1	5.9	6	6.7	10.3	5.2	8.8
Copper	14.2	23.8	10.1	11	13.6	11.9	13	5.6
Iron	31500 J	40800 J	14800 J	19500 J	27200 J	18300 J	18600 J	11300 J
Lead	14.6 J	13.9 J	8.2 J	9.3 J	15.2 J	11.3 J	8.9 J	11.7 J
Magnesium	2010 J	1100 J	1660 J	1800 J	1810 J	1960 J	1900 J	654 J
Manganese	444 J	323 J	29 J	71.8 J	274 J	457 J	249 J	327 J
Mercury	0.05 U	0.04 U	0.04 U	0.05 U	0.05 U	0.05 U	0.05 U	0.04 U
Nickel	15.7 J	23.7 J	9.6 J	10.3 J	11.3 J	12.5 J	11.3 J	4.6 J
Potassium	988	1290	697	718 J	900 J	866	744 J	353
Selenium	0.88	0.56	0.42 J	0.28 U	0.39 J	0.45 J	0.37 J	0.28 J
Silver	0.1 J	0.05 J	0.05 U	0.05 J	0.05 J	0.05 J	0.05 J	0.05 J
Sodium	145	25.9 J	191	125 U	30.6 U	11.7 J	46.7 U	2.3 U
Strontium	10.4 J	11.8 J	20.3 J	17.2 J	13.0 J	10.0 J	11.6 J	5.4 J
Thallium	0.25 J	0.15 J	0.14 J	0.19 J	0.2 J	0.2 J	0.14 J	0.09 J
Thorium-Calc	NA	NA	NA	NA	NA	NA	NA	NA
Tin	0.5 U	0.65 U	0.65 U	0.91 U	0.6 U	0.6 U	0.61 U	0.43 U
Vanadium	48.5 J	26.6 J	20.9 J	30 J	38.5 J	30 J	28.3 J	14.1 J
Zinc	31.4 J	58.2 J	25.8 J	24.3 J	29.4 J	35.5 J	32 J	11.4 J
Miscellaneous Parameters								
1,4-Dithiane (ug/kg)	NA	NA	NA	NA	NA	NA	NA	NA
1,4-Oxathiane (ug/kg)	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-Chloroethyl)Sulfide (ug/kg)	NA	NA	NA	NA	NA	NA	NA	NA
Cation Exchange Capacity (meq/100g)	NA	NA	NA	NA	NA	NA	NA	NA
pH (S.U.)	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon (mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA
Total Radiologicals (pCi/g)								
Actinium-228	1.17 J	2.11 J	1.65 J	1.64 J	1.46 J	1.36 J	1.23 J	0.77 J
Bismuth-212	1.35 J	2.36 J	1.63 J	2.18 J	1.7 J	1.67 J	1.53 J	1.18 J
Bismuth-214	1.05 J	1.54 J	1.10 J	1.35 J	1.29 J	1.29 J	1.01 J	0.70 J
Cesium-137	0.038 UJ	0.0657 UJ	0.0594 UJ	0.0585 UJ	0.025 UJ	0.0673 UJ	0.0412 UJ	0.0456 UJ
Cobalt-60	0.0474 UJ	0.0541 UJ	0.0279 UJ	0.0602 UJ	0.0323 UJ	0.0306 UJ	0.0507 UJ	0.03 UJ
Europium-154	0.0589 UJ	0.077 UJ	0.0798 UJ	0.0438 UJ	0.0497 UJ	0.09 UJ	0.0494 UJ	0.0567 UJ
Europium-155	0.09 J	0.103 UJ	0.31 J	0.13 J	0.08 J	0.09 J	0.37 J	0.0831 UJ

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-2

SUMMARY OF ANALYTIC RESULTS- SUBSURFACE SOIL
MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	BG1SBP02	BG1SBP03	BG1SBP04	BG1SBP05	BG1SBP06	BG1SBP08	BG1SBP10	BG1SBP08
Sample	BG1SBP0206	BG1SBP0305	BG1SBP0406	BG1SBP0505	BG1SBP0603	BG1SBP0804	BG1SBP1004	BG1SBP0806
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range	5 - 6	4 - 5	5 - 6	4 - 5	2 - 3	3 - 4	3 - 4	5 - 6
Risk	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background	Basewide Background
Soil Group	8	8	8	8	8	8	8	9
Sample Date	11/6/1999	11/6/1999	11/6/1999	11/5/1999	11/5/1999	11/6/1999	11/5/1999	11/6/1999
Lead-210	0.95 J	1.37 J	1.11 J	0.77 J	0.89 J	0.56 J	0.82 J	0.53 J
Lead-212	1.18 J	2.15 J	1.64 J	1.51 J	1.45 J	1.41 J	1.16 J	0.86 J
Lead-214	1.03 J	1.49 J	1.14 J	1.28 J	1.21 J	1.25 J	1.08 J	0.70 J
Potassium-40	13.7 J	27.40 J	13.90 J	13.80 J	18.1 J	22.20 J	18.00 J	11.70 J
Protactinium-234	6.2 UJ	8.52 UJ	4.06 UJ	5.37 UJ	8.13 UJ	6.05 UJ	6.98 J	3.14 UJ
Radium-226	1.56 J	3.68 J	2.04 J	2.40 J	2.37 J	2.59 J	1.64 J	1.36 J
Thallium-208	0.98 J	1.81 J	1.33 J	1.35 J	1.34 J	1.08 J	0.97 J	0.78 J
Thorium-228	NA	NA	NA	NA	NA	NA	NA	NA
Thorium-230	NA	NA	NA	NA	NA	NA	NA	NA
Thorium-232	NA	NA	NA	NA	NA	NA	NA	NA
Thorium-234	1.22 J	1.87 J	1.41 J	1.35 J	1.8 J	1.32 J	1.98 J	0.83 J
Uranium-235	0.213 UJ	0.345 UJ	0.376 UJ	0.386 UJ	0.269 UJ	0.359 UJ	0.20 J	0.33 UJ

Calc = Calculated Value as descibed in Section 3.4.2.1 (TtNUS, 2003).
NA = Not Analyzed

TABLE A-3-1

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 1 GROUND WATER
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-01	01-02	01-03	01-04	01-05	01-06	01-07	01-08	01-09	01-10	01-11	01-12
Sample	01GW0101	01GW0201	01GW0301	01GW0401	01GW0501	01GW0601	01GW0701	01GW0801	01GW0901	01GW1001	01GW1101	01GW1201
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	9/6/2001	9/8/2001	9/7/2001	8/28/2001	9/19/2001	9/4/2001	9/18/2001	9/18/2001	9/7/2001	9/8/2001	8/22/2001	9/5/2001
Volatile Organic Compounds (ug/L)												
1,1,1,2-Tetrachloroethane	0.5 U	500 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	3	7 U
1,1,1-Trichloroethane	0.5 U	500 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U	7 U
1,1,2,2-Tetrachloroethane	0.5 U	38000	0.5 U	0.5 U	9 J	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	170	230
1,1,2-Trichloroethane	1 UJ	1000 U	1 U	1 U	9 J	1 U	1 U	0.6 J	1 U	1 U	5	13 U
1,1-Dichloroethane	0.5 U	500 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U	7 U
1,1-Dichloroethene	1 U	1000 U	1 U	1 U	0.2 J	1 U	1 U	1 UJ	1 U	1 U	0.7 J	13 U
1,2,3-Trichloropropane	0.5 U	500 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U	7 U
1,2-Dibromo-3-Chloropropane	1 UJ	1000 UJ	1 UJ	1 UJ	1 U	1 UJ	1 U	1 UJ	1 UJ	1 UJ	1 U	13 UJ
1,2-Dibromoethane	0.6 U	600 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 UJ	0.6 U	0.6 U	0.6 U	8 U
1,2-Dichloroethane	0.5 U	500 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	4	7 U
1,2-Dichloropropane	1 U	1000 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	13 U
1,4-Dioxane	100 UR	100000 UR	100 UR	100 UR	100 UR	100 UR	100 UR	100 UR	100 UR	100 UR	100 UR	1300 UR
2-Butanone	5 UR	5000 UR	5 UR	5 UR	5 UJ	5 UR	5 U	5 UJ	5 UR	5 UR	5 UR	63 UR
2-Hexanone	5 UJ	5000 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 U	63 UJ
3-Chloropropene	5 U	5000 U	5 U	5 U	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	63 U
4-Methyl-2-Pentanone	3 UJ	2500 UJ	3 UJ	3 U	3 U	3 UJ	3 U	3 UJ	3 UJ	3 U	3 U	32 UJ
Acetone	5 UR	5000 UR	5 UR	5 UR	5 UR	5 UR	5 UR	5 UR	5 UR	5 UR	5 UR	63 UR
Acetonitrile	40 U	40000 U	40 U	40 U	40 U	40 U	40 U	40 UJ	40 U	40 U	40 U	500 U
Acrolein	10 UR	10000 UR	10 UR	10 UR	10 UR	10 UR	10 UR	10 UR	10 UR	10 UR	10 UR	130 UR
Acrylonitrile	10 UR	10000 UR	10 UR	10 UR	10 UR	10 UR	10 UR	10 UR	10 UR	10 UR	10 UR	130 UR
Benzene	0.5 U	500 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U	7 U
Bromodichloromethane	0.5 U	500 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U	7 U
Bromoform	0.5 UJ	500 UJ	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 UJ	0.5 U	0.5 U	7 UJ
Bromomethane	1 U	1000 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	13 U
Carbon Disulfide	1 U	1000 U	1 U	1 UJ	1 U	1 U	1 U	1 UJ	1 U	1 U	1 UJ	13 U
Carbon Tetrachloride	0.5 U	500 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 UJ	0.5 UJ	0.5 U	0.5 U	0.5 U	7 U
Chlorobenzene	0.5 U	500 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U	7 U
Chlorodibromomethane	0.5 U	500 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U	7 U
Chloroethane	1 U	1000 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	13 U
Chloroform	0.5 U	840 J	0.5 U	0.5 U	0.2 BU	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	15	9 BJ
Chloromethane	1 U	1000 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	13 U
Chloroprene	1 UJ	1000 UJ	1 UJ	1 UJ	1 U	1 U	1 U	1 UJ	1 UJ	1 UJ	1 U	13 UJ
Cis-1,2-Dichloroethene	1 UJ	1000 U	1 U	1 U	2 J	1 U	1 U	1 UJ	1 U	1 U	5	13 U
Cis-1,3-Dichloropropene	3 UJ	2500 U	3 U	3 U	3 U	3 U	3 U	3 UJ	3 U	3 U	3 U	32 U
Dibromomethane	1 U	1000 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	13 U
Dichlorodifluoromethane	0.7 UJ	700 UJ	0.7 UJ	0.7 U	0.7 U	0.7 U	0.7 U	0.7 UJ	0.7 UJ	0.7 UJ	0.7 U	9 UJ
Ethyl Methacrylate	1 U	1000 U	1 U	1 UJ	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	13 U
Ethylbenzene	0.5 U	500 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U	7 U
Isobutanol	40 UR	40000 UR	40 UR	40 UR	40 UR	40 UR	40 UR	40 UR	40 UR	40 UR	40 UR	500 UR
Methacrylonitrile	20 UR	20000 UR	20 UR	20 UR	20 UR	20 UR	20 UR	20 UR	20 UR	20 UR	20 UR	250 UR
Methyl Iodide	1 U	1000 U	1 U	1 U	1 U	1 UJ	1 U	1 UJ	1 U	1 U	1 U	13 U
Methyl Methacrylate	1 U	1000 U	1 U	1 UJ	1 U	1 UJ	1 U	1 UJ	1 U	1 U	1 UJ	13 UJ
Methylene Chloride	1 BU	1000 U	0.3 BU	5 BU	1 U	3 BU	1 U	1 UJ	0.8 BU	0.5 U	6 BU	5 BU
Pentachloroethane	5 U	5000 U	5 U	5 UJ	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	63 U
Propionitrile	20 UR	20000 UR	20 UR	20 UR	20 UR	20 UR	20 UR	20 UR	20 UR	20 UR	20 UR	250 UR
Styrene	0.5 U	500 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U	7 U
Tetrachloroethene	0.5 U	370 J	0.5 U	0.5 U	2 J	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	6	7 U
Toluene	0.5 U	500 U	0.5 U	0.5 U	0.5 U	0.5 U	1	0.5 UJ	0.5 U	0.5 U	0.5 U	7 U
Total Xylenes	3 UJ	2500 U	3 U	3 U	3 U	3 U	3 U	3 UJ	3 U	3 U	3 U	32 U
Trans-1,2-Dichloroethene	1 U	1000 U	1 U	1 U	0.3 J	1 U	1 U	1 UJ	1 U	1 U	2	13 U
Trans-1,3-Dichloropropene	3 UJ	2800 UJ	3 UJ	3 U	3 U	3 U	3 U	3 UJ	3 UJ	3 U	3 U	35 UJ
Trans-1,4-Dichloro-2-Butene	1 UJ	1000 UJ	1 UJ	1 U	1 UJ	1 UJ	1 U	1 UJ	1 UJ	1 UJ	1 U	13 UJ
Trichloroethene	0.5 U	16000	0.5 U	0.5 U	550 J	0.5 U	0.5 U	4 J	0.5 U	0.4 J	180 J	190
Trichlorofluoromethane	1 U	1000 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	13 U
Vinyl Acetate	3 UJ	2500 UJ	3 UJ	3 UJ	3 U	3 UJ	3 U	3 UJ	3 UJ	3 UJ	3 U	32 UJ

(1) Reanalyzed on February 22, 2002 for gross beta.
Calc = Calculated Value as descibed in Section 3.4.2.1.
NA = Not Analyzed

TABLE A-3-1

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 1 GROUND WATER
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-01	01-02	01-03	01-04	01-05	01-06	01-07	01-08	01-09	01-10	01-11	01-12
Sample	01GW0101	01GW0201	01GW0301	01GW0401	01GW0501	01GW0601	01GW0701	01GW0801	01GW0901	01GW1001	01GW1101	01GW1201
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Vinyl Chloride	1 U	1000 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	13 U
Semivolatile Organic Compounds (ug/L)												
1,2,4,5-Tetrachlorobenzene	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
1,2,4-Trichlorobenzene	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
1,2-Dichlorobenzene	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
1,3-Dichlorobenzene	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
1,4-Dichlorobenzene	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
1,4-Naphthoquinone	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
1,4-Phenylenediamine	25 U	25 U	25 U	25 U	25 U	25 U	NA	NA	NA	NA	25 UJ	NA
1-Naphthylamine	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
2,2'-Oxybis(1-Chloropropane)	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
2,3,4,6-Tetrachlorophenol	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
2,4,5-Trichlorophenol	25 U	25 U	25 U	25 U	25 U	25 U	NA	NA	NA	NA	25 U	NA
2,4,6-Trichlorophenol	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
2,4-Dichlorophenol	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
2,4-Dimethylphenol	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
2,4-Dinitrophenol	25 U	25 U	25 U	25 U	25 U	25 U	NA	NA	NA	NA	25 U	NA
2,6-Dichlorophenol	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
2-Acetylaminofluorene	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
2-Chloronaphthalene	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
2-Chlorophenol	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
2-Methylnaphthalene	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
2-Methylphenol	6 U	6 U	6 U	6 U	6 U	6 U	NA	NA	NA	NA	6 U	NA
2-Naphthylamine	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
2-Nitroaniline	13 U	13 U	13 U	13 U	13 U	13 U	NA	NA	NA	NA	13 U	NA
2-Nitrophenol	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
2-Picoline	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
3,3'-Dichlorobenzidine	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
3,3'-Dimethylbenzidine	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
3-Methylcholanthrene	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
3-Methylphenol	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
3-Nitroaniline	25 U	25 U	25 U	25 U	25 U	25 U	NA	NA	NA	NA	25 U	NA
4,6-Dinitro-2-Methylphenol	25 U	25 U	25 U	25 U	25 U	25 U	NA	NA	NA	NA	25 U	NA
4-Aminobiphenyl	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
4-Bromophenyl Phenyl Ether	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
4-Chloro-3-Methylphenol	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
4-Chloroaniline	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
4-Chlorophenyl Phenyl Ether	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
4-Methylphenol	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
4-Nitroaniline	25 U	25 U	25 U	25 U	25 U	25 U	NA	NA	NA	NA	25 U	NA
4-Nitrophenol	25 U	25 U	25 U	25 U	15 J	25 U	NA	NA	NA	NA	25 U	NA
4-Nitroquinoline-1-Oxide	25 UR	25 UR	25 UR	25 UR	25 UR	25 UR	NA	NA	NA	NA	25 UR	NA
5-Nitro-O-Toluidine	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
7,12-Dimethylbenz(A)Anthracene	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
A,A-Dimethylphenethylamine	25 U	25 U	25 U	25 U	25 U	25 U	NA	NA	NA	NA	25 U	NA
Acenaphthene	0.2 UJ	0.2 U	0.2 U	0.0793 J	0.2 U	0.2 U	NA	NA	NA	NA	0.0896 J	NA
Acenaphthylene	0.2 U	0.763	0.2 U	0.2 U	0.2 U	0.2 U	NA	NA	NA	NA	0.2 U	NA
Acetophenone	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
Aniline	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
Anthracene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	NA	NA	NA	NA	0.2 U	NA
Aramite	25 U	25 U	25 U	25 U	25 U	25 U	NA	NA	NA	NA	25 U	NA
Benzo(A)Anthracene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	NA	NA	NA	NA	0.2 U	NA
Benzo(A)Pyrene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	NA	NA	NA	NA	0.2 U	NA
Benzo(B)Fluoranthene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	NA	NA	NA	NA	0.2 U	NA
Benzo(G,H,I)Perylene	0.2 UJ	0.2 U	0.2 U	0.2 U	0.2 U	0.2 UJ	NA	NA	NA	NA	0.2 U	NA
Benzo(K)Fluoranthene	0.2 UJ	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	NA	NA	NA	NA	0.2 U	NA
Benzyl Alcohol	7 U	7 U	7 U	7 U	7 U	7 U	NA	NA	NA	NA	7 U	NA
Bis(2-Chloroethoxy)Methane	10 UJ	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA

(1) Reanalyzed on February 22, 2002 for gross beta.
Calc = Calculated Value as descibed in Section 3.4.2.1.
NA = Not Analyzed

TABLE A-3-1

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 1 GROUND WATER
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-01	01-02	01-03	01-04	01-05	01-06	01-07	01-08	01-09	01-10	01-11	01-12
Sample	01GW0101	01GW0201	01GW0301	01GW0401	01GW0501	01GW0601	01GW0701	01GW0801	01GW0901	01GW1001	01GW1101	01GW1201
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Bis(2-Chloroethyl)Ether	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
Bis(2-Ethylhexyl)Phthalate	7 J	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	15 J	NA
Butyl Benzyl Phthalate	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	9 J	NA
Chlorobenzilate	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
Chrysene	0.2 UJ	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	NA	NA	NA	NA	0.2 U	NA
Diallate	5 U	5 UJ	5 UJ	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
Dibenzo(A,H)Anthracene	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
Dibenzofuran	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
Diethyl Phthalate	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	NA	NA	NA	NA	0.2 U	NA
Dimethyl Phthalate	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
Di-N-Butyl Phthalate	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
Di-N-Octyl Phthalate	6 U	6 U	6 U	6 U	6 U	6 U	NA	NA	NA	NA	6 U	NA
Diphenylamine	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
Ethyl Methane Sulfonate	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
Fluoranthene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	NA	NA	NA	NA	0.2 U	NA
Fluorene	0.2 U	0.0593 J	0.2 U	0.2 U	0.2 U	0.2 U	NA	NA	NA	NA	0.2 U	NA
Hexachlorobenzene	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
Hexachlorobutadiene	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
Hexachlorocyclopentadiene	10 UR	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
Hexachloroethane	5 U	5 J	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
Hexachlorophene	400 UJ	400 UJ	400 UJ	400 UJ	400 UJ	400 UJ	NA	NA	NA	NA	400 UJ	NA
Hexachloropropene	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 UJ	NA
Indeno(1,2,3-CD)Pyrene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	NA	NA	NA	NA	0.2 U	NA
Isodrin	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
Isophorone	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
Isosafrole	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
Kepone	25 U	25 U	25 U	25 U	25 U	25 U	NA	NA	NA	NA	25 U	NA
Methapyrilene	25 UR	25 UR	25 UR	25 U	25 UR	25 U	NA	NA	NA	NA	25 U	NA
Methyl Methane Sulfonate	13 U	13 U	13 U	13 U	13 U	13 U	NA	NA	NA	NA	13 U	NA
Naphthalene	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
N-Nitrosodiethylamine	6 U	6 U	6 U	6 U	6 U	6 U	NA	NA	NA	NA	6 UJ	NA
N-Nitrosodimethylamine	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
N-Nitroso-Di-N-Butylamine	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
N-Nitroso-Di-N-Propylamine	7 U	7 U	7 U	7 U	7 U	7 U	NA	NA	NA	NA	7 U	NA
N-Nitrosomethylethylamine	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
N-Nitrosomorpholine	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
N-Nitrosopiperidine	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 UJ	NA
N-Nitrosopyrrolidine	0.2 U	0.579	0.2 U	0.2 U	0.2 U	0.0796 J	NA	NA	NA	NA	0.103 J	NA
O,O,O-Triethyl Phosphorothioate	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
O-Toluidine	5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	NA	5 U	NA
P-(Dimethylamino)Azobenzene	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
Pentachlorobenzene	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
Pentachloronitrobenzene	25 U	25 U	25 U	25 U	25 U	25 U	NA	NA	NA	NA	25 U	NA
Phenacetin	10 U	10 U	10 U	10 U	10 UJ	10 U	NA	NA	NA	NA	10 U	NA
Phenanthrene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	NA	NA	NA	NA	0.2 U	NA
Phenol	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
Pronamide	10 UR	10 UR	10 UR	10 UR	10 UR	10 UR	NA	NA	NA	NA	10 UR	NA
Pyrene	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	NA	NA	NA	NA	0.2 U	NA
Pyridine	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
Safrole	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	NA	10 U	NA
Energertics (ug/L)												
1,3,5-Trinitrobenzene	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	NA	NA	NA	NA	0.65 U	NA
1,3-Dinitrobenzene	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	NA	NA	NA	NA	0.65 U	NA
2,4,6-Trinitrotoluene	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	NA	NA	NA	NA	0.65 U	NA
2,4-Dinitrotoluene	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	NA	NA	NA	NA	0.65 U	NA
2,6-Dinitrotoluene	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	NA	NA	NA	NA	0.65 U	NA
2-Amino-4,6-Dinitrotoluene	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	NA	NA	NA	NA	0.65 U	NA
2-Nitrotoluene	0.65 U	0.202 J	0.65 U	0.65 U	0.65 U	0.65 U	NA	NA	NA	NA	0.65 U	NA

(1) Reanalyzed on February 22, 2002 for gross beta.
Calc = Calculated Value as descibed in Section 3.4.2.1.
NA = Not Analyzed

TABLE A-3-1

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 1 GROUND WATER
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-01	01-02	01-03	01-04	01-05	01-06	01-07	01-08	01-09	01-10	01-11	01-12
Sample	01GW0101	01GW0201	01GW0301	01GW0401	01GW0501	01GW0601	01GW0701	01GW0801	01GW0901	01GW1001	01GW1101	01GW1201
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
3-Nitrotoluene	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	NA	NA	NA	NA	0.65 U	NA
4-Amino-2,6-Dinitrotoluene	0.65 U	0.65 U	0.65 U	0.65 U	0.263 J	0.65 U	NA	NA	NA	NA	0.65 U	NA
4-Nitrotoluene	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	NA	NA	NA	NA	0.65 U	NA
HMX	0.201 J	0.65 U	0.65 U	0.65 U	0.65 U	0.171 R	NA	NA	NA	NA	0.65 U	NA
Nitrobenzene	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	NA	NA	NA	NA	0.65 U	NA
RDX	0.65 U	0.855 R	0.0858 R	0.65 U	0.65 U	0.65 U	NA	NA	NA	NA	0.65 U	NA
Tetryl	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	NA	NA	NA	NA	0.65 U	NA
Pesticides/PCBs (ug/L)												
4,4'-DDD	0.08 U	0.08 U	0.08 U	0.08 UJ	0.08 U	0.08 U	NA	NA	NA	NA	0.08 U	NA
4,4'-DDE	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	NA	NA	NA	NA	0.08 U	NA
4,4'-DDT	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	NA	NA	NA	NA	0.08 U	NA
Aldrin	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	NA	NA	NA	NA	0.04 U	NA
Alpha-BHC	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	NA	NA	NA	NA	0.04 UJ	NA
Alpha-Chlordane	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	NA	NA	NA	NA	0.04 U	NA
Aroclor-1016	1 U	1 U	1 U	1 U	1 U	1 U	NA	NA	NA	NA	1 U	NA
Aroclor-1221	1 U	1 U	1 U	1 U	1 U	1 U	NA	NA	NA	NA	1 U	NA
Aroclor-1232	1 U	1 U	1 U	1 U	1 U	1 U	NA	NA	NA	NA	1 U	NA
Aroclor-1242	1 U	1 U	1 U	1 U	1 U	1 U	NA	NA	NA	NA	1 U	NA
Aroclor-1248	1 U	1 U	1 U	1 U	1 U	1 U	NA	NA	NA	NA	1 U	NA
Aroclor-1254	1 U	1 U	1 U	1 U	1 U	1 U	NA	NA	NA	NA	1 U	NA
Aroclor-1260	1 U	1 U	1 U	1 U	1 U	1 U	NA	NA	NA	NA	1 U	NA
Beta-BHC	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	NA	NA	NA	NA	0.04 U	NA
Delta-BHC	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	NA	NA	NA	NA	0.04 U	NA
Dieldrin	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	NA	NA	NA	NA	0.08 U	NA
Endosulfan I	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	NA	NA	NA	NA	0.04 U	NA
Endosulfan II	0.08 U	0.25 R	0.08 U	0.08 U	0.08 U	0.08 U	NA	NA	NA	NA	0.08 U	NA
Endosulfan Sulfate	0.08 U	0.08 U	0.08 U	0.08 UJ	0.08 U	0.08 U	NA	NA	NA	NA	0.08 U	NA
Endrin	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	NA	NA	NA	NA	0.08 U	NA
Endrin Aldehyde	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	NA	NA	NA	NA	0.08 U	NA
Gamma-BHC (Lindane)	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	NA	NA	NA	NA	0.04 U	NA
Gamma-Chlordane	0.025 J	0.04 U	0.075 J	0.04 U	0.04 U	0.04 U	NA	NA	NA	NA	0.04 U	NA
Heptachlor	0.042 BU	0.04 U	0.059 U	0.013 BU	0.05 BU	0.049 BU	NA	NA	NA	NA	0.023 J	NA
Heptachlor Epoxide	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	NA	NA	NA	NA	0.04 U	NA
Methoxychlor	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U	0.38 U	NA	NA	NA	NA	0.38 U	NA
Toxaphene	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	NA	NA	NA	NA	2.5 U	NA
Herbicides (ug/L)												
2,4,5-T	0.8 UJ	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	NA	NA	NA	NA	0.8 U	NA
2,4,5-TP (Silvex)	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	NA	NA	NA	NA	0.5 U	NA
2,4-D	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	NA	NA	NA	NA	2.5 U	NA
Dinoseb	1 UR	1 U	1 U	1 U	1 U	1 UJ	NA	NA	NA	NA	1 UJ	NA
Pentachlorophenol	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	NA	NA	NA	NA	0.5 U	NA
Total Metals (ug/L)												
Aluminum	68.8	40.2 U	5700	40.2 U	40.3 U	40.2 U	1330	40.3 U	162	40.2 U	1370 J	447
Antimony	1.6 U	1.6 U	1.6 U	1.9	3.0	1.6 U	1.6 U	1.6 U	1.6 U	2.1 U	4.7 U	1.6 U
Arsenic	1.5 U	1.5 U	7.9	2.5 U	1.5 U	3.2 U	2.7	1.5 U	1.5 U	1.5 U	3.6	1.5 U
Barium	29.1	134	258	17.1	25.0	21.3	156	19.4	16.0	41.7	45.4	15.0
Beryllium	0.40 U	0.40 U	0.59	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.70 U	0.40 U
Cadmium	0.30 U	0.74	0.94	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.41 U	0.30 U
Calcium	105000 J	121000 J	60200 J	89100	196000	170000	77100	66100	39800 J	113000 J	95100	86000
Chromium	0.60 U	0.61 U	7.1 J	0.60 U	0.70 U	0.60 U	1.5	0.70 U	0.98 U	0.60 U	3.6 U	1.7 U
Cobalt	11.1	3.1	14.1	1.0 U	3.0	1.0 U	6.4	2.7	1.2	2.7	17.8	1.9
Copper	0.90 U	0.90 U	14.5 J	0.90 U	0.90 U	0.90 U	2.9	0.90 U	0.90 U	0.90 U	2.6 U	0.90 U
Iron	1410	22.1	8670	24.9	319	398	1410	6370	624	673	1160 J	487
Lead	1.6 U	1.6 U	8.2 J	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	0.70 U	1.6 U
Magnesium	72400 J	72100 J	18000 J	59800	151000	156000	22000	23400	10400 J	20400 J	5780 J	25000
Manganese	2450 J	434 J	2670 J	1.5	590	37.9	1500	886	144 J	987 J	303 J	401
Mercury	0.10 U	0.10 U	0.10 U	0.10 U	0.15	0.10 U	0.24	0.13	0.10 U	0.10 U	0.13 U	0.10 U
Nickel	10.2 J	41.4 J	31.9 J	0.70 U	6.9	2.6	17.6	4.1	11.5 J	8.5 J	10.5	64.7

(1) Reanalyzed on February 22, 2002 for gross beta.
Calc = Calculated Value as descibed in Section 3.4.2.1.
NA = Not Analyzed

TABLE A-3-1

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 1 GROUND WATER
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-01	01-02	01-03	01-04	01-05	01-06	01-07	01-08	01-09	01-10	01-11	01-12
Sample	01GW0101	01GW0201	01GW0301	01GW0401	01GW0501	01GW0601	01GW0701	01GW0801	01GW0901	01GW1001	01GW1101	01GW1201
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Potassium	3010	1530	4300	1310	2800 J	2790	10400 J	2370 J	1170	2070	1350 J	1340
Selenium	0.80 U	0.80 U	0.80 U	0.80 U	0.80 U	0.80 U	0.80 U	0.80 U	0.80 U	2.2 U	2.3 U	0.80 U
Silver	3.0 U	3.0 U	3.0 U	3.0 U	0.70 U	3.0 U	1.1	0.71	3.0 U	3.0 U	0.65 J	3.0 U
Sodium	48500 J	102000 J	10700 J	80800	117000	17200	12500	6100	3070 J	7900 J	5830 J	14800
Strontium	265 J	257 J	158 J	148 J	347 J	958 J	576 J	211 J	76.5 J	214 J	98.8 J	132 J
Thallium	5.0 UJ	5.0 UJ	5.0 UJ	5.0 U	4.1	5.0 U	4.6	3.6	5.0 UJ	5.0 UJ	3.9 U	5.0 U
Thorium - Calc	0.605 U	1.45 U	0.363 U	0.585 U	0.810	0.329	NA	NA	NA	NA	0.228	NA
Tin	190 U	190 U	190 U	190 U	17.3 U	190 U	17.3 U	17.3 U	190 U	190 U	17.3 U	190 U
Vanadium	3.0 U	3.0 U	11.8	3.0 U	0.50 U	3.0 U	1.1	0.50 U	3.0 U	3.0 U	3.3 U	3.0 U
Zinc	11.3 U	61.9 J	43.8 U	1.1 U	1.7 U	1.1 U	8.6	8.2	9.4 U	3.6 U	27.4	23.2
Dissolved Metals (ug/L)												
Aluminum	NA	NA	40.2 U	NA	NA	NA	NA	NA	NA	40.2 U	87.0 U	NA
Antimony	NA	NA	1.6 U	NA	NA	NA	NA	NA	NA	3.1 U	2.1 U	NA
Arsenic	NA	NA	2.3	NA	NA	NA	NA	NA	NA	1.5 U	3.0 U	NA
Barium	NA	NA	215	NA	NA	NA	NA	NA	NA	41.0	36.2	NA
Beryllium	NA	NA	0.40 U	NA	NA	NA	NA	NA	NA	0.40 U	0.70 U	NA
Cadmium	NA	NA	0.30 U	NA	NA	NA	NA	NA	NA	0.30 U	0.49 U	NA
Calcium	NA	NA	60500 J	NA	NA	NA	NA	NA	NA	115000 J	93100	NA
Chromium	NA	NA	0.60 U	NA	NA	NA	NA	NA	NA	0.60 U	1.0 U	NA
Cobalt	NA	NA	8.3	NA	NA	NA	NA	NA	NA	2.4	1.0 U	NA
Copper	NA	NA	0.90 U	NA	NA	NA	NA	NA	NA	0.90 U	1.3 U	NA
Iron	NA	NA	288	NA	NA	NA	NA	NA	NA	414	51.7 J	NA
Lead	NA	NA	1.6 U	NA	NA	NA	NA	NA	NA	1.6 U	0.70 U	NA
Magnesium	NA	NA	16600 J	NA	NA	NA	NA	NA	NA	20400 J	5430 J	NA
Manganese	NA	NA	2740 J	NA	NA	NA	NA	NA	NA	1010 J	22.4 J	NA
Mercury	NA	NA	0.10 U	NA	NA	NA	NA	NA	NA	0.10 U	0.14 U	NA
Nickel	NA	NA	17.7 J	NA	NA	NA	NA	NA	NA	8.7 J	4.9 U	NA
Potassium	NA	NA	3630	NA	NA	NA	NA	NA	NA	1990	1100 J	NA
Selenium	NA	NA	0.80 U	NA	NA	NA	NA	NA	NA	0.80 U	2.3 U	NA
Silver	NA	NA	3.0 U	NA	NA	NA	NA	NA	NA	3.0 U	0.20 U	NA
Sodium	NA	NA	7100 J	NA	NA	NA	NA	NA	NA	7640 J	5000 J	NA
Strontium	NA	NA	153 J	NA	NA	NA	NA	NA	NA	212 J	96.5 J	NA
Thallium	NA	NA	5.0 UJ	NA	NA	NA	NA	NA	NA	5.0 UJ	3.9 U	NA
Thorium - Calc	NA	NA	0.404 U	NA	NA	NA	NA	NA	NA	NA	0.377 U	NA
Tin	NA	NA	190 U	NA	NA	NA	NA	NA	NA	190 U	17.3 U	NA
Vanadium	NA	NA	3.0 U	NA	NA	NA	NA	NA	NA	3.0 U	0.30 U	NA
Zinc	NA	NA	6.2 U	NA	NA	NA	NA	NA	NA	7.0 U	9.4 U	NA
Miscellaneous Parameters (mg/L)												
1,4-Dithiane	200 U	200 U	200 U	200 U	200 U	200 U	NA	NA	NA	NA	200 U	NA
1,4-Oxathiane	200 U	200 U	200 U	200 U	200 U	200 U	NA	NA	NA	NA	200 U	NA
Bis(2-Chloroethyl)Sulfide	200 U	200 U	200 U	200 U	200 U	200 U	NA	NA	NA	NA	200 U	NA
Total Organic Carbon	4.5 J	7.8 J	35.3 J	3.7	4.78	6.21	NA	NA	NA	NA	NA	NA
Total Radiologicals (pCi/L)												
Gross Alpha	4.82 J	3.00 UJ	1.50 J	2.05 J	3.35 U	5.26 J	1.08 U	1.49 J	1.87 J	2.46 J	4.76 J	2.04 J
Gross Beta	11.8 J	3.18	6.79	4.86 U	4.46 U	5.16 U	14.2	2.58	2.32 U	3.53	8.28 J	3.81 U
Thorium-228	0.0875 U	0.166 U	0.0399 U	0.108 U	0.0863 U	0.0408	NA	NA	NA	NA	0.0329	NA
Thorium-230	0.230 U	0.106 U	0.119 U	0.130 U	0.135 U	0.122 U	NA	NA	NA	NA	0.146 U	NA
Thorium-232	0.0457 U	0.154 U	0.0399 U	0.0207 U	0.135	0.0631 U	NA	NA	NA	NA	0.0346 U	NA
Dissolved Radiologicals (pCi/L)												
Gross Alpha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gross Beta	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thorium-228	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.0493 U	NA
Thorium-230	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.124 U	NA
Thorium-232	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.0337 U	NA
Field Parameters												
Dissolved Oxygen (mg/L)	0.95	1.6	0.84	0.63	2.37	0.69	0.38	0.39	0.71	0.72	1.01	1.56
Oxidation Reduction Potential (mV)	393	480	-152	490	490.4	109	221.5	39.6	618.1	71	444.8	466
pH (S.U.)	6.00	6.17	6.26	6.7	6	5.25	6.9	6.28	4.41	6.33	5.74	5.89

(1) Reanalyzed on February 22, 2002 for gross beta.
Calc = Calculated Value as descibed in Section 3.4.2.1.
NA = Not Analyzed

TABLE A-3-1

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 1 GROUND WATER
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-01	01-02	01-03	01-04	01-05	01-06	01-07	01-08	01-09	01-10	01-11	01-12
Sample	01GW0101	01GW0201	01GW0301	01GW0401	01GW0501	01GW0601	01GW0701	01GW0801	01GW0901	01GW1001	01GW1101	01GW1201
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Specific Conductance (mS/cm)	1.007	1.659	0.486	0.922	2.37	1.67	0.518	0.546	0.272	0.699	0.444	0.643
Temperature (C)	15.38	17.5	17.4	18.7	15.46	14.62	13.86	14.39	15.4	21.89	17.15	18.3
Turbidity (NTU)	4.7	3.3	14	1.5	2.6	2.6	4.9	5	4.8	8.9	27	4.1

(1) Reanalyzed on February 22, 2002 for gross beta.
Calc = Calculated Value as descibed in Section 3.4.2.1.
NA = [illegible]alyzed

TABLE A-3-1

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 1 GROUND WATER
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-13	01-14	01-15	01-17	01-18	01-19	01-20	01-21	01-22	01-23	01-23 [1]	01-24
Sample	01GW1301	01GW1401	01GW1501	01GW1701	01GW1801	01GW1901	01GW2001	01GW2101	01GW2201	01GW2301	01GW2301-RE	01GW2401
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	9/5/2001	8/24/2001	9/5/2001	9/19/2001	9/20/2001	9/18/2001	9/20/2001	9/5/2001	9/19/2001	9/7/2001	9/7/2001	9/20/2001
Volatile Organic Compounds (ug/L												
1,1,1,2-Tetrachloroethane	0.5 U	0.5 U	13 U	0.3 J	0.5 U	5 J	0.5 U	0.5 U	2 J	0.5 U	NA	0.5 U
1,1,1-Trichloroethane	0.5 U	0.5 U	13 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	NA	0.5 U
1,1,2,2-Tetrachloroethane	9 J	8	250	10 J	0.3 J	270	30 J	0.5 U	150 J	0.5 U	NA	0.5 U
1,1,2-Trichloroethane	1 U	0.4 J	14 J	0.8 J	1 U	9 J	0.6 J	1 U	4 J	1 U	NA	1 U
1,1-Dichloroethane	0.5 U	0.5 U	13 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	NA	0.5 U
1,1-Dichloroethene	1 U	1 U	25 U	0.4 J	1 U	2 J	1 U	1 U	0.8 J	1 U	NA	1 U
1,2,3-Trichloropropane	0.5 U	0.5 U	13 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	NA	0.5 U
1,2-Dibromo-3-Chloropropane	1 UJ	1 U	25 UJ	1 U	1 U	1 U	1 U	1 UJ	1 U	1 UJ	NA	1 U
1,2-Dibromoethane	0.6 U	0.8 U	15 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	NA	0.6 U
1,2-Dichloroethane	0.5 U	0.3 J	13 U	1 J	0.5 U	10 J	0.5 U	0.5 U	0.5 U	0.5 U	NA	0.5 U
1,2-Dichloropropane	1 U	1 U	25 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	1 U
1,4-Dioxane	100 UR	100 UR	2500 UR	100 UR	100 UR	100 UR	100 UR	100 UR	100 UR	100 UR	NA	100 UR
2-Butanone	5 UR	5 UR	130 UR	5 UJ	5 UJ	5 U	5 UJ	5 UR	5 UJ	5 UR	NA	5 UJ
2-Hexanone	5 UJ	5 UJ	130 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	NA	5 UJ
3-Chloropropene	5 U	5 U	130 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	NA	5 U
4-Methyl-2-Pentanone	3 UJ	3 UJ	65 UJ	3 U	3 U	3 U	3 U	3 UJ	3 U	3 U	NA	3 U
Acetone	5 UR	5 UJ	130 UR	5 UR	5 UR	5 UR	5 UR	5 UR	5 UR	5 UR	NA	5 UR
Acetonitrile	40 U	40 U	1000 U	40 U	40 U	40 U	40 U	40 U	40 U	40 U	NA	40 U
Acrolein	10 UR	10 UR	250 UR	10 UR	10 UR	10 UR	10 UR	10 UR	10 UR	10 UR	NA	10 UR
Acrylonitrile	10 UR	10 UR	250 UR	10 UR	10 UR	10 UR	10 UR	10 UR	10 UR	10 UR	NA	10 UR
Benzene	0.5 U	0.5 U	13 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	NA	0.5 U
Bromodichloromethane	0.5 U	0.5 U	13 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	NA	0.5 U
Bromoform	0.5 UJ	0.5 U	13 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	NA	0.5 U
Bromomethane	1 U	1 U	25 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	1 U
Carbon Disulfide	1 U	1 UJ	25 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	1 U
Carbon Tetrachloride	0.5 U	0.5 U	13 U	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ	0.5 U	0.5 UJ	0.5 U	NA	0.5 UJ
Chlorobenzene	0.5 U	0.5 U	13 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	NA	0.5 U
Chlorodibromomethane	0.5 U	0.5 U	13 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	NA	0.5 U
Chloroethane	1 U	1 U	25 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	1 U
Chloroform	0.5 BU	0.1 J	18 U	4 J	0.5 U	27 J	0.5 BU	0.5 U	15 J	0.5 U	NA	0.5 U
Chloromethane	1 U	1 U	25 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	1 U
Chloroprene	1 UJ	1 U	25 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 UJ	NA	1 U
Cis-1,2-Dichloroethene	1 U	0.9 J	25 U	1 J	1 U	8 J	1 U	1 U	4 J	1 U	NA	1 U
Cis-1,3-Dichloropropene	3 U	3 U	65 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	NA	3 U
Dibromomethane	1 U	1 U	25 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	1 U
Dichlorodifluoromethane	0.7 UJ	0.7 U	18 U	0.7 U	0.7 U	0.7 U	0.7 U	0.7 UJ	0.7 U	0.7 UJ	NA	0.7 U
Ethyl Methacrylate	1 U	1 UJ	25 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	1 U
Ethylbenzene	0.5 U	0.5 U	13 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	NA	0.5 U
Isobutanol	40 UR	40 UR	1000 UR	40 UR	40 UR	40 UR	40 UR	40 UR	40 UR	40 UR	NA	40 UR
Methacrylonitrile	20 UR	20 UR	500 UR	20 UR	20 UR	20 UR	20 UR	20 UR	20 UR	20 UR	NA	20 UR
Methyl Iodide	1 U	1 U	25 UJ	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	1 U
Methyl Methacrylate	1 UJ	1 UJ	25 UJ	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	NA	1 U
Methylene Chloride	0.5 BU	2 BU	53 BU	1 U	0.2 J	0.4 J	0.3 J	0.5 BU	0.3 J	0.2 U	NA	1 U
Pentachloroethane	5 U	5 U	130 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	NA	5 U
Propionitrile	20 UR	20 UR	500 UR	20 UR	20 UR	20 UR	20 UR	20 UR	20 UR	20 UR	NA	20 UR
Styrene	0.5 U	0.5 U	13 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	NA	0.5 U
Tetrachloroethene	0.5 U	0.5 U	13 U	1 J	0.5 U	6 J	0.5 U	0.5 U	3 J	0.5 U	NA	0.5 U
Toluene	0.5 U	0.5 U	13 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	NA	0.5 U
Total Xylenes	3 U	3 U	65 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	NA	3 U
Trans-1,2-Dichloroethene	1 U	0.3 J	25 U	0.7 J	1 U	3 J	1 U	1 U	2 J	1 U	NA	1 U
Trans-1,3-Dichloropropene	3 UJ	3 U	70 U	3 U	3 U	3 U	3 U	3 UJ	3 U	3 U	NA	3 U
Trans-1,4-Dichloro-2-Butene	1 UJ	1 U	25 UJ	1 UJ	1 UJ	1 U	1 UJ	1 UJ	1 UJ	1 UJ	NA	1 UJ
Trichloroethene	8 J	20	310	45 J	5 J	300	30 J	0.5 U	120 J	0.5 U	NA	0.4 J
Trichlorofluoromethane	1 U	1 U	25 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	1 U
Vinyl Acetate	3 UJ	3 UJ	65 UJ	3 U	3 U	3 U	3 U	3 UJ	3 U	3 UJ	NA	3 U

[1] Reanalyzed on February 22, 2002 for gross beta.
Calc = Calculated Value as descibed in Section 3.4.2.1.
NA = Not Analyzed

TABLE A-3-1

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 1 GROUND WATER
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-13	01-14	01-15	01-17	01-18	01-19	01-20	01-21	01-22	01-23	01-23 [1]	01-24
Sample	01GW1301	01GW1401	01GW1501	01GW1701	01GW1801	01GW1901	01GW2001	01GW2101	01GW2201	01GW2301	01GW2301-RE	01GW2401
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Vinyl Chloride	1 U	1 U	25 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	1 U
Semivolatile Organic Compounds (												
1,2,4,5-Tetrachlorobenzene	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
1,2,4-Trichlorobenzene	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
1,2-Dichlorobenzene	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
1,3-Dichlorobenzene	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
1,4-Dichlorobenzene	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
1,4-Naphthoquinone	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
1,4-Phenylenediamine	NA	NA	NA	25 U	25 U	NA	NA	NA	NA	NA	NA	NA
1-Naphthylamine	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
2,2'-Oxybis(1-Chloropropane)	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
2,3,4,6-Tetrachlorophenol	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
2,4,5-Trichlorophenol	NA	NA	NA	25 U	25 U	NA	NA	NA	NA	NA	NA	NA
2,4,6-Trichlorophenol	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
2,4-Dichlorophenol	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
2,4-Dimethylphenol	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
2,4-Dinitrophenol	NA	NA	NA	25 U	25 U	NA	NA	NA	NA	NA	NA	NA
2,6-Dichlorophenol	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
2-Acetylaminofluorene	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
2-Chloronaphthalene	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
2-Chlorophenol	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
2-Methylphenol	NA	NA	NA	6 U	6 U	NA	NA	NA	NA	NA	NA	NA
2-Naphthylamine	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
2-Nitroaniline	NA	NA	NA	13 U	13 U	NA	NA	NA	NA	NA	NA	NA
2-Nitrophenol	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
2-Picoline	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
3,3'-Dichlorobenzidine	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
3,3'-Dimethylbenzidine	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
3-Methylcholanthrene	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
3-Methylphenol	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
3-Nitroaniline	NA	NA	NA	25 U	25 U	NA	NA	NA	NA	NA	NA	NA
4,6-Dinitro-2-Methylphenol	NA	NA	NA	25 U	25 U	NA	NA	NA	NA	NA	NA	NA
4-Aminobiphenyl	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
4-Bromophenyl Phenyl Ether	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
4-Chloro-3-Methylphenol	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
4-Chloroaniline	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
4-Chlorophenyl Phenyl Ether	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
4-Methylphenol	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
4-Nitroaniline	NA	NA	NA	25 U	25 U	NA	NA	NA	NA	NA	NA	NA
4-Nitrophenol	NA	NA	NA	25 U	25 U	NA	NA	NA	NA	NA	NA	NA
4-Nitroquinoline-1-Oxide	NA	NA	NA	25 UR	25 UR	NA	NA	NA	NA	NA	NA	NA
5-Nitro-O-Toluidine	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
7,12-Dimethylbenz(A)Anthracene	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
A,A-Dimethylphenethylamine	NA	NA	NA	25 U	25 U	NA	NA	NA	NA	NA	NA	NA
Acenaphthene	NA	NA	NA	0.2 U	0.2 U	NA	NA	NA	NA	NA	NA	NA
Acenaphthylene	NA	NA	NA	0.2 U	0.2 U	NA	NA	NA	NA	NA	NA	NA
Acetophenone	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
Aniline	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
Anthracene	NA	NA	NA	0.2 U	0.2 U	NA	NA	NA	NA	NA	NA	NA
Aramite	NA	NA	NA	25 U	25 U	NA	NA	NA	NA	NA	NA	NA
Benzo(A)Anthracene	NA	NA	NA	0.2 U	0.2 U	NA	NA	NA	NA	NA	NA	NA
Benzo(A)Pyrene	NA	NA	NA	0.2 U	0.2 U	NA	NA	NA	NA	NA	NA	NA
Benzo(B)Fluoranthene	NA	NA	NA	0.2 U	0.2 U	NA	NA	NA	NA	NA	NA	NA
Benzo(G,H,I)Perylene	NA	NA	NA	0.2 U	0.2 U	NA	NA	NA	NA	NA	NA	NA
Benzo(K)Fluoranthene	NA	NA	NA	0.2 U	0.2 U	NA	NA	NA	NA	NA	NA	NA
Benzyl Alcohol	NA	NA	NA	7 U	7 U	NA	NA	NA	NA	NA	NA	NA
Bis(2-Chloroethoxy)Methane	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA

[1] Reanalyzed on February 22, 2002 for gross beta.
Calc = Calculated Value as descibed in Section 3.4.2.1.
NA = Not Analyzed

TABLE A-3-1

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 1 GROUND WATER
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-13	01-14	01-15	01-17	01-18	01-19	01-20	01-21	01-22	01-23	01-23 [1]	01-24
Sample	01GW1301	01GW1401	01GW1501	01GW1701	01GW1801	01GW1901	01GW2001	01GW2101	01GW2201	01GW2301	01GW2301-RE	01GW2401
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Bis(2-Chloroethyl)Ether	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
Bis(2-Ethylhexyl)Phthalate	NA	NA	NA	5 J	5 U	NA	NA	NA	NA	NA	NA	NA
Butyl Benzyl Phthalate	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
Chlorobenzilate	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	0.2 U	0.2 U	NA	NA	NA	NA	NA	NA	NA
Diallate	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
Dibenzo(A,H)Anthracene	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
Dibenzofuran	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
Diethyl Phthalate	NA	NA	NA	0.2 U	0.2 U	NA	NA	NA	NA	NA	NA	NA
Dimethyl Phthalate	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
Di-N-Butyl Phthalate	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
Di-N-Octyl Phthalate	NA	NA	NA	6 U	6 U	NA	NA	NA	NA	NA	NA	NA
Diphenylamine	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
Ethyl Methane Sulfonate	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	0.2 U	0.2 U	NA	NA	NA	NA	NA	NA	NA
Fluorene	NA	NA	NA	0.2 U	0.2 U	NA	NA	NA	NA	NA	NA	NA
Hexachlorobenzene	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
Hexachlorobutadiene	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
Hexachlorocyclopentadiene	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
Hexachloroethane	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
Hexachlorophene	NA	NA	NA	400 UJ	400 UJ	NA	NA	NA	NA	NA	NA	NA
Hexachloropropene	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-CD)Pyrene	NA	NA	NA	0.2 U	0.2 U	NA	NA	NA	NA	NA	NA	NA
Isodrin	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
Isophorone	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
Isosafrole	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
Kepone	NA	NA	NA	25 U	25 U	NA	NA	NA	NA	NA	NA	NA
Methapyrilene	NA	NA	NA	25 UR	25 UR	NA	NA	NA	NA	NA	NA	NA
Methyl Methane Sulfonate	NA	NA	NA	13 U	13 U	NA	NA	NA	NA	NA	NA	NA
Naphthalene	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
N-Nitrosodiethylamine	NA	NA	NA	6 U	6 U	NA	NA	NA	NA	NA	NA	NA
N-Nitrosodimethylamine	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
N-Nitroso-Di-N-Butylamine	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
N-Nitroso-Di-N-Propylamine	NA	NA	NA	7 U	7 U	NA	NA	NA	NA	NA	NA	NA
N-Nitrosomethylethylamine	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
N-Nitrosomorpholine	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
N-Nitrosopiperidine	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
N-Nitrosopyrrolidine	NA	NA	NA	0.2 U	0.2 U	NA	NA	NA	NA	NA	NA	NA
O,O,O-Triethyl Phosphorothioate	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
O-Toluidine	NA	NA	NA	5 U	5 U	NA	NA	NA	NA	NA	NA	NA
P-(Dimethylamino)Azobenzene	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
Pentachlorobenzene	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
Pentachloronitrobenzene	NA	NA	NA	25 U	25 U	NA	NA	NA	NA	NA	NA	NA
Phenacetin	NA	NA	NA	10 UJ	10 UJ	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	0.2 U	0.2 U	NA	NA	NA	NA	NA	NA	NA
Phenol	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
Pronamide	NA	NA	NA	10 UR	10 UR	NA	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	0.2 U	0.2 U	NA	NA	NA	NA	NA	NA	NA
Pyridine	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
Safrole	NA	NA	NA	10 U	10 U	NA	NA	NA	NA	NA	NA	NA
Energertics (ug/L)												
1,3,5-Trinitrobenzene	NA	NA	NA	0.65 U	0.65 U	NA	NA	NA	NA	NA	NA	NA
1,3-Dinitrobenzene	NA	NA	NA	0.65 U	0.65 U	NA	NA	NA	NA	NA	NA	NA
2,4,6-Trinitrotoluene	NA	NA	NA	0.127 J	0.65 U	NA	NA	NA	NA	NA	NA	NA
2,4-Dinitrotoluene	NA	NA	NA	0.65 U	0.65 U	NA	NA	NA	NA	NA	NA	NA
2,6-Dinitrotoluene	NA	NA	NA	0.65 U	0.65 U	NA	NA	NA	NA	NA	NA	NA
2-Amino-4,6-Dinitrotoluene	NA	NA	NA	0.65 U	0.65 U	NA	NA	NA	NA	NA	NA	NA
2-Nitrotoluene	NA	NA	NA	0.65 U	0.65 U	NA	NA	NA	NA	NA	NA	NA

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TABLE A-3-1

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 1 GROUND WATER
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-13	01-14	01-15	01-17	01-18	01-19	01-20	01-21	01-22	01-23	01-23 [1]	01-24
Sample	01GW1301	01GW1401	01GW1501	01GW1701	01GW1801	01GW1901	01GW2001	01GW2101	01GW2201	01GW2301	01GW2301-RE	01GW2401
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
3-Nitrotoluene	NA	NA	NA	0.65 U	0.65 U	NA	NA	NA	NA	NA	NA	NA
4-Amino-2,6-Dinitrotoluene	NA	NA	NA	0.65 U	0.65 U	NA	NA	NA	NA	NA	NA	NA
4-Nitrotoluene	NA	NA	NA	0.65 U	0.65 U	NA	NA	NA	NA	NA	NA	NA
HMX	NA	NA	NA	0.65 U	0.65 U	NA	NA	NA	NA	NA	NA	NA
Nitrobenzene	NA	NA	NA	0.65 U	0.65 U	NA	NA	NA	NA	NA	NA	NA
RDX	NA	NA	NA	0.65 U	0.65 U	NA	NA	NA	NA	NA	NA	NA
Tetryl	NA	NA	NA	0.65 U	0.65 U	NA	NA	NA	NA	NA	NA	NA
Pesticides/PCBs (ug/L)												
4,4'-DDD	NA	NA	NA	0.08 U	0.08 U	NA	NA	NA	NA	NA	NA	NA
4,4'-DDE	NA	NA	NA	0.08 U	0.08 U	NA	NA	NA	NA	NA	NA	NA
4,4'-DDT	NA	NA	NA	0.08 U	0.08 U	NA	NA	NA	NA	NA	NA	NA
Aldrin	NA	NA	NA	0.04 U	0.04 U	NA	NA	NA	NA	NA	NA	NA
Alpha-BHC	NA	NA	NA	0.04 U	0.04 U	NA	NA	NA	NA	NA	NA	NA
Alpha-Chlordane	NA	NA	NA	0.04 U	0.04 U	NA	NA	NA	NA	NA	NA	NA
Aroclor-1016	NA	NA	NA	1 U	1 U	NA	NA	NA	NA	NA	NA	NA
Aroclor-1221	NA	NA	NA	1 U	1 U	NA	NA	NA	NA	NA	NA	NA
Aroclor-1232	NA	NA	NA	1 U	1 U	NA	NA	NA	NA	NA	NA	NA
Aroclor-1242	NA	NA	NA	1 U	1 U	NA	NA	NA	NA	NA	NA	NA
Aroclor-1248	NA	NA	NA	1 U	1 U	NA	NA	NA	NA	NA	NA	NA
Aroclor-1254	NA	NA	NA	1 U	1 U	NA	NA	NA	NA	NA	NA	NA
Aroclor-1260	NA	NA	NA	1 U	1 U	NA	NA	NA	NA	NA	NA	NA
Beta-BHC	NA	NA	NA	0.04 U	0.04 U	NA	NA	NA	NA	NA	NA	NA
Delta-BHC	NA	NA	NA	0.04 U	0.04 U	NA	NA	NA	NA	NA	NA	NA
Dieldrin	NA	NA	NA	0.08 U	0.08 U	NA	NA	NA	NA	NA	NA	NA
Endosulfan I	NA	NA	NA	0.04 U	0.04 U	NA	NA	NA	NA	NA	NA	NA
Endosulfan II	NA	NA	NA	0.08 U	0.08 U	NA	NA	NA	NA	NA	NA	NA
Endosulfan Sulfate	NA	NA	NA	0.08 U	0.08 U	NA	NA	NA	NA	NA	NA	NA
Endrin	NA	NA	NA	0.08 U	0.08 U	NA	NA	NA	NA	NA	NA	NA
Endrin Aldehyde	NA	NA	NA	0.08 U	0.08 U	NA	NA	NA	NA	NA	NA	NA
Gamma-BHC (Lindane)	NA	NA	NA	0.04 U	0.04 U	NA	NA	NA	NA	NA	NA	NA
Gamma-Chlordane	NA	NA	NA	0.04 U	0.04 U	NA	NA	NA	NA	NA	NA	NA
Heptachlor	NA	NA	NA	0.041 BU	0.032 BU	NA	NA	NA	NA	NA	NA	NA
Heptachlor Epoxide	NA	NA	NA	0.04 U	0.04 U	NA	NA	NA	NA	NA	NA	NA
Methoxychlor	NA	NA	NA	0.38 U	0.38 U	NA	NA	NA	NA	NA	NA	NA
Toxaphene	NA	NA	NA	2.5 U	2.5 U	NA	NA	NA	NA	NA	NA	NA
Herbicides (ug/L)												
2,4,5-T	NA	NA	NA	0.8 U	0.8 U	NA	NA	NA	NA	NA	NA	NA
2,4,5-TP (Silvex)	NA	NA	NA	0.5 U	0.5 U	NA	NA	NA	NA	NA	NA	NA
2,4-D	NA	NA	NA	2.5 U	2.5 U	NA	NA	NA	NA	NA	NA	NA
Dinoseb	NA	NA	NA	1 U	1 U	NA	NA	NA	NA	NA	NA	NA
Pentachlorophenol	NA	NA	NA	0.5 U	0.5 U	NA	NA	NA	NA	NA	NA	NA
Total Metals (ug/L)												
Aluminum	40.2 U	40.2 U	46.3	40.3 U	249	62.6	40.3 U	40.2 U	40.3 U	40.2 U	NA	107
Antimony	1.6 U	4.1 U	3.1	1.6 U	2.0	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	NA	1.6 U
Arsenic	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	NA	1.5 U
Barium	24.9	15.1	24.3	9.7	26.5	9.5	13.4	30.3	9.9	5.4 J	NA	88.1
Beryllium	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	NA	0.40 U
Cadmium	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	NA	0.30 U
Calcium	107000	154000 J	145000	46000	93800	110000	244000	128000	112000	282000 J	NA	75800
Chromium	0.60 U	0.60 UJ	0.60 U	0.83	0.79	1.6	1.2	0.60 U	0.70	0.60 U	NA	0.70 U
Cobalt	4.6	27.8 J	10.8	1.9	4.3	1.0 U	1.6	1.0 U	1.0 U	1.0 U	NA	6.6
Copper	0.90 U	0.90 U	0.90 U	0.90 U	0.90 U	0.90 U	0.90 U	0.90 U	0.90 U	0.90 UJ	NA	0.94
Iron	488	44600	16700	89.6	4090	134	158	15300	20.3 U	1050	NA	4460
Lead	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	NA	1.6 U
Magnesium	17800	59200 J	48600	36500	16300	45700	148000	64300	50000	139000 J	NA	27300
Manganese	647	6050 J	3860	4.7	736	6.0	44.5	977	2.9	446 J	NA	949
Mercury	0.10 U	0.10 U	0.10 U	0.12	0.10 U	0.12	0.10 U	0.10 U	0.12	0.10 U	NA	0.10
Nickel	19.5	52.2	12.7	0.70 U	4.3	2.5	27.3	1.4	2.3	3.5 U	NA	13.6

[1] Reanalyzed on February 22, 2002 for gross beta.
Calc = Calculated Value as descibed in Section 3.4.2.1.
NA = Not Analyzed

TABLE A-3-1

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 1 GROUND WATER
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-13	01-14	01-15	01-17	01-18	01-19	01-20	01-21	01-22	01-23	01-23 [1]	01-24
Sample	01GW1301	01GW1401	01GW1501	01GW1701	01GW1801	01GW1901	01GW2001	01GW2101	01GW2201	01GW2301	01GW2301-RE	01GW2401
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Potassium	1330	2560 J	1980	1200 J	1720 J	1370 J	5440 J	6060	1320 J	6150	NA	2370 J
Selenium	0.80 U	4.2 U	0.80 U	0.80 U	0.80 U	0.80 U	0.80 U	0.80 U	2.0 U	0.80 UJ	NA	0.80 U
Silver	3.0 U	3.0 U	3.0 U	0.90	0.88	0.87	0.70 U	3.0 U	0.70 U	3.0 U	NA	0.70
Sodium	7290	54700 J	35200	61700	27000	71600	22000	14800	81900	29300 J	NA	10400
Strontium	132 J	277 J	253 J	124 J	109 J	137 J	333 J	948 J	185 J	823 J	NA	325 J
Thallium	5.0 U	5.0 U	5.0 U	5.1	2.5	3.9	5.1	5.0 U	3.0	5.0 UJ	NA	4.4
Thorium - Calc	NA	NA	NA	0.579 U	0.683 U	NA	NA	NA	NA	NA	NA	NA
Tin	190 U	190 U	190 U	17.3 U	17.3 U	17.3 U	17.3 U	190 U	17.3 U	190 U	NA	17.3 U
Vanadium	3.0 U	3.0 U	3.0 U	0.50 U	0.75	0.53	0.53	3.0 U	0.50 U	3.0 U	NA	0.58
Zinc	17.9	24.0 U	1.1 U	1.7 U	4.3	7.0	5.0	1.1 U	3.9	1.1 UJ	NA	3.9
Dissolved Metals (ug/L)												
Aluminum	40.2 U	NA	NA	NA	40.3 U	NA	40.3 U	NA	NA	40.2 U	NA	NA
Antimony	1.6 U	NA	NA	NA	1.6 U	NA	2.1 J	NA	NA	2.3 U	NA	NA
Arsenic	2.1 U	NA	NA	NA	1.5 U	NA	1.5 UJ	NA	NA	1.7 J	NA	NA
Barium	23.5	NA	NA	NA	24.8	NA	12.9	NA	NA	5.4 J	NA	NA
Beryllium	0.40 U	NA	NA	NA	0.40 U	NA	0.40 U	NA	NA	0.40 U	NA	NA
Cadmium	0.30 U	NA	NA	NA	0.30 U	NA	0.30 UJ	NA	NA	0.30 U	NA	NA
Calcium	102000	NA	NA	NA	96600	NA	275000	NA	NA	279000 J	NA	NA
Chromium	0.60 U	NA	NA	NA	0.70 U	NA	1.1	NA	NA	0.60 U	NA	NA
Cobalt	3.0	NA	NA	NA	3.2	NA	1.0 U	NA	NA	1.0 U	NA	NA
Copper	0.90 U	NA	NA	NA	0.90 U	NA	0.90 U	NA	NA	1.2 U	NA	NA
Iron	252	NA	NA	NA	748	NA	20.3 U	NA	NA	150	NA	NA
Lead	1.6 U	NA	NA	NA	1.6 U	NA	1.6 U	NA	NA	1.6 U	NA	NA
Magnesium	17100	NA	NA	NA	16700	NA	173000	NA	NA	138000 J	NA	NA
Manganese	538	NA	NA	NA	765	NA	13.7	NA	NA	386 J	NA	NA
Mercury	0.10 U	NA	NA	NA	0.10 U	NA	0.10	NA	NA	0.10 U	NA	NA
Nickel	16.1	NA	NA	NA	4.6	NA	27.2	NA	NA	1.4 U	NA	NA
Potassium	1270	NA	NA	NA	1770 J	NA	5480 J	NA	NA	5940	NA	NA
Selenium	0.80 U	NA	NA	NA	0.80 U	NA	1.5 U	NA	NA	0.80 UJ	NA	NA
Silver	3.0 U	NA	NA	NA	0.70 U	NA	0.70 U	NA	NA	3.0 U	NA	NA
Sodium	7130	NA	NA	NA	27500	NA	23600	NA	NA	28800 J	NA	NA
Strontium	128 J	NA	NA	NA	109 J	NA	366 J	NA	NA	807 J	NA	NA
Thallium	5.0 U	NA	NA	NA	5.4	NA	7.7 J	NA	NA	5.0 UJ	NA	NA
Thorium - Calc	NA	NA	NA	NA	1.10 U	NA	NA	NA	NA	NA	NA	NA
Tin	190 U	NA	NA	NA	17.3 U	NA	17.3 U	NA	NA	190 U	NA	NA
Vanadium	3.0 U	NA	NA	NA	0.50 U	NA	0.77	NA	NA	3.0 U	NA	NA
Zinc	13.5	NA	NA	NA	7.1	NA	7.6	NA	NA	1.1 UJ	NA	NA
Miscellaneous Parameters (mg/L)												
1,4-Dithiane	NA	NA	NA	200 U	200 U	NA	NA	NA	NA	NA	NA	NA
1,4-Oxathiane	NA	NA	NA	200 U	200 U	NA	NA	NA	NA	NA	NA	NA
Bis(2-Chloroethyl)Sulfide	NA	NA	NA	200 U	200 U	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Radiologicals (pCi/L)												
Gross Alpha	1.68 J	5.57	3.92 J	1.24 U	2.30 J	2.01 U	4.73 U	2.60 J	2.06 U	8.53 J	NA	1.36 J
Gross Beta	3.28 U	6.38	9.25 J	1.58 U	2.78	2.52 U	9.81	7.78 J	2.40 U	50.2 J	8.35	1.99
Thorium-228	NA	NA	NA	0.0710 U	0.0893 U	NA	NA	NA	NA	NA	NA	NA
Thorium-230	NA	NA	NA	0.0764 U	0.0746 U	NA	NA	NA	NA	NA	NA	NA
Thorium-232	NA	NA	NA	0.0563 U	0.0610 U	NA	NA	NA	NA	NA	NA	NA
Dissolved Radiologicals (pCi/L)												
Gross Alpha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gross Beta	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thorium-228	NA	NA	NA	NA	0.149 U	NA	NA	NA	NA	NA	NA	NA
Thorium-230	NA	NA	NA	NA	0.158 U	NA	NA	NA	NA	NA	NA	NA
Thorium-232	NA	NA	NA	NA	0.0919 U	NA	NA	NA	NA	NA	NA	NA
Field Parameters												
Dissolved Oxygen (mg/L)	0.38	0.08	0.702	2.82	0.86	2.07	2.67	1.19	1.55	1.58	NA	0.54
Oxidation Reduction Potential (mV)	206	-156	75.2	474	93.8	434	327	28.1	511	433.2	NA	78.5
pH (S.U.)	6.44	6.50	6.59	5.54	6.94	6.43	7.14	5.61	6.41	4.99	NA	6.69

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NA = Not Analyzed

TABLE A-3-1

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 1 GROUND WATER
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location Sample Matrix	01-13 01GW1301 Ground Water	01-14 01GW1401 Ground Water	01-15 01GW1501 Ground Water	01-17 01GW1701 Ground Water	01-18 01GW1801 Ground Water	01-19 01GW1901 Ground Water	01-20 01GW2001 Ground Water	01-21 01GW2101 Ground Water	01-22 01GW2201 Ground Water	01-23 01GW2301 Ground Water	01-23 [1] 01GW2301-RE Ground Water	01-24 01GW2401 Ground Water
Specific Conductance (mS/cm)	0.608	1.47	1.352	0.824	0.768	1.162	1.567	1.1	1.281	2.161	NA	0.679
Temperature (C)	16.34	16.5	14.74	16.5	16.77	16.8	15	14.73	16.46	17.79	NA	15.02
Turbidity (NTU)	6	4	3.9	3.7	31	3.4	11	4.2	1.7	30	NA	2

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NA = Not Analyzed

TABLE A-3-1

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 1 GROUND WATER
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-25	01-26	01-27	01C01	01T02	01T02
Sample	01GW2501	01GW2601	01GW2701	01GWC0101	01GWT0201	01GWT0202
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Background	Background
Risk	Site	Site	Site	Site	Site	Site
Sample Date	9/8/2001	9/6/2001	9/8/2001	8/25/2001	9/19/2001	9/22/2001
Volatile Organic Compounds (ug/L						
1,1,1,2-Tetrachloroethane	2 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,1-Trichloroethane	3 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2,2-Tetrachloroethane	32	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloroethane	5 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethane	3 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1-Dichloroethene	5 U	1 U	1 U	1 U	1 U	1 U
1,2,3-Trichloropropane	3 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dibromo-3-Chloropropane	5 UJ	1 UJ	1 UJ	1 UJ	1 U	1 U
1,2-Dibromoethane	3 U	0.6 U	0.6 U	0.8 U	0.6 U	0.6 U
1,2-Dichloroethane	3 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichloropropane	5 U	1 U	1 U	1 U	1 U	1 U
1,4-Dioxane	500 UR	100 UR	100 UR	100 UR	100 UR	100 UR
2-Butanone	25 UR	5 UR	5 UR	5 UR	5 UJ	5 UJ
2-Hexanone	25 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ
3-Chloropropene	25 U	5 U	5 U	5 U	5 U	5 U
4-Methyl-2-Pentanone	13 U	3 U	3 UJ	3 UJ	3 U	3 U
Acetone	25 UR	5 UR	5 UR	5 UR	5 UR	5 UR
Acetonitrile	200 U	40 U	40 U	40 U	40 U	40 U
Acrolein	50 UR	10 UR	10 UR	10 UR	10 UR	10 UR
Acrylonitrile	50 UR	10 UR	10 UR	10 U	10 UR	10 UR
Benzene	3 U	0.5 U	0.5 U	0.5 UR	0.5 U	0.5 U
Bromodichloromethane	3 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromoform	3 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U
Bromomethane	5 UJ	1 U	1 U	1 U	1 U	1 U
Carbon Disulfide	5 U	1 U	1 U	1 UJ	1 U	1 U
Carbon Tetrachloride	3 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 UJ
Chlorobenzene	3 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chlorodibromomethane	3 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chloroethane	5 U	1 U	1 U	1 U	1 U	1 U
Chloroform	7 J	0.5 U	0.5 U	0.5 U	0.3 BU	0.2 BU
Chloromethane	5 U	1 U	1 U	1 U	1 U	1 U
Chloroprene	5 UJ	1 UJ	1 UJ	1 U	1 U	1 U
Cis-1,2-Dichloroethene	5 U	1 U	1 U	1 U	1 U	1 U
Cis-1,3-Dichloropropene	13 U	3 U	3 U	3 U	3 U	3 U
Dibromomethane	5 U	1 U	1 U	1 U	1 U	1 U
Dichlorodifluoromethane	4 UJ	0.7 UJ	0.7 UJ	0.7 U	0.7 U	0.7 U
Ethyl Methacrylate	5 U	1 U	1 U	1 UJ	1 U	1 U
Ethylbenzene	3 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Isobutanol	200 UR	40 UR	40 UR	40 UR	40 UR	40 UR
Methacrylonitrile	100 UR	20 UR	20 UR	20 UR	20 UR	20 UR
Methyl Iodide	5 U	1 U	1 U	1 U	1 U	1 U
Methyl Methacrylate	5 U	1 U	1 U	1 UJ	1 U	1 U
Methylene Chloride	1 U	1 U	0.3 BU	1 BU	0.2 J	1 U
Pentachloroethane	25 U	5 U	5 U	5 UJ	5 U	5 U
Propionitrile	100 UR	20 UR	20 UR	20 UR	20 UR	20 UR
Styrene	3 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Tetrachloroethene	3 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Toluene	3 U	0.5 U	0.5 U	0.5 U	0.6 J	0.3 J
Total Xylenes	13 U	3 U	3 U	3 U	3 U	3 U
Trans-1,2-Dichloroethene	5 U	1 U	1 U	1 U	1 U	1 U
Trans-1,3-Dichloropropene	14 U	3 U	3 UJ	3 U	3 U	3 U
Trans-1,4-Dichloro-2-Butene	5 UJ	1 UJ	1 UJ	1 U	1 UJ	1 UJ
Trichloroethene	65 J	0.5 U	0.5 U	0.5 U	0.2 J	0.2 J
Trichlorofluoromethane	5 U	1 U	1 U	1 U	1 U	1 U
Vinyl Acetate	13 UJ	3 UJ	3 UJ	3 UJ	3 U	3 U

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NA = Not Analyzed

TABLE A-3-1

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 1 GROUND WATER
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location Sample Matrix	01-25 01GW2501 Ground Water	01-26 01GW2601 Ground Water	01-27 01GW2701 Ground Water	01C01 01GWC0101 Ground Water	01T02 01GWT0201 Background	01T02 01GWT0202 Background
Vinyl Chloride	5 U	1 U	1 U	1 U	1 U	1 U
Semivolatile Organic Compounds (						
1,2,4,5-Tetrachlorobenzene	10 U	NA	NA	10 U	10 U	10 U
1,2,4-Trichlorobenzene	10 U	NA	NA	10 U	10 U	10 U
1,2-Dichlorobenzene	5 U	NA	NA	5 U	5 U	5 U
1,3-Dichlorobenzene	5 U	NA	NA	5 U	5 U	5 U
1,4-Dichlorobenzene	5 U	NA	NA	5 U	5 U	5 U
1,4-Naphthoquinone	10 U	NA	NA	10 U	10 U	10 U
1,4-Phenylenediamine	25 U	NA	NA	25 UJ	25 U	25 U
1-Naphthylamine	10 U	NA	NA	10 U	10 U	10 U
2,2'-Oxybis(1-Chloropropane)	5 U	NA	NA	5 U	5 U	5 U
2,3,4,6-Tetrachlorophenol	10 U	NA	NA	10 U	10 U	10 U
2,4,5-Trichlorophenol	25 U	NA	NA	25 U	25 U	25 U
2,4,6-Trichlorophenol	10 U	NA	NA	10 U	10 U	10 U
2,4-Dichlorophenol	10 U	NA	NA	10 U	10 U	10 U
2,4-Dimethylphenol	10 U	NA	NA	10 U	10 U	10 U
2,4-Dinitrophenol	25 U	NA	NA	25 U	25 U	25 U
2,6-Dichlorophenol	10 U	NA	NA	10 U	10 U	10 U
2-Acetylaminofluorene	5 U	NA	NA	5 U	5 U	5 U
2-Chloronaphthalene	5 U	NA	NA	5 U	5 U	5 U
2-Chlorophenol	5 U	NA	NA	5 U	5 U	5 U
2-Methylnaphthalene	5 U	NA	NA	5 U	5 U	5 U
2-Methylphenol	6 U	NA	NA	6 U	6 U	6 U
2-Naphthylamine	5 U	NA	NA	5 U	5 U	5 U
2-Nitroaniline	13 U	NA	NA	13 U	13 U	13 U
2-Nitrophenol	10 U	NA	NA	10 U	10 U	10 U
2-Picoline	5 U	NA	NA	5 U	5 U	5 U
3,3'-Dichlorobenzidine	10 U	NA	NA	10 U	10 U	10 U
3,3'-Dimethylbenzidine	10 U	NA	NA	10 U	10 U	10 UJ
3-Methylcholanthrene	5 U	NA	NA	5 U	5 U	5 U
3-Methylphenol	5 U	NA	NA	5 U	5 U	5 U
3-Nitroaniline	25 U	NA	NA	25 U	25 U	25 U
4,6-Dinitro-2-Methylphenol	25 U	NA	NA	25 U	25 U	25 U
4-Aminobiphenyl	5 U	NA	NA	5 U	5 U	5 U
4-Bromophenyl Phenyl Ether	10 U	NA	NA	10 U	10 U	10 U
4-Chloro-3-Methylphenol	10 U	NA	NA	10 U	10 U	10 U
4-Chloroaniline	10 U	NA	NA	10 U	10 U	10 U
4-Chlorophenyl Phenyl Ether	5 U	NA	NA	5 U	5 U	5 U
4-Methylphenol	5 U	NA	NA	5 U	5 U	5 U
4-Nitroaniline	25 U	NA	NA	25 U	25 U	25 U
4-Nitrophenol	25 U	NA	NA	25 U	25 U	25 U
4-Nitroquinoline-1-Oxide	25 UR	NA	NA	25 UR	25 UR	25 UR
5-Nitro-O-Toluidine	10 U	NA	NA	10 U	10 U	10 U
7,12-Dimethylbenz(A)Anthracene	5 U	NA	NA	5 U	5 U	5 UJ
A,A-Dimethylphenethylamine	25 U	NA	NA	25 U	25 U	25 U
Acenaphthene	0.2 U	NA	NA	0.108 J	0.2 U	0.2 U
Acenaphthylene	0.2 U	NA	NA	0.2 U	0.2 U	0.2 U
Acetophenone	5 U	NA	NA	5 U	5 U	5 U
Aniline	10 U	NA	NA	10 U	10 U	10 U
Anthracene	0.2 U	NA	NA	0.2 U	0.2 U	0.2 U
Aramite	25 U	NA	NA	25 U	25 U	25 U
Benzo(A)Anthracene	0.2 U	NA	NA	0.2 U	0.2 U	0.2 U
Benzo(A)Pyrene	0.2 U	NA	NA	0.2 U	0.2 U	0.2 U
Benzo(B)Fluoranthene	0.2 U	NA	NA	0.2 U	0.2 U	0.2 U
Benzo(G,H,I)Perylene	0.2 U	NA	NA	0.2 U	0.2 U	0.2 U
Benzo(K)Fluoranthene	0.2 U	NA	NA	0.2 U	0.2 U	0.2 U
Benzyl Alcohol	7 U	NA	NA	7 U	7 U	7 U
Bis(2-Chloroethoxy)Methane	10 U	NA	NA	10 U	10 U	10 U

(1) Reanalyzed on February 22, 2002 for gross beta.
Calc = Calculated Value as descibed in Section 3.4.2.1.
NA = N[illegible]yzed

TABLE A-3-1

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 1 GROUND WATER
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-25	01-26	01-27	01C01	01T02	01T02
Sample	01GW2501	01GW2601	01GW2701	01GWC0101	01GWT0201	01GWT0202
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Background	Background
Bis(2-Chloroethyl)Ether	5 U	NA	NA	5 U	5 U	5 U
Bis(2-Ethylhexyl)Phthalate	5 U	NA	NA	5 U	5 U	5 U
Butyl Benzyl Phthalate	5 U	NA	NA	5 U	5 U	5 U
Chlorobenzilate	10 U	NA	NA	10 U	10 U	10 U
Chrysene	0.2 U	NA	NA	0.2 U	0.2 U	0.2 U
Diallate	5 UJ	NA	NA	5 U	5 U	5 U
Dibenzo(A,H)Anthracene	5 U	NA	NA	5 U	5 U	5 U
Dibenzofuran	10 U	NA	NA	10 U	10 U	10 U
Diethyl Phthalate	0.2 U	NA	NA	0.2 U	0.2 U	0.2 U
Dimethyl Phthalate	5 U	NA	NA	5 U	5 U	5 U
Di-N-Butyl Phthalate	5 U	NA	NA	5 U	5 U	5 U
Di-N-Octyl Phthalate	6 U	NA	NA	6 U	6 U	6 U
Diphenylamine	5 U	NA	NA	5 U	5 U	5 U
Ethyl Methane Sulfonate	5 U	NA	NA	5 U	5 U	5 U
Fluoranthene	0.2 U	NA	NA	0.2 U	0.2 U	0.2 U
Fluorene	0.2 U	NA	NA	0.2 U	0.2 U	0.2 U
Hexachlorobenzene	10 U	NA	NA	10 U	10 U	10 U
Hexachlorobutadiene	10 U	NA	NA	10 U	10 U	10 U
Hexachlorocyclopentadiene	10 U	NA	NA	10 U	10 U	10 U
Hexachloroethane	5 U	NA	NA	5 U	5 U	5 U
Hexachlorophene	400 UJ	NA	NA	400 UJ	400 UJ	400 UR
Hexachloropropene	10 U	NA	NA	10 U	10 U	10 U
Indeno(1,2,3-CD)Pyrene	0.2 U	NA	NA	0.2 U	0.2 U	0.2 U
Isodrin	10 U	NA	NA	10 U	10 U	10 U
Isophorone	5 U	NA	NA	5 U	5 U	5 U
Isosafrole	10 U	NA	NA	10 U	10 U	10 U
Kepone	25 U	NA	NA	25 U	25 U	25 U
Methapyrilene	25 UR	NA	NA	25 U	25 UR	25 UR
Methyl Methane Sulfonate	13 U	NA	NA	13 U	13 U	13 U
Naphthalene	10 U	NA	NA	10 U	10 U	10 U
N-Nitrosodiethylamine	6 U	NA	NA	6 U	6 U	6 U
N-Nitrosodimethylamine	5 U	NA	NA	5 U	5 U	5 U
N-Nitroso-Di-N-Butylamine	5 U	NA	NA	5 U	5 U	5 U
N-Nitroso-Di-N-Propylamine	7 U	NA	NA	7 U	7 U	7 U
N-Nitrosomethylethylamine	5 U	NA	NA	5 U	5 U	5 U
N-Nitrosomorpholine	10 U	NA	NA	10 U	10 U	10 U
N-Nitrosopiperidine	5 U	NA	NA	5 U	5 U	5 U
N-Nitrosopyrrolidine	0.2 U	NA	NA	0.2 U	0.2 U	0.2 U
O,O,O-Triethyl Phosphorothioate	10 U	NA	NA	10 U	10 U	10 U
O-Toluidine	5 U	NA	NA	5 U	5 U	5 U
P-(Dimethylamino)Azobenzene	10 U	NA	NA	10 U	10 U	10 U
Pentachlorobenzene	10 U	NA	NA	10 U	10 U	10 U
Pentachloronitrobenzene	25 U	NA	NA	25 U	25 U	25 U
Phenacetin	10 U	NA	NA	10 U	10 UJ	10 UJ
Phenanthrene	0.2 U	NA	NA	0.2 U	0.2 U	0.2 U
Phenol	10 U	NA	NA	10 U	10 U	10 U
Pronamide	10 UR	NA	NA	10 UR	10 UR	10 UR
Pyrene	0.2 U	NA	NA	0.2 U	0.2 U	0.2 U
Pyridine	10 U	NA	NA	10 U	10 U	10 U
Safrole	10 U	NA	NA	10 U	10 U	10 U
Energertics (ug/L)						
1,3,5-Trinitrobenzene	0.65 U	NA	NA	0.65 U	0.65 U	0.65 U
1,3-Dinitrobenzene	0.65 U	NA	NA	0.65 U	0.0771 J	0.65 U
2,4,6-Trinitrotoluene	0.65 U	NA	NA	0.65 U	0.65 U	0.65 U
2,4-Dinitrotoluene	0.65 U	NA	NA	0.65 U	0.65 U	0.65 U
2,6-Dinitrotoluene	0.65 U	NA	NA	0.65 U	0.65 U	0.65 U
2-Amino-4,6-Dinitrotoluene	0.65 U	NA	NA	0.65 U	0.65 U	0.65 U
2-Nitrotoluene	0.65 U	NA	NA	0.65 U	0.65 U	0.65 U

(1) Reanalyzed on February 22, 2002 for gross beta.
Calc = Calculated Value as descibed in Section 3.4.2.1.
NA = Not Analyzed

TABLE A-3-1

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 1 GROUND WATER
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location Sample Matrix	01-25 01GW2501 Ground Water	01-26 01GW2601 Ground Water	01-27 01GW2701 Ground Water	01C01 01GWC0101 Ground Water	01T02 01GWT0201 Background	01T02 01GWT0202 Background
3-Nitrotoluene	0.65 U	NA	NA	0.65 U	0.65 U	0.65 U
4-Amino-2,6-Dinitrotoluene	0.65 U	NA	NA	0.65 U	0.275 J	0.65 U
4-Nitrotoluene	0.65 U	NA	NA	0.65 U	0.65 U	0.65 U
HMX	0.65 U	NA	NA	0.65 U	0.65 U	0.65 U
Nitrobenzene	0.65 U	NA	NA	0.65 U	0.65 U	0.65 U
RDX	0.65 U	NA	NA	0.65 U	0.65 U	0.65 U
Tetryl	0.65 U	NA	NA	0.65 U	0.65 U	0.65 U
Pesticides/PCBs (ug/L)						
4,4'-DDD	0.08 U	NA	NA	0.08 U	0.08 U	0.08 U
4,4'-DDE	0.08 U	NA	NA	0.08 U	0.08 U	0.08 U
4,4'-DDT	0.08 U	NA	NA	0.08 U	0.08 U	0.08 U
Aldrin	0.04 U	NA	NA	0.04 U	0.04 U	0.04 U
Alpha-BHC	0.04 U	NA	NA	0.04 U	0.04 U	0.04 U
Alpha-Chlordane	0.04 U	NA	NA	0.04 U	0.04 U	0.04 U
Aroclor-1016	1 U	NA	NA	1 U	1 U	1 U
Aroclor-1221	1 U	NA	NA	1 U	1 U	1 U
Aroclor-1232	1 U	NA	NA	1 U	1 U	1 U
Aroclor-1242	1 U	NA	NA	1 U	1 U	1 U
Aroclor-1248	1 U	NA	NA	1 U	1 U	1 U
Aroclor-1254	1 U	NA	NA	1 U	1 U	1 U
Aroclor-1260	1 U	NA	NA	1 U	1 U	1 U
Beta-BHC	0.04 U	NA	NA	0.04 U	0.04 U	0.04 U
Delta-BHC	0.04 U	NA	NA	0.04 U	0.04 U	0.04 U
Dieldrin	0.08 U	NA	NA	0.08 U	0.08 U	0.08 U
Endosulfan I	0.04 U	NA	NA	0.04 U	0.04 U	0.04 U
Endosulfan Ii	0.08 U	NA	NA	0.08 U	0.08 U	0.08 U
Endosulfan Sulfate	0.08 U	NA	NA	0.08 U	0.08 U	0.08 U
Endrin	0.08 U	NA	NA	0.08 U	0.08 U	0.08 U
Endrin Aldehyde	0.08 U	NA	NA	0.08 U	0.08 U	0.08 U
Gamma-BHC (Lindane)	0.04 U	NA	NA	0.04 U	0.04 U	0.04 U
Gamma-Chlordane	0.04 U	NA	NA	0.04 U	0.04 U	0.04 U
Heptachlor	0.02 U	NA	NA	0.017 J	0.051 BU	0.034 U
Heptachlor Epoxide	0.04 U	NA	NA	0.04 U	0.04 U	0.04 U
Methoxychlor	0.38 U	NA	NA	0.38 U	0.38 U	0.38 U
Toxaphene	2.5 U	NA	NA	2.5 U	2.5 U	2.5 U
Herbicides (ug/L)						
2,4,5-T	0.8 U	NA	NA	0.8 U	0.8 U	0.8 U
2,4,5-TP (Silvex)	0.5 U	NA	NA	0.5 U	0.5 U	0.5 U
2,4-D	2.5 U	NA	NA	2.5 U	2.5 U	2.5 U
Dinoseb	1 U	NA	NA	1 U	1 U	1 U
Pentachlorophenol	0.5 U	NA	NA	0.5 U	0.5 U	0.5 U
Total Metals (ug/L)						
Aluminum	40.2 U	170	163	40.2 U	1580	40.3 U
Antimony	1.6 U	1.7 U	2.6 U	1.6 U	1.6 U	1.6 U
Arsenic	1.5 U	1.5 U	1.5 U	1.6 U	2.2 J	1.5 UJ
Barium	10.3	21.2	54.9	39.2	59.0	17.8
Beryllium	0.40 U	0.40 U	0.40 U	0.40 U	0.70 J	0.40 U
Cadmium	0.30 U	0.30 U	0.30 U	0.30 U	0.30 UJ	0.30 UJ
Calcium	120000 J	149000 J	138000 J	72800 J	304000	330000
Chromium	0.60 U	0.60 U	0.62 U	0.80	5.4	0.70 U
Cobalt	1.0 U	4.0	2.6	1.0 U	55.8	66.3
Copper	0.90 U	0.90 U	0.98 U	0.90 U	4.9	0.90 U
Iron	20.2 U	3560	941	37.8	19500	10600
Lead	1.6 U	1.6 U	1.6 U	1.6 U	4.3	1.6 U
Magnesium	52800 J	71900 J	62000 J	26500	218000	242000
Manganese	43.3 J	3410 J	1150 J	24.8 J	8040	9170
Mercury	0.10 U	0.10 U	0.10 U	0.10 U	0.12	0.11
Nickel	2.0 U	5.7 U	4.0 U	1.5	115	124

(1) Reanalyzed on February 22, 2002 for gross beta.
Calc = Calculated Value as descibed in Section 3.4.2.1.
NA = Not Analyzed

TABLE A-3-1

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 1 GROUND WATER
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-25	01-26	01-27	01C01	01T02	01T02
Sample	01GW2501	01GW2601	01GW2701	01GWC0101	01GWT0201	01GWT0202
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Background	Background
Potassium	1860	3650	2300	1300 J	14300 J	15500 J
Selenium	0.80 U	0.80 U	0.80 U	0.80 U	0.80 U	0.95 U
Silver	3.0 U	3.0 U	3.0 U	3.0 U	0.70 U	0.70 U
Sodium	87000 J	64400 J	57300 J	5710 J	81500	84000
Strontium	209 J	375 J	266 J	228 J	3820 J	3990 J
Thallium	5.0 UJ	5.0 UJ	5.0 UJ	5.0 U	2.4 UJ	2.4 UJ
Thorium - Calc	0.845 U	NA	NA	0.672 U	1.50	0.156
Tin	190 U	190 U	190 U	190 U	17.3 U	17.3 U
Vanadium	3.0 U	3.0 U	3.0 U	3.0 U	1.4	0.50 U
Zinc	1.1 U	5.3 U	1.6 U	4.5 U	32.1	16.4
Dissolved Metals (ug/L)						
Aluminum	NA	146	40.2 U	NA	NA	NA
Antimony	NA	1.6 U	1.6 U	NA	NA	NA
Arsenic	NA	1.5 U	1.5 U	NA	NA	NA
Barium	NA	21.6	50.4	NA	NA	NA
Beryllium	NA	0.40 U	0.40 U	NA	NA	NA
Cadmium	NA	0.30 U	0.30 U	NA	NA	NA
Calcium	NA	158000 J	136000 J	NA	NA	NA
Chromium	NA	0.60 U	0.60 U	NA	NA	NA
Cobalt	NA	4.0	1.7	NA	NA	NA
Copper	NA	0.90 U	0.99 U	NA	NA	NA
Iron	NA	3270	416	NA	NA	NA
Lead	NA	1.6 U	1.6 U	NA	NA	NA
Magnesium	NA	76500 J	60000 J	NA	NA	NA
Manganese	NA	3610 J	1070 J	NA	NA	NA
Mercury	NA	0.10 U	0.10 U	NA	NA	NA
Nickel	NA	5.3 U	3.1 U	NA	NA	NA
Potassium	NA	3860	2190	NA	NA	NA
Selenium	NA	0.80 U	0.80 U	NA	NA	NA
Silver	NA	3.0 U	3.0 U	NA	NA	NA
Sodium	NA	66900 J	54100 J	NA	NA	NA
Strontium	NA	395 J	259 J	NA	NA	NA
Thallium	NA	5.0 UJ	5.0 UJ	NA	NA	NA
Thorium - Calc	NA	NA	NA	NA	NA	NA
Tin	NA	190 U	190 U	NA	NA	NA
Vanadium	NA	3.0 U	3.0 U	NA	NA	NA
Zinc	NA	1.1 U	1.1 U	NA	NA	NA
Miscellaneous Parameters (mg/L)						
1,4-Dithiane	200 U	NA	NA	200 U	200 U	200 U
1,4-Oxathiane	200 U	NA	NA	200 U	200 U	200 U
Bis(2-Chloroethyl)Sulfide	200 U	NA	NA	200 U	200 U	200 U
Total Organic Carbon	NA	NA	NA	2.9	1.73	2.38
Total Radiologicals (pCi/L)						
Gross Alpha	2.59 UJ	4.28 J	2.32 UJ	3.26 J	10.5 J	6.06 U
Gross Beta	2.50 U	7.97 J	2.70	4.03 U	20.8	19.3
Thorium-228	0.119 U	NA	NA	0.0933 U	0.172	0.0216 U
Thorium-230	0.145 U	NA	NA	0.0941 U	0.329 U	0.047 U
Thorium-232	0.0669 U	NA	NA	0.0546 U	0.157	0.0235
Dissolved Radiologicals (pCi/L)						
Gross Alpha	NA	NA	NA	NA	NA	NA
Gross Beta	NA	NA	NA	NA	NA	NA
Thorium-228	NA	NA	NA	NA	NA	NA
Thorium-230	NA	NA	NA	NA	NA	NA
Thorium-232	NA	NA	NA	NA	NA	NA
Field Parameters						
Dissolved Oxygen (mg/L)	0.74	0.75	2.89	0.12	7.67	6.7
Oxidation Reduction Potential (mV)	433	543.9	396.1	365.7	346	343
pH (S.U.)	6.4	7	6.06	6.97	5.4	5.42

(1) Reanalyzed on February 22, 2002 for gross beta.
Calc = Calculated Value as descibed in Section 3.4.2.1.
NA = Not Analyzed

TABLE A-3-1

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 1 GROUND WATER
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location Sample Matrix	01-25 01GW2501 Ground Water	01-26 01GW2601 Ground Water	01-27 01GW2701 Ground Water	01C01 01GWC0101 Ground Water	01T02 01GWT0201 Background	01T02 01GWT0202 Background
Specific Conductance (mS/cm)	1.289	1.428	1.297	0.522	2.948	2.929
Temperature (C)	20.58	17.1	17.01	16.34	14.4	15.9
Turbidity (NTU)	5	24	16	1.7	3.6	2.6

(1) Reanalyzed on February 22, 2002 for gross beta.
Calc = Calculated Value as descibed in Section 3.4.2.1.
NA = [illegible]lyzed

TABLE A-3-2

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 2 GROUND WATER
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-01	01-02	01-03	01-04	01-05	01-06	01-08	01-09	01-10	01-11	01-14
Nsample	01GW0102	01GW0202	01GW0302	01GW0402	01GW0502	01GW0602	01GW0802	01GW0902	01GW1002	01GW1102	01GW1402
Sample	01GW0102	01GW0202	01GW0302	01GW0402	01GW0502	01GW0602	01GW0802	01GW0902	01GW1002	01GW1102	01GW1402
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	6/2/2002	6/17/2002	6/1/2002	6/1/2002	6/15/2002	6/2/2002	6/3/2002	6/3/2002	6/11/2002	6/14/2002	6/5/2002
Volatile Organic Compounds (ug/L)											
1,1,1,2-Tetrachloroethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,1-Trichloroethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2,2-Tetrachloroethane	0.5 U	30	0.5 U	0.5 U	8	0.5 U	3	0.5 U	0.5 U	1	0.5 U
1,1,2-Trichloroethane	1 U	0.6 J	1 U	1 U	11	1 U	3	1 U	1 U	1 U	1 U
1,1-Dichloroethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2,3-Trichloropropane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dibromo-3-Chloropropane	1 UJ	1 U	1 UJ	1 UJ	1 U	1 UJ	1 UJ	1 UJ	1 U	1 U	1 U
1,2-Dibromoethane	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U
1,2-Dichloroethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichloropropane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,4-Dioxane	100 UR	100 UR	100 UR	100 UR	100 UR	100 UR	100 UR	100 UR	100 UR	100 UR	100 UR
2-Butanone	5 UR	5 UR	5 UR	5 UR	5 UR	5 UR	5 UR	5 UR	5 UR	5 UR	5 U
2-Hexanone	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
3-Chloropropene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
4-Methyl-2-Pentanone	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 UJ
Acetone	5 UR	5 UR	5 UR	5 UR	5 UR	5 UR	5 UR	5 UR	5 UR	5 UR	5 UR
Acetonitrile	40 UR	40 UR	40 UR	40 UR	40 UR	40 UR	40 UR	40 UR	40 UR	40 UR	40 U
Acrolein	10 UR	10 UR	10 UR	10 UR	10 UR	10 UR	10 UR	10 UR	10 UR	10 UR	10 UR
Acrylonitrile	10 UR	10 UR	10 UR	10 UR	10 UR	10 UR	10 UR	10 UR	10 UR	10 UR	10 UR
Benzene	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromodichloromethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromoform	0.5 UJ	0.5 U	0.5 UJ	0.5 UJ	0.5 U	0.5 UJ	0.5 UJ	0.5 UJ	0.5 U	0.5 U	0.5 U
Bromomethane	1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	1 U
Carbon Disulfide	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Carbon Tetrachloride	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chlorobenzene	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chlorodibromomethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ
Chloroform	0.5 U	1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.7 J	0.5 U
Chloromethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloroprene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Cis-1,2-Dichloroethene	1 U	1 U	1 U	1 U	2	1 U	1 U	1 U	1 U	1 U	1
Cis-1,3-Dichloropropene	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Dibromomethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Dichlorodifluoromethane	0.7 U	0.7 UJ	0.7 U	0.7 U	0.7 UJ	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U
Ethane	NA	1 U	NA	NA	NA	NA	NA	NA	NA	1 U	NA
Ethene	NA	1 U	NA	NA	NA	NA	NA	NA	NA	1 U	NA
Ethyl Methacrylate	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Ethylbenzene	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Isobutanol	40 UR	40 UR	40 UR	40 UR	40 UR	40 UR	40 UR	40 UR	40 UR	40 UR	40 UR
Methacrylonitrile	20 UR	20 UR	20 UR	20 UR	20 UR	20 UR	20 UR	20 UR	20 UR	20 UR	20 UR
Methane	NA	1 UJ	NA	NA	NA	NA	NA	NA	NA	1 UJ	NA
Methyl Iodide	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Methyl Methacrylate	1 UJ	1 U	1 UJ	1 UJ	1 U	1 UJ	1 UJ	1 UJ	1 U	1 U	1 U
Methylene Chloride	1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	1 J	1 UJ
Pentachloroethane	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Propionitrile	20 UR	20 UR	20 UR	20 UR	20 UR	20 UR	20 UR	20 UR	20 UR	20 UR	20 UR
Styrene	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Tetrachloroethene	0.5 U	1	0.5 U	0.5 U	2	0.5 U	0.5 U	0.5 U	0.5 U	2	0.5 U
Toluene	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.7 J	0.5 U

Calc = Calculated Value as descibed in Section 3.4.2.1.
NA = Not Analyzed

TABLE A-3-2

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 2 GROUND WATER
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-01	01-02	01-03	01-04	01-05	01-06	01-08	01-09	01-10	01-11	01-14
Nsample	01GW0102	01GW0202	01GW0302	01GW0402	01GW0502	01GW0602	01GW0802	01GW0902	01GW1002	01GW1102	01GW1402
Sample	01GW0102	01GW0202	01GW0302	01GW0402	01GW0502	01GW0602	01GW0802	01GW0902	01GW1002	01GW1102	01GW1402
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	6/2/2002	6/17/2002	6/1/2002	6/1/2002	6/15/2002	6/2/2002	6/3/2002	6/3/2002	6/11/2002	6/14/2002	6/5/2002
Total Xylenes	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Trans-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.4 J
Trans-1,3-Dichloropropene	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Trans-1,4-Dichloro-2-Butene	1 UJ	1 U	1 UJ	1 UJ	1 U	1 UJ	1 UJ	1 UJ	1 U	1 U	1 UJ
Trichloroethene	0.5 U	20	0.5 U	0.5 U	840	0.5 U	7	0.5 U	0.5 U	15	26
Trichlorofluoromethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ
Vinyl Acetate	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Vinyl Chloride	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Total Metals (ug/L)											
Aluminum	NA	21.2 U	NA	NA	NA	NA	NA	NA	NA	180 J	NA
Antimony	NA	5.1 U	NA	NA	NA	NA	NA	NA	NA	5.1 U	NA
Arsenic	NA	2.2 U	NA	NA	NA	NA	NA	NA	NA	2.2 U	NA
Barium	NA	32.4 J	NA	NA	NA	NA	NA	NA	NA	21.8 J	NA
Beryllium	NA	0.30 U	NA	NA	NA	NA	NA	NA	NA	0.30 U	NA
Cadmium	NA	0.60 U	NA	NA	NA	NA	NA	NA	NA	0.60 U	NA
Calcium	NA	21800	NA	NA	NA	NA	NA	NA	NA	7640	NA
Chromium	NA	0.80 U	NA	NA	NA	NA	NA	NA	NA	0.80 U	NA
Cobalt	NA	1.1 U	NA	NA	NA	NA	NA	NA	NA	1.1 U	NA
Copper	NA	3.2 U	NA	NA	NA	NA	NA	NA	NA	3.2 U	NA
Iron	NA	27.0 U	NA	NA	NA	NA	NA	NA	NA	151	NA
Lead	NA	2.8 U	NA	NA	NA	NA	NA	NA	NA	2.8 U	NA
Magnesium	NA	8970	NA	NA	NA	NA	NA	NA	NA	2720	NA
Manganese	NA	22.0	NA	NA	NA	NA	NA	NA	NA	14.9	NA
Mercury	NA	0.10 U	NA	NA	NA	NA	NA	NA	NA	0.10 U	NA
Nickel	NA	3.0	NA	NA	NA	NA	NA	NA	NA	2.7 U	NA
Potassium	NA	446	NA	NA	NA	NA	NA	NA	NA	797	NA
Selenium	NA	2.7 U	NA	NA	NA	NA	NA	NA	NA	2.6 U	NA
Silver	NA	1.8 U	NA	NA	NA	NA	NA	NA	NA	1.8 U	NA
Sodium	NA	5550	NA	NA	NA	NA	NA	NA	NA	1510	NA
Strontium	NA	75.2 J	NA	NA	NA	NA	NA	NA	NA	33.1 J	NA
Thallium	NA	0.60 U	NA	NA	NA	NA	NA	NA	NA	1.3 U	NA
Tin	NA	17.0 U	NA	NA	NA	NA	NA	NA	NA	17.0 U	NA
Vanadium	NA	0.80 U	NA	NA	NA	NA	NA	NA	NA	0.80 U	NA
Zinc	NA	8.3 U	NA	NA	NA	NA	NA	NA	NA	8.3 U	NA
Dissolved Metals (ug/L)											
Aluminum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Calcium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Magnesium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Potassium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Calc = Calculated Value as descibed in Section 3.4.2.1.
NA = Not Analyzed

TABLE A-3-2

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 2 GROUND WATER
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-01	01-02	01-03	01-04	01-05	01-06	01-08	01-09	01-10	01-11	01-14
Nsample	01GW0102	01GW0202	01GW0302	01GW0402	01GW0502	01GW0602	01GW0802	01GW0902	01GW1002	01GW1102	01GW1402
Sample	01GW0102	01GW0202	01GW0302	01GW0402	01GW0502	01GW0602	01GW0802	01GW0902	01GW1002	01GW1102	01GW1402
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	6/2/2002	6/17/2002	6/1/2002	6/1/2002	6/15/2002	6/2/2002	6/3/2002	6/3/2002	6/11/2002	6/14/2002	6/5/2002
Selenium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sodium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Strontium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Radiologicals (pCi/L)											
Gross Alpha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gross Beta	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Miscellaneous Parameters (mg/L)											
Chloride	NA	4.1	NA	NA	NA	NA	NA	NA	NA	0.60	NA
Hardness	NA	91.4	NA	NA	NA	NA	NA	NA	NA	30.3	NA
Hardness, Filtered	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon	NA	3.6 J	NA	NA	NA	NA	NA	NA	NA	2.9 J	NA
Field Parameters (mg/L)											
Alkalinity	NA	50	NA	NA	NA	NA	NA	NA	NA	15	NA
Carbon Dioxide	NA	75	NA	NA	NA	NA	NA	NA	NA	60	NA
Dissolved Oxygen	NA	4.5	NA	NA	NA	NA	NA	NA	NA	2	NA
Dissolved Oxygen - Meter	1.28	7.57	6.77	5.61	9.06	2.56	0.73	1.55	1.76	3.55	2.41
Ferrous Iron	NA	0.01	NA	NA	NA	NA	NA	NA	NA	0.01	NA
Hydrogen Sulfide	NA	0	NA	NA	NA	NA	NA	NA	NA	0	NA
Manganese(+2)	NA	0.4	NA	NA	NA	NA	NA	NA	NA	0.7	NA
Nitrate	NA	0.08	NA	NA	NA	NA	NA	NA	NA	0.29	NA
Nitrite	NA	0.008	NA	NA	NA	NA	NA	NA	NA	0	NA
Sulfate	NA	25	NA	NA	NA	NA	NA	NA	NA	12	NA
Sulfide	NA	0.01	NA	NA	NA	NA	NA	NA	NA	0.01	NA
Field Parameters											
Oxidation Reduction Potential (MV)	168	488	-6	575	50	142	-51	433	-16	562	-57
pH (S.U.)	5.77	5.89	6.58	6	6.86	6.61	6.75	5.26	6.87	5.32	6.34
Specific Conductance (MS/CM)	0.873	0.209	0.207	1.466	2.112	1.466	0.404	0.088	0.812	0.065	1.083
Temperature (C)	14.8	15.1	12.77	16.62	12.93	14.98	13.29	14.47	15.1	16.17	14.24
Turbidity (Ntu)	4.3	2	21	0.1	4.2	1.3	4.2	8.3	2.4	4.4	16

Calc = Calculated Value as descibed in Section 3.4.2.1.
NA = Not Analyzed

TABLE A-3-2

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 2 GROUND WATER
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-15	01-23	01-25	01-25	01-26	01C01	01T02	01T02	01T03	01T04	01T05
Nsample	01GW1502	01GW2302	01GW2502	01GW2502-F	01GW2602	01GWC0102	01GWT0203	01GWT0203-F	01GWT0301	01GWT0401	01GWT0501
Sample	01GW1502	01GW2302	01GW2502	01GW2502-F	01GW2602	01GWC0102	01GWT0203	01GWT0203-F	01GWT0301	01GWT0401	01GWT0501
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	6/15/2002	6/4/2002	6/14/2002	6/14/2002	6/4/2002	6/11/2002	6/12/2002	6/12/2002	6/17/2002	6/15/2002	6/15/2002
Volatile Organic Compounds (ug/L)											
1,1,1,2-Tetrachloroethane	1	0.5 U	1	NA	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U
1,1,1-Trichloroethane	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U
1,1,2,2-Tetrachloroethane	230	0.5 U	24	NA	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	2
1,1,2-Trichloroethane	16	1 U	2	NA	1 U	1 U	1 U	NA	1 U	1 U	1 U
1,1-Dichloroethane	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U
1,1-Dichloroethene	1	1 U	1 U	NA	1 U	1 U	1 U	NA	1 U	1 U	1 U
1,2,3-Trichloropropane	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U
1,2-Dibromo-3-Chloropropane	1 U	1 U	1 U	NA	1 U	1 U	1 U	NA	1 U	1 U	1 U
1,2-Dibromoethane	0.6 U	0.6 U	0.6 U	NA	0.6 U	0.6 U	0.6 U	NA	0.6 U	0.6 U	0.6 U
1,2-Dichloroethane	9	0.5 U	2	NA	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U
1,2-Dichloropropane	1 U	1 U	1 U	NA	1 U	1 U	1 U	NA	1 U	1 U	1 U
1,4-Dioxane	100 UR	100 UR	100 UR	NA	100 UR	100 UR	100 UR	NA	100 UR	100 UR	100 UR
2-Butanone	5 UR	5 U	5 UR	NA	5 U	5 UR	5 UR	NA	5 UR	5 UR	5 UR
2-Hexanone	5 U	5 U	5 U	NA	5 U	5 U	5 U	NA	5 U	5 U	5 U
3-Chloropropene	5 U	5 U	5 U	NA	5 U	5 U	5 U	NA	5 U	5 U	5 U
4-Methyl-2-Pentanone	3 U	3 UJ	3 U	NA	3 UJ	3 U	3 U	NA	3 U	3 U	3 U
Acetone	5 UR	5 UR	5 UR	NA	5 UR	5 UR	5 UR	NA	5 UR	5 UR	5 UR
Acetonitrile	40 UR	40 U	40 UR	NA	40 U	40 UR	40 UR	NA	40 UR	40 UR	40 UR
Acrolein	10 UR	10 UR	10 UR	NA	10 UR	10 UR	10 UR	NA	10 UR	10 UR	10 UR
Acrylonitrile	10 UR	10 UR	10 UR	NA	10 UR	10 UR	10 UR	NA	10 UR	10 UR	10 UR
Benzene	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U
Bromodichloromethane	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U
Bromoform	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U
Bromomethane	1 UJ	1 U	1 UJ	NA	1 U	1 UJ	1 UJ	NA	1 UJ	1 UJ	1 UJ
Carbon Disulfide	1 U	1 U	1 U	NA	1 U	1 U	1 U	NA	1 U	1 U	1 U
Carbon Tetrachloride	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U
Chlorobenzene	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U
Chlorodibromomethane	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U
Chloroethane	1 U	1 UJ	1 U	NA	1 UJ	1 U	1 U	NA	1 U	1 U	1 U
Chloroform	6	0.5 U	6	NA	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	1
Chloromethane	1 U	1 U	1 U	NA	1 U	1 U	1 U	NA	1 U	1 U	1 U
Chloroprene	1 U	1 U	1 U	NA	1 U	1 U	1 U	NA	1 U	1 U	1 U
Cis-1,2-Dichloroethene	9	1 U	2	NA	1 U	1 U	1 U	NA	1 U	1 U	1 U
Cis-1,3-Dichloropropene	3 U	3 U	3 U	NA	3 U	3 U	3 U	NA	3 U	3 U	3 U
Dibromomethane	1 U	1 U	1 U	NA	1 U	1 U	1 U	NA	1 U	1 U	1 U
Dichlorodifluoromethane	0.7 UJ	0.7 U	0.7 U	NA	0.7 U	0.7 U	0.7 U	NA	0.7 UJ	0.7 U	0.7 UJ
Ethane	1 U	NA	1 U	NA	NA	NA	1 UJ	NA	1 U	1 U	1 U
Ethene	1 U	NA	1 U	NA	NA	NA	2 J	NA	1 U	1 U	1 U
Ethyl Methacrylate	1 U	1 U	1 U	NA	1 U	1 U	1 U	NA	1 U	1 U	1 U
Ethylbenzene	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U
Isobutanol	40 UR	40 UR	40 UR	NA	40 UR	40 UR	40 UR	NA	40 UR	40 UR	40 UR
Methacrylonitrile	20 UR	20 UR	20 UR	NA	20 UR	20 UR	20 UR	NA	20 UR	20 UR	20 UR
Methane	24 J	NA	1 UJ	NA	NA	NA	0.9 J	NA	1 UJ	1 UJ	1 UJ
Methyl Iodide	1 U	1 U	1 U	NA	1 U	1 U	1 U	NA	1 U	1 U	1 U
Methyl Methacrylate	1 U	1 U	1 U	NA	1 U	1 U	1 U	NA	1 U	1 U	1 U
Methylene Chloride	1 UJ	1 UJ	1 J	NA	1 UJ	1 UJ	1 UJ	NA	1 UJ	1 UJ	1 UJ
Pentachloroethane	5 U	5 U	5 U	NA	5 U	5 U	5 U	NA	5 U	5 U	5 U
Propionitrile	20 UR	20 UR	20 UR	NA	20 UR	20 UR	20 UR	NA	20 UR	20 UR	20 UR
Styrene	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U
Tetrachloroethene	5	0.5 U	1	NA	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U
Toluene	0.5 U	0.5 U	0.7 J	NA	0.5 U	0.5 U	0.5 J	NA	0.5 U	0.5 U	0.5 U

Calc = Calculated Value as descibed in Section 3.4.2.1.
NA = Not Analyzed

TABLE A-3-2

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 2 GROUND WATER
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-15	01-23	01-25	01-25	01-26	01C01	01T02	01T02	01T03	01T04	01T05
Nsample	01GW1502	01GW2302	01GW2502	01GW2502-F	01GW2602	01GWC0102	01GWT0203	01GWT0203-F	01GWT0301	01GWT0401	01GWT0501
Sample	01GW1502	01GW2302	01GW2502	01GW2502-F	01GW2602	01GWC0102	01GWT0203	01GWT0203-F	01GWT0301	01GWT0401	01GWT0501
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	6/15/2002	6/4/2002	6/14/2002	6/14/2002	6/4/2002	6/11/2002	6/12/2002	6/12/2002	6/17/2002	6/15/2002	6/15/2002
Total Xylenes	3 U	3 U	3 U	NA	3 U	3 U	3 U	NA	3 U	3 U	3 U
Trans-1,2-Dichloroethene	3	1 U	0.8 J	NA	1 U	1 U	1 U	NA	1 U	1 U	1 U
Trans-1,3-Dichloropropene	3 U	3 U	3 U	NA	3 U	3 U	3 U	NA	3 U	3 U	3 U
Trans-1,4-Dichloro-2-Butene	1 U	1 UJ	1 U	NA	1 UJ	1 U	1 U	NA	1 U	1 U	1 U
Trichloroethene	360	0.5 U	74	NA	0.5 U	0.5 U	0.5 U	NA	1	0.5 U	2
Trichlorofluoromethane	1 U	1 UJ	1 U	NA	1 UJ	1 U	1 U	NA	1 U	1 U	1 U
Vinyl Acetate	3 U	3 U	3 U	NA	3 U	3 U	3 U	NA	3 U	3 U	3 U
Vinyl Chloride	1 U	1 U	1 U	NA	1 U	1 U	1 U	NA	1 U	1 U	1 U
Total Metals (ug/L)											
Aluminum	21.2 U	NA	21.2 U	NA	NA	NA	57.8 U	NA	21.2 U	21.2 U	21.2 U
Antimony	5.1 U	NA	5.1 U	NA	NA	NA	5.1 U	NA	5.1 U	5.1 U	5.1 U
Arsenic	2.2 U	NA	2.2 U	NA	NA	NA	2.2 U	NA	2.2 U	2.2 U	2.2 U
Barium	29.9 J	NA	10 J	NA	NA	NA	16.6 J	NA	40.1 J	33.1 J	22.8 J
Beryllium	0.30 U	NA	0.30 U	NA	NA	NA	0.30 U	NA	0.30 U	0.30 U	0.30 U
Cadmium	0.60 U	NA	0.60 U	NA	NA	NA	0.60 U	NA	0.60 U	0.60 U	0.60 U
Calcium	162000	NA	131000	NA	NA	NA	344000	NA	87700	70400	147000
Chromium	0.80 U	NA	0.80 U	NA	NA	NA	0.80 UJ	NA	0.80 U	0.80 U	0.80 U
Cobalt	4.3 U	NA	1.1 U	NA	NA	NA	126 J	NA	1.2 U	1.1 U	11.2 J
Copper	3.2 U	NA	3.2 U	NA	NA	NA	3.2 U	NA	3.2 U	3.2 U	3.2 U
Iron	11600	NA	27.0 U	NA	NA	NA	14800	NA	27.0 U	27.0 U	31.0
Lead	2.8 U	NA	2.8 U	NA	NA	NA	2.8 UJ	NA	2.8 U	2.8 U	2.8 U
Magnesium	52300	NA	56000	NA	NA	NA	250000	NA	59900	21500	233000
Manganese	1970	NA	4.0	NA	NA	NA	9600	NA	45.2	5.9	5420
Mercury	0.10 U	NA	0.10 U	NA	NA	NA	0.10 U	NA	0.10 U	0.10 U	0.10 U
Nickel	5.1	NA	2.7 U	NA	NA	NA	273	NA	9.3	2.7 U	75.1
Potassium	2450	NA	1760	NA	NA	NA	15300	NA	4830	1720	4130
Selenium	5.6 U	NA	2.6 U	NA	NA	NA	4.2 U	NA	2.6 U	2.6 U	2.6 U
Silver	1.8 U	NA	1.8 U	NA	NA	NA	1.8 UJ	NA	1.8 U	1.8 U	1.8 U
Sodium	49900	NA	73400	NA	NA	NA	69700	NA	4300	4050	110000
Strontium	310 J	NA	229 J	NA	NA	NA	3910 J	NA	329 J	172 J	468 J
Thallium	0.60 U	NA	0.60 U	NA	NA	NA	2.1 U	NA	0.60 U	0.60 U	0.6 U
Tin	17.0 U	NA	17.0 U	NA	NA	NA	17.0 U	NA	17.0 U	17.0 U	17.0 U
Vanadium	0.80 U	NA	0.80 U	NA	NA	NA	0.80 U	NA	0.80 U	0.80 U	0.80 U
Zinc	8.3 U	NA	8.3 U	NA	NA	NA	103	NA	8.3 U	8.3 U	12.1
Dissolved Metals (ug/L)											
Aluminum	NA	NA	NA	80.5 U	NA	NA	NA	21.2 U	NA	NA	NA
Antimony	NA	NA	NA	5.1 U	NA	NA	NA	5.1 U	NA	NA	NA
Arsenic	NA	NA	NA	2.2 U	NA	NA	NA	2.2 U	NA	NA	NA
Barium	NA	NA	NA	9.9 J	NA	NA	NA	13.8 J	NA	NA	NA
Beryllium	NA	NA	NA	0.30 U	NA	NA	NA	0.30 U	NA	NA	NA
Cadmium	NA	NA	NA	0.60 U	NA	NA	NA	0.60 U	NA	NA	NA
Calcium	NA	NA	NA	123000	NA	NA	NA	349000	NA	NA	NA
Chromium	NA	NA	NA	0.80 U	NA	NA	NA	0.80 UJ	NA	NA	NA
Cobalt	NA	NA	NA	1.1 U	NA	NA	NA	96.8 J	NA	NA	NA
Copper	NA	NA	NA	3.2 U	NA	NA	NA	3.2 U	NA	NA	NA
Iron	NA	NA	NA	123	NA	NA	NA	20300	NA	NA	NA
Lead	NA	NA	NA	2.8 U	NA	NA	NA	2.8 UJ	NA	NA	NA
Magnesium	NA	NA	NA	52700	NA	NA	NA	254000	NA	NA	NA
Manganese	NA	NA	NA	10.4	NA	NA	NA	9650	NA	NA	NA
Mercury	NA	NA	NA	0.10 U	NA	NA	NA	0.10 U	NA	NA	NA
Nickel	NA	NA	NA	2.7 U	NA	NA	NA	208	NA	NA	NA
Potassium	NA	NA	NA	1690	NA	NA	NA	15200	NA	NA	NA

Calc = Calculated Value as descibed in Section 3.4.2.1.
NA = Not Analyzed

TABLE A-3-2

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 2 GROUND WATER
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-15	01-23	01-25	01-25	01-26	01C01	01T02	01T02	01T03	01T04	01T05
Nsample	01GW1502	01GW2302	01GW2502	01GW2502-F	01GW2602	01GWC0102	01GWT0203	01GWT0203-F	01GWT0301	01GWT0401	01GWT0501
Sample	01GW1502	01GW2302	01GW2502	01GW2502-F	01GW2602	01GWC0102	01GWT0203	01GWT0203-F	01GWT0301	01GWT0401	01GWT0501
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	6/15/2002	6/4/2002	6/14/2002	6/14/2002	6/4/2002	6/11/2002	6/12/2002	6/12/2002	6/17/2002	6/15/2002	6/15/2002
Selenium	NA	NA	NA	2.6 U	NA	NA	NA	2.8 U	NA	NA	NA
Silver	NA	NA	NA	1.8 U	NA	NA	NA	1.8 UJ	NA	NA	NA
Sodium	NA	NA	NA	70200	NA	NA	NA	70700	NA	NA	NA
Strontium	NA	NA	NA	192 J	NA	NA	NA	4040 J	NA	NA	NA
Thallium	NA	NA	NA	0.60 U	NA	NA	NA	2.1 U	NA	NA	NA
Tin	NA	NA	NA	17.0 U	NA	NA	NA	17.0 U	NA	NA	NA
Vanadium	NA	NA	NA	0.80 U	NA	NA	NA	0.80 U	NA	NA	NA
Zinc	NA	NA	NA	8.3 U	NA	NA	NA	65.6	NA	NA	NA
Total Radiologicals (pCi/L)											
Gross Alpha	NA	4.89	NA	NA	NA	NA	8.22	NA	2.60 U	0.906 U	4.83 U
Gross Beta	NA	12.3	NA	NA	NA	NA	18.8	NA	3.75	1.69	5.21
Miscellaneous Parameters (mg/L)											
Chloride	56.8	NA	42.8	NA	NA	NA	94.4	NA	2.1	1.6	127
Hardness	619.9	NA	557.7	NA	NA	NA	1888.5	NA	465.7	264.3	1326.6
Hardness, Filtered	NA	NA	NA	524.1	NA	NA	NA	1917.4	NA	NA	NA
Total Organic Carbon	4.4 J	NA	4.7 J	NA	NA	NA	9.2 J	NA	3.7 J	2.6 J	5.1 J
Field Parameters (mg/L)											
Alkalinity	250	NA	250	NA	NA	NA	120	NA	275	150	70
Carbon Dioxide	58	NA	25	NA	NA	NA	350	NA	18	12	225
Dissolved Oxygen	0.3	NA	0.4	NA	NA	NA	1.5	NA	0.7	2	3
Dissolved Oxygen - Meter	8.35	3.01	0.63	NA	2.66	2.28	10.17	NA	7.72	2.63	3.92
Ferrous Iron	8.8	NA	0	NA	NA	NA	8.5	NA	0.01	0.01	0.07
Hydrogen Sulfide	0	NA	0	NA	NA	NA	0	NA	0	0	0
Manganese(+2)	1.7	NA	0.3	NA	NA	NA	22 >	NA	0.3	0	6.2
Nitrate	0	NA	0.21	NA	NA	NA	0.04	NA	0.32	1.28	0.38
Nitrite	0	NA	0	NA	NA	NA	0	NA	0.008	0	0.006
Sulfate	80 >	NA	80 >	NA	NA	NA	80 >	NA	80 >	54	80 >
Sulfide	0	NA	0.02	NA	NA	NA	0.04	NA	0	0	0
Field Parameters											
Oxidation Reduction Potential (MV)	-71	3	232	NA	7	565	98	NA	404	272	228
pH (S.U.)	6.42	6.28	7.02	NA	6.34	6.9	5.68	NA	7.23	7.45	5.77
Specific Conductance (MS/CM)	1.396	1.648	1.363	NA	1.129	0.394	2.686	NA	0.739	0.482	2.61
Temperature (C)	16.92	15.91	14.5	NA	15.42	16.42	14.99	NA	13.9	13.4	13.8
Turbidity (Ntu)	2	9.1	14	NA	16	0.6	18	NA	2.7	0.7	2.3

Calc = Calculated Value as descibed in Section 3.4.2.1.
NA = Not Analyzed

TABLE A-4-1

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 1 SEDIMENT
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SD01	01SD02	01SD03	01SD04	01SD05	01SD06	01SD07	01SD08
Sample	01SD01	01SD02	01SD03	01SD04	01SD05	01SD06	01SD07	01SD08
Matrix	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
Depth Range	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5
Risk	*Background*	Site	Site	Site	Site	Site	Site	Site
Sample Date	8/14/2001	8/14/2001	8/14/2001	8/14/2001	8/14/2001	8/14/2001	8/14/2001	8/14/2001
Volatile Organics (ug/kg)								
1,1,1,2-Tetrachloroethane	3 U	3 U	3 U	4 U	3 U	4 U	3 U	4 U
1,1,1-Trichloroethane	3 U	3 U	3 U	4 U	3 U	4 U	3 U	4 U
1,1,2,2-Tetrachloroethane	3 U	3 U	7	4 U	3 UJ	4 U	3 U	4 U
1,1,2-Trichloroethane	5 U	5 U	6 U	7 U	5 U	8 U	5 U	7 U
1,1-Dichloroethane	3 U	3 U	3 U	4 U	3 U	4 U	3 U	4 U
1,1-Dichloroethene	5 U	5 U	6 U	7 U	5 U	8 U	5 U	7 U
1,2,3-Trichloropropane	3 U	3 U	3 U	4 U	3 UJ	4 U	3 U	4 U
1,2-Dibromo-3-Chloropropane	5 U	5 U	6 U	7 U	5 UJ	8 U	5 U	7 U
1,2-Dibromoethane	3 U	3 U	3 U	4 U	3 U	4 U	3 U	4 U
1,2-Dichloroethane	3 U	3 U	3 U	4 U	3 U	4 U	3 U	4 U
1,2-Dichloropropane	5 U	5 U	6 U	7 U	5 U	8 U	5 U	7 U
1,4-Dioxane	470 UR	500 UR	560 UR	680 UR	540 UR	780 UR	540 UR	720 UR
2-Butanone	5 U	5 U	6 U	7 U	5 U	8 U	5 U	7 U
2-Hexanone	5 U	5 U	6 U	7 U	5 U	8 U	5 U	7 U
3-Chloropropene	5 UJ	5 UJ	6 UJ	7 UJ	5 UJ	8 UJ	5 UJ	7 UJ
4-Methyl-2-Pentanone	3 U	3 U	3 U	4 U	3 U	4 U	3 U	4 U
Acetone	5 UJ	5 UJ	6 UJ	7 UJ	5 UJ	12 J	5 UJ	7 UJ
Acetonitrile	190 UJ	200 UJ	220 UJ	270 UJ	220 UJ	310 UJ	220 UJ	290 UJ
Acrolein	47 UR	50 UR	56 UR	68 UR	54 UR	78 UR	54 UR	72 UR
Acrylonitrile	47 U	50 U	56 U	68 U	54 U	78 U	54 U	72 U
Benzene	3 U	3 U	3 U	4 U	3 U	4 U	3 U	4 U
Bromodichloromethane	3 U	3 U	3 U	4 U	3 U	4 U	3 U	4 U
Bromoform	3 U	3 U	3 U	4 U	3 U	4 U	3 U	4 U
Bromomethane	5 U	5 U	6 U	7 U	5 U	8 U	5 U	7 U
Carbon Disulfide	3 U	3 U	3 U	4 U	3 U	4 U	3 U	4 U
Carbon Tetrachloride	3 UJ	3 UJ	3 UJ	4 UJ	3 UJ	4 UJ	3 UJ	4 UJ
Chlorobenzene	3 U	3 U	3 U	4 U	3 U	4 U	3 U	4 U
Chlorodibromomethane	3 U	3 U	3 U	4 U	3 U	4 U	3 U	4 U
Chloroethane	5 U	5 U	6 U	7 U	5 U	8 U	5 U	7 U
Chloroform	3 U	3 U	3 U	4 U	3 U	4 U	3 U	4 U
Chloromethane	5 U	5 U	6 U	7 U	5 U	8 U	5 U	7 U
Chloroprene	5 UJ	5 UJ	6 UJ	7 UJ	5 UJ	8 UJ	5 UJ	7 UJ
Cis-1,2-Dichloroethene	5 U	5 U	6 U	7 U	5 U	8 U	5 U	7 U
Cis-1,3-Dichloropropene	3 U	3 U	3 U	4 U	3 U	4 U	3 U	4 U
Dibromomethane	5 U	5 U	6 U	7 U	5 U	8 U	5 U	7 U
Dichlorodifluoromethane	3 UJ	3 J	1 J	4 UJ	3 UJ	4 UJ	3 UJ	2 J
Ethyl Methacrylate	5 U	5 U	6 U	7 U	5 U	8 U	5 U	7 U
Ethylbenzene	3 U	3 U	3 U	4 U	3 U	4 U	3 U	4 U
Isobutanol	190 UR	200 UR	220 UR	270 UR	220 UR	310 UR	220 UR	290 UR
Methacrylonitrile	95 U	100 U	110 U	140 U	110 U	160 U	110 U	140 U
Methyl Iodide	5 UJ	5 UJ	6 UJ	7 UJ	5 UJ	8 UJ	5 UJ	7 UJ
Methyl Methacrylate	5 U	5 U	6 U	7 U	5 U	8 U	5 U	7 U
Methylene Chloride	5 UJ	5 UJ	6 UJ	7 UJ	5 UJ	8 UJ	5 UJ	7 UJ
Pentachloroethane	5 U	5 U	6 U	7 U	5 UJ	8 U	5 U	7 U
Propionitrile	95 UR	100 UR	110 UR	140 UR	110 UR	160 UR	110 UR	140 UR
Styrene	3 U	3 U	3 U	4 U	3 U	4 U	3 U	4 U
Tetrachloroethene	3 U	3 U	3 U	4 U	3 U	4 U	3 U	4 U
Toluene	3 U	3 U	3 U	4 U	3 U	4 U	3 U	4 U
Total Xylenes	3 U	3 U	3 U	4 U	3 U	4 U	3 U	4 U
Trans-1,2-Dichloroethene	5 U	5 U	6 U	7 U	5 U	8 U	5 U	7 U
Trans-1,3-Dichloropropene	3 U	3 U	3 U	4 U	3 U	4 U	3 U	4 U

Calc = Calculated Value as descibed in Section 3.4.2.1.

TABLE A-4-1

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 1 SEDIMENT
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SD01	01SD02	01SD03	01SD04	01SD05	01SD06	01SD07	01SD08
Sample	01SD01	01SD02	01SD03	01SD04	01SD05	01SD06	01SD07	01SD08
Matrix	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
Depth Range	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5
Risk	Background	Site	Site	Site	Site	Site	Site	Site
Sample Date	8/14/2001	8/14/2001	8/14/2001	8/14/2001	8/14/2001	8/14/2001	8/14/2001	8/14/2001
Trans-1,4-Dichloro-2-Butene	5 U	5 U	6 U	7 U	5 U	8 U	5 U	7 U
Trichloroethene	3 U	3 U	3 U	4 U	3 U	4 U	3 U	4 U
Trichlorofluoromethane	5 U	5 U	6 U	7 U	5 U	8 U	5 U	7 U
Vinyl Acetate	3 U	3 U	3 U	4 U	3 U	4 U	3 U	4 U
Vinyl Chloride	5 U	5 U	6 U	7 U	5 U	8 U	5 U	7 U
Semivolatile Organics (ug/kg)								
1,2,4,5-Tetrachlorobenzene	390 U	380 U	450 U	450 U	380 U	370 U	380 U	460 U
1,2,4-Trichlorobenzene	390 U	380 U	450 U	450 U	380 U	370 U	380 U	460 U
1,2-Dichlorobenzene	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
1,3-Dichlorobenzene	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
1,4-Dichlorobenzene	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
1,4-Naphthoquinone	390 U	380 U	450 U	450 U	380 U	370 U	380 U	460 U
1,4-Phenylenediamine	970 UJ	940 UJ	1100 UJ	1100 UJ	960 UJ	930 UJ	940 UJ	1200 UJ
1-Naphthylamine	390 U	380 U	450 U	450 U	380 U	370 U	380 U	460 U
2,2'-Oxybis(1-Chloropropane)	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
2,3,4,6-Tetrachlorophenol	390 U	380 U	450 U	450 U	380 U	370 U	380 U	460 U
2,4,5-Trichlorophenol	970 U	940 U	1100 U	1100 U	960 U	930 U	940 U	1200 U
2,4,6-Trichlorophenol	390 U	380 U	450 U	450 U	380 U	370 U	380 U	460 U
2,4-Dichlorophenol	390 U	380 U	450 U	450 U	380 U	370 U	380 U	460 U
2,4-Dimethylphenol	390 U	380 U	450 U	450 U	380 U	370 U	380 U	460 U
2,4-Dinitrophenol	970 U	940 U	1100 U	1100 U	960 U	930 U	940 U	1200 U
2,6-Dichlorophenol	390 U	380 U	450 U	450 U	380 U	370 U	380 U	460 U
2-Acetylaminofluorene	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
2-Chloronaphthalene	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
2-Chlorophenol	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
2-Methylnaphthalene	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
2-Methylphenol	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
2-Naphthylamine	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
2-Nitroaniline	490 U	470 U	550 U	550 U	480 U	470 U	470 U	600 U
2-Nitrophenol	390 U	380 U	450 U	450 U	380 U	370 U	380 U	460 U
2-Picoline	300 U	290 U	350 U	340 U	290 U	280 U	290 U	350 U
3,3'-Dichlorobenzidine	390 U	380 U	450 U	450 U	380 U	370 U	380 UJ	460 U
3,3'-Dimethylbenzidine	390 U	380 U	450 U	450 U	380 U	370 U	380 U	460 U
3-Methylcholanthrene	440 U	420 U	510 U	500 U	430 UJ	420 U	420 U	520 UJ
3-Methylphenol	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
3-Nitroaniline	970 U	940 U	1100 U	1100 U	960 U	930 U	940 U	1200 U
4,6-Dinitro-2-Methylphenol	970 U	940 U	1100 U	1100 U	960 U	930 U	940 U	1200 U
4-Aminobiphenyl	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
4-Bromophenyl Phenyl Ether	390 U	380 U	450 U	450 U	380 U	370 U	380 U	460 U
4-Chloro-3-Methylphenol	390 U	380 U	450 U	450 U	380 U	370 U	380 U	460 U
4-Chloroaniline	390 U	380 U	450 U	450 U	380 U	370 U	380 U	460 U
4-Chlorophenyl Phenyl Ether	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
4-Methylphenol	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
4-Nitroaniline	970 U	940 U	1100 U	1100 U	960 U	930 U	940 U	1200 U
4-Nitrophenol	970 U	940 U	1100 U	1100 U	960 U	930 U	940 U	1200 U
4-Nitroquinoline-1-Oxide	970 UR	940 UR	1100 UR	1100 UR	960 UR	930 UR	940 UR	1200 UR
5-Nitro-O-Toluidine	390 U	380 U	450 U	450 U	380 U	370 U	380 U	460 U
7,12-Dimethylbenz(A)Anthracene	300 U	290 U	350 U	340 U	290 UJ	280 U	290 U	350 UJ
A,A-Dimethylphenethylamine	970 U	940 U	1100 U	1100 U	960 U	930 U	940 U	1200 U
Acenaphthene	11.8 U	11.6 U	13.9 U	13.7 U	11.7 U	11.2 U	139 J	13.8 U
Acenaphthylene	11.8 U	11.6 U	13.9 U	13.7 U	11.7 U	11.2 U	11.5 UJ	13.8 U
Acetophenone	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U

Calc [illegible]lated Value as descibed in Section 3.4.2.1.

TABLE A-4-1

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 1 SEDIMENT
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SD01	01SD02	01SD03	01SD04	01SD05	01SD06	01SD07	01SD08
Sample	01SD01	01SD02	01SD03	01SD04	01SD05	01SD06	01SD07	01SD08
Matrix	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
Depth Range	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5
Risk	Background	Site	Site	Site	Site	Site	Site	Site
Sample Date	8/14/2001	8/14/2001	8/14/2001	8/14/2001	8/14/2001	8/14/2001	8/14/2001	8/14/2001
Aniline	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
Anthracene	11.8 U	11.6 U	13.9 U	13.7 U	11.7 U	11.2 U	11.5 U	13.8 U
Aramite	970 U	940 U	1100 U	1100 U	960 U	930 U	940 U	1200 U
Benzo(A)Anthracene	11.8 U	11.6 U	13.9 U	13.7 U	11.7 U	11.2 U	14.4	13.8 U
Benzo(A)Pyrene	11.8 U	11.6 U	13.9 U	13.7 U	7.05 J	4.97 J	27.5 J	6.73 J
Benzo(B)Fluoranthene	11.8 U	11.6 U	9.95 J	13.7 U	11.7 U	7.7 J	120 J	22.5 J
Benzo(G,H,I)Perylene	11.8 U	11.6 U	13.9 U	13.7 U	11.7 U	11.2 U	21.8 J	13.8 U
Benzo(K)Fluoranthene	11.8 U	11.6 U	13.9 U	13.7 U	8.96 J	11.2 U	14.6 J	6.26 J
Benzyl Alcohol	270 U	270 U	270 U	270 U	270 U	270 U	270 U	270 U
Bis(2-Chloroethoxy)Methane	390 U	380 U	450 U	450 U	380 U	370 U	380 U	460 U
Bis(2-Chloroethyl)Ether	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
Bis(2-Ethylhexyl)Phthalate	200 U	190 U	230 U	230 U	190 U	190 U	190 UJ	98 J
Butyl Benzyl Phthalate	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
Chlorobenzilate	390 U	380 U	450 U	450 U	380 U	370 U	380 U	460 U
Chrysene	11.8 U	11.6 U	13.9 U	13.7 U	11.7 U	11.2 U	17.3 J	13.8 U
Di-N-Butyl Phthalate	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
Di-N-Octyl Phthalate	200 U	190 U	230 U	230 U	190 UJ	190 U	190 UJ	230 UJ
Diallate	390 U	380 U	450 U	450 U	380 U	370 U	380 U	460 U
Dibenzo(A,H)Anthracene	11.8 U	11.6 U	13.9 U	13.7 U	11.7 U	11.2 U	11.5 UJ	13.8 U
Dibenzofuran	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
Diethyl Phthalate	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
Dimethyl Phthalate	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
Diphenylamine	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
Ethyl Methane Sulfonate	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
Fluoranthene	11.8 U	11.6 U	13.9 U	13.7 U	4.93 J	5.39 J	18.4 J	7.83 J
Fluorene	11.8 U	11.6 U	13.9 U	13.7 U	11.7 U	11.2 U	11.5 U	13.8 U
Hexachlorobenzene	390 U	380 U	450 U	450 U	380 U	370 U	380 U	460 U
Hexachlorobutadiene	390 U	380 U	450 U	450 U	380 U	370 U	380 U	460 U
Hexachlorocyclopentadiene	390 U	380 U	450 U	450 U	380 U	370 U	380 UJ	460 U
Hexachloroethane	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
Hexachlorophene	16000 UJ	15000 UJ	18000 UJ	18000 UJ	15000 UJ	15000 UJ	15000 UJ	19000 UJ
Hexachloropropene	390 U	380 U	450 U	450 UJ	380 U	370 U	380 U	460 U
Indeno(1,2,3-CD)Pyrene	11.8 U	11.6 U	13.9 U	13.7 U	11.7 U	11.2 U	12.8	13.8 U
Isodrin	390 U	380 U	450 U	450 U	380 U	370 U	380 U	460 U
Isophorone	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
Isosafrole	390 U	380 U	450 U	450 U	380 U	7600	380 U	460 U
Kepone	970 U	940 U	1100 U	1100 U	960 U	930 U	940 U	1200 U
Methapyrilene	970 U	940 U	1100 U	1100 U	960 U	930 U	940 U	1200 U
Methyl Methane Sulfonate	490 U	470 U	550 U	550 U	480 U	470 U	470 U	600 U
N-Nitroso-Di-N-Butylamine	390 U	380 U	450 U	450 U	380 U	370 U	380 U	460 U
N-Nitroso-Di-N-Propylamine	200 U	190 U	230 U	230 UJ	190 U	190 U	190 U	230 U
N-Nitrosodiethylamine	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
N-Nitrosodimethylamine	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
N-Nitrosomethylethylamine	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
N-Nitrosomorpholine	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
N-Nitrosopiperidine	390 U	380 U	450 U	450 U	380 U	370 U	380 U	460 U
N-Nitrosopyrrolidine	200 U	190 U	230 U	230 UJ	190 U	190 U	190 U	230 U
Naphthalene	11.8 U	11.6 U	13.9 U	13.7 U	11.7 U	11.2 UR	11.5 UJ	13.8 U
O,O,O-Triethyl Phosphorothioate	390 U	380 U	450 U	450 U	380 U	370 U	380 U	460 U
O-Toluidine	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
P-(Dimethylamino)Azobenzene	390 U	380 U	450 U	450 U	380 U	370 U	380 U	460 U
Pentachlorobenzene	390 U	380 U	450 U	450 U	380 U	370 U	380 U	460 U

Calc = Calculated Value as descibed in Section 3.4.2.1.

TABLE A-4-1

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 1 SEDIMENT
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SD01	01SD02	01SD03	01SD04	01SD05	01SD06	01SD07	01SD08
Sample	01SD01	01SD02	01SD03	01SD04	01SD05	01SD06	01SD07	01SD08
Matrix	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
Depth Range	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5
Risk	Background	Site	Site	Site	Site	Site	Site	Site
Sample Date	8/14/2001	8/14/2001	8/14/2001	8/14/2001	8/14/2001	8/14/2001	8/14/2001	8/14/2001
Pentachloronitrobenzene	970 U	940 U	1100 U	1100 U	960 U	930 U	940 U	1200 U
Phenacetin	390 U	380 U	450 U	450 U	380 U	370 U	380 U	460 U
Phenanthrene	11.8 U	11.6 U	13.9 U	13.7 U	11.7 U	11.2 U	11.5 U	13.8 U
Phenol	200 U	190 U	230 U	230 U	190 U	190 U	190 U	230 U
Pronamide	390 UR	380 UR	450 UR	450 UR	380 UR	370 UR	380 UR	460 UR
Pyrene	11.8 U	11.6 U	13.9 U	13.7 U	11.7 U	11.2 U	24 J	5.31 J
Pyridine	220 U	220 U	230 U	230 U	220 U	220 U	220 U	230 U
Safrole	390 U	380 U	450 U	450 U	380 U	370 U	380 U	460 U
Energertics (ug/kg)								
1,3,5-Trinitrobenzene	476 U	476 U	476 U	476 U	500 U	500 U	476 U	500 U
1,3-Dinitrobenzene	476 U	476 U	476 U	476 U	500 U	500 U	476 U	500 U
2,4,6-Trinitrotoluene	476 U	476 U	476 U	476 U	500 U	500 U	476 U	500 U
2,4-Dinitrotoluene	476 U	476 U	476 U	476 U	500 U	500 U	476 U	500 U
2,6-Dinitrotoluene	476 U	476 U	476 U	476 U	500 U	500 U	476 U	500 U
2-Amino-4,6-Dinitrotoluene	476 U	476 U	476 U	476 U	500 U	500 U	476 U	500 U
2-Nitrotoluene	476 U	476 U	476 U	476 U	500 U	500 U	476 U	500 U
3-Nitrotoluene	476 U	476 U	476 U	476 U	500 U	500 U	476 U	500 U
4-Amino-2,6-Dinitrotoluene	476 U	476 U	476 U	476 U	500 U	500 U	476 U	500 U
4-Nitrotoluene	476 U	476 U	476 U	476 U	500 U	500 U	476 U	500 U
HMX	476 U	54.2 J	422 J	86.7 J	134 J	500 U	476 U	500 U
Nitrobenzene	476 U	476 U	476 U	476 U	500 U	500 U	476 U	500 U
RDX	476 U	476 U	476 U	476 U	500 U	500 U	476 U	500 U
Tetryl	476 U	476 U	476 U	476 U	500 U	500 U	476 U	500 U
Pesticides/PCBs (ug/kg)								
4,4'-DDD	2.9 U	2.8 U	3.4 U	3.4 U	2.9 U	2.8 U	2.8 U	3.5 U
4,4'-DDE	2.9 U	2.8 U	3.4 U	3.4 U	2.9 U	2.8 U	2.8 U	3.5 U
4,4'-DDT	2.9 UJ	2.8 UJ	3.4 UJ	3.4 UJ	2.9 UJ	2.8 UJ	2.8 UJ	3.5 UJ
Aldrin	1.5 U	1.5 U	1.8 U	1.8 U	1.5 U	1.4 U	1.5 U	1.8 U
Alpha-BHC	1.5 U	1.5 U	1.8 U	1.8 U	1.5 U	1.4 U	1.5 U	1.8 U
Alpha-Chlordane	1.5 U	1.5 U	1.8 U	1.8 U	1.5 U	1.4 U	1.5 U	1.8 U
Aroclor-1016	38 U	38 U	46 U	45 U	38 U	37 U	37 U	45 U
Aroclor-1221	38 U	38 U	46 U	45 U	38 U	37 U	37 U	45 U
Aroclor-1232	38 U	38 U	46 U	45 U	38 U	37 U	37 U	45 U
Aroclor-1242	38 U	38 U	46 U	45 U	38 U	37 U	37 U	45 U
Aroclor-1248	38 U	38 U	46 U	45 U	38 U	37 U	37 U	45 U
Aroclor-1254	38 U	38 U	46 U	45 U	38 U	37 U	37 U	45 U
Aroclor-1260	38 U	38 U	46 U	45 U	38 U	37 U	19 J	45 U
Beta-BHC	1.5 U	1.5 U	1.8 U	1.8 U	1.5 U	1.4 U	1.5 U	1.8 U
Delta-BHC	1.5 U	1.5 U	1.8 U	1.8 U	1.5 U	1.4 U	1.5 U	1.8 U
Dieldrin	2.9 U	2.8 U	3.4 U	3.4 U	2.9 U	2.8 U	2.8 U	3.5 U
Endosulfan I	1.5 U	1.5 U	1.8 U	1.8 U	1.5 U	1.4 U	1.5 U	1.8 U
Endosulfan II	2.9 U	2.8 U	3.4 U	3.4 U	2.9 U	2.8 U	2.8 U	3.5 U
Endosulfan Sulfate	2.9 U	2.8 U	3.4 U	3.4 U	2.9 U	2.8 U	2.8 U	3.5 U
Endrin	2.9 U	2.8 U	3.4 U	3.4 U	2.9 U	2.8 U	2.8 U	3.5 U
Endrin Aldehyde	2.9 U	2.8 U	3.4 U	3.4 U	2.9 U	2.8 U	2.8 UR	3.5 U
Gamma-Bhc (Lindane)	1.5 U	1.5 U	1.8 U	1.8 U	1.5 U	1.4 U	1.5 U	1.8 U
Gamma-Chlordane	1.5 U	1.5 U	1.8 U	1.8 U	1.5 U	1.4 U	1.5 U	1.8 U
Heptachlor	0.95 J	1.7	1.8 U	1.4 J	1.2 J	2.5	1.1 J	1.8 U
Heptachlor Epoxide	1.5 U	1.5 U	1.8 U	1.8 U	1.5 U	1.4 U	1.5 U	1.8 U
Methoxychlor	15 U	15 U	18 U	18 U	15 U	14 U	15 U	18 U
Toxaphene	96 U	95 U	110 U	110 U	96 U	92 U	94 U	120 U
Herbicides (ug/kg)								

Calc[illegible]lated Value as descibed in Section 3.4.2.1.

TABLE A-4-1

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 1 SEDIMENT
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SD01	01SD02	01SD03	01SD04	01SD05	01SD06	01SD07	01SD08
Sample	01SD01	01SD02	01SD03	01SD04	01SD05	01SD06	01SD07	01SD08
Matrix	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
Depth Range	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5
Risk	Background	Site	Site	Site	Site	Site	Site	Site
Sample Date	8/14/2001	8/14/2001	8/14/2001	8/14/2001	8/14/2001	8/14/2001	8/14/2001	8/14/2001
2,4,5-T	12 U	12 U	14 U	8.6 J	12 U	11 U	11 U	14 U
2,4,5-TP (Silvex)	16	12	14 U	14 U	12 U	11 J	3.1 J	14 U
2,4-D	82 U	81 U	99 U	96 U	82 U	79 U	80 UJ	98 U
Dinoseb	23 UJ	23 UJ	28 UJ	27 UJ	23 UJ	22 UJ	23 U	28 U
Pentachlorophenol	12 U	12 U	14 U	14 U	12 U	11 U	11 U	14 U
Inorganics (mg/kg)								
Aluminum	9670	8790	6770	7470	9270	8190	11700	13700
Antimony	1.2 J	2.0 J	0.59 UJ	0.58 UJ	0.51 UJ	0.48 UJ	0.50 UJ	0.61 UJ
Arsenic	31.9	31.1	27.9	6.5	4.4	5.5	8.1	6.7
Barium	105	92.4	47.4	105	120	120	94.6	80.7
Beryllium	1.4 J	1.7 J	0.65 J	0.84 J	0.80 J	0.78 J	0.57 J	0.62 U
Cadmium	0.05 UJ	0.05 UJ	0.05 UJ	0.05 UJ	0.23 U	0.39 J	0.05 UJ	0.06 UJ
Calcium	1000	769	941	1690	2630	1960	3020	5520
Chromium	30.5	45.1	15.0	13.5	9.4	10.2	13.7	17.4
Cobalt	25.0	28.8	6.9	17.8	15.3	17.5	12.2	7.4
Copper	17.6 J	19.4 J	16.9 J	11.0 J	10.1 J	9.5 J	16.1 J	14.6 J
Iron	45700	76900	28600	20000	12500	12300	19900	21700
Lead	24.8	32.0	22.2	19.1	16.1	26.7	16.5	28.2
Magnesium	1520	1060	1050	1030	1200	1090	1820	1940
Manganese	1490	1640	278	1230	1250	1330	607	341
Mercury	0.06 U	0.05 U	0.09 U	0.06 U	0.05 U	0.07 U	0.06 U	0.08 U
Nickel	37.1	35.9	12.1	15.6	13.7	11.3	11.9	13.7
Potassium	875 J	703 J	1100 J	604 J	623 J	497 J	583 J	915 J
Selenium	0.66	1.2	0.92	0.66	0.38 U	0.45	0.59	1.0
Silver	0.15 U	0.15 U	0.18 U	0.18 U	0.15 U	0.14 U	0.15 U	0.18 U
Sodium	265	345 J	416	334	335	298	311	402
Strontium	10.2 J	8.1 J	10.6 J	9.6 J	11.2 J	8.2 J	8.7 J	14.5 J
Thallium	4.3	7.1	2.2	1.2	0.56 U	0.57	2.0	1.5
Thorium-Calc	9.3	9.4	12.5	7.75	7.54	6.47	6.53	7.31
Tin	3.6	3.4	3.6	3.4	3.1	3.2	3.0	3.7
Vanadium	32.5	45.8	20.4	20.5	18.9	19.6	27.0	31.5
Zinc	79.2	78.0	35.6	42.5	41.2	47.8	46.1	70.2
Miscellaneous Parameters								
1,4-Dithiane (ug/kg)	237 U	234 U	282 U	275 U	235 U	225 U	231 U	282 U
1,4-Oxathiane (ug/kg)	237 U	234 U	282 U	275 U	235 U	225 U	231 U	282 U
Bis(2-Chloroethyl)Sulfide (ug/kg)	237 U	234 U	282 U	275 U	235 U	225 U	231 U	282 U
Cation Exchange Capacity (meq/100g)	11.1	17.9	22.0	22.9	45.5	26.9	22.6	58.6
pH (S.U.)	5.8 J	5.6 J	5.5 J	6.1 J	7.0 J	6.2 J	7.3 J	7.1 J
Total Organic Carbon (mg/kg)	5950	5580	17600	21600	34900	24500	14300	49600
Total Radiologicals (pCi/g)								
Thorium-228	0.937	1.15	1.49	1.08	0.868	0.705	0.694	0.781
Thorium-230	1.20 J	1.14 J	1.26 J	0.832 J	0.791 J	1.08 J	0.937 J	1.05 J
Thorium-232	1.11	0.917	1.25	0.624	0.791	0.718	0.742	0.828

Calc = Calculated Value as descibed in Section 3.4.2.1.

TABLE A-4-2

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 2 SEDIMENT
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SD01	01SD03	01SD09	01SD10	01SD11	01SD12
Nsample	01SD0102	01SD0302	01SD0902	01SD1002	01SD1102	01SD1202
Sample	01SD0102	01SD0302	01SD0902	01SD1002	01SD1102	01SD1202
Matrix	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
Depth Range	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5
Risk	Background	Site	Site	Site	Site	Site
Sample Date	6/17/2002	6/17/2002	6/17/2002	6/17/2002	6/17/2002	6/17/2002
Volatile Organics (ug/kg)						
1,1,1,2-Tetrachloroethane	3 U	4 U	4 U	3 UJ	3 UJ	4 UJ
1,1,1-Trichloroethane	3 U	4 U	4 U	3 UJ	3 UJ	4 UJ
1,1,2,2-Tetrachloroethane	3 UJ	9	4 U	3 UJ	3 UJ	4 UJ
1,1,2-Trichloroethane	6 U	8 U	7 U	6 UJ	6 UJ	7 UJ
1,1-Dichloroethane	3 U	4 U	4 U	3 UJ	3 UJ	4 UJ
1,1-Dichloroethene	6 UJ	8 U	7 U	6 UJ	6 UJ	7 UJ
1,2,3-Trichloropropane	3 U	4 U	4 U	3 UJ	3 UJ	4 UJ
1,2-Dibromo-3-Chloropropane	6 U	8 U	7 U	6 UJ	6 UJ	7 UJ
1,2-Dibromoethane	3 U	4 U	4 U	3 UJ	3 UJ	4 UJ
1,2-Dichloroethane	3 U	4 U	4 U	3 UJ	3 UJ	4 UJ
1,2-Dichloropropane	6 U	8 U	7 U	6 UJ	6 UJ	7 UJ
1,4-Dioxane	580 UR	750 UR	670 UR	610 UR	570 UR	720 UR
2-Butanone	6 U	8 U	7 U	6 UJ	6 UJ	7 UJ
2-Hexanone	6 UJ	8 UJ	7 UJ	6 UJ	6 UJ	7 UJ
3-Chloropropene	6 U	8 U	7 UJ	6 UJ	6 UJ	7 UJ
4-Methyl-2-Pentanone	3 U	4 U	4 U	3 UJ	3 UJ	4 UJ
Acetone	290 J	510 J	190 J	230 J	540 J	630 J
Acetonitrile	230 UR	300 UR	270 UR	250 UR	230 UR	290 UR
Acrolein	58 UR	75 UR	67 UR	61 UR	57 UR	72 UR
Acrylonitrile	58 UR	75 UR	67 U	61 UJ	57 UR	72 UR
Benzene	3 U	4 U	4 U	3 UJ	3 UJ	4 UJ
Bromodichloromethane	3 U	4 U	4 U	3 UJ	3 UJ	4 UJ
Bromoform	3 U	4 U	4 U	3 UJ	3 UJ	4 UJ
Bromomethane	6 UJ	8 UJ	7 UJ	6 UJ	6 UJ	7 UJ
Carbon Disulfide	2 J	2 J	4 U	3 UJ	2 J	4 UJ
Carbon Tetrachloride	3 U	4 U	4 U	3 UJ	3 UJ	4 UJ
Chlorobenzene	3 U	4 U	4 U	3 UJ	3 UJ	4 UJ
Chlorodibromomethane	3 U	4 U	4 U	3 UJ	3 UJ	4 UJ
Chloroethane	6 U	8 U	7 U	6 UJ	6 UJ	7 UJ
Chloroform	3 U	4 U	4 U	3 UJ	3 UJ	4 UJ
Chloromethane	6 U	8 U	7 U	6 UJ	6 UJ	7 UJ
Chloroprene	6 U	8 U	7 U	6 UJ	6 UJ	7 UJ
Cis-1,2-Dichloroethene	6 U	8 U	7 U	6 UJ	6 UJ	7 UJ
Cis-1,3-Dichloropropene	3 U	4 U	4 U	3 UJ	3 UJ	4 UJ
Dibromomethane	6 U	8 U	7 U	6 UJ	6 UJ	7 UJ
Dichlorodifluoromethane	3 U	4 U	4 U	8 J	3 UJ	4 UJ
Ethyl Methacrylate	6 U	8 U	7 U	6 UJ	6 UJ	7 UJ
Ethylbenzene	3 U	4 U	4 U	3 UJ	3 UJ	4 UJ
Isobutanol	230 UR	300 UR	270 UR	250 UR	230 UR	290 UR
Methacrylonitrile	120 U	150 U	130 U	120 UJ	110 UJ	140 UJ
Methyl Iodide	6 UJ	8 UJ	7 UJ	6 UJ	6 UJ	7 UJ
Methyl Methacrylate	6 U	8 U	7 U	6 UJ	6 UJ	7 UJ
Methylene Chloride	6 UJ	8 UJ	7 UJ	6 UJ	6 UJ	7 UJ
Pentachloroethane	6 U	8 U	7 U	6 UJ	6 UJ	7 UJ
Propionitrile	120 UR	150 UR	130 UR	120 UR	110 UR	140 UR
Styrene	3 U	4 U	4 U	3 UJ	3 UJ	4 UJ

Calc = Calculated Value as descibed in Section 3.4.2.1.
NA = [illegible]nalyzed

TABLE A-4-2

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI ROUND 2 SEDIMENT
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SD01	01SD03	01SD09	01SD10	01SD11	01SD12
Nsample	01SD0102	01SD0302	01SD0902	01SD1002	01SD1102	01SD1202
Sample	01SD0102	01SD0302	01SD0902	01SD1002	01SD1102	01SD1202
Matrix	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
Depth Range	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5
Risk	Background	Site	Site	Site	Site	Site
Sample Date	6/17/2002	6/17/2002	6/17/2002	6/17/2002	6/17/2002	6/17/2002
Tetrachloroethene	3 U	4 U	4 U	3 UJ	3 UJ	4 UJ
Toluene	3 U	2 J	1 J	3 UJ	1 J	4 UJ
Total Xylenes	3 U	4 U	4 U	3 UJ	3 UJ	4 UJ
Trans-1,2-Dichloroethene	6 UJ	8 U	7 U	6 UJ	6 UJ	7 UJ
Trans-1,3-Dichloropropene	3 U	4 U	4 U	3 UJ	3 UJ	4 UJ
Trans-1,4-Dichloro-2-Butene	6 U	8 U	7 U	6 UJ	6 UJ	7 UJ
Trichloroethene	3 U	4 U	4 U	3 UJ	3 UJ	4 UJ
Trichlorofluoromethane	6 U	8 U	7 U	6 UJ	6 UJ	7 UJ
Vinyl Acetate	3 U	4 U	4 U	3 UJ	3 UJ	4 UJ
Vinyl Chloride	6 U	8 U	7 U	6 UJ	6 UJ	7 UJ
Inorganics (mg/kg)						
Aluminum	7360	NA	NA	NA	NA	NA
Antimony	1.6 J	NA	NA	NA	NA	NA
Arsenic	28.4 J	NA	NA	NA	NA	NA
Barium	93.1	NA	NA	NA	NA	NA
Beryllium	1.7	NA	NA	NA	NA	NA
Cadmium	0.06 U	NA	NA	NA	NA	NA
Calcium	894 J	NA	NA	NA	NA	NA
Chromium	40.8 J	NA	NA	NA	NA	NA
Cobalt	27.4	NA	NA	NA	NA	NA
Copper	14.7 J	NA	NA	NA	NA	NA
Iron	76500 J	NA	NA	NA	NA	NA
Lead	26.3	NA	NA	NA	NA	NA
Magnesium	1190	NA	NA	NA	NA	NA
Manganese	1890	NA	NA	NA	NA	NA
Mercury	0.04	NA	NA	NA	NA	NA
Nickel	38.7	NA	NA	NA	NA	NA
Potassium	6.6 J	NA	NA	NA	NA	NA
Selenium	2.1	NA	NA	NA	NA	NA
Silver	0.14 U	NA	NA	NA	NA	NA
Sodium	308	NA	NA	NA	NA	NA
Strontium	8.8	NA	NA	NA	NA	NA
Thallium	0.57 U	NA	NA	NA	NA	NA
Tin	1.9 J	NA	NA	NA	NA	NA
Vanadium	43.6 J	NA	NA	NA	NA	NA
Zinc	71.7 J	NA	NA	NA	NA	NA
Total Radiologicals (pCi/g)						
Thorium-228	1.09	NA	NA	NA	NA	NA
Thorium-230	0.908	NA	NA	NA	NA	NA
Thorium-232	1.13	NA	NA	NA	NA	NA

Calc = Calculated Value as descibed in Section 3.4.2.1.
NA = Not Analyzed

TABLE A-5

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI SURFACE WATER
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SW01	01SW02	01SW04	01SW05
Nsample	01SW0102	01SW0202	01SW0402	01SW0502
Sample	01SW0102	01SW0202	01SW0402	01SW0502
Matrix	Surface Water	Surface Water	Surface Water	Surface Water
Risk	Back	Site	Back	Site
Sample Date	6/17/2002	6/17/2002	6/18/2002	6/17/2002
Volatile Organics (ug/L)				
1,1,1,2-Tetrachloroethane	0.5 U	0.5 U	0.5 U	0.5 U
1,1,1-Trichloroethane	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2,2-Tetrachloroethane	0.5 U	0.5 U	0.5 U	0.5 UJ
1,1,2-Trichloroethane	1 U	1 U	1 U	1 U
1,1-Dichloroethane	0.5 U	0.5 U	0.5 U	0.5 U
1,1-Dichloroethene	1 U	1 U	1 U	1 U
1,2,3-Trichloropropane	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dibromo-3-Chloropropane	1 UJ	1 UJ	1 UJ	1 UJ
1,2-Dibromoethane	0.6 U	0.6 U	0.6 U	0.6 U
1,2-Dichloroethane	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichloropropane	1 U	1 U	1 U	1 U
1,4-Dioxane	100 UR	100 UR	100 UR	100 UR
2-Butanone	5 UR	5 UR	5 UR	5 UR
2-Hexanone	5 U	5 U	5 U	5 U
3-Chloropropene	5 U	5 U	5 U	5 U
4-Methyl-2-Pentanone	3 U	3 U	3 U	3 U
Acetone	5 UR	5 UR	5 UR	5 UR
Acetonitrile	40 UR	40 UR	40 UR	40 UR
Acrolein	10 UR	10 UR	10 UR	10 UR
Acrylonitrile	10 UR	10 UR	10 UR	10 UR
Benzene	0.5 U	0.5 U	0.5 U	0.5 U
Bromodichloromethane	0.5 U	0.5 U	0.5 U	0.5 U
Bromoform	0.5 U	0.5 U	0.5 U	0.5 U
Bromomethane	1 UJ	1 UJ	1 UJ	1 UJ
Carbon Disulfide	1 U	1 U	1 U	1 U
Carbon Tetrachloride	0.5 U	0.5 U	0.5 U	0.5 U
Chlorobenzene	0.5 U	0.5 U	0.5 U	0.5 U
Chlorodibromomethane	0.5 U	0.5 U	0.5 U	0.5 U
Chloroethane	1 U	1 U	1 U	1 U
Chloroform	0.5 U	0.5 U	0.5 U	0.5 U
Chloromethane	1 U	1 U	1 U	1 U
Chloroprene	1 U	1 U	1 U	1 U
Cis-1,2-Dichloroethene	1 U	1 U	1 U	1 U
Cis-1,3-Dichloropropene	3 U	3 U	3 U	3 U
Dibromomethane	1 U	1 U	1 U	1 U
Dichlorodifluoromethane	0.7 UJ	0.7 UJ	0.7 UJ	0.7 UJ
Ethyl Methacrylate	1 U	1 U	1 U	1 U
Ethylbenzene	0.5 U	0.5 U	0.5 U	0.5 U
Isobutanol	40 UR	40 UR	40 UR	40 UR
Methacrylonitrile	20 UR	20 UR	20 UR	20 UR
Methyl Iodide	1 U	1 U	1 U	1 U
Methyl Methacrylate	1 U	1 U	1 U	1 U
Methylene Chloride	1 UJ	1 UJ	1 UJ	1 UJ
Pentachloroethane	5 U	5 U	5 U	5 U
Propionitrile	20 UR	20 UR	20 UR	20 UR
Styrene	0.5 U	0.5 U	0.5 U	0.5 U

TABLE A-5

SUMMARY OF ANALYTIC RESULTS - PHASE III RFI SURFACE WATER
CRANE 158 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SW01	01SW02	01SW04	01SW05
Nsample	01SW0102	01SW0202	01SW0402	01SW0502
Sample	01SW0102	01SW0202	01SW0402	01SW0502
Matrix	Surface Water	Surface Water	Surface Water	Surface Water
Risk	Back	Site	Back	Site
Sample Date	6/17/2002	6/17/2002	6/18/2002	6/17/2002
Tetrachloroethene	0.5 U	0.5 U	0.5 U	0.5 UJ
Toluene	0.5 U	0.5 U	0.5 U	0.5 U
Total Xylenes	3 U	3 U	3 U	3 U
Trans-1,2-Dichloroethene	1 U	1 U	1 U	1 U
Trans-1,3-Dichloropropene	3 U	3 U	3 U	3 U
Trans-1,4-Dichloro-2-Butene	1 U	1 U	1 U	1 U
Trichloroethene	0.5 U	0.5 U	0.5 U	0.5 UJ
Trichlorofluoromethane	1 U	1 U	1 U	1 U
Vinyl Acetate	3 U	3 U	3 U	3 U
Vinyl Chloride	1 U	1 U	1 U	1 U
Field Parameters				
Dissolved Oxygen - Meter (mg/L)	6.63	2.94	7.59	7.96
Oxidation Reduction Potential (MV)	335.9	278.4	274	291
pH (S.U.)	6.6	6.41	7.08	6.37
Specific Conductance (MS/CM)	0.114	0.121	0.114	0.058
Temperature (C)	17.08	17.53	16.4	16.79
Turbidity (NTU)	5.1	5.4	3.8	1.2

TABLE A-6

SUMMARY OF CHEMICALS DETECTED IN SURFACE SOIL
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB01	01SB02	01SB03	01SB04	01SB05	01SB06	01SB07	01SB08	01SB09	01SB10	01SB11	01SB12	01SB13
Sample	01SS010002	01SS020002	01SS030002	01SS040002	01SS050002	01SS060002	01SS070002	01SS080002	01SS090002	01SS100002	01SS110002	01SS120002	01SS130002
Matrix	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil
Depth Range (bgs)	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/27/2001	8/27/2001	8/21/2001	8/26/2001	8/27/2001	8/22/2001	8/25/2001	8/24/2001
VOCs (ug/kg)													
2-Butanone	6 UJ	5 UJ	5 UJ	6 UJ	5 UJ	38	6 U	6 U	6 UJ	5 UJ	6 U	6 UJ	71 J
Acetone	6 UJ	5 UJ	5 UJ	6 UJ	5 UJ	680 UJ	130 J	6 UJ	6 UJ	5 UJ	6 UJ	6 U	650 U
Carbon Disulfide	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	4 U
Methylene Chloride	6 UJ	5 UJ	5 UJ	6 U	39 U	61 J	41 J	6 UJ	25 U	13 J	6 UJ	6 UJ	9
Toluene	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 UJ	3 U	3 U	2 J
SVOCs (ug/kg)													
7,12-Dimethylbenz(a)Anthracene	320 UJ	310 U	310 U	310 U	300 U	320 U	300 U	290 U	310 U	300 UJ	300 U	310 U	350 U
Acenaphthene	12.8 U	12.5 U	12.5 U	12.4 U	15.8	70.8	11.8 U	11.4 U	12.3 U	11.8 U	11.8 U	12.4 U	14 U
Benzo(a)Pyrene	12.8 U	12.5 U	12.5 U	12.4 U	12.1 U	12.7 U	11.8 U	11.4 U	11.9 J	11.8 U	11.8 U	12.4 U	14 U
Benzo(g,h,i)Perylene	12.8 U	12.5 U	12.5 U	12.4 U	12.1 U	12.7 U	11.8 U	11.4 U	11.8 J	11.8 U	11.8 U	12.4 U	14 U
Benzo(k)Fluoranthene	12.8 U	12.5 U	12.5 U	12.4 U	12.1 U	12.7 U	11.8 U	11.4 U	12.3 U	11.8 U	11.8 U	12.4 U	14 U
bis(2-Ethylhexyl) phthalate	220 U	210 U	210 U	210 U	200 U	210 U	200 U	190 U	420	200 U	89 J	210 U	240 U
Dibenzo(a,h)Anthracene	12.8 U	12.5 U	12.5 U	12.4 UJ	12.1 U	12.7 U	11.8 U	11.4 UJ	12.3 U	11.8 U	11.8 UJ	12.4 U	14 U
Fluoranthene	12.8 U	12.5 U	12.5 U	12.4 U	12.1 U	12.7 U	11.8 U	11.4 U	3.98 J	11.8 U	11.8 U	12.4 U	14 U
Indeno(1,2,3-cd) pyrene	12.8 U	12.5 U	12.5 U	12.4 U	12.1 U	12.7 U	11.8 U	11.4 U	4.55 J	11.8 U	11.8 U	12.4 U	14 U
Isosafrole	430 U	410 U	420 U	410 U	46000	3200	400 U	380 U	410 U	390 U	2700	420 U	470 U
Pyrene	12.8 U	12.5 U	12.5 U	14.6 J	12.1 U	12.7 U	11.8 U	11.4 U	12.3 U	11.8 U	11.8 U	12.4 U	14 U
Pesticides/PCBs (ug/kg)													
gamma-Chlordane	5.6 R	1.6 U	1.6 U	0.55 J	1.6 U	1.7 U	1.5 U	1.5 U	1.6 U	3.4 R	1.5 U	0.62 J	0.89 J
Heptachlor	1.4 J	1.2 J	1.3 J	1.6 U	1.4 J	3.8 R	1.5 U	1.8	1.3 J	1.6	1.3 J	1.4 BU	1.5 BU
Herbicides (ug/kg)													
2,4,5-TP (Silvex)	13 U	12 U	13 U	12 U	12 U	13 U	12 U	12 UJ	12 U	12 U	15 J	12 U	14 U
2,4-D	36 R	38 J	35 J	87 U	85 U	100 R	83 U	81 U	87 U	83 U	82 U	87 U	130
Inorganics (mg/kg)													
Aluminum	9670 J	13200 J	13200 J	14900 J	12300 J	13700	15900	14700 J	10100 J	19400	13400 J	12700 J	12700 J
Antimony	1.7 J	0.53 U	0.66 U	0.88 U	0.50 U	0.61 U	1.3 U	0.81 U	0.60 U	1.4 U	0.67 U	0.20 UJ	0.62 U
Arsenic	7.0 J	10.9 J	10.3 J	9.0 J	7.9 J	7.7 J	8.8 J	7.6	7.2 J	9.3 J	8.0	6.9 J	7.1 J
Barium	69.2 J	82.8 J	45.1 J	66.4	56.6 J	157	71.8	130	75.5 J	66.0	104	122	109
Beryllium	0.50 J	0.52 J	0.40 J	0.63 J	0.41 J	0.96	0.30	0.88 J	0.47 J	0.21	0.88 J	1.0 J	0.79 J
Cadmium	0.42 J	0.04 UJ	0.04 UJ	0.49 J	0.15 J	0.05 U	0.05 U	0.01 U	0.27 J	0.22 J	0.01 U	0.25 J	0.30 J
Calcium	8440 J	5010 J	510 J	1480 J	891 J	1300 J	557 J	578 J	24100 J	27900 J	678 J	1190 J	3450 J
Chromium	13.4	17.0	17.8	17.6 J	16.2	15.8	19.1	14.7	14.5	22.8	13.4	12.2 J	13.6 J
Cobalt	9.9	8.2	5.1	10.9 J	5.2	20.7	10.4	12.9 J	6.5	7.2	15.5 J	17.7 J	20.2 J
Copper	12.1 J	16.5 J	16.5 J	14.0 J	13.9 J	10.1	15.9	12.1 J	13.1 J	18.5	11.6 J	10.1 J	8.7 J
Iron	16300	24600	25500	23100	20300	18100	24000	19100	18300	24700	19000	15700	16300
Lead	20.4	16.2	14.7	19.0	17.2	19.0	15.5	15.0 J	13.1	17.2	16.2 J	16.1	19.0
Magnesium	1820 J	3060 J	2470 J	2160 J	1900 J	1600 J	2380 J	1890 J	3790 J	5260 J	1760 J	1360 J	2340 J
Manganese	588 J	453 J	232 J	420 J	305 J	2010	489	920 J	369 J	380	991 J	1230 J	1270 J
Mercury	0.04 J	0.05 J	0.06 J	0.05 J	0.05 J	0.05 J	0.05 J	0.05	0.07 J	0.07 J	0.06	0.03 U	0.05 U
Nickel	10.1	11.9	13.9	12.4 J	11.2	16.0	13.8	15.6	10.1	13.7	13.9	13.2 J	13.8 J
Potassium	668 J	587 J	755 J	817 J	596 J	709 J	837 J	849 J	540 J	1310 J	674 J	672 J	671 J
Selenium	0.62 J	0.88 J	1.2 J	1.4 U	0.79 J	0.69	1.3	0.49 J	0.58 J	1.1	0.51 J	0.99 U	1.0 U
Sodium	355 J	350 J	296 J	325 J	219 J	614	603	386 J	290 J	648	358 J	342 J	418 J
Strontium	11.3 J	11.5 J	7.0 J	8.8 J	8.5 J	11.2 J	10.3 J	9.4 J	24.7 J	33.5 J	8.4 J	8.8 J	10.1 J
Thallium	0.85	1.8	2.8	2.2 J	1.8	1.4	0.57 U	0.87 J	1.2	0.55 U	1.4 J	1.0 J	1.4 J
Thorium-Calc	2.531818	3.995455	3.881818	6.436364	3.895455	3.963636	4.3	3.25	4.690909	4.886364	4.5	5.440909	3.140909
Tin	24.5 U	22.7 U	23.1 U	23.7 U	22.3 U	2.5 U	2.5	3.9	23.4 U	2.6	3.8	23.6 U	27.0 U

TABLE A-6

SUMMARY OF CHEMICALS DETECTED IN SURFACE SOIL
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB01	01SB02	01SB03	01SB04	01SB05	01SB06	01SB07	01SB08	01SB09	01SB10	01SB11	01SB12	01SB13
Sample	01SS010002	01SS020002	01SS030002	01SS040002	01SS050002	01SS060002	01SS070002	01SS080002	01SS090002	01SS100002	01SS110002	01SS120002	01SS130002
Matrix	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil
Depth Range (bgs)	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/27/2001	8/27/2001	8/21/2001	8/26/2001	8/27/2001	8/22/2001	8/25/2001	8/24/2001
Vanadium	23.8	32.1	30.3	32.2	28.9	31.9	37.5	30.7 J	24.5	44.5	28.5 J	26.8	26.9
Zinc	41.7 J	50.6 J	49.3 J	49.8 J	37.9 J	55.9	57.7	51.1	41.4 J	67.8	45.2	42.4 J	41.7 J
Miscellaneous Parameters													
Cation Exchange Capacity (meq/100g	13.9	NA	12.8	NA	12.2	NA	23.4 J	NA	NA	NA	NA	NA	24.4 J
pH (S.U.)	7.8 J	NA	5.4 J	NA	5.2 J	NA	5	NA	NA	NA	NA	NA	5.8
Total Radionuclides (pCi/g)													
Actinium-228	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bismuth-212	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bismuth-214	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cesium-137	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead-210	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead-212	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead-214	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Potassium-40	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Radium-226	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium-208	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thorium-228	0.257	0.433	0.388	0.730	0.357	0.417	0.467	0.320	0.480	0.502	0.458	0.623	0.337
Thorium-230	0.0178 J	0.052 J	0.0342 U	0.621 J	0.0345 U	0.0414	0.0490	0.385 J	0.0198 J	0.0688	0.473 J	0.474 J	0.0898 U
Thorium-232	0.300	0.446	0.466	0.686	0.500	0.455	0.479	0.395	0.552	0.573	0.532	0.574	0.354
Thorium-234	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium-235	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE A-6

SUMMARY OF CHEMICALS DETECTED IN SURFACE SOIL
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB14	01SB15	01SB16	01SB17	01SB18	01SB19	01SB20	01SB21	01TPL	01TPL	01TPL	01TPS
Sample	01SS140002	01SS150002	01SS160002	01SS170002	01SS180002	01SS190002	01SS200002	01SS210002	01TPL01	01TPL02	01TPL03	01TPS04
Matrix	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil
Depth Range (bgs)	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	1 - 1.5	1 - 1.5	1 - 1.5	1 - 1.5
Risk	Site	Site	Site	Site	Site	Site	Site	Background	Site	Site	Site	Site
Sample Date	8/24/2001	8/22/2001	8/21/2001	8/24/2001	8/24/2001	8/24/2001	8/21/2001	8/21/2001	8/27/2001	8/27/2001	8/27/2001	8/27/2001
VOCs (ug/kg)												
2-Butanone	6 UJ	6 U	5 U	10 UJ	8 UJ	7 UJ	6 U	NA	5 UJ	6 UJ	5 UJ	6 UJ
Acetone	6 UJ	6 UJ	5 UJ	750 U	180	90	21 J	NA	5 UJ	6 UJ	5 UJ	6 UJ
Carbon Disulfide	3 U	3 U	3 U	6	4 U	4 U	3 U	NA	3 U	3 U	3 U	3 U
Methylene Chloride	47	6 UJ	2 J	14 J	13 J	7 J	15 J	NA	5 UJ	6 UJ	5 UJ	26 U
Toluene	3 U	3 U	3 U	5 U	4 U	4 U	3 U	NA	3 U	3 U	3 U	3 U
SVOCs (ug/kg)												
7,12-Dimethylbenz(a)Anthracene	320 U	300 U	310 U	260 J	280 U	320 U	310 U	NA	1500 UJ	300 U	310 U	310 U
Acenaphthene	12.6 UJ	12.1 U	12.3 U	15.8 U	11.2 UJ	12.5 UJ	12.4 U	NA	12.3 U	12.1 U	12.5 U	12.4 U
Benzo(a)Pyrene	12.6 UJ	12.1 U	12.3 U	15.8 U	11.2 UJ	12.5 UJ	12.4 U	NA	5.85 J	12.1 U	12.5 U	12.4 U
Benzo(g,h,i)Perylene	12.6 UJ	12.1 U	12.3 U	15.8 U	11.2 UJ	12.5 UJ	12.4 U	NA	9.3 J	12.1 U	12.5 U	12.4 U
Benzo(k)Fluoranthene	12.6 UJ	12.1 U	12.3 U	15.8 U	11.2 UJ	12.5 UJ	12.4 U	NA	14.1 J	12.1 U	12.5 U	12.4 U
bis(2-Ethylhexyl) phthalate	210 U	200 U	210 U	270 U	83 J	210 U	210 U	NA	1000 U	200 U	210 U	210 U
Dibenzo(a,h)Anthracene	12.6 UJ	12.1 UJ	12.3 U	15.8 U	11.2 UJ	12.5 UJ	12.4 U	NA	5.76 J	12.1 U	12.5 U	12.4 U
Fluoranthene	12.6 UJ	12.1 U	12.3 U	15.8 U	11.2 UJ	12.5 UJ	12.4 U	NA	4.39 J	12.1 U	12.5 U	12.4 U
Indeno(1,2,3-cd) pyrene	12.6 UJ	12.1 U	12.3 U	15.8 U	11.2 UJ	12.5 UJ	12.4 U	NA	4.52 J	12.1 U	12.5 U	12.4 U
Isosafrole	420 U	400 U	410 U	540 U	410	420 U	400 J	NA	2000 U	400 U	410 U	150 J
Pyrene	12.6 UJ	12.1 U	12.3 U	15.8 U	11.2 UJ	12.5 UJ	12.4 U	NA	4.1 J	12.1 U	12.5 U	12.4 U
Pesticides/PCBs (ug/kg)												
gamma-Chlordane	0.9 J	3 R	1.6 U	1.1 J	0.71 J	0.81 J	1.6 U	NA	NA	NA	NA	NA
Heptachlor	2 BU	2	1.4 J	2.4 BU	1 BU	1.2 BU	2.4	NA	NA	NA	NA	NA
Herbicides (ug/kg)												
2,4,5-TP (Silvex)	13 U	5.9 J	12 U	16 U	11 U	13 U	13 U	NA	NA	NA	NA	NA
2,4-D	88 U	85 U	86 U	210	69 J	90 U	88 U	NA	NA	NA	NA	NA
Inorganics (mg/kg)												
Aluminum	16200 J	17200 J	12200	15300 J	9400 J	12400 J	13800	NA	9820 J	9900 J	9570 J	12400 J
Antimony	0.48 U	0.89 U	0.51 U	0.36 U	0.49 U	0.55 U	0.54 U	NA	0.34 U	0.45 U	0.40 U	0.28 U
Arsenic	8.9 J	9.1	8.3	10.8 J	6.0 J	7.9 J	7.5	NA	6.9 J	6.4 J	6.2 J	7.1 J
Barium	69.6	76.2	104	169	49.9	42.9	112	NA	117 J	118 J	114 J	131 J
Beryllium	0.63 J	0.59 U	0.72 J	1.0 J	0.45 J	0.38 J	0.78 J	NA	0.93 J	0.77 J	0.86 J	0.72 J
Cadmium	0.17 J	0.01 U	0.05 UJ	1.3 J	0.09 J	0.15 J	0.05 UJ	NA	0.14 J	0.05 J	0.04 UJ	0.11 J
Calcium	1010 J	1050 J	2520	1450 J	421 J	579 J	946	NA	12600 J	18800 J	4810 J	1120 J
Chromium	16.8 J	19.3	13.9	24.3 J	12.1 J	15.9 J	14.1	NA	12.8	13.1	11.5	14.0
Cobalt	8.0 J	8.3 J	11.6	18.8 J	8.8 J	3.2 J	20.3	NA	22.3	19.0	16.2	18.6
Copper	14.5 J	17.6 J	12.6 J	12.6 J	8.1 J	12.3 J	10.9 J	NA	7.4 J	7.9 J	9.1 J	10.5 J
Iron	23500	23500	19900	24600	17200	22800	18000	NA	15400	14600	15000	17600
Lead	15.6	12.9 J	16.5	20.0	11.4	11.0	18.1	NA	21.6	17.6	17.8	16.3
Magnesium	2220 J	2380 J	1780	1930 J	1050 J	1850 J	1570	NA	1540 J	1830 J	1190 J	1500 J
Manganese	291 J	382 J	629	1420 J	427 J	114 J	1220	NA	1720 J	1540 J	1290 J	1070 J
Mercury	0.05 U	0.07	0.07 U	0.04 U	0.04 U	0.10 U	0.05 U	NA	0.04 J	0.03 J	0.04 J	0.04 J
Nickel	12.6 J	12.2	11.7	16.0 J	6.9 J	8.1 J	13.4	NA	12.1	11.1	10.9	13.9
Potassium	846 J	823 J	668 J	853 J	436 J	575 J	846 J	NA	503 J	519 J	479 J	676 J
Selenium	1.0 U	0.62 J	0.38 U	1.5 U	0.68 U	0.87 U	0.49	NA	0.76 J	0.72 J	0.74 J	0.70 J
Sodium	348 J	384 J	304	452 J	329 J	426 J	400	NA	336 J	283 J	351 J	297 J
Strontium	9.0 J	10.4 J	11.9 J	13.7 J	5.0 J	6.8 J	8.8 J	NA	15.9 J	20.2 J	9.5 J	12.8 J
Thallium	2.6 J	1.5 J	1.6	2.5 J	1.9 J	2.7 J	1.6	NA	0.69	0.61 U	0.62 U	0.99
Thorium-Calc	1.895455	4.036364	4.581818	4.2	3.572727	3.563636	3.704545	3.590909	4.727273	3.763636	4.113636	4.318182
Tin	23.8 U	3.8	3.1	29.2 U	21.6 U	23.4 U	3.4	NA	23.2 U	23.1 U	23.7 U	22.8 U

TABLE A-6

SUMMARY OF CHEMICALS DETECTED IN SURFACE SOIL
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB14	01SB15	01SB16	01SB17	01SB18	01SB19	01SB20	01SB21	01TPL	01TPL	01TPL	01TPS
Sample	01SS140002	01SS150002	01SS160002	01SS170002	01SS180002	01SS190002	01SS200002	01SS210002	01TPL01	01TPL02	01TPL03	01TPS04
Matrix	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil	Surface Soil
Depth Range (bgs)	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	1 - 1.5	1 - 1.5	1 - 1.5	1 - 1.5
Risk	Site	Site	Site	Site	Site	Site	Site	Background	Site	Site	Site	Site
Sample Date	8/24/2001	8/22/2001	8/21/2001	8/24/2001	8/24/2001	8/24/2001	8/21/2001	8/21/2001	8/27/2001	8/27/2001	8/27/2001	8/27/2001
Vanadium	31.7	35.7 J	28.1	36.2	24.8	30.4	28.6	NA	24.8	23.6	22.8	29.2
Zinc	49.8 J	50.9	42.5	54.9 J	25.1 J	34.3 J	45.3	NA	41.2 J	35.5 J	38.6 J	46.3 J
Miscellaneous Parameters												
Cation Exchange Capacity (meq/100g	NA	NA	NA	NA	NA	NA	11.2	NA	NA	NA	NA	NA
pH (S.U.)	NA	NA	NA	NA	NA	NA	5.0 J	NA	7.5 J	NA	NA	NA
Total Radionuclides (pCi/g)												
Actinium-228	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.92	0.97	NA
Bismuth-212	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.91	0.94	NA
Bismuth-214	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.68	0.74	NA
Cesium-137	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.0359 U	0.09	NA
Lead-210	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.47	0.52	NA
Lead-212	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.83	0.86	NA
Lead-214	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.71	0.69	NA
Potassium-40	NA	NA	NA	NA	NA	NA	NA	NA	NA	9.94	9.76	NA
Radium-226	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.56	1.68	NA
Thallium-208	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.77	0.81	NA
Thorium-228	0.227	0.387	0.490	0.427	0.416	0.299	0.436	0.431	0.483	0.377	0.353	0.449
Thorium-230	0.0554 U	0.562 J	0.475	0.0395 U	0.0345 U	0.0848 U	0.578	0.0764	0.0278 J	0.0179 J	0.023 J	0.0215 J
Thorium-232	0.190	0.501	0.518	0.497	0.370	0.485	0.379	0.359	0.557	0.451	0.552	0.501
Thorium-234	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.00	1.73	NA
Uranium-235	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.12	0.14	NA

Calc = Calculated value.
NA = Not analyzed
U - Indicates that the chemical was not detected at the numerical detection limit (sample-specific quantitation limit) noted. Nondetected results from the laboratory are reported in this manner. This qualifier is also added to a positive result (reported by the laboratory) if the detected concentration is determined to be attributable to contamination introduced during field sampling or laboratory analysis.
UJ - Indicates that the chemical was not detected. However, the detection limit (sample-specific quantitation limit) is considered to be estimated based on problems encountered during laboratory analysis. The associated numerical detection limit is regarded as inaccurate or imprecise.
J - Indicates that the chemical was detected. However, the associated numerical result is not a precise representation of the amount that is actually present in the sample. The laboratory-reported concentration is considered to be an estimate of the true concentration.
R - Indicates that the chemical may or may not be present. The positive analytical result reported by the laboratory is considered to be unreliable and unusable. This qualifier is applied in cases of gross technical deficiencies.
BU - Indicates that the chemical was detected in this sample as well as the associated laboratory method blank, but has been qualified non-detected result as a laboratory blank contamination (i.e., concentration was less than the blank action level).
MEQ - milliequivalents
S.U. - Standard units.

TABLE A-7

SUMMARY OF CHEMICALS DETECTED IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-01	01-01	01-02	01-02	01-03	01-03	01-03	01-04	01-04	01-05	01-05
Nsample	01GW0101	01GW0102	01GW0201	01GW0202	01GW0301	01GW0301-F	01GW0302	01GW0401	01GW0402	01GW0501	01GW0502
Sample	01GW0101	01GW0102	01GW0201	01GW0202	01GW0301	01GW0301-F	01GW0302	01GW0401	01GW0402	01GW0501	01GW0502
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	9/6/2001	6/2/2002	9/6/2001	6/17/2002	9/7/2001	9/7/2001	6/1/2002	8/28/2001	6/1/2002	9/19/2001	6/15/2002
VOCs (ug/L)											
1,1,1,2-Tetrachloroethane	0.5 U	0.5 U	500 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2,2-Tetrachloroethane	0.5 U	0.5 U	38000	30	0.5 U	NA	0.5 U	0.5 U	0.5 U	9 J	8
1,1,2-Trichloroethane	1 UJ	1 U	1000 U	0.6 J	1 U	NA	1 U	1 U	1 U	9 J	11
1,1-Dichloroethene	1 U	1 U	1000 U	1 U	1 U	NA	1 U	1 U	1 U	0.2 J	1 U
1,2-Dichloroethane	0.5 U	0.5 U	500 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chloroform	0.5 U	0.5 U	840 J	1	0.5 U	NA	0.5 U	0.5 U	0.5 U	0.2 BU	0.5 U
cis-1,2-Dichloroethene	1 UJ	1 U	1000 U	1 U	1 U	NA	1 U	1 U	1 U	2 J	2
Ethene	NA	NA	NA	1 U	NA	NA	NA	NA	NA	NA	NA
Methane	NA	NA	NA	1 UJ	NA	NA	NA	NA	NA	NA	NA
Methylene Chloride	1 BU	1 UJ	1000 U	1 UJ	0.3 BU	NA	1 UJ	5 BU	1 UJ	1 U	1 UJ
Tetrachloroethene	0.5 U	0.5 U	370 J	1	0.5 U	NA	0.5 U	0.5 U	0.5 U	2 J	2
Toluene	0.5 U	0.5 U	500 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
trans-1,2-Dichloroethene	1 U	1 U	1000 U	1 U	1 U	NA	1 U	1 U	1 U	0.3 J	1 U
Trichloroethene	0.5 U	0.5 U	16000	20	0.5 U	NA	0.5 U	0.5 U	0.5 U	550 J	840
SVOCs (ug/L)											
4-Nitrophenol	25 U	NA	25 U	NA	25 U	NA	NA	25 U	NA	15 J	NA
Acenaphthene	0.2 UJ	NA	0.2 U	NA	0.2 U	NA	NA	0.0793 J	NA	0.2 U	NA
Acenaphthylene	0.2 U	NA	0.763	NA	0.2 U	NA	NA	0.2 U	NA	0.2 U	NA
bis(2-Ethylhexyl) phthalate	7 J	NA	5 U	NA	5 U	NA	NA	5 U	NA	5 U	NA
Butyl Benzyl Phthalate	5 U	NA	5 U	NA	5 U	NA	NA	5 U	NA	5 U	NA
Fluorene	0.2 U	NA	0.0593 J	NA	0.2 U	NA	NA	0.2 U	NA	0.2 U	NA
Hexachloroethane	5 U	NA	5 J	NA	5 U	NA	NA	5 U	NA	5 U	NA
Naphthalene	0.2 U	NA	0.579	NA	0.2 U	NA	NA	0.2 U	NA	0.2 U	NA
Energetics (ug/L)											
2,4,6-Trinitrotoluene	0.65 U	NA	0.65 U	NA	0.65 U	NA	NA	0.65 U	NA	0.65 U	NA
2-Nitrotoluene	0.65 U	NA	0.202 J	NA	0.65 U	NA	NA	0.65 U	NA	0.65 U	NA
4-Amino-2,6-Dinitrotoluene	0.65 U	NA	0.65 U	NA	0.65 U	NA	NA	0.65 U	NA	0.263 J	NA
HMX	0.201 J	NA	0.65 U	NA	0.65 U	NA	NA	0.65 U	NA	0.65 U	NA
Pesticides/PCBs (ug/L)											
gamma-Chlordane	0.025 J	NA	0.04 U	NA	0.075 J	NA	NA	0.04 U	NA	0.04 U	NA
Heptachlor	0.042 BU	NA	0.04 U	NA	0.059 U	NA	NA	0.013 BU	NA	0.05 BU	NA
Total Metals (ug/L)											
Aluminum	68.8	NA	40.2 U	21.2 U	5700	NA	NA	40.2 U	NA	40.3 U	NA
Antimony	1.6 U	NA	1.6 U	5.1 U	1.6 U	NA	NA	1.9	NA	3.0	NA
Arsenic	1.5 U	NA	1.5 U	2.2 U	7.9	NA	NA	2.5 U	NA	1.5 U	NA
Barium	29.1	NA	134	32.4 J	258	NA	NA	17.1	NA	25.0	NA
Beryllium	0.40 U	NA	0.40 U	0.30 U	0.59	NA	NA	0.40 U	NA	0.40 U	NA
Cadmium	0.30 U	NA	0.74	0.60 U	0.94	NA	NA	0.30 U	NA	0.30 U	NA
Calcium	105000 J	NA	121000 J	21800	60200 J	NA	NA	89100	NA	196000	NA
Chromium	0.60 U	NA	0.61 U	0.80 U	7.1 J	NA	NA	0.60 U	NA	0.70 U	NA
Cobalt	11.1	NA	3.1	1.1 U	14.1	NA	NA	1.0 U	NA	3.0	NA
Copper	0.90 U	NA	0.90 U	3.2 U	14.5 J	NA	NA	0.90 U	NA	0.90 U	NA
Iron	1410	NA	22.1	27.0 U	8670	NA	NA	24.9	NA	319	NA
Lead	1.6 U	NA	1.6 U	2.8 U	8.2 J	NA	NA	1.6 U	NA	1.6 U	NA
Magnesium	72400 J	NA	72100 J	8970	18000 J	NA	NA	59800	NA	151000	NA
Manganese	2450 J	NA	434 J	22.0	2670 J	NA	NA	1.5	NA	590	NA
Mercury	0.10 U	NA	0.10 U	0.10 U	0.10 U	NA	NA	0.10 U	NA	0.15	NA

TABLE A-7

SUMMARY OF CHEMICALS DETECTED IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-01	01-01	01-02	01-02	01-03	01-03	01-03	01-04	01-04	01-05	01-05
Nsample	01GW0101	01GW0102	01GW0201	01GW0202	01GW0301	01GW0301-F	01GW0302	01GW0401	01GW0402	01GW0501	01GW0502
Sample	01GW0101	01GW0102	01GW0201	01GW0202	01GW0301	01GW0301-F	01GW0302	01GW0401	01GW0402	01GW0501	01GW0502
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	9/6/2001	6/2/2002	9/8/2001	6/17/2002	9/7/2001	9/7/2001	6/1/2002	8/28/2001	6/1/2002	9/19/2001	6/15/2002
Nickel	10.2 J	NA	41.4 J	3.0	31.9 J	NA	NA	0.70 U	NA	6.9	NA
Potassium	3010	NA	1530	446	4300	NA	NA	1310	NA	2800 J	NA
Silver	3.0 U	NA	3.0 U	1.8 U	3.0 U	NA	NA	3.0 U	NA	0.70 U	NA
Sodium	48500 J	NA	102000 J	5550	10700 J	NA	NA	80800	NA	117000	NA
Strontium	265 J	NA	257 J	75.2 J	158 J	NA	NA	148 J	NA	347 J	NA
Thallium	5.0 UJ	NA	5.0 UJ	0.60 U	5.0 UJ	NA	NA	5.0 U	NA	4.1	NA
Thorium-Calc	0.605454 U	NA	1.454545 U	NA	0.362727 U	0.404091 U	NA	0.585 U	NA	0.809773	NA
Vanadium	3.0 U	NA	3.0 U	0.80 U	11.8	NA	NA	3.0 U	NA	0.50 U	NA
Zinc	11.3 U	NA	61.9 J	8.3 U	43.8 U	NA	NA	1.1 U	NA	1.7 U	NA
Dissolved Metals (ug/L)											
Aluminum	NA	NA	NA	NA	NA	40.2 U	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	1.6 U	NA	NA	NA	NA	NA
Arsenic	NA	NA	NA	NA	NA	2.3	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	215	NA	NA	NA	NA	NA
Calcium	NA	NA	NA	NA	NA	60500 J	NA	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	NA	0.60 U	NA	NA	NA	NA	NA
Cobalt	NA	NA	NA	NA	NA	8.3	NA	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA	288	NA	NA	NA	NA	NA
Magnesium	NA	NA	NA	NA	NA	16600 J	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA	2740 J	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA	0.10 U	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	17.7 J	NA	NA	NA	NA	NA
Potassium	NA	NA	NA	NA	NA	3630	NA	NA	NA	NA	NA
Sodium	NA	NA	NA	NA	NA	7100 J	NA	NA	NA	NA	NA
Strontium	NA	NA	NA	NA	NA	153 J	NA	NA	NA	NA	NA
Thallium	NA	NA	NA	NA	NA	5.0 UJ	NA	NA	NA	NA	NA
Vanadium	NA	NA	NA	NA	NA	3.0 U	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA	6.2 U	NA	NA	NA	NA	NA
Total Radionuclides (pCi/L)											
Gross Alpha	4.82 J	NA	3.00 UJ	NA	1.50 J	NA	NA	2.05 J	NA	3.35 U	NA
Gross Beta	11.8 J	NA	3.18	NA	6.79	NA	NA	4.86 U	NA	4.46 U	NA
Thorium-228	0.0875 U	NA	0.166 U	NA	0.0399 U	0.0528 U	NA	0.108 U	NA	0.0863 U	NA
Thorium-232	0.0457 U	NA	0.154 U	NA	0.0399 U	0.0361 U	NA	0.0207 U	NA	0.135	NA
Miscellaneous Parameters (mg/L)											
Chloride	NA	NA	NA	4.1	NA	NA	NA	NA	NA	NA	NA
Hardness	560.3	NA	599.0	91.4	224.4	NA	NA	468.7	NA	1111.2	NA
Hardness, Filtered	NA	NA	NA	NA	NA	219.4	NA	NA	NA	NA	NA
Total Organic Carbon	4.5 J	NA	7.8 J	3.6 J	35.3 J	NA	NA	3.7	NA	4.78	NA
Field Parameters (mg/L)											
Alkalinity	NA	NA	NA	50	NA	NA	NA	NA	NA	NA	NA
Carbon Dioxide	NA	NA	NA	75	NA	NA	NA	NA	NA	NA	NA
Dissolved Oxygen	0.95	NA	1.6	4.5	0.84	NA	NA	0.63	NA	2.37	NA
Dissolved Oxygen - Meter	NA	1.28	NA	7.57	NA	NA	6.77	NA	5.61	NA	9.06
Ferrous Iron	NA	NA	NA	0.01	NA	NA	NA	NA	NA	NA	NA
Hydrogen Sulfide	NA	NA	NA	0	NA	NA	NA	NA	NA	NA	NA
Manganese(+2)	NA	NA	NA	0.4	NA	NA	NA	NA	NA	NA	NA
Nitrate	NA	NA	NA	0.08	NA	NA	NA	NA	NA	NA	NA
Nitrite	NA	NA	NA	0.008	NA	NA	NA	NA	NA	NA	NA

TABLE A-7

SUMMARY OF CHEMICALS DETECTED IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-01	01-01	01-02	01-02	01-03	01-03	01-03	01-04	01-04	01-05	01-05
Nsample	01GW0101	01GW0102	01GW0201	01GW0202	01GW0301	01GW0301-F	01GW0302	01GW0401	01GW0402	01GW0501	01GW0502
Sample	01GW0101	01GW0102	01GW0201	01GW0202	01GW0301	01GW0301-F	01GW0302	01GW0401	01GW0402	01GW0501	01GW0502
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	9/6/2001	6/2/2002	9/8/2001	6/17/2002	9/7/2001	9/7/2001	6/1/2002	8/28/2001	6/1/2002	9/19/2001	6/15/2002
Sulfate	NA	NA	NA	25	NA	NA	NA	NA	NA	NA	NA
Sulfide	NA	NA	NA	0.01	NA	NA	NA	NA	NA	NA	NA
Field Parameters											
Oxidation Reduction Potential (MV)	393	168	480	488	-152	NA	-6	490	575	490.4	50
pH (S.U.)	6.00	5.77	6.17	5.89	6.26	NA	6.58	6.7	6	6	6.86
Specific Conductance (MS/CM)	1.007	0.873	1.659	0.209	0.486	NA	0.207	0.922	1.466	2.37	2.112
Temperature (C)	15.38	14.8	17.5	15.1	17.4	NA	12.77	18.7	16.62	15.46	12.93
Turbidity (NTU)	4.7	4.3	3.3	2	14	NA	21	1.5	0.1	2.6	4.2

TABLE A-7

SUMMARY OF CHEMICALS DETECTED IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-06	01-06	01-07	01-08	01-08	01-09	01-09	01-10	01-10	01-10	01-11
Nsample	01GW0601	01GW0602	01GW0701	01GW0801	01GW0802	01GW0901	01GW0902	01GW1001	01GW1001-F	01GW1002	01GW1101
Sample	01GW0601	01GW0602	01GW0701	01GW0801	01GW0802	01GW0901	01GW0902	01GW1001	01GW1001-F	01GW1002	01GW1101
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	9/4/2001	6/2/2002	9/18/2001	9/18/2001	6/3/2002	9/7/2001	6/3/2002	9/8/2001	9/8/2001	6/11/2002	8/22/2001
VOCs (ug/L)											
1,1,1,2-Tetrachloroethane	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	NA	0.5 U	3
1,1,2,2-Tetrachloroethane	0.5 U	0.5 U	0.5 U	0.5 UJ	3	0.5 U	0.5 U	0.5 U	NA	0.5 U	170
1,1,2-Trichloroethane	1 U	1 U	1 U	0.6 J	3	1 U	1 U	1 U	NA	1 U	5
1,1-Dichloroethene	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	1 U	NA	1 U	0.7 J
1,2-Dichloroethane	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	NA	0.5 U	4
Chloroform	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	NA	0.5 U	15
cis-1,2-Dichloroethene	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	1 U	NA	1 U	5
Ethene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methylene Chloride	3 BU	1 UJ	1 U	1 UJ	1 UJ	0.8 BU	1 UJ	0.5 U	NA	1 UJ	6 BU
Tetrachloroethene	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	NA	0.5 U	6
Toluene	0.5 U	0.5 U	1	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U
trans-1,2-Dichloroethene	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	1 U	NA	1 U	2
Trichloroethene	0.5 U	0.5 U	0.5 U	4 J	7	0.5 U	0.5 U	0.4 J	NA	0.5 U	180 J
SVOCs (ug/L)											
4-Nitrophenol	25 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	25 U
Acenaphthene	0.2 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.0896 J
Acenaphthylene	0.2 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.2 U
bis(2-Ethylhexyl) phthalate	5 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	15 J
Butyl Benzyl Phthalate	5 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	9 J
Fluorene	0.2 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.2 U
Hexachloroethane	5 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	5 U
Naphthalene	0.0796 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.103 J
Energertics (ug/L)											
2,4,6-Trinitrotoluene	0.65 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.65 U
2-Nitrotoluene	0.65 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.65 U
4-Amino-2,6-Dinitrotoluene	0.65 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.65 U
HMX	0.171 R	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.65 U
Pesticides/PCBs (ug/L)											
gamma-Chlordane	0.04 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.04 U
Heptachlor	0.049 BU	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.023 J
Total Metals (ug/L)											
Aluminum	40.2 U	NA	1330	40.3 U	NA	162	NA	40.2 U	NA	NA	1370 J
Antimony	1.6 U	NA	1.6 U	1.6 U	NA	1.6 U	NA	2.1 U	NA	NA	4.7 U
Arsenic	3.2 U	NA	2.7	1.5 U	NA	1.5 U	NA	1.5 U	NA	NA	3.6
Barium	21.3	NA	156	19.4	NA	16.0	NA	41.7	NA	NA	45.4
Beryllium	0.40 U	NA	0.40 U	0.40 U	NA	0.40 U	NA	0.40 U	NA	NA	0.70 U
Cadmium	0.30 U	NA	0.30 U	0.30 U	NA	0.30 U	NA	0.30 U	NA	NA	0.41 U
Calcium	170000	NA	77100	66100	NA	39800 J	NA	113000 J	NA	NA	95100
Chromium	0.60 U	NA	1.5	0.70 U	NA	0.98 U	NA	0.60 U	NA	NA	3.6 U
Cobalt	1.0 U	NA	6.4	2.7	NA	1.2	NA	2.7	NA	NA	17.8
Copper	0.90 U	NA	2.9	0.90 U	NA	0.90 U	NA	0.90 U	NA	NA	2.6 U
Iron	398	NA	1410	6370	NA	624	NA	673	NA	NA	1160 J
Lead	1.6 U	NA	1.6 U	1.6 U	NA	1.6 U	NA	1.6 U	NA	NA	0.70 U
Magnesium	156000	NA	22000	23400	NA	10400 J	NA	20400 J	NA	NA	5780 J
Manganese	37.9	NA	1500	886	NA	144 J	NA	987 J	NA	NA	303 J
Mercury	0.10 U	NA	0.24	0.13	NA	0.10 U	NA	0.10 U	NA	NA	0.13 U

TABLE A-7

SUMMARY OF CHEMICALS DETECTED IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-06	01-06	01-07	01-08	01-08	01-09	01-09	01-10	01-10	01-10	01-11
Nsample	01GW0601	01GW0602	01GW0701	01GW0801	01GW0802	01GW0901	01GW0902	01GW1001	01GW1001-F	01GW1002	01GW1101
Sample	01GW0601	01GW0602	01GW0701	01GW0801	01GW0802	01GW0901	01GW0902	01GW1001	01GW1001-F	01GW1002	01GW1101
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	9/4/2001	6/2/2002	9/18/2001	9/18/2001	6/3/2002	9/7/2001	6/3/2002	9/8/2001	9/8/2001	6/11/2002	8/22/2001
Nickel	2.6	NA	17.6	4.1	NA	11.5 J	NA	8.5 J	NA	NA	10.5
Potassium	2790	NA	10400 J	2370 J	NA	1170	NA	2070	NA	NA	1350 J
Silver	3.0 U	NA	1.1	0.71	NA	3.0 U	NA	3.0 U	NA	NA	0.65 J
Sodium	17200	NA	12500	6100	NA	3070 J	NA	7900 J	NA	NA	5830 J
Strontium	958 J	NA	576 J	211 J	NA	76.5 J	NA	214 J	NA	NA	98.8 J
Thallium	5.0 U	NA	4.6	3.6	NA	5.0 UJ	NA	5.0 UJ	NA	NA	3.9 U
Thorium-Calc	0.328864	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.228182
Vanadium	3.0 U	NA	1.1	0.50 U	NA	3.0 U	NA	3.0 U	NA	NA	3.3 U
Zinc	1.1 U	NA	8.6	8.2	NA	9.4 U	NA	3.6 U	NA	NA	27.4
Dissolved Metals (ug/L)											
Aluminum	NA	NA	NA	NA	NA	NA	NA	NA	40.2 U	NA	NA
Antimony	NA	NA	NA	NA	NA	NA	NA	NA	3.1 U	NA	NA
Arsenic	NA	NA	NA	NA	NA	NA	NA	NA	1.5 U	NA	NA
Barium	NA	NA	NA	NA	NA	NA	NA	NA	41.0	NA	NA
Calcium	NA	NA	NA	NA	NA	NA	NA	NA	115000 J	NA	NA
Chromium	NA	NA	NA	NA	NA	NA	NA	NA	0.60 U	NA	NA
Cobalt	NA	NA	NA	NA	NA	NA	NA	NA	2.4	NA	NA
Iron	NA	NA	NA	NA	NA	NA	NA	NA	414	NA	NA
Magnesium	NA	NA	NA	NA	NA	NA	NA	NA	20400 J	NA	NA
Manganese	NA	NA	NA	NA	NA	NA	NA	NA	1010 J	NA	NA
Mercury	NA	NA	NA	NA	NA	NA	NA	NA	0.10 U	NA	NA
Nickel	NA	NA	NA	NA	NA	NA	NA	NA	8.7 J	NA	NA
Potassium	NA	NA	NA	NA	NA	NA	NA	NA	1990	NA	NA
Sodium	NA	NA	NA	NA	NA	NA	NA	NA	7640 J	NA	NA
Strontium	NA	NA	NA	NA	NA	NA	NA	NA	212 J	NA	NA
Thallium	NA	NA	NA	NA	NA	NA	NA	NA	5.0 UJ	NA	NA
Vanadium	NA	NA	NA	NA	NA	NA	NA	NA	3.0 U	NA	NA
Zinc	NA	NA	NA	NA	NA	NA	NA	NA	7.0 U	NA	NA
Total Radionuclides (pCi/L)											
Gross Alpha	5.26 J	NA	1.08 U	1.49 J	NA	1.87 J	NA	2.46 J	NA	NA	4.76 J
Gross Beta	5.16 U	NA	14.2	2.58	NA	2.32 U	NA	3.53	NA	NA	8.28 J
Thorium-228	0.0408	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.0329
Thorium-232	0.0631 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.0346 U
Miscellaneous Parameters (mg/L)											
Chloride	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hardness	1066.9	NA	283.1	261.4	NA	142.2	NA	366.2	NA	NA	261.3
Hardness, Filtered	NA	NA	NA	NA	NA	NA	NA	NA	371.2	NA	NA
Total Organic Carbon	6.21	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Field Parameters (mg/L)											
Alkalinity	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon Dioxide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved Oxygen	0.69	NA	0.38	0.39	NA	0.71	NA	0.72	NA	NA	1.01
Dissolved Oxygen - Meter	NA	2.56	NA	NA	0.73	NA	1.55	NA	NA	1.76	NA
Ferrous Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hydrogen Sulfide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese(+2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrite	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE A-7

SUMMARY OF CHEMICALS DETECTED IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-06	01-06	01-07	01-08	01-08	01-09	01-09	01-10	01-10	01-10	01-11
Nsample	01GW0601	01GW0602	01GW0701	01GW0801	01GW0802	01GW0901	01GW0902	01GW1001	01GW1001-F	01GW1002	01GW1101
Sample	01GW0601	01GW0602	01GW0701	01GW0801	01GW0802	01GW0901	01GW0902	01GW1001	01GW1001-F	01GW1002	01GW1101
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	9/4/2001	6/2/2002	9/18/2001	9/18/2001	6/3/2002	9/7/2001	6/3/2002	9/8/2001	9/8/2001	6/11/2002	8/22/2001
Sulfate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Field Parameters											
Oxidation Reduction Potential (MV)	109	142	221.5	39.6	-51	618.1	433	71	NA	-16	444.8
pH (S.U.)	5.25	6.61	6.9	6.28	6.75	4.41	5.26	6.33	NA	6.87	5.74
Specific Conductance (MS/CM)	1.67	1.466	0.518	0.546	0.404	0.272	0.088	0.699	NA	0.812	0.444
Temperature (C)	14.62	14.98	13.86	14.39	13.29	15.4	14.47	21.89	NA	15.1	17.15
Turbidity (NTU)	2.6	1.3	4.9	5	4.2	4.8	8.3	8.9	NA	2.4	27

TABLE A-7

SUMMARY OF CHEMICALS DETECTED IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-11	01-11	01-12	01-13	01-13	01-14	01-14	01-15	01-15	01-17	01-18
Nsample	01GW1101-F	01GW1102	01GW1201	01GW1301	01GW1301-F	01GW1401	01GW1402	01GW1501	01GW1502	01GW1701	01GW1801
Sample	01GW1101-F	01GW1102	01GW1201	01GW1301	01GW1301-F	01GW1401	01GW1402	01GW1501	01GW1502	01GW1701	01GW1801
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	8/22/2001	6/14/2002	9/5/2001	9/5/2001	9/5/2001	8/24/2001	6/5/2002	9/5/2001	6/15/2002	9/19/2001	9/20/2001
VOCs (ug/L)											
1,1,1,2-Tetrachloroethane	NA	0.5 U	7 U	0.5 U	NA	0.5 U	0.5 U	13 U	1	0.3 J	0.5 U
1,1,2,2-Tetrachloroethane	NA	1	230	9 J	NA	8	0.5 U	250	230	10 J	0.3 J
1,1,2-Trichloroethane	NA	1 U	13 U	1 U	NA	0.4 J	1 U	14 J	16	0.8 J	1 U
1,1-Dichloroethene	NA	1 U	13 U	1 U	NA	1 U	1 U	25 U	1	0.4 J	1 U
1,2-Dichloroethane	NA	0.5 U	7 U	0.5 U	NA	0.3 J	0.5 U	13 U	9	1 J	0.5 U
Chloroform	NA	0.7 J	9 BJ	0.5 BU	NA	0.1 J	0.5 U	18 U	6	4 J	0.5 U
cis-1,2-Dichloroethene	NA	1 U	13 U	1 U	NA	0.9 J	1	25 U	9	1 J	1 U
Ethene	NA	1 U	NA	NA	NA	NA	NA	NA	1 U	NA	NA
Methane	NA	1 UJ	NA	NA	NA	NA	NA	NA	24 J	NA	NA
Methylene Chloride	NA	1 J	5 BU	0.5 BU	NA	2 BU	1 UJ	53 BU	1 UJ	1 U	0.2 J
Tetrachloroethene	NA	2	7 U	0.5 U	NA	0.5 U	0.5 U	13 U	5	1 J	0.5 U
Toluene	NA	0.7 J	7 U	0.5 U	NA	0.5 U	0.5 U	13 U	0.5 U	0.5 U	0.5 U
trans-1,2-Dichloroethene	NA	1 U	13 U	1 U	NA	0.3 J	0.4 J	25 U	3	0.7 J	1 U
Trichloroethene	NA	15	190	8 J	NA	20	26	310	360	45 J	5 J
SVOCs (ug/L)											
4-Nitrophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	25 U	25 U
Acenaphthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.2 U	0.2 U
Acenaphthylene	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.2 U	0.2 U
bis(2-Ethylhexyl) phthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	5 J	5 U
Butyl Benzyl Phthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	5 U	5 U
Fluorene	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.2 U	0.2 U
Hexachloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	5 U	5 U
Naphthalene	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.2 U	0.2 U
Energertics (ug/L)											
2,4,6-Trinitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.127 J	0.65 U
2-Nitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.65 U	0.65 U
4-Amino-2,6-Dinitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.65 U	0.65 U
HMX	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.65 U	0.65 U
Pesticides/PCBs (ug/L)											
gamma-Chlordane	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.04 U	0.04 U
Heptachlor	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.041 BU	0.032 BU
Total Metals (ug/L)											
Aluminum	NA	180 J	447	40.2 U	NA	40.2 U	NA	46.3	21.2 U	40.3 U	249
Antimony	NA	5.1 U	1.6 U	1.6 U	NA	4.1 U	NA	3.1	5.1 U	1.6 U	2.0
Arsenic	NA	2.2 U	1.5 U	1.5 U	NA	1.5 U	NA	1.5 U	2.2 U	1.5 U	1.5 U
Barium	NA	21.8 J	15.0	24.9	NA	15.1	NA	24.3	29.9 J	9.7	26.5
Beryllium	NA	0.30 U	0.40 U	0.40 U	NA	0.40 U	NA	0.40 U	0.30 U	0.40 U	0.40 U
Cadmium	NA	0.60 U	0.30 U	0.30 U	NA	0.30 U	NA	0.30 U	0.60 U	0.30 U	0.30 U
Calcium	NA	7640	86000	107000	NA	154000 J	NA	145000	162000	46000	93800
Chromium	NA	0.80 U	1.7 U	0.60 U	NA	0.60 UJ	NA	0.60 U	0.80 U	0.83	0.79
Cobalt	NA	1.1 U	1.9	4.6	NA	27.8 J	NA	10.8	4.3 U	1.9	4.3
Copper	NA	3.2 U	0.90 U	0.90 U	NA	0.90 U	NA	0.90 U	3.2 U	0.90 U	0.90 U
Iron	NA	151	487	488	NA	44600	NA	16700	11600	89.6	4090
Lead	NA	2.8 U	1.6 U	1.6 U	NA	1.6 U	NA	1.6 U	2.8 U	1.6 U	1.6 U
Magnesium	NA	2720	25000	17800	NA	59200 J	NA	48600	52300	36500	16300
Manganese	NA	14.9	401	647	NA	6050 J	NA	3860	1970	4.7	736
Mercury	NA	0.10 U	0.10 U	0.10 U	NA	0.10 U	NA	0.10 U	0.10 U	0.12	0.10 U

TABLE A-7

SUMMARY OF CHEMICALS DETECTED IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-11	01-11	01-12	01-13	01-13	01-14	01-14	01-15	01-15	01-17	01-18
Nsample	01GW1101-F	01GW1102	01GW1201	01GW1301	01GW1301-F	01GW1401	01GW1402	01GW1501	01GW1502	01GW1701	01GW1801
Sample	01GW1101-F	01GW1102	01GW1201	01GW1301	01GW1301-F	01GW1401	01GW1402	01GW1501	01GW1502	01GW1701	01GW1801
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	8/22/2001	6/14/2002	9/5/2001	9/5/2001	9/5/2001	8/24/2001	6/5/2002	9/5/2001	6/15/2002	9/19/2001	9/20/2001
Nickel	NA	2.7 U	64.7	19.5	NA	52.2	NA	12.7	5.1	0.70 U	4.3
Potassium	NA	797	1340	1330	NA	2560 J	NA	1980	2450	1200 J	1720 J
Silver	NA	1.8 U	3.0 U	3.0 U	NA	3.0 U	NA	3.0 U	1.8 U	0.90	0.88
Sodium	NA	1510	14800	7290	NA	54700 J	NA	35200	49900	61700	27000
Strontium	NA	33.1 J	132 J	132 J	NA	277 J	NA	253 J	310 J	124 J	109 J
Thallium	NA	1.3 U	5.0 U	5.0 U	NA	5.0 U	NA	5.0 U	0.60 U	5.1	2.5
Thorium-Calc	0.377273 U	NA	NA	NA	NA	NA	NA	NA	NA	0.578636 U	0.683182 U
Vanadium	NA	0.80 U	3.0 U	3.0 U	NA	3.0 U	NA	3.0 U	0.80 U	0.50 U	0.75
Zinc	NA	8.3 U	23.2	17.9	NA	24.0 U	NA	1.1 U	8.3 U	1.7 U	4.3
Dissolved Metals (ug/L)											
Aluminum	87.0 U	NA	NA	NA	40.2 U	NA	NA	NA	NA	NA	NA
Antimony	2.1 U	NA	NA	NA	1.6 U	NA	NA	NA	NA	NA	NA
Arsenic	3.0 U	NA	NA	NA	2.1 U	NA	NA	NA	NA	NA	NA
Barium	36.2	NA	NA	NA	23.5	NA	NA	NA	NA	NA	NA
Calcium	93100	NA	NA	NA	102000	NA	NA	NA	NA	NA	NA
Chromium	1.0 U	NA	NA	NA	0.60 U	NA	NA	NA	NA	NA	NA
Cobalt	1.0 U	NA	NA	NA	3.0	NA	NA	NA	NA	NA	NA
Iron	51.7 J	NA	NA	NA	252	NA	NA	NA	NA	NA	NA
Magnesium	5430 J	NA	NA	NA	17100	NA	NA	NA	NA	NA	NA
Manganese	22.4 J	NA	NA	NA	538	NA	NA	NA	NA	NA	NA
Mercury	0.14 U	NA	NA	NA	0.10 U	NA	NA	NA	NA	NA	NA
Nickel	4.9 U	NA	NA	NA	16.1	NA	NA	NA	NA	NA	NA
Potassium	1100 J	NA	NA	NA	1270	NA	NA	NA	NA	NA	NA
Sodium	5000 J	NA	NA	NA	7130	NA	NA	NA	NA	NA	NA
Strontium	96.5 J	NA	NA	NA	128 J	NA	NA	NA	NA	NA	NA
Thallium	3.9 U	NA	NA	NA	5.0 U	NA	NA	NA	NA	NA	NA
Vanadium	0.30 U	NA	NA	NA	3.0 U	NA	NA	NA	NA	NA	NA
Zinc	9.4 U	NA	NA	NA	13.5	NA	NA	NA	NA	NA	NA
Total Radionuclides (pCi/L)											
Gross Alpha	NA	NA	2.04 J	1.68 J	NA	5.57	NA	3.92 J	NA	1.24 U	2.30 J
Gross Beta	NA	NA	3.81 U	3.28 U	NA	6.38	NA	9.25 J	NA	1.58 U	2.78
Thorium-228	0.0493 U	NA	NA	NA	NA	NA	NA	NA	NA	0.0710 U	0.0893 U
Thorium-232	0.0337 U	NA	NA	NA	NA	NA	NA	NA	NA	0.0563 U	0.0610 U
Miscellaneous Parameters (mg/L)											
Chloride	NA	0.60	NA	NA	NA	NA	NA	NA	56.8	NA	NA
Hardness	NA	30.3	317.7	340.5	NA	628.3	NA	562.2	619.9	265.2	301.3
Hardness, Filtered	254.8	NA	NA	NA	325.1	NA	NA	NA	NA	NA	NA
Total Organic Carbon	NA	2.9 J	NA	NA	NA	NA	NA	NA	4.4 J	NA	NA
Field Parameters (mg/L)											
Alkalinity	NA	15	NA	NA	NA	NA	NA	NA	250	NA	NA
Carbon Dioxide	NA	60	NA	NA	NA	NA	NA	NA	58	NA	NA
Dissolved Oxygen	NA	2	1.56	0.38	NA	0.08	NA	0.702	0.3	2.82	0.86
Dissolved Oxygen - Meter	NA	3.55	NA	NA	NA	NA	2.41	NA	8.35	NA	NA
Ferrous Iron	NA	0.01	NA	NA	NA	NA	NA	NA	8.8	NA	NA
Hydrogen Sulfide	NA	0	NA	NA	NA	NA	NA	NA	0	NA	NA
Manganese(+2)	NA	0.7	NA	NA	NA	NA	NA	NA	1.7	NA	NA
Nitrate	NA	0.29	NA	NA	NA	NA	NA	NA	0	NA	NA
Nitrite	NA	0	NA	NA	NA	NA	NA	NA	0	NA	NA

TABLE A-7

SUMMARY OF CHEMICALS DETECTED IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-11	01-11	01-12	01-13	01-13	01-14	01-14	01-15	01-15	01-17	01-18
Nsample	01GW1101-F	01GW1102	01GW1201	01GW1301	01GW1301-F	01GW1401	01GW1402	01GW1501	01GW1502	01GW1701	01GW1801
Sample	01GW1101-F	01GW1102	01GW1201	01GW1301	01GW1301-F	01GW1401	01GW1402	01GW1501	01GW1502	01GW1701	01GW1801
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	8/22/2001	6/14/2002	9/5/2001	9/5/2001	9/5/2001	8/24/2001	6/5/2002	9/5/2001	6/15/2002	9/19/2001	9/20/2001
Sulfate	NA	12	NA	NA	NA	NA	NA	NA	> 80	NA	NA
Sulfide	NA	0.01	NA	NA	NA	NA	NA	NA	0	NA	NA
Field Parameters											
Oxidation Reduction Potential (MV)	NA	562	466	206	NA	-156	-57	75.2	-71	474	93.8
pH (S.U.)	NA	5.32	5.89	6.44	NA	6.50	6.34	6.59	6.42	5.54	6.94
Specific Conductance (MS/CM)	NA	0.065	0.643	0.608	NA	1.47	1.083	1.352	1.396	0.824	0.768
Temperature (C)	NA	16.17	18.3	16.34	NA	16.5	14.24	14.74	16.92	16.5	16.77
Turbidity (NTU)	NA	4.4	4.1	6	NA	4	16	3.9	2	3.7	31

TABLE A-7

SUMMARY OF CHEMICALS DETECTED IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-18	01-19	01-20	01-20	01-21	01-22	01-23	01-23	01-23 [1]	01-23	01-24
Nsample	01GW1801-F	01GW1901	01GW2001	01GW2001-F	01GW2101	01GW2201	01GW2301	01GW2301-F	01GW2301RE	01GW2302	01GW2401
Sample	01GW1801-F	01GW1901	01GW2001	01GW2001-F	01GW2101	01GW2201	01GW2301	01GW2301-F	01GW2301	01GW2302	01GW2401
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	9/20/2001	9/18/2001	9/20/2001	9/20/2001	9/5/2001	9/19/2001	9/7/2001	9/7/2001	9/7/2001	6/4/2002	9/20/2001
VOCs (ug/L)											
1,1,1,2-Tetrachloroethane	NA	5 J	0.5 U	NA	0.5 U	2 J	0.5 U	NA	NA	0.5 U	0.5 U
1,1,2,2-Tetrachloroethane	NA	270	30 J	NA	0.5 U	150 J	0.5 U	NA	NA	0.5 U	0.5 U
1,1,2-Trichloroethane	NA	9 J	0.6 J	NA	1 U	4 J	1 U	NA	NA	1 U	1 U
1,1-Dichloroethene	NA	2 J	1 U	NA	1 U	0.8 J	1 U	NA	NA	1 U	1 U
1,2-Dichloroethane	NA	10 J	0.5 U	NA	0.5 U	0.5 U	0.5 U	NA	NA	0.5 U	0.5 U
Chloroform	NA	27 J	0.5 BU	NA	0.5 U	15 J	0.5 U	NA	NA	0.5 U	0.5 U
cis-1,2-Dichloroethene	NA	8 J	1 U	NA	1 U	4 J	1 U	NA	NA	1 U	1 U
Ethene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methylene Chloride	NA	0.4 J	0.3 J	NA	0.5 BU	0.3 J	0.2 U	NA	NA	1 UJ	1 U
Tetrachloroethene	NA	6 J	0.5 U	NA	0.5 U	3 J	0.5 U	NA	NA	0.5 U	0.5 U
Toluene	NA	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U	NA	NA	0.5 U	0.5 U
trans-1,2-Dichloroethene	NA	3 J	1 U	NA	1 U	2 J	1 U	NA	NA	1 U	1 U
Trichloroethene	NA	300	30 J	NA	0.5 U	120 J	0.5 U	NA	NA	0.5 U	0.4 J
SVOCs (ug/L)											
4-Nitrophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthylene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
bis(2-Ethylhexyl) phthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Butyl Benzyl Phthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Energertics (ug/L)											
2,4,6-Trinitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Nitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Amino-2,6-Dinitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
HMX	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pesticides/PCBs (ug/L)											
gamma-Chlordane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Heptachlor	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Metals (ug/L)											
Aluminum	NA	62.6	40.3 U	NA	40.2 U	40.3 U	40.2 U	NA	NA	NA	107
Antimony	NA	1.6 U	1.6 U	NA	1.6 U	1.6 U	1.6 U	NA	NA	NA	1.6 U
Arsenic	NA	1.5 U	1.5 U	NA	1.5 U	1.5 U	1.5 U	NA	NA	NA	1.5 U
Barium	NA	9.5	13.4	NA	30.3	9.9	5.4 J	NA	NA	NA	88.1
Beryllium	NA	0.40 U	0.40 U	NA	0.40 U	0.40 U	0.40 U	NA	NA	NA	0.40 U
Cadmium	NA	0.30 U	0.30 U	NA	0.30 U	0.30 U	0.30 U	NA	NA	NA	0.30 U
Calcium	NA	110000	244000	NA	128000	112000	282000 J	NA	NA	NA	75800
Chromium	NA	1.6	1.2	NA	0.60 U	0.70	0.60 U	NA	NA	NA	0.70 U
Cobalt	NA	1.0 U	1.6	NA	1.0 U	1.0 U	1.0 U	NA	NA	NA	6.6
Copper	NA	0.90 U	0.90 U	NA	0.90 U	0.90 U	0.90 UJ	NA	NA	NA	0.94
Iron	NA	134	158	NA	15300	20.3 U	1050	NA	NA	NA	4460
Lead	NA	1.6 U	1.6 U	NA	1.6 U	1.6 U	1.6 U	NA	NA	NA	1.6 U
Magnesium	NA	45700	148000	NA	64300	50000	139000 J	NA	NA	NA	27300
Manganese	NA	6.0	44.5	NA	977	2.9	446 J	NA	NA	NA	949
Mercury	NA	0.12	0.10 U	NA	0.10 U	0.12	0.10 U	NA	NA	NA	0.10

TABLE A-7

SUMMARY OF CHEMICALS DETECTED IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-18	01-19	01-20	01-20	01-21	01-22	01-23	01-23	01-23 [1]	01-23	01-24
Nsample	01GW1801-F	01GW1901	01GW2001	01GW2001-F	01GW2101	01GW2201	01GW2301	01GW2301-F	01GW2301RE	01GW2302	01GW2401
Sample	01GW1801-F	01GW1901	01GW2001	01GW2001-F	01GW2101	01GW2201	01GW2301	01GW2301-F	01GW2301	01GW2302	01GW2401
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	9/20/2001	9/18/2001	9/20/2001	9/20/2001	9/5/2001	9/19/2001	9/7/2001	9/7/2001	9/7/2001	6/4/2002	9/20/2001
Nickel	NA	2.5	27.3	NA	1.4	2.3	3.5 U	NA	NA	NA	13.6
Potassium	NA	1370 J	5440 J	NA	6060	1320 J	6150	NA	NA	NA	2370 J
Silver	NA	0.87	0.70 U	NA	3.0 U	0.70 U	3.0 U	NA	NA	NA	0.70
Sodium	NA	71600	22000	NA	14800	81900	29300 J	NA	NA	NA	10400
Strontium	NA	137 J	333 J	NA	948 J	185 J	823 J	NA	NA	NA	325 J
Thallium	NA	3.9	5.1	NA	5.0 U	3.0	5.0 UJ	NA	NA	NA	4.4
Thorium-Calc	1.095 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	0.53	0.53	NA	3.0 U	0.50 U	3.0 U	NA	NA	NA	0.58
Zinc	NA	7.0	5.0	NA	1.1 U	3.9	1.1 UJ	NA	NA	NA	3.9
Dissolved Metals (ug/L)											
Aluminum	40.3 U	NA	NA	40.3 U	NA	NA	NA	40.2 U	NA	NA	NA
Antimony	1.6 U	NA	NA	2.1 J	NA	NA	NA	2.3 U	NA	NA	NA
Arsenic	1.5 U	NA	NA	1.5 UJ	NA	NA	NA	1.7 J	NA	NA	NA
Barium	24.8	NA	NA	12.9	NA	NA	NA	5.4 J	NA	NA	NA
Calcium	96600	NA	NA	275000	NA	NA	NA	279000 J	NA	NA	NA
Chromium	0.70 U	NA	NA	1.1	NA	NA	NA	0.60 U	NA	NA	NA
Cobalt	3.2	NA	NA	1.0 U	NA	NA	NA	1.0 U	NA	NA	NA
Iron	748	NA	NA	20.3 U	NA	NA	NA	150	NA	NA	NA
Magnesium	16700	NA	NA	173000	NA	NA	NA	138000 J	NA	NA	NA
Manganese	765	NA	NA	13.7	NA	NA	NA	386 J	NA	NA	NA
Mercury	0.10 U	NA	NA	0.10	NA	NA	NA	0.10 U	NA	NA	NA
Nickel	4.6	NA	NA	27.2	NA	NA	NA	1.4 U	NA	NA	NA
Potassium	1770 J	NA	NA	5480 J	NA	NA	NA	5940	NA	NA	NA
Sodium	27500	NA	NA	23600	NA	NA	NA	28800 J	NA	NA	NA
Strontium	109 J	NA	NA	366 J	NA	NA	NA	807 J	NA	NA	NA
Thallium	5.4	NA	NA	7.7 J	NA	NA	NA	5.0 UJ	NA	NA	NA
Vanadium	0.50 U	NA	NA	0.77	NA	NA	NA	3.0 U	NA	NA	NA
Zinc	7.1	NA	NA	7.6	NA	NA	NA	1.1 UJ	NA	NA	NA
Total Radionuclides (pCi/L)											
Gross Alpha	NA	2.01 U	4.73 U	NA	2.60 J	2.06 U	8.53 J	NA	NA	4.89	1.36 J
Gross Beta	NA	2.52 U	9.81	NA	7.78 J	2.40 U	50.2 J	NA	8.35	12.3	1.99
Thorium-228	0.149 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thorium-232	0.0919 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Miscellaneous Parameters (mg/L)											
Chloride	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hardness	NA	462.9	1218.7	NA	584.4	485.6	1276.6	NA	NA	NA	301.7
Hardness, Filtered	310.0	NA	NA	1399.1	NA	NA	NA	1264.9	NA	NA	NA
Total Organic Carbon	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Field Parameters (mg/L)											
Alkalinity	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon Dioxide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved Oxygen	NA	2.07	2.67	NA	1.19	1.55	1.58	NA	NA	NA	0.54
Dissolved Oxygen - Meter	NA	NA	NA	NA	NA	NA	NA	NA	NA	3.01	NA
Ferrous Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hydrogen Sulfide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese(+2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrite	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE A-7

SUMMARY OF CHEMICALS DETECTED IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-18	01-19	01-20	01-20	01-21	01-22	01-23	01-23	01-23 [1]	01-23	01-24
Nsample	01GW1801-F	01GW1901	01GW2001	01GW2001-F	01GW2101	01GW2201	01GW2301	01GW2301-F	01GW2301RE	01GW2302	01GW2401
Sample	01GW1801-F	01GW1901	01GW2001	01GW2001-F	01GW2101	01GW2201	01GW2301	01GW2301-F	01GW2301	01GW2302	01GW2401
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	9/20/2001	9/18/2001	9/20/2001	9/20/2001	9/5/2001	9/19/2001	9/7/2001	9/7/2001	9/7/2001	6/4/2002	9/20/2001
Sulfate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Field Parameters											
Oxidation Reduction Potential (MV)	NA	434	327	NA	28.1	511	433.2	NA	NA	3	78.5
pH (S.U.)	NA	6.43	7.14	NA	5.61	6.41	4.99	NA	NA	6.28	6.69
Specific Conductance (MS/CM)	NA	1.162	1.567	NA	1.1	1.281	2.161	NA	NA	1.648	0.679
Temperature (C)	NA	16.8	15	NA	14.73	16.46	17.79	NA	NA	15.91	15.02
Turbidity (NTU)	NA	3.4	11	NA	4.2	1.7	30	NA	NA	9.1	2

TABLE A-7

SUMMARY OF CHEMICALS DETECTED IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-25	01-25	01-25	01-26	01-26	01-26	01-27	01-27	01C01	01C01	01T02
Nsample	01GW2501	01GW2502	01GW2502-F	01GW2601	01GW2601-F	01GW2602	01GW2701	01GW2701-F	01GWC0101	01GWC0102	01GWT0201
Sample	01GW2501	01GW2502	01GW2502-F	01GW2601	01GW2601-F	01GW2602	01GW2701	01GW2701-F	01GWC0101	01GWC0102	01GWT0201
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	9/8/2001	6/14/2002	6/14/2002	9/6/2001	9/6/2001	6/4/2002	9/8/2001	9/8/2001	8/25/2001	6/11/2002	9/19/2001
VOCs (ug/L)											
1,1,1,2-Tetrachloroethane	2 J	1	NA	0.5 U	NA	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U
1,1,2,2-Tetrachloroethane	32	24	NA	0.5 U	NA	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U
1,1,2-Trichloroethane	5 U	2	NA	1 U	NA	1 U	1 U	NA	1 U	1 U	1 U
1,1-Dichloroethene	5 U	1 U	NA	1 U	NA	1 U	1 U	NA	1 U	1 U	1 U
1,2-Dichloroethane	3 U	2	NA	0.5 U	NA	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U
Chloroform	7 J	6	NA	0.5 U	NA	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.3 BU
cis-1,2-Dichloroethene	5 U	2	NA	1 U	NA	1 U	1 U	NA	1 U	1 U	1 U
Ethene	NA	1 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methane	NA	1 UJ	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methylene Chloride	1 U	1 J	NA	1 U	NA	1 UJ	0.3 BU	NA	1 BU	1 UJ	0.2 J
Tetrachloroethene	3 U	1	NA	0.5 U	NA	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U
Toluene	3 U	0.7 J	NA	0.5 U	NA	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.6 J
trans-1,2-Dichloroethene	5 U	0.8 J	NA	1 U	NA	1 U	1 U	NA	1 U	1 U	1 U
Trichloroethene	65 J	74	NA	0.5 U	NA	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.2 J
SVOCs (ug/L)											
4-Nitrophenol	25 U	NA	NA	NA	NA	NA	NA	NA	25 U	NA	25 U
Acenaphthene	0.2 U	NA	NA	NA	NA	NA	NA	NA	0.108 J	NA	0.2 U
Acenaphthylene	0.2 U	NA	NA	NA	NA	NA	NA	NA	0.2 U	NA	0.2 U
bis(2-Ethylhexyl) phthalate	5 U	NA	NA	NA	NA	NA	NA	NA	5 U	NA	5 U
Butyl Benzyl Phthalate	5 U	NA	NA	NA	NA	NA	NA	NA	5 U	NA	5 U
Fluorene	0.2 U	NA	NA	NA	NA	NA	NA	NA	0.2 U	NA	0.2 U
Hexachloroethane	5 U	NA	NA	NA	NA	NA	NA	NA	5 U	NA	5 U
Naphthalene	0.2 U	NA	NA	NA	NA	NA	NA	NA	0.2 U	NA	0.2 U
Energertics (ug/L)											
2,4,6-Trinitrotoluene	0.65 U	NA	NA	NA	NA	NA	NA	NA	0.65 U	NA	0.65 U
2-Nitrotoluene	0.65 U	NA	NA	NA	NA	NA	NA	NA	0.65 U	NA	0.65 U
4-Amino-2,6-Dinitrotoluene	0.65 U	NA	NA	NA	NA	NA	NA	NA	0.65 U	NA	0.275 J
HMX	0.65 U	NA	NA	NA	NA	NA	NA	NA	0.65 U	NA	0.65 U
Pesticides/PCBs (ug/L)											
gamma-Chlordane	0.04 U	NA	NA	NA	NA	NA	NA	NA	0.04 U	NA	0.04 U
Heptachlor	0.02 U	NA	NA	NA	NA	NA	NA	NA	0.017 J	NA	0.051 BU
Total Metals (ug/L)											
Aluminum	40.2 U	21.2 U	NA	170	NA	NA	163	NA	40.2 U	NA	1580
Antimony	1.6 U	5.1 U	NA	1.7 U	NA	NA	2.6 U	NA	1.6 U	NA	1.6 U
Arsenic	1.5 U	2.2 U	NA	1.5 U	NA	NA	1.5 U	NA	1.6 U	NA	2.2 J
Barium	10.3	10 J	NA	21.2	NA	NA	54.9	NA	39.2	NA	59.0
Beryllium	0.40 U	0.30 U	NA	0.40 U	NA	NA	0.40 U	NA	0.40 U	NA	0.70 J
Cadmium	0.30 U	0.60 U	NA	0.30 U	NA	NA	0.30 U	NA	0.30 U	NA	0.30 UJ
Calcium	120000 J	131000	NA	149000 J	NA	NA	138000 J	NA	72800 J	NA	304000
Chromium	0.60 U	0.80 U	NA	0.60 U	NA	NA	0.62 U	NA	0.80	NA	5.4
Cobalt	1.0 U	1.1 U	NA	4.0	NA	NA	2.6	NA	1.0 U	NA	55.8
Copper	0.90 U	3.2 U	NA	0.90 U	NA	NA	0.98 U	NA	0.90 U	NA	4.9
Iron	20.2 U	27.0 U	NA	3560	NA	NA	941	NA	37.8	NA	19500
Lead	1.6 U	2.8 U	NA	1.6 U	NA	NA	1.6 U	NA	1.6 U	NA	4.3
Magnesium	52800 J	56000	NA	71900 J	NA	NA	62000 J	NA	26500	NA	218000
Manganese	43.3 J	4.0	NA	3410 J	NA	NA	1150 J	NA	24.8 J	NA	8040
Mercury	0.10 U	0.10 U	NA	0.10 U	NA	NA	0.10 U	NA	0.10 U	NA	0.12

TABLE A-7

SUMMARY OF CHEMICALS DETECTED IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-25	01-25	01-25	01-26	01-26	01-26	01-27	01-27	01C01	01C01	01T02
Nsample	01GW2501	01GW2502	01GW2502-F	01GW2601	01GW2601-F	01GW2602	01GW2701	01GW2701-F	01GWC0101	01GWC0102	01GWT0201
Sample	01GW2501	01GW2502	01GW2502-F	01GW2601	01GW2601-F	01GW2602	01GW2701	01GW2701-F	01GWC0101	01GWC0102	01GWT0201
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	9/8/2001	6/14/2002	6/14/2002	9/6/2001	9/6/2001	6/4/2002	9/8/2001	9/8/2001	8/25/2001	6/11/2002	9/19/2001
Nickel	2.0 U	2.7 U	NA	5.7 U	NA	NA	4.0 U	NA	1.5	NA	115
Potassium	1860	1760	NA	3650	NA	NA	2300	NA	1300 J	NA	14300 J
Silver	3.0 U	1.8 U	NA	3.0 U	NA	NA	3.0 U	NA	3.0 U	NA	0.70 U
Sodium	87000 J	73400	NA	64400 J	NA	NA	57300 J	NA	5710 J	NA	81500
Strontium	209 J	229 J	NA	375 J	NA	NA	266 J	NA	228 J	NA	3820 J
Thallium	5.0 UJ	0.60 U	NA	5.0 UJ	NA	NA	5.0 UJ	NA	5.0 U	NA	2.4 UJ
Thorium-Calc	0.845 U	NA	NA	NA	NA	NA	NA	NA	0.672273 U	NA	1.495455
Vanadium	3.0 U	0.80 U	NA	3.0 U	NA	NA	3.0 U	NA	3.0 U	NA	1.4
Zinc	1.1 U	8.3 U	NA	5.3 U	NA	NA	1.6 U	NA	4.5 U	NA	32.1
Dissolved Metals (ug/L)											
Aluminum	NA	NA	80.5 U	NA	146	NA	NA	40.2 U	NA	NA	NA
Antimony	NA	NA	5.1 U	NA	1.6 U	NA	NA	1.6 U	NA	NA	NA
Arsenic	NA	NA	2.2 U	NA	1.5 U	NA	NA	1.5 U	NA	NA	NA
Barium	NA	NA	9.9 J	NA	21.6	NA	NA	50.4	NA	NA	NA
Calcium	NA	NA	123000	NA	158000 J	NA	NA	136000 J	NA	NA	NA
Chromium	NA	NA	0.80 U	NA	0.60 U	NA	NA	0.60 U	NA	NA	NA
Cobalt	NA	NA	1.1 U	NA	4.0	NA	NA	1.7	NA	NA	NA
Iron	NA	NA	123	NA	3270	NA	NA	416	NA	NA	NA
Magnesium	NA	NA	52700	NA	76500 J	NA	NA	60000 J	NA	NA	NA
Manganese	NA	NA	10.4	NA	3610 J	NA	NA	1070 J	NA	NA	NA
Mercury	NA	NA	0.10 U	NA	0.10 U	NA	NA	0.10 U	NA	NA	NA
Nickel	NA	NA	2.7 U	NA	5.3 U	NA	NA	3.1 U	NA	NA	NA
Potassium	NA	NA	1690	NA	3860	NA	NA	2190	NA	NA	NA
Sodium	NA	NA	70200	NA	66900 J	NA	NA	54100 J	NA	NA	NA
Strontium	NA	NA	192 J	NA	395 J	NA	NA	259 J	NA	NA	NA
Thallium	NA	NA	0.60 U	NA	5.0 UJ	NA	NA	5.0 UJ	NA	NA	NA
Vanadium	NA	NA	0.80 U	NA	3.0 U	NA	NA	3.0 U	NA	NA	NA
Zinc	NA	NA	8.3 U	NA	1.1 U	NA	NA	1.1 U	NA	NA	NA
Total Radionuclides (pCi/L)											
Gross Alpha	2.59 UJ	NA	NA	4.28 J	NA	NA	2.32 UJ	NA	3.26 J	NA	10.5 J
Gross Beta	2.50 U	NA	NA	7.97 J	NA	NA	2.70	NA	4.03 U	NA	20.8
Thorium-228	0.119 U	NA	NA	NA	NA	NA	NA	NA	0.0933 U	NA	0.172
Thorium-232	0.0669 U	NA	NA	NA	NA	NA	NA	NA	0.0546 U	NA	0.157
Miscellaneous Parameters (mg/L)											
Chloride	NA	42.8	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hardness	517.1	557.7	NA	668.1	NA	NA	599.9	NA	290.9	NA	1656.8
Hardness, Filtered	NA	NA	524.1	NA	709.6	NA	NA	586.7	NA	NA	NA
Total Organic Carbon	NA	4.7 J	NA	NA	NA	NA	NA	NA	2.9	NA	1.73
Field Parameters (mg/L)											
Alkalinity	NA	250	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon Dioxide	NA	25	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved Oxygen	0.74	0.4	NA	0.75	NA	NA	2.89	NA	0.12	NA	7.67
Dissolved Oxygen - Meter	NA	0.63	NA	NA	NA	2.66	NA	NA	NA	2.28	NA
Ferrous Iron	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hydrogen Sulfide	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese(+2)	NA	0.3	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrate	NA	0.21	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrite	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE A-7

SUMMARY OF CHEMICALS DETECTED IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01-25	01-25	01-25	01-26	01-26	01-26	01-27	01-27	01C01	01C01	01T02
Nsample	01GW2501	01GW2502	01GW2502-F	01GW2601	01GW2601-F	01GW2602	01GW2701	01GW2701-F	01GWC0101	01GWC0102	01GWT0201
Sample	01GW2501	01GW2502	01GW2502-F	01GW2601	01GW2601-F	01GW2602	01GW2701	01GW2701-F	01GWC0101	01GWC0102	01GWT0201
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	9/8/2001	6/14/2002	6/14/2002	9/6/2001	9/6/2001	6/4/2002	9/8/2001	9/8/2001	8/25/2001	6/11/2002	9/19/2001
Sulfate	NA	> 80	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfide	NA	0.02	NA	NA	NA	NA	NA	NA	NA	NA	NA
Field Parameters											
Oxidation Reduction Potential (MV)	433	232	NA	543.9	NA	7	396.1	NA	365.7	565	346
pH (S.U.)	6.4	7.02	NA	7	NA	6.34	6.06	NA	6.97	6.9	5.4
Specific Conductance (MS/CM)	1.289	1.363	NA	1.428	NA	1.129	1.297	NA	0.522	0.394	2.948
Temperature (C)	20.58	14.5	NA	17.1	NA	15.42	17.01	NA	16.34	16.42	14.4
Turbidity (NTU)	5	14	NA	24	NA	16	16	NA	1.7	0.6	3.6

TABLE A-7

SUMMARY OF CHEMICALS DETECTED IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01T02	01T02	01T02	01T03	01T04	01T05
Nsample	01GWT0202	01GWT0203	01GWT0203-F	01GWT0301	01GWT0401	01GWT0501
Sample	01GWT0202	01GWT0203	01GWT0203-F	01GWT0301	01GWT0401	01GWT0501
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Risk	Site	Site	Site	Site	Site	Site
Sample Date	9/22/2001	6/12/2002	6/12/2002	6/17/2002	6/15/2002	6/15/2002
VOCs (ug/L)						
1,1,1,2-Tetrachloroethane	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U
1,1,2,2-Tetrachloroethane	0.5 U	0.5 U	NA	0.5 U	0.5 U	2
1,1,2-Trichloroethane	1 U	1 U	NA	1 U	1 U	1 U
1,1-Dichloroethene	1 U	1 U	NA	1 U	1 U	1 U
1,2-Dichloroethane	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U
Chloroform	0.2 BU	0.5 U	NA	0.5 U	0.5 U	1
cis-1,2-Dichloroethene	1 U	1 U	NA	1 U	1 U	1 U
Ethene	NA	2 J	NA	1 U	1 U	1 U
Methane	NA	0.9 J	NA	1 UJ	1 UJ	1 UJ
Methylene Chloride	1 U	1 UJ	NA	1 UJ	1 UJ	1 UJ
Tetrachloroethene	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U
Toluene	0.3 J	0.5 J	NA	0.5 U	0.5 U	0.5 U
trans-1,2-Dichloroethene	1 U	1 U	NA	1 U	1 U	1 U
Trichloroethene	0.2 J	0.5 U	NA	1	0.5 U	2
SVOCs (ug/L)						
4-Nitrophenol	25 U	NA	NA	NA	NA	NA
Acenaphthene	0.2 U	NA	NA	NA	NA	NA
Acenaphthylene	0.2 U	NA	NA	NA	NA	NA
bis(2-Ethylhexyl) phthalate	5 U	NA	NA	NA	NA	NA
Butyl Benzyl Phthalate	5 U	NA	NA	NA	NA	NA
Fluorene	0.2 U	NA	NA	NA	NA	NA
Hexachloroethane	5 U	NA	NA	NA	NA	NA
Naphthalene	0.2 U	NA	NA	NA	NA	NA
Energertics (ug/L)						
2,4,6-Trinitrotoluene	0.65 U	NA	NA	NA	NA	NA
2-Nitrotoluene	0.65 U	NA	NA	NA	NA	NA
4-Amino-2,6-Dinitrotoluene	0.65 U	NA	NA	NA	NA	NA
HMX	0.65 U	NA	NA	NA	NA	NA
Pesticides/PCBs (ug/L)						
gamma-Chlordane	0.04 U	NA	NA	NA	NA	NA
Heptachlor	0.034 U	NA	NA	NA	NA	NA
Total Metals (ug/L)						
Aluminum	40.3 U	57.8 U	NA	21.2 U	21.2 U	21.2 U
Antimony	1.6 U	5.1 U	NA	5.1 U	5.1 U	5.1 U
Arsenic	1.5 UJ	2.2 U	NA	2.2 U	2.2 U	2.2 U
Barium	17.8	16.6 J	NA	40.1 J	33.1 J	22.8 J
Beryllium	0.40 U	0.30 U	NA	0.30 U	0.30 U	0.30 U
Cadmium	0.30 UJ	0.60 U	NA	0.60 U	0.60 U	0.60 U
Calcium	330000	344000	NA	87700	70400	147000
Chromium	0.70 U	0.80 UJ	NA	0.80 U	0.80 U	0.80 U
Cobalt	66.3	126 J	NA	1.2 U	1.1 U	11.2 J
Copper	0.90 U	3.2 U	NA	3.2 U	3.2 U	3.2 U
Iron	10600	14800	NA	27.0 U	27.0 U	31.0
Lead	1.6 U	2.8 UJ	NA	2.8 U	2.8 U	2.8 U
Magnesium	242000	250000	NA	59900	21500	233000
Manganese	9170	9600	NA	45.2	5.9	5420
Mercury	0.11	0.10 U	NA	0.10 U	0.10 U	0.10 U

TABLE A-7

SUMMARY OF CHEMICALS DETECTED IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01T02	01T02	01T02	01T03	01T04	01T05
Nsample	01GWT0202	01GWT0203	01GWT0203-F	01GWT0301	01GWT0401	01GWT0501
Sample	01GWT0202	01GWT0203	01GWT0203-F	01GWT0301	01GWT0401	01GWT0501
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Risk	Site	Site	Site	Site	Site	Site
Sample Date	9/22/2001	6/12/2002	6/12/2002	6/17/2002	6/15/2002	6/15/2002
Nickel	124	273	NA	9.3	2.7 U	75.1
Potassium	15500 J	15300	NA	4830	1720	4130
Silver	0.70 U	1.8 UJ	NA	1.8 U	1.8 U	1.8 U
Sodium	84000	69700	NA	4300	4050	110000
Strontium	3990 J	3910 J	NA	329 J	172 J	468 J
Thallium	2.4 UJ	2.1 U	NA	0.60 U	0.60 U	0.6 U
Thorium-Calc	0.155909	NA	NA	NA	NA	NA
Vanadium	0.50 U	0.80 U	NA	0.80 U	0.80 U	0.80 U
Zinc	16.4	103	NA	8.3 U	8.3 U	12.1
Dissolved Metals (ug/L)						
Aluminum	NA	NA	21.2 U	NA	NA	NA
Antimony	NA	NA	5.1 U	NA	NA	NA
Arsenic	NA	NA	2.2 U	NA	NA	NA
Barium	NA	NA	13.8 J	NA	NA	NA
Calcium	NA	NA	349000	NA	NA	NA
Chromium	NA	NA	0.80 UJ	NA	NA	NA
Cobalt	NA	NA	96.8 J	NA	NA	NA
Iron	NA	NA	20300	NA	NA	NA
Magnesium	NA	NA	254000	NA	NA	NA
Manganese	NA	NA	9650	NA	NA	NA
Mercury	NA	NA	0.10 U	NA	NA	NA
Nickel	NA	NA	208	NA	NA	NA
Potassium	NA	NA	15200	NA	NA	NA
Sodium	NA	NA	70700	NA	NA	NA
Strontium	NA	NA	4040 J	NA	NA	NA
Thallium	NA	NA	2.1 U	NA	NA	NA
Vanadium	NA	NA	0.80 U	NA	NA	NA
Zinc	NA	NA	65.6	NA	NA	NA
Total Radionuclides (pCi/L)						
Gross Alpha	6.06 U	8.22	NA	2.60 U	0.906 U	4.83 U
Gross Beta	19.3	18.8	NA	3.75	1.69	5.21
Thorium-228	0.0216 U	NA	NA	NA	NA	NA
Thorium-232	0.0235	NA	NA	NA	NA	NA
Miscellaneous Parameters (mg/L)						
Chloride	NA	94.4	NA	2.1	1.6	127
Hardness	1820.6	1888.5	NA	465.7	264.3	1326.6
Hardness, Filtered	NA	NA	1917.4	NA	NA	NA
Total Organic Carbon	2.38	9.2 J	NA	3.7 J	2.6 J	5.1 J
Field Parameters (mg/L)						
Alkalinity	NA	120	NA	275	150	70
Carbon Dioxide	NA	350	NA	18	12	225
Dissolved Oxygen	6.7	1.5	NA	0.7	2	3
Dissolved Oxygen - Meter	NA	10.17	NA	7.72	2.63	3.92
Ferrous Iron	NA	8.5	NA	0.01	0.01	0.07
Hydrogen Sulfide	NA	0	NA	0	0	0
Manganese(+2)	NA	> 22	NA	0.3	0	6.2
Nitrate	NA	0.04	NA	0.32	1.28	0.38
Nitrite	NA	0	NA	0.008	0	0.006

TABLE A-7

SUMMARY OF CHEMICALS DETECTED IN GROUND WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01T02	01T02	01T02	01T03	01T04	01T05
Nsample	01GWT0202	01GWT0203	01GWT0203-F	01GWT0301	01GWT0401	01GWT0501
Sample	01GWT0202	01GWT0203	01GWT0203-F	01GWT0301	01GWT0401	01GWT0501
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Risk	Site	Site	Site	Site	Site	Site
Sample Date	9/22/2001	6/12/2002	6/12/2002	6/17/2002	6/15/2002	6/15/2002
Sulfate	NA	> 80	NA	> 80	54	> 80
Sulfide	NA	0.04	NA	0	0	0
Field Parameters						
Oxidation Reduction Potential (MV)	343	98	NA	404	272	228
pH (S.U.)	5.42	5.68	NA	7.23	7.45	5.77
Specific Conductance (MS/CM)	2.929	2.686	NA	0.739	0.482	2.61
Temperature (C)	15.9	14.99	NA	13.9	13.4	13.8
Turbidity (NTU)	2.6	18	NA	2.7	0.7	2.3

Calc = Calculated value.
NA = Not analyzed
U - Indicates that the chemical was not detected at the numerical detection limit (sample-specific quantitation limit) noted. Nondetected results from the laboratory are reported in this manner. This qualifier is also added to a positive result (reported by the laboratory) if the detected concentration is determined to be attributable to contamination introduced during field sampling or laboratory analysis.
UJ - Indicates that the chemical was not detected. However, the detection limit (sample-specific quantitation limit) is considered to be estimated based on problems encountered during laboratory analysis. The associated numerical detection limit is regarded as inaccurate or imprecise.
J - Indicates that the chemical was detected. However, the associated numerical result is not a precise representation of the amount that is actually present in the sample. The laboratory-reported concentration is considered to be an estimate of the true concentration.
UR - Indicates that the chemical may or may not be present. The nondetected analytical result reported by the laboratory is considered to be unreliable and unusable. This qualifier is applied in cases of gross technical deficiencies (i.e., holding times missed by a factor of two times the specified time limit, severe calibration noncompliances, and extremely low quality control recoveries).
BU - Indicates that the chemical was detected in this sample as well as the associated laboratory method blank, but has been qualified non-detected result as a laboratory blank contamination (i.e., concentration was less than the blank action level).
bgs - below ground surface.
MEQ - milliequivalents
S.U. - Standard units.

TABLE A-8

SUMMARY OF CHEMICALS DETECTED IN SUBSURFACE SOIL
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB01	01SB02	01SB02	01SB03	01SB04	01SB04	01SB05	01SB05	01SB06	01SB06
Sample	01SB010206	01SB020206	01SB020610	01SB030206	01SB040206	01SB040610	01SB050206	01SB050610	01SB060206	01SB060610
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range (bgs)	2 - 6	2 - 6	6 - 9.5	2 - 6	2 - 6	6 - 10	2 - 6	6 - 8.5	2 - 6	6 - 10
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/27/2001	8/27/2001
VOCs (ug/kg)										
1,1,2,2-Tetrachloroethane	3 UJ	3 UJ	3 UJ	3 U	2 UJ	3 UJ	3 U	3 UJ	3 U	3 U
Acetone	6 UJ	5 UJ	5 UJ	5 UJ	4 UJ	5 UJ	5 UJ	5 UJ	32 J	9 J
Chloroform	3 U	3 U	3 U	3 U	2 U	3 U	3 U	3 U	3 U	3 U
Methylene Chloride	40 BU	20 U	6 U	9 U	3 J	5 U	54 U	48 BU	58 J	46 J
SVOCs (ug/kg)										
Acenaphthene	11.7 U	12.1 U	10.9 U	12.3 U	11 U	11 U	10.7 U	11.2 U	30.3	4.34 J
Anthracene	11.7 U	12.1 U	10.9 U	12.3 U	11 U	11 U	10.7 U	11.2 U	12 U	12 U
Benzo(a)Anthracene	11.7 U	12.1 U	10.9 U	12.3 U	11 U	11 U	10.7 U	11.2 U	12 U	12 U
Benzo(a)Pyrene	11.7 U	12.1 U	10.9 U	12.3 U	11 U	11 U	10.7 U	11.2 U	12 U	12 U
Benzo(b)Fluoranthene	11.7 U	12.1 U	10.9 U	12.3 U	11 U	11 U	10.7 U	11.2 U	12 U	12 U
Benzo(g,h,i)Perylene	11.7 U	12.1 U	10.9 U	12.3 U	11 U	11 U	10.7 U	11.2 U	12 U	12 U
bis(2-Ethylhexyl) phthalate	200 U	200 U	180 U	210 U	190 U	190 U	180 U	110 J	200 U	200 U
Chrysene	11.7 U	12.1 U	10.9 U	12.3 U	11 U	11 U	10.7 U	11.2 U	12 U	12 U
Fluoranthene	11.7 U	12.1 U	10.9 U	12.3 U	11 U	11 U	10.7 U	11.2 U	12 U	12 U
Fluorene	11.7 U	12.1 U	10.9 U	12.3 U	11 U	11 U	10.7 U	11.2 U	12 U	12 U
Indeno(1,2,3-cd)Pyrene	11.7 U	12.1 U	10.9 U	12.3 U	11 U	11 U	10.7 U	11.2 U	12 U	12 U
Naphthalene	11.7 U	8.85 J	10.9 U	8.52 J	11 U	11 U	10.7 U	11.2 U	12 U	12 U
Phenanthrene	11.7 U	12.1 U	10.9 U	12.3 U	11 U	11 U	10.7 U	11.2 U	12 U	12 U
Pyrene	11.7 U	12.1 U	10.9 U	12.3 U	11 U	11 U	10.7 U	11.2 U	12 U	12 U
Energetics (ug/kg)										
HMX	476 U	500 U	476 U	476 U	476 U	476 U	454 U	476 U	454 U	476 U
Pesticides/PCBs (ug/kg)										
gamma-Chlordane	1.5 U	1.6 U	NA	1.6 U	1.4 U	NA	1.4 U	NA	1.5 U	NA
Heptachlor	1.4 J	1.2 J	NA	1.2 J	1.2 BU	NA	0.96 J	NA	1 J	NA
Inorganics (mg/kg)										
Aluminum	8350 J	7610 J	3180 J	9130 J	8280 J	4100 J	4890 J	3730 J	18100	7010
Arsenic	3.2 J	2.9 J	0.36 U	4.8 J	4.7 J	0.88 U	5.1 J	2.3 U	7.7 J	2.0 J
Barium	64.9 J	35.5 J	58.2 J	38.1 J	30.9	52.0	15.7 J	14.9 J	52.8	28.3
Beryllium	0.37 J	0.38 J	1.2 J	0.45 J	0.38 J	1.1 J	0.34 J	0.42 J	0.38	1.5
Cadmium	0.04 J	0.76	0.03 UJ	1.1	0.21 J	0.35 J	0.03 UJ	0.03 UJ	0.05 U	0.05 U
Calcium	43200 J	485 J	487 J	553 J	461 J	540 J	121 J	69.6 J	629 J	673 J
Chromium	12.2	11.5	8.7	14.6	12.7 J	10.7 J	9.0	7.7	24.0	21.3
Cobalt	2.6	3.4	25.8	3.5	2.9 J	14.6 J	5.5	4.3	8.0	22.3
Copper	10.6 J	10.2 J	12.8 J	11.3 J	9.5 J	13.1 J	6.8 J	7.6 J	14.2	17.5
Iron	12400	13900	30800	18300	15000	24800 J	18000	13200	27700	22400
Lead	8.3	18.6	15.4	36.9	9.9	10.6	6.2	7.9	16.0	12.6
Magnesium	4670 J	1320 J	1030 J	1480 J	1390 J	1130 J	395 J	311 J	1830 J	1530 J
Manganese	69.6 J	70.1 J	379 J	107 J	86.4 J	270 J	133 J	100 J	251	408
Mercury	0.02 UJ	0.02 UJ	0.02 UJ	0.02 UJ	0.02 U	0.02 U	0.02 J	0.02 J	0.07 J	0.03 J
Nickel	6.5	8.3	32.7	7.2	7.5 J	26.6 J	11.2	9.2	11.5	39.3
Potassium	358 J	420 J	488 J	371 J	393 J	752 J	305 J	427 J	792 J	1190 J
Selenium	0.12 J	0.21 J	0.85 J	0.45 J	0.45 U	0.90 U	0.32 J	0.28 J	1.7	0.71
Sodium	365 J	392 J	357 J	411 J	332 J	347 J	240 J	251 J	657	755
Strontium	46.0 J	5.7 J	4.0 J	6.9 J	5.6 J	4.8 J	2.0 J	1.3 J	11.6 J	12.5 J
Thallium	0.84	1.0	2.7	1.5	1.7 J	2.7	1.7	1.1	0.55 U	0.58 U
Thorium-Calc	3.790909	3.604545	5.181818	3.818182	6.427273	5.054545	2.195455	3.068182	4.795455	6.936364
Tin	22.5 U	23.1 U	20.1 U	23.5 U	21.1 U	21.0 U	19.9 U	21.4 U	2.4	2.3 U

TABLE A-8

SUMMARY OF CHEMICALS DETECTED IN SUBSURFACE SOIL
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB01	01SB02	01SB02	01SB03	01SB04	01SB04	01SB05	01SB05	01SB06	01SB06
Sample	01SB010206	01SB020206	01SB020610	01SB030206	01SB040206	01SB040610	01SB050206	01SB050610	01SB060206	01SB060610
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range (bgs)	2 - 6	2 - 6	6 - 9.5	2 - 6	2 - 6	6 - 10	2 - 6	6 - 8.5	2 - 6	6 - 10
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/26/2001	8/27/2001	8/27/2001
Vanadium	18.7	18.7	9.2	27.7	21.6	9.4	13.8	8.9	42.6	14.7
Zinc	31.3 J	23.9 J	70.9 J	22.1 J	23.1 J	62.0 J	49.8 J	29.4 J	43.6	72.1
Miscellaneous Parameters										
Cation Exchange Capacity (meq/100g)	12.9	NA	NA	18.2	NA	NA	20.1	18.7	NA	NA
pH (S.U.)	7.1 J	NA	NA	5.1 J	NA	NA	4.4 J	5.1 J	NA	NA
Total Radionuclides (pCi/g)										
Actinium-228	1.11	1.27	NA	1.07	1.01	NA	NA	NA	NA	NA
Bismuth-212	1.30	1.07	NA	1.13	0.98	NA	NA	NA	NA	NA
Bismuth-214	0.87	0.85	NA	0.73	0.73	NA	NA	NA	NA	NA
Europium-155	0.242 U	0.09	NA	0.244 U	0.08	NA	NA	NA	NA	NA
Lead-210	0.45	0.57	NA	0.65	0.36	NA	NA	NA	NA	NA
Lead-212	1.00	1.13	NA	1.00	0.95	NA	NA	NA	NA	NA
Lead-214	0.87	0.83	NA	0.72	0.75	NA	NA	NA	NA	NA
Potassium-40	5.98	9.23	NA	9.05	8.48	NA	NA	NA	NA	NA
Radium-226	1.79	1.90	NA	1.68	1.66	NA	NA	NA	NA	NA
Thallium-208	0.91	1.04	NA	0.94	0.91	NA	NA	NA	NA	NA
Thorium-228	0.359	0.393	0.477	0.343	0.781	0.494	0.207	0.332	0.512	0.654
Thorium-230	0.0522 U	0.0646 U	0.0661 J	0.113 J	0.485 J	0.520 J	0.0386 J	0.0332 J	0.0536 U	0.140
Thorium-232	0.475	0.400	0.663	0.497	0.633	0.618	0.276	0.343	0.543	0.872
Thorium-234	1.10	1.14	NA	1.88	1.00	NA	NA	NA	NA	NA

TABLE A-8

SUMMARY OF CHEMICALS DETECTED IN SUBSURFACE SOIL
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB07	01SB08	01SB08	01SB09	01SB10	01SB11	01SB11	01SB12	01SB12	01SB13
Sample	01SB070206	01SB080206	01SB080610	01SB090206	01SB100206	01SB110206	01SB110610	01SB120206	01SB120610	01SB130206
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range (bgs)	2 - 5	2 - 6	6 - 10	2 - 6	2 - 6	2 - 6	6 - 10	2 - 6	6 - 10	2 - 6
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	8/27/2001	8/21/2001	8/21/2001	8/27/2001	8/27/2001	8/22/2001	8/22/2001	8/25/2001	8/25/2001	8/24/2001
VOCs (ug/kg)										
1,1,2,2-Tetrachloroethane	3 U	3 U	3 U	2 J	3 UJ	3 U	3 U	3 U	3 U	3 U
Acetone	29 J	5 UJ	5 UJ	5 UJ	5 UJ	6 UJ	5 UJ	6	5 U	36
Chloroform	3 U	3 U	3 U	4 J	3 U	3 U	3 U	3 U	3 U	3 U
Methylene Chloride	86 J	21 J	16 J	45 U	50 J	26 J	15 J	15 J	13 J	10
SVOCs (ug/kg)										
Acenaphthene	13.5 U	11.6 U	11.3 U	11.6 U	11.6 U	11.8 U	11.3 U	11.1 U	11 U	12.7 UJ
Anthracene	13.5 U	11.6 UJ	11.3 UJ	11.6 U	11.6 U	11.8 UJ	11.3 UJ	11.1 U	11 U	12.7 UJ
Benzo(a)Anthracene	13.5 U	11.6 U	11.3 U	11.6 U	11.6 U	11.8 U	11.3 U	11.1 U	11 U	12.7 UJ
Benzo(a)Pyrene	13.5 U	11.6 U	11.3 U	11.6 U	11.6 U	11.8 U	11.3 U	11.1 U	11 U	12.7 UJ
Benzo(b)Fluoranthene	13.5 U	11.6 U	11.3 U	11.6 U	11.6 U	11.8 U	11.3 U	11.1 U	11 U	12.7 UJ
Benzo(g,h,i)Perylene	13.5 U	11.6 U	11.3 U	11.6 U	11.6 U	11.8 U	11.3 U	11.1 U	11 U	12.7 UJ
bis(2-Ethylhexyl) phthalate	230 U	200 U	190 U	5600	200 U	200 U	190 U	190 U	190 U	210 U
Chrysene	13.5 U	11.6 U	11.3 U	11.6 U	11.6 U	11.8 U	11.3 U	11.1 U	11 U	12.7 UJ
Fluoranthene	13.5 U	11.6 U	11.3 U	11.6 U	11.6 U	11.8 U	11.3 U	11.1 U	11 U	12.7 UJ
Fluorene	13.5 U	11.6 U	11.3 U	11.6 U	11.6 U	11.8 U	11.3 U	11.1 U	11 U	12.7 UJ
Indeno(1,2,3-cd)Pyrene	13.5 U	11.6 U	11.3 U	11.6 U	11.6 U	11.8 U	11.3 U	11.1 U	11 U	12.7 UJ
Naphthalene	13.5 U	11.6 UR	11.3 UR	10.2 J	11.6 U	11.8 UR	11.3 UR	11.1 U	11 U	12.7 UJ
Phenanthrene	13.5 U	11.6 U	11.3 U	11.6 U	11.6 U	11.8 U	11.3 U	11.1 U	11 U	12.7 UJ
Pyrene	13.5 U	11.6 U	11.3 U	11.6 U	11.6 U	11.8 U	11.3 U	11.1 U	11 U	12.7 UJ
Energetics (ug/kg)										
HMX	476 U	70.6 J	476 U	476 U	476 U	500 U	500 U	500 U	476 U	476 U
Pesticides/PCBs (ug/kg)										
gamma-Chlordane	1.8 U	1.5 U	NA	1.5 U	1.5 U	1.5 U	NA	0.82 J	NA	2.6 J
Heptachlor	1.5 J	1.6 J	NA	1.2 J	0.94 J	1.5 J	NA	1 BU	NA	1.5 BU
Inorganics (mg/kg)										
Aluminum	12700	7030 J	4290 J	10100 J	14200	11900 J	4530 J	8210 J	4330 J	9510 J
Arsenic	6.7 J	4.2	0.48 J	4.1 J	2.7 J	8.1	3.1	3.4 J	1.7 U	5.3 J
Barium	55.4	26.3	23.6	34.8 J	51.2	44.0	28.1	27.9	52.2	39.7
Beryllium	0.24	0.31 U	1.6 J	0.55 J	0.24	0.42 U	0.32 U	0.33 J	0.47 J	0.35 J
Cadmium	0.05 U	0.01 U	0.01 U	0.03 UJ	0.04 U	0.01 U	0.01 U	0.16 J	0.16	0.04 J
Calcium	549 J	262 J	362 J	901 J	10000 J	332 J	557 J	305 J	485 J	263 J
Chromium	18.7	10.4	15.0	14.9	17.6	15.9	10.3	11.3 J	8.5 J	12.7 J
Cobalt	5.5	2.0 J	16.8 J	2.6	4.0	4.0 J	1.3 J	3.0 J	3.9 J	3.4 J
Copper	14.4	9.4 J	25.3 J	10.7 J	11.4	12.7 J	9.1 J	7.4 J	7.8 J	10.8 J
Iron	24400	12600	71500	15800	15700	23600	16200	12800	8750	17800
Lead	12.2	8.0 J	7.6 J	10.3	10.5	11.9 J	9.6 J	10.5	9.8	9.2
Magnesium	2350 J	826 J	395 J	1210 J	1840 J	1750 J	512 J	1120 J	663 J	1630 J
Manganese	250	45.4 J	329 J	20.3 J	137	180 J	21.7 J	157 J	20.9 J	131 J
Mercury	0.02 J	0.04	0.03	0.02 J	0.02 J	0.06	0.03	0.03 J	0.02 U	0.03 U
Nickel	11.5	4.5	24.9	6.7	8.8	8.1	3.2	5.6 J	8.2 J	8.2 J
Potassium	617 J	441 J	754 J	353 J	615 J	553 J	207 J	381 J	449 J	504 J
Selenium	1.4	0.31 J	1.3 J	0.36 J	1.1	0.41 J	0.34 J	0.48 U	0.18 U	0.55 U
Sodium	567	359 J	379 J	342 J	706	336 J	343 J	329 J	379 J	391 J
Strontium	10.2 J	5.0 J	4.4 J	9.9 J	17.5 J	6.1 J	4.1 J	5.2 J	4.9 J	5.4 J
Thallium	0.63 U	1.1 J	5.3 J	1.5	0.53 U	2.1	1.4 J	1.1 J	1.0	1.8 J
Thorium-Calc	4.222727	3.436364	2.931818	3.977273	5.222727	3.340909	4.836364	4.736364	4.481818	3.409091
Tin	2.5 U	3.6	4.0	21.8 U	2.8	3.3	2.3	20.4 U	21.1 U	24.0 U

TABLE A-8

SUMMARY OF CHEMICALS DETECTED IN SUBSURFACE SOIL
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB07	01SB08	01SB08	01SB09	01SB10	01SB11	01SB11	01SB12	01SB12	01SB13
Sample	01SB070206	01SB080206	01SB080610	01SB090206	01SB100206	01SB110206	01SB110610	01SB120206	01SB120610	01SB130206
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range (bgs)	2 - 5	2 - 6	6 - 10	2 - 6	2 - 6	2 - 6	6 - 10	2 - 6	6 - 10	2 - 6
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	8/27/2001	8/21/2001	8/21/2001	8/27/2001	8/27/2001	8/22/2001	8/22/2001	8/25/2001	8/25/2001	8/24/2001
Vanadium	32.9	18.3 J	15.9 J	26.8	28.1	29.4 J	20.5 J	20.9	10.2	22.2
Zinc	46.9	18.1	129	16.2 J	43.3	34.2	15.0	17.6 J	26.1 J	31.7 J
Miscellaneous Parameters										
Cation Exchange Capacity (meq/100g)	19.2 J	NA	NA	NA	NA	NA	NA	NA	NA	14.8 J
pH (S.U.)	5	NA	NA	NA	NA	NA	NA	NA	NA	4.8
Total Radionuclides (pCi/g)										
Actinium-228	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bismuth-212	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bismuth-214	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Europium-155	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead-210	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead-212	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead-214	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Potassium-40	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Radium-226	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium-208	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thorium-228	0.355	0.242	0.400	0.400	0.537	0.319	0.502	0.504	0.507	0.291
Thorium-230	0.164	0.334 J	0.385 J	0.0427 U	0.111	0.434 J	0.637 J	0.394 U	0.360 U	0.421 J
Thorium-232	0.574	0.514	0.245	0.475	0.612	0.416	0.562	0.538	0.479	0.459
Thorium-234	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE A-8

SUMMARY OF CHEMICALS DETECTED IN SUBSURFACE SOIL
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB13	01SB14	01SB14	01SB15	01SB15	01SB16	01SB16	01SB17	01SB17	01SB18
Sample	01SB130610	01SB140206	01SB140610	01SB150206	01SB150610	01SB160206	01SB160610	01SB170206	01SB170610	01SB180206
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range (bgs)	6 - 10	2 - 6	6 - 8	2 - 6	6 - 10	2 - 6	6 - 10	2 - 6	6 - 9.7	2 - 6
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	8/24/2001	8/24/2001	8/24/2001	8/22/2001	8/22/2001	8/21/2001	8/21/2001	8/24/2001	8/24/2001	8/24/2001
VOCs (ug/kg)										
1,1,2,2-Tetrachloroethane	3 U	3 UJ	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Acetone	17	5 UJ	5 U	5 UJ	5 UJ	5 UJ	5 UJ	11	14	26
Chloroform	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
Methylene Chloride	5 J	5 J	47	14 J	16 J	13 J	11 J	7 J	4 J	7 J
SVOCs (ug/kg)										
Acenaphthene	11.9 U	14.2	11.4 U	11.9 U	12 U	12 U	11.8 U	12.7 U	11.4 UR	12 U
Anthracene	11.9 U	11.6 U	11.4 U	11.9 UJ	12 UJ	12 U	11.8 U	12.7 U	11.4 UR	12 U
Benzo(a)Anthracene	11.9 U	11.6 U	11.4 U	11.9 U	12 U	12 U	11.8 U	12.7 U	11.4 UR	12 U
Benzo(a)Pyrene	11.9 U	11.6 U	11.4 U	11.9 U	12 U	12 U	11.8 U	12.7 U	11.4 UR	12 U
Benzo(b)Fluoranthene	11.9 U	11.6 U	11.4 U	11.9 U	12 U	12 U	11.8 U	12.7 U	11.4 UR	12 U
Benzo(g,h,i)Perylene	11.9 U	11.6 U	11.4 U	11.9 U	12 U	12 U	11.8 U	12.7 U	11.4 UR	12 U
bis(2-Ethylhexyl) phthalate	200 U	200 U	190 U	200 U	200 U	200 U	97 J	180 U	190 U	210 U
Chrysene	11.9 U	11.6 U	11.4 U	11.9 U	12 U	12 U	11.8 U	12.7 U	11.4 UR	12 U
Fluoranthene	11.9 U	11.6 U	11.4 U	11.9 U	12 U	12 U	11.8 U	12.7 U	11.4 UR	12 U
Fluorene	11.9 U	11.6 U	11.4 U	11.9 U	12 U	12 U	11.8 U	12.7 U	11.4 UR	12 U
Indeno(1,2,3-cd)Pyrene	11.9 U	11.6 U	11.4 U	11.9 U	12 U	12 U	11.8 U	12.7 U	11.4 UR	12 U
Naphthalene	11.9 U	11.6 U	11.4 U	11.9 UR	12 UR	12 UR	11.8 UR	12.7 U	11.4 UR	12 U
Phenanthrene	11.9 U	11.6 U	11.4 U	11.9 U	12 U	12 U	11.8 U	12.7 U	11.4 UR	12 U
Pyrene	11.9 U	11.6 U	11.4 U	11.9 U	12 U	12 U	11.8 U	12.7 U	11.4 UR	12 U
Energertics (ug/kg)										
HMX	454 U	476 U	476 U	476 U	476 U	476 U	454 U	454 U	476 U	476 U
Pesticides/PCBs (ug/kg)										
gamma-Chlordane	NA	0.64 J	NA	1.6 U	NA	3 J	NA	0.65 J	NA	0.98 J
Heptachlor	NA	1.4 BU	NA	2 J	NA	1.9	NA	2.1 BU	NA	1 BU
Inorganics (mg/kg)										
Aluminum	4090 J	7630 J	3270 J	8610 J	4280 J	9900	5760	10600 J	6800 J	4700 J
Arsenic	2.0 U	2.8 J	1.7 U	4.7	0.85	4.4	7.8	7.2 J	1.2 U	1.8 U
Barium	34.3	30.8	21.4	36.3	41.7	32.7	34.1	43.7	300	31.4
Beryllium	0.36 J	0.34 J	0.22 U	0.38 U	0.69 J	0.27 U	0.33 U	0.38 J	0.58 J	0.34 J
Cadmium	0.04	0.04 J	0.05	0.01 U	0.01 U	0.05 UJ	0.59 J	0.20 J	0.04	0.04 U
Calcium	475 J	314 J	251 J	350 J	1080 J	3250	834	393 J	912 J	223 J
Chromium	7.5 J	12.1 J	6.9 J	15.5	6.4 J	12.7	9.8	12.7 J	8.7 J	8.0 J
Cobalt	2.2 J	2.4 J	1.7 J	3.4 J	8.1 J	2.7 J	1.4 J	4.5 J	4.3 J	2.6 J
Copper	7.5 J	6.7 J	4.3 J	9.6 J	9.5 J	9.8 J	7.6 J	12.8 J	6.8 J	9.4 J
Iron	8200	11700	6540	19500	9730 J	17400	12000	18800	4940	8540
Lead	8.8	12.0	6.1	12.0 J	5.8 J	10.3	18.0	12.8	9.8	8.4
Magnesium	640 J	945 J	477 J	1430 J	1150 J	1760	617	1900 J	1300 J	683 J
Manganese	12.8 J	114 J	23.3 J	155 J	32.2 J	66.4	12.3	177 J	12.9 J	15.6 J
Mercury	0.02 U	0.02 U	0.02 U	0.04	0.03	0.05 U	0.03 U	0.02 U	0.02 U	0.02 U
Nickel	6.0 J	4.9 J	4.0 J	6.8	12.1	6.0	3.4	9.1 J	10.5 J	6.8 J
Potassium	531 J	329 J	359 J	356 J	488 J	417 J	254 J	574 J	550 J	570 J
Selenium	0.52 U	0.52 U	0.28 U	0.28 UJ	0.28 U	0.38 U	0.38 U	0.65 U	0.22 U	0.35 U
Sodium	349 J	318 J	329 J	360 J	351 J	356	355	379 J	441 J	385 J
Strontium	4.1 J	5.1 J	3.2 J	4.7 J	5.3 J	7.8 J	5.2 J	6.4 J	11.3 J	3.5 J
Thallium	0.86	1.3 J	1.1	1.4 J	1.0	2.2	1.4	1.8 J	0.75	1.1
Thorium-Calc	3.118182	3.586364	3.377273	3.077273	4.840909	3.495455	4.586364	3.513636	4.109091	4.704545
Tin	22.6 U	22.1 U	21.4 U	3.4	3.6	2.7	2.3 U	23.9 U	21.8 U	22.3 U

TABLE A-8

SUMMARY OF CHEMICALS DETECTED IN SUBSURFACE SOIL
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB13	01SB14	01SB14	01SB15	01SB15	01SB16	01SB16	01SB17	01SB17	01SB18
Sample	01SB130610	01SB140206	01SB140610	01SB150206	01SB150610	01SB160206	01SB160610	01SB170206	01SB170610	01SB180206
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range (bgs)	6 - 10	2 - 6	6 - 8	2 - 6	6 - 10	2 - 6	6 - 10	2 - 6	6 - 9.7	2 - 6
Risk	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	8/24/2001	8/24/2001	8/24/2001	8/22/2001	8/22/2001	8/21/2001	8/21/2001	8/24/2001	8/24/2001	8/24/2001
Vanadium	10.4	21.7	7.4	25.2 J	7.2 J	22.4	16.1	26.4	7.1	10.1
Zinc	20.6 J	15.7 J	18.0 J	26.8	31.8	22.8	11.2	36.8 J	29.0 J	25.6 J
Miscellaneous Parameters										
Cation Exchange Capacity (meq/100g)	11 J	NA	NA	NA	NA	NA	NA	NA	NA	NA
pH (S.U.)	5.7	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Radionuclides (pCi/g)										
Actinium-228	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bismuth-212	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bismuth-214	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Europium-155	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead-210	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead-212	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead-214	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Potassium-40	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Radium-226	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium-208	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thorium-228	0.298	0.331	0.378	0.308	0.627	0.266	0.535	0.360	0.480	0.452
Thorium-230	0.284 J	0.0540 U	0.257 J	0.539 J	0.474 J	0.438	0.349	0.0428 U	0.0683 U	0.265 J
Thorium-232	0.388	0.458	0.365	0.369	0.438	0.503	0.474	0.413	0.424	0.583
Thorium-234	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE A-8

SUMMARY OF CHEMICALS DETECTED IN SUBSURFACE SOIL
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB18	01SB19	01SB19	01SB20	01SB20	01SB21	01SB21
Sample	01SB180610	01SB190206	01SB190610	01SB200206	01SB200610	01SB210206	01SB210610
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range (bgs)	6 - 8	2 - 6	6 - 8	2 - 6	6 - 8	0 - 2	6 - 10
Risk	Site	Site	Site	Site	Site	Background	Background
Sample Date	8/24/2001	8/24/2001	8/24/2001	8/21/2001	8/21/2001	8/21/2001	8/21/2001
VOCs (ug/kg)							
1,1,2,2-Tetrachloroethane	3 U	4 U	3 U	3 U	3 U	NA	NA
Acetone	42	20	31	5 UJ	5 UJ	NA	NA
Chloroform	3 U	4 U	3 U	3 U	3 U	NA	NA
Methylene Chloride	6 J	7 J	5 J	12 J	9 J	NA	NA
SVOCs (ug/kg)							
Acenaphthene	12.3 U	14.8 U	11.8 U	11.7 U	12.1 U	NA	NA
Anthracene	12.3 U	14.8 U	11.8 U	11.7 U	41.5	NA	NA
Benzo(a)Anthracene	12.3 U	14.8 U	11.8 U	11.7 U	153 J	NA	NA
Benzo(a)Pyrene	12.3 U	14.8 U	11.8 U	11.7 U	181 J	NA	NA
Benzo(b)Fluoranthene	12.3 U	14.8 U	11.8 U	11.7 U	318 J	NA	NA
Benzo(g,h,i)Perylene	12.3 U	14.8 U	11.8 U	11.7 U	160 J	NA	NA
bis(2-Ethylhexyl) phthalate	210 U	250 U	200 U	200 U	210 U	NA	NA
Chrysene	12.3 U	14.8 U	11.8 U	11.7 U	108 J	NA	NA
Fluoranthene	12.3 U	14.8 U	11.8 U	11.7 U	540 J	NA	NA
Fluorene	12.3 U	14.8 U	11.8 U	11.7 U	22.3	NA	NA
Indeno(1,2,3-cd)Pyrene	12.3 U	14.8 U	11.8 U	11.7 U	68.1	NA	NA
Naphthalene	12.3 U	14.8 U	11.8 U	11.7 UR	12.1 UR	NA	NA
Phenanthrene	12.3 U	14.8 U	11.8 U	11.7 U	278 J	NA	NA
Pyrene	12.3 U	14.8 U	11.8 U	11.7 U	306 J	NA	NA
Energertics (ug/kg)							
HMX	454 U	476 U	476 U	500 U	500 U	NA	NA
Pesticides/PCBs (ug/kg)							
gamma-Chlordane	NA	1.9 U	NA	1.6 U	NA	NA	NA
Heptachlor	NA	1.3 BU	NA	1.4 J	NA	NA	NA
Inorganics (mg/kg)							
Aluminum	4490 J	12500 J	1420 J	11700	10100	NA	NA
Arsenic	2.3 U	3.5 J	20.2 J	5.0 J	1.5 J	NA	NA
Barium	40.1	85.1	11.3	35.3	47.6	NA	NA
Beryllium	0.43 J	0.52 J	0.22 U	0.48 U	0.76 J	NA	NA
Cadmium	0.05	0.07 J	0.20	0.05 UJ	0.05 UJ	NA	NA
Calcium	385 J	510 J	222 J	271	427	NA	NA
Chromium	11.0 J	15.3 J	6.8 J	18.6	14.6	NA	NA
Cobalt	8.2 J	2.3 J	0.60 U	4.3	5.5	NA	NA
Copper	8.9 J	9.1 J	6.5 J	11.3 J	13.4 J	NA	NA
Iron	7420	19100	7360	26100	25400	NA	NA
Lead	10.5	12.1	8.4	14.7	11.6	NA	NA
Magnesium	909 J	1240 J	193 J	1380	1050	NA	NA
Manganese	109 J	48.1 J	8.6 J	172	36.8	NA	NA
Mercury	0.02 U	0.02 U	0.02 U	0.03 U	0.03 U	NA	NA
Nickel	12.1 J	5.8 J	1.6 J	7.5	10.4	NA	NA
Potassium	594 J	382 J	233 J	488 J	460 J	NA	NA
Selenium	0.33 U	0.55 U	0.31 U	0.37 U	0.40	NA	NA
Sodium	426 J	446 J	321 J	399	456	NA	NA
Strontium	4.3 J	6.7 J	2.1 J	5.3 J	7.1 J	NA	NA
Thallium	0.99	1.7 J	0.94	2.1	2.6	NA	NA
Thorium-Calc	3.85	2.436364	3.922727	1.872727	4.277273	3.527273	4.113636
Tin	23.9 U	27.0 U	22.5 U	3.3	3.2	NA	NA

TABLE A-8

SUMMARY OF CHEMICALS DETECTED IN SUBSURFACE SOIL
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SB18	01SB19	01SB19	01SB20	01SB20	01SB21	01SB21
Sample	01SB180610	01SB190206	01SB190610	01SB200206	01SB200610	01SB210206	01SB210610
Matrix	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil	Subsurface Soil
Depth Range (bgs)	6 - 8	2 - 6	6 - 8	2 - 6	6 - 8	0 - 2	6 - 10
Risk	Site	Site	Site	Site	Site	Background	Background
Sample Date	8/24/2001	8/24/2001	8/24/2001	8/21/2001	8/21/2001	8/21/2001	8/21/2001
Vanadium	8.2	28.1	10.3	32.1	21.3	NA	NA
Zinc	37.0 J	20.4 J	9.3 J	26.7	42.6	NA	NA
Miscellaneous Parameters							
Cation Exchange Capacity (meq/100g)	NA	NA	NA	11.5	20.1	NA	NA
pH (S.U.)	NA	NA	NA	5.0 J	5.1 J	NA	NA
Total Radionuclides (pCi/g)							
Actinium-228	NA	NA	NA	NA	NA	NA	NA
Bismuth-212	NA	NA	NA	NA	NA	NA	NA
Bismuth-214	NA	NA	NA	NA	NA	NA	NA
Europium-155	NA	NA	NA	NA	NA	NA	NA
Lead-210	NA	NA	NA	NA	NA	NA	NA
Lead-212	NA	NA	NA	NA	NA	NA	NA
Lead-214	NA	NA	NA	NA	NA	NA	NA
Potassium-40	NA	NA	NA	NA	NA	NA	NA
Radium-226	NA	NA	NA	NA	NA	NA	NA
Thallium-208	NA	NA	NA	NA	NA	NA	NA
Thorium-228	0.467	0.226	0.485	0.167	0.392	0.387	0.450
Thorium-230	0.0747 U	0.0148 U	0.126 U	0.0418	0.136	0.289	0.254
Thorium-232	0.380	0.310	0.378	0.245	0.549	0.389	0.455
Thorium-234	NA	NA	NA	NA	NA	NA	NA

Calc = Calculated value.
NA = Not analyzed
U - Indicates that the chemical was not detected at the numerical detection limit (sample-specific quantitation limit) noted. Nondetected results from the laboratory are reported in this manner. This qualifier is also added to a positive result (reported by the laboratory) if the detected concentration is determined to be attributable to contamination introduced during field sampling or laboratory analysis.
UJ - Indicates that the chemical was not detected. However, the detection limit (sample-specific quantitation limit) is considered to be estimated based on problems encountered during laboratory analysis. The associated numerical detection limit is regarded as inaccurate or imprecise.
J - Indicates that the chemical was detected. However, the associated numerical result is not a precise representation of the amount that is actually present in the sample. The laboratory-reported concentration is considered to be an estimate of the true concentration.
UR - Indicates that the chemical may or may not be present. The nondetected analytical result reported by the laboratory is considered to be unreliable and unusable. This qualifier is applied in cases of gross technical deficiencies (i.e., holding times missed by a factor of two times the specified time limit, severe calibration noncompliances, and extremely low quality control recoveries).
BU - Indicates that the chemical was detected in this sample as well as the associated laboratory method blank, but has been qualified non-detected result as a laboratory blank contamination (i.e., concentration was less than the blank action level).
bgs - below ground surface.
MEQ - milliequivalents
S.U. - Standard units.

TABLE A-9

SUMMARY OF CHEMICALS DETECTED IN SEDIMENT
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SD01[1]	01SD01	01SD02	01SD03	01SD03	01SD04	01SD05	01SD06	01SD07	01SD08	01SD09	01SD10	01SD11	01SD12
Nsample	01SD0101	01SD0102	01SD0201	01SD0301	01SD0302	01SD0401	01SD0501	01SD0601	01SD0701	01SD0801	01SD0902	01SD1002	01SD1102	01SD1202
Sample	01SD01	01SD0102	01SD02	01SD03	01SD0302	01SD04	01SD05	01SD06	01SD07	01SD08	01SD0902	01SD1002	01SD1102	01SD1202
Matrix	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
Depth Range	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5
Risk	Background	Background	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	8/14/2001	6/17/2002	8/14/2001	8/14/2001	6/17/2002	8/14/2001	8/14/2001	8/14/2001	8/14/2001	8/14/2001	6/17/2002	6/17/2002	6/17/2002	6/17/2002
VOCs (ug/kg)														
1,1,2,2-Tetrachloroethane	3 U	3 UJ	3 U	7	9	4 U	3 UJ	4 U	3 U	4 U	4 U	3 UJ	3 UJ	4 UJ
Acetone	5 UJ	290 J	5 UJ	6 UJ	510 J	7 UJ	5 UJ	12 J	5 UJ	7 UJ	190 J	230 J	540 J	630 J
Carbon Disulfide	3 U	2 J	3 U	3 U	2 J	4 U	3 U	4 U	3 U	4 U	4 U	3 UJ	2 J	4 UJ
Dichlorodifluoromethane	3 UJ	3 U	3 J	1 J	4 U	4 UJ	3 UJ	4 UJ	3 UJ	2 J	4 U	8 J	3 UJ	4 UJ
Toluene	3 U	3 U	3 U	3 U	2 J	4 U	3 U	4 U	3 U	4 U	1 J	3 UJ	1 J	4 UJ
SVOCs (ug/kg)														
Acenaphthene	11.8 U	NA	11.6 U	13.9 U	NA	13.7 U	11.7 U	11.2 U	139 J	13.8 U	NA	NA	NA	NA
Benzo(a)Anthracene	11.8 U	NA	11.6 U	13.9 U	NA	13.7 U	11.7 U	11.2 U	14.4	13.8 U	NA	NA	NA	NA
Benzo(a)Pyrene	11.8 U	NA	11.6 U	13.9 U	NA	13.7 U	7.05 J	4.97 J	27.5 J	6.73 J	NA	NA	NA	NA
Benzo(b)Fluoranthene	11.8 U	NA	11.6 U	9.95 J	NA	13.7 U	11.7 U	7.7 J	120 J	22.5 J	NA	NA	NA	NA
Benzo(g,h,i)Perylene	11.8 U	NA	11.6 U	13.9 U	NA	13.7 U	11.7 U	11.2 U	21.8 J	13.8 U	NA	NA	NA	NA
Benzo(k)Fluoranthene	11.8 U	NA	11.6 U	13.9 U	NA	13.7 U	8.96 J	11.2 U	14.6 J	6.26 J	NA	NA	NA	NA
bis(2-Ethylhexyl) Phthalate	200 U	NA	190 U	230 U	NA	230 U	190 U	190 U	190 UJ	98 J	NA	NA	NA	NA
Chrysene	11.8 U	NA	11.6 U	13.9 U	NA	13.7 U	11.7 U	11.2 U	17.3 J	13.8 U	NA	NA	NA	NA
Fluoranthene	11.8 U	NA	11.6 U	13.9 U	NA	13.7 U	4.93 J	5.39 J	18.4 J	7.83 J	NA	NA	NA	NA
Indeno(1,2,3-cd)Pyrene	11.8 U	NA	11.6 U	13.9 U	NA	13.7 U	11.7 U	11.2 U	12.8	13.8 U	NA	NA	NA	NA
Isosafrole	390 U	NA	380 U	450 U	NA	450 U	380 U	7600	380 U	460 U	NA	NA	NA	NA
Pyrene	11.8 U	NA	11.6 U	13.9 U	NA	13.7 U	11.7 U	11.2 U	24 J	5.31 J	NA	NA	NA	NA
Energetics (ug/kg)														
HMX	476 U	NA	54.2 J	422 J	NA	86.7 J	134 J	500 U	476 U	500 U	NA	NA	NA	NA
Pesticides/PCBs (ug/kg)														
Aroclor-1260	38 U	NA	38 U	46 U	NA	45 U	38 U	37 U	19 J	45 U	NA	NA	NA	NA
Heptachlor	0.95 J	NA	1.7	1.8 U	NA	1.4 J	1.2 J	2.5	1.1 J	1.8 U	NA	NA	NA	NA
Herbicides (ug/kg)														
2,4,5-T	12 U	NA	12 U	14 U	NA	8.6 J	12 U	11 U	11 U	14 U	NA	NA	NA	NA
2,4,5-TP (Silvex)	16	NA	12	14 U	NA	14 U	12 U	11 J	3.1 J	14 U	NA	NA	NA	NA
Inorganics (mg/kg)														
Aluminum	9670	7360	8790	6770	NA	7470	9270	8190	11700	13700	NA	NA	NA	NA
Antimony	1.2 J	1.6 J	2.0 J	0.59 UJ	NA	0.58 UJ	0.51 UJ	0.48 UJ	0.50 UJ	0.61 UJ	NA	NA	NA	NA
Arsenic	31.9	28.4 J	31.1	27.9	NA	6.5	4.4	5.5	8.1	6.7	NA	NA	NA	NA
Barium	105	93.1	92.4	47.4	NA	105	120	120	94.6	80.7	NA	NA	NA	NA
Beryllium	1.4 J	1.7	1.7 J	0.65 J	NA	0.84 J	0.80 J	0.78 J	0.57 J	0.62 U	NA	NA	NA	NA
Cadmium	0.05 UJ	0.06 U	0.05 UJ	0.05 UJ	NA	0.05 UJ	0.23 U	0.39 J	0.05 UJ	0.06 UJ	NA	NA	NA	NA
Calcium	1000	894 J	769	941	NA	1690	2630	1960	3020	5520	NA	NA	NA	NA
Chromium	30.5	40.8 J	45.1	15.0	NA	13.5	9.4	10.2	13.7	17.4	NA	NA	NA	NA
Cobalt	25.0	27.4	28.8	6.9	NA	17.8	15.3	17.5	12.2	7.4	NA	NA	NA	NA
Copper	17.6 J	14.7 J	19.4 J	16.9 J	NA	11.0 J	10.1 J	9.5 J	16.1 J	14.6 J	NA	NA	NA	NA
Iron	45700	76500 J	76900	28600	NA	20000	12500	12300	19900	21700	NA	NA	NA	NA
Lead	24.8	26.3	32.0	22.2	NA	19.1	16.1	26.7	16.5	28.2	NA	NA	NA	NA
Magnesium	1520	1190	1060	1050	NA	1030	1200	1090	1820	1940	NA	NA	NA	NA
Manganese	1490	1890	1640	278	NA	1230	1250	1330	607	341	NA	NA	NA	NA

TABLE A-9

SUMMARY OF CHEMICALS DETECTED IN SEDIMENT
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SD01[1]	01SD01	01SD02	01SD03	01SD03	01SD04	01SD05	01SD06	01SD07	01SD08	01SD09	01SD10	01SD11	01SD12
Nsample	01SD0101	01SD0102	01SD0201	01SD0301	01SD0302	01SD0401	01SD0501	01SD0601	01SD0701	01SD0801	01SD0902	01SD1002	01SD1102	01SD1202
Sample	01SD01	01SD0102	01SD02	01SD03	01SD0302	01SD04	01SD05	01SD06	01SD07	01SD08	01SD0902	01SD1002	01SD1102	01SD1202
Matrix	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
Depth Range	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5
Risk	Background	Background	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site	Site
Sample Date	8/14/2001	6/17/2002	8/14/2001	8/14/2001	6/17/2002	8/14/2001	8/14/2001	8/14/2001	8/14/2001	8/14/2001	6/17/2002	6/17/2002	6/17/2002	6/17/2002
Nickel	37.1	38.7	35.9	12.1	NA	15.6	13.7	11.3	11.9	13.7	NA	NA	NA	NA
Potassium	875 J	6.6 J	703 J	1100 J	NA	604 J	623 J	497 J	583 J	915 J	NA	NA	NA	NA
Selenium	0.66	2.1	1.2	0.92	NA	0.66	0.38 U	0.45	0.59	1.0	NA	NA	NA	NA
Sodium	265	308	345 J	416	NA	334	335	298	311	402	NA	NA	NA	NA
Strontium	10.2 J	8.8	8.1 J	10.6 J	NA	9.6 J	11.2 J	8.2 J	8.7 J	14.5 J	NA	NA	NA	NA
Thallium	4.3	0.57 U	7.1	2.2	NA	1.2	0.56 U	0.57	2.0	1.5	NA	NA	NA	NA
Thallium-GF	0.10 J	NA	0.10 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thorium-Calc	9.304545	NA	9.395455	12.454545	NA	7.745455	7.540909	6.468182	6.527273	7.313636	NA	NA	NA	NA
Tin	3.6	1.9 J	3.4	3.6	NA	3.4	3.1	3.2	3.0	3.7	NA	NA	NA	NA
Vanadium	32.5	43.6 J	45.8	20.4	NA	20.5	18.9	19.6	27.0	31.5	NA	NA	NA	NA
Zinc	79.2	71.7 J	78.0	35.6	NA	42.5	41.2	47.8	46.1	70.2	NA	NA	NA	NA
Total Radiologicals (pCi/g)														
Thorium-228	0.937	1.09	1.15	1.49	NA	1.08	0.868	0.705	0.694	0.781	NA	NA	NA	NA
Thorium-230	1.20 J	0.908	1.14 J	1.26 J	NA	0.832 J	0.791 J	1.08 J	0.937 J	1.05 J	NA	NA	NA	NA
Thorium-232	1.11	1.13	0.917	1.25	NA	0.624	0.791	0.718	0.742	0.828	NA	NA	NA	NA
Miscellaneous Parameters														
Cation Exchange Capacity (MEQ/1)	11.1	NA	17.9	22.0	NA	22.9	45.5	26.9	22.6	58.6	NA	NA	NA	NA
pH (S.U.)	5.8 J	NA	5.6 J	5.5 J	NA	6.1 J	7.0 J	6.2 J	7.3 J	7.1 J	NA	NA	NA	NA
Total Organic Carbon (mg/kg)	5950	NA	5580	17600	NA	21600	34900	24500	14300	49600	NA	NA	NA	NA

1 Upgradient location.
Calc = Calculated value.
NA = Not analyzed
U - Indicates that the chemical was not detected at the numerical detection limit (sample-specific quantitation limit) noted. Nondetected results from the laboratory are reported in this manner. This qualifier is also added to a positive result (reported by the laboratory) if the detected concentration is determined to be attributable to contamination introduced during field sampling or laboratory analysis.
UJ - Indicates that the chemical was not detected. However, the detection limit (sample-specific quantitation limit) is considered to be estimated based on problems encountered during laboratory analysis. The associated numerical detection limit is regarded as inaccurate or imprecise.
J - Indicates that the chemical was detected. However, the associated numerical result is not a precise representation of the amount that is actually present in the sample. The laboratory-reported concentration is considered to be an estimate of the true concentration.
UR - Indicates that the chemical may or may not be present. The nondetected analytical result reported by the laboratory is considered to be unreliable and unusable. This qualifier is applied in cases of gross technical deficiencies (i.e., holding times missed by a factor of two times the specified time limit, severe calibration noncompliances, and extremely low quality control recoveries).
BU - Indicates that the chemical was detected in this sample as well as the associated laboratory method blank, but has been qualified non-detected result as a laboratory blank contamination (i.e., concentration was less than the blank action level).
bgs - below ground surface.
MEQ - milliequivalents
S.U. - Standard units.

TABLE A-10

SUMMARY OF PARAMETERS DETECTED IN SURFACE WATER
SWMU 01 - MUSTARD GAS BURIAL GROUND
NSWC CRANE
CRANE, INDIANA

Location	01SW01[1]	01SW02	01SW04[1]	01SW05
Nsample	01SW0102	01SW0202	01SW0402	01SW0502
Sample	01SW0102	01SW0202	01SW0402	01SW0502
Matrix	Surface Water	Surface Water	Surface Water	Surface Water
Risk	Background	Site	Background	Site
Sample Date	6/17/2002	6/17/2002	6/18/2002	6/17/2002
Field Parameters				
Dissolved Oxygen - Meter (MG/L)	6.63	2.94	7.59	7.96
Oxidation Reduction Potential (MV)	335.9	278.4	274	291
pH (S.U.)	6.6	6.41	7.08	6.37
Specific Conductance (MS/CM)	0.114	0.121	0.114	0.058
Temperature (C)	17.08	17.53	16.4	16.79
Turbidity (NTU)	5.1	5.4	3.8	1.2

1 Upgradient location.

TABLE A-11

TABULAR PRESENTATION OF RBSLs FOR RBTL SELECTION
NSWC CRANE, CRANE, INDIANA

PARAMETER	CAS	REGION 5 ECO DQLs SURFACE WATER(1) (ug/L)	REGION 9 TAP WATER PRGs(4) (ug/L)	MINIMUM CRITERIA VALUE
1,1,1,2-Tetrachloroethane	630-20-6	90.25	0.43	0.43
1,1,1-Trichloroethane	71-55-6	88	3200	88
1,1,2,2-Tetrachloroethane	79-34-5	13	0.055	0.055
1,1,2-Trichloroethane	79-00-5	650	0.2	0.2
1,1-Dichloroethane	75-34-3	47	810	47
1,1-Dichloroethene	75-35-4	78	340	7
1,2,3-Trichloropropane	96-18-4	12.11	0.0056	0.0056
1,2-Dibromo-3-chloropropane	96-12-8	11.2	0.048	0.048
1,2-Dibromoethane	106-93-4	22.5	0.00076	0.00076
1,2-Dichloroethane	107-06-2	190	0.12	0.12
1,2-Dichloropropane	78-87-5	380	0.16	0.16
2-Butanone	78-93-3	7100	1900	1900
2-Chloro-1,3-butadiene (chloroprene)	126-99-8	NA	14	14
2-Hexanone	591-78-6	1710	1500	1500
4-Methyl-2-pentanone	108-10-1	3680	160	160
Acetone	67-64-1	78000	610	610
Acrolein	107-02-8	0.205	0.042	0.042
Acrylonitrile	107-13-1	0.89	0.039	0.039
Allyl chloride (3-chloro-1-propene)	107-05-1	NA	1800	1800
Benzene	71-43-2	114	0.34	0.34
Bromodichloromethane	75-27-4	NA	0.18	0.18
Bromoform	75-25-2	466	8.5	8.5
Bromomethane	74-83-9	NA	8.7	8.7
Carbon disulfide	75-15-0	84.1	1000	84.1
Carbon tetrachloride	56-23-5	5.9	0.17	0.17
Chlorobenzene	108-90-7	10	110	10
Chloroethane	75-00-3	230000	4.6	4.6
Chloroform	67-66-3	79	6.2	6.2
Chloromethane	74-87-3	NA	1.5	1.5
cis-1,2-Dichloroethene	156-59-2	NA	61	5
cis-1,3-Dichloropropene	10061-01-5	7.9	0.4	0.4
Dibromochloromethane	124-48-1	6400	0.13	0.13
Dibromomethane	74-95-3	NA	61	61
Dichlorodifluoromethane	75-71-8	NA	390	390
Ethyl methacrylate	97-63-2	NA	550	550
Ethylbenzene	100-41-4	17.2	2.9	2.9
Methacrylonitrile	126-98-7	NA	1	1
Methyl iodide	74-88-4	NA	NA	0
Methyl methacrylate	80-62-6	2800	1400	1400
Methylene chloride	75-09-2	430	4.3	4.3
Pentachloroethane	76-01-7	56.42	NA	56.42
Styrene	100-42-5	56	1600	56
Tetrachloroethene	127-18-4	8.9	0.66	0.66
Toluene	108-88-3	253	720	253
Total Xylenes	1330-20-7	117	210	117
trans-1,2-Dichloroethene	156-60-5	310	120	100
trans-1,3-Dichloropropene	10061-02-6	7.9	0.4	0.4
trans-1,4-Dichloro-2-butene	110-57-6	NA	0.0012	0.0012
Trichloroethene	79-01-6	75	0.028	0.028
Trichlorofluoromethane	75-69-4	NA	1300	1300
Vinyl acetate	108-05-4	248.03	410	248.03
Vinyl chloride	75-01-4	9.2	0.02	0.02
1,4-Dioxane	123-91-1	NA	6.1	6.1
Acetonitrile	75-05-8	30000	100	100
Isobutyl Alcohol	78-83-1	34800	1800	1800
Propiontirile	107-12-0	6080	NA	6080

1. U.S. EPA, U.S. Region 5 Ecological Data Quality Levels, October 1999.
2. U.S. EPA, 2002 Edition of the Drinking Water Standards and Health Advisories, EPA 822-R-02-038, Office of Water, Washin
3. IDEM, RISC (Risk-Integrated System of Cleanups). Indiana Department of Environmental Management, Office of Environme
4. U.S. EPA Region 9, Preliminary Remediation Goals, October 2002.

TABLE A-12

TABULAR PRESENTATION OF SOIL AND SEDIMENT RBSLs FOR RBTL SELECTION
NSWC CRANE, CRANE,
INDIANA

PARAMETER	CAS	EPA GENERIC SSLs INHALATION(1) (mg/kg)	EPA GENERIC SSLs MIGRATION TO GW(1) (mg/kg) DAF = 1	REGION 5 ECO DQLs SOIL(2) (mg/kg)	REGION 5 ECO DQLs SEDIMENT(2) (mg/kg)	IDEM TIER 1 DEFAULT RESIDENTIAL SOIL CLOSURE LEVELS(3) (mg/kg)	IDEM TIER 1 DEFAULT INDUSTRIAL SOIL CLOSURE LEVELS(3) (mg/kg)	REGION 9 SOIL PRGs FOR RESIDENTIAL LAND USE(4) (mg/kg)	REGION 9 SOIL PRGs FOR INDUSTRIAL LAND USE(4) (mg/kg)	MINIMUM CRITERIA VALUE (SOIL) (mg/kg)	MINIMUM CRITERIA VALUE (SED) (mg/kg)	MINIMUM CRITERIA VALUE (SOIL AND SED) (mg/kg)
1,1,1,2-Tetrachloroethane	630-20-6	6.7	0.0071	225	0.01089	0.05	0.8	3.2	7.3	0.0071	0.0071	0.0071
1,1,1-Trichloroethane	71-55-6	1200	0.097	29.8	0.24685	1.9	35	1200	1200	0.097	0.097	0.097
1,1,2,2-Tetrachloroethane	79-34-5	0.59	0.00017	0.12722	0.02908	0.007	0.11	0.41	0.93	0.00017	0.00017	0.00017
1,1,2-Trichloroethane	79-00-5	0.98	0.00091	28.6	0.67351	0.03	0.31	0.73	1.6	0.00091	0.00091	0.00091
1,1-Dichloroethane	75-34-3	1300	1	20.1	0.000575	5.6	58	510	1700	1	0.000575	0.000575
1,1-Dichloroethene	75-35-4	300	0.0029	8.27	0.02327	0.058	42	120	410	0.0029	0.0029	0.0029
1,2,3-Trichloropropane	96-18-4		0.0000037	3.36	0.00835		NA	0.005	0.011	0.0000037	0.0000037	0.0000037
1,2-Dibromo-3-chloropropane	96-12-8	23	0.000092	0.03518	0.01998		NA	0.45	2	0.000092	0.000092	0.000092
1,2-Dibromoethane	106-93-4	0.28	0.000029	1.23	0.01237		NA	0.0069	0.028	0.000029	0.000029	0.000029
1,2-Dichloroethane	107-06-2	0.36	0.0012	21.2	0.05418	0.024	0.15	0.28	0.6	0.0012	0.0012	0.0012
1,2-Dichloropropane	78-87-5	15	0.0015	32.7	0.35161	0.03	0.25	0.34	0.74	0.0015	0.0015	0.0015
2-Butanone	78-93-3	9000	4.4	89.6	0.13696	11	260	7300	27000	4.4	0.13696	0.13696
2-Chloro-1,3-butadiene (chloroprene)	126-99-8	84	0.56	0.0029	0.00106		NA	3.6	12	0.0029	0.00106	0.00106
2-Hexanone	591-78-6			12.6	1.01		NA	3100	41000	12.6	1.01	1.01
4-Methyl-2-pentanone	108-10-1	490	0.62	443	0.54437	0.99	39	790	2800	0.62	0.54437	0.54437
Acetone	67-64-1		0.73	2.5	0.45337	3.1	41	1600	6000	0.73	0.45337	0.45337
Acrolein	107-02-8	0.19	0.15	5.27	0.0000144	0.00023	0.22	0.1	0.34	0.00023	0.0000144	0.0000144
Acrylonitrile	107-13-1	0.28	0.000032	0.02393	0.0000157		NA	0.21	0.49	0.000032	0.0000157	0.0000157
Allyl chloride (3-chloro-1-propene)	107-05-1	1.8		0.01338	0.000266		NA	3000	30000	0.01338	0.000266	0.000266
Benzene	71-43-2	0.84	0.0017	0.25462	0.14157	0.034	0.67	0.6	1.3	0.0017	0.0017	0.0017
Bromodichloromethane	75-27-4		0.032	0.53978	0.00113	0.63	0.63	0.82	1.8	0.032	0.00113	0.00113
Bromoform	75-25-2	53	0.038	15.9	0.99627	0.75	2.7	62	220	0.038	0.038	0.038
Bromomethane	74-83-9	9.5	0.012	0.23516	0.94674	0.053	0.7	3.9	13	0.012	0.012	0.012
Carbon disulfide	75-15-0	720	1.5	0.09412	0.13397	10	82	360	720	0.09412	0.13397	0.09412
Carbon tetrachloride	56-23-5	0.33	0.0033	2.98	0.03573	0.066	0.29	0.25	0.55	0.0033	0.0033	0.0033
Chlorobenzene	108-90-7	130	0.065	13.1	0.06194	1.3	27	150	530	0.065	0.06194	0.06194
Chloroethane	75-00-3	7100			58.6	0.33	5.2	3	6.5	0.33	0.33	0.33
Chloroform	67-66-3	0.28	0.029	1.19	0.027	0.59	1.2	3.6	12	0.029	0.027	0.027
Chloromethane	74-87-3	2.1	0.002	10.4	0.0000785		NA	1.2	2.6	0.002	0.0000785	0.0000785
cis-1,2-Dichloroethene	156-59-2		0.02	0.78373	0.20894	0.4	5.8	43	150	0.02	0.02	0.02
cis-1,3-Dichloropropene	10061-01-5	1.1	0.0003	0.39786	0.00296		0.2	0.78	1.8	0.0003	0.0003	0.0003
Dibromochloromethane	124-48-1		0.02	2.05	0.26761		NA	1.1	2.6	0.02	0.02	0.02
Dibromomethane	74-95-3		0.077	65	0.0000859		NA	67	230	0.077	0.0000859	0.0000859
Dichlorodifluoromethane	75-71-8	250	28	39.5	0.00133		NA	94	310	28	0.00133	0.00133
Ethyl methacrylate	97-63-2		0.81	30	0.000602		NA	140	140	0.81	0.000602	0.000602
Ethylbenzene	100-41-4	12	0.67	5.16	0.0001	13	200	8.9	20	0.67	0.0001	0.0001
Methacrylonitrile	126-98-7	8.1	0.001	0.05705	0.0000297		NA	2.1	8.4	0.001	0.0000297	0.0000297
Methyl iodide	74-88-4						NA	NA	NA	NA	NA	NA
Methyl methacrylate	80-62-6	2700	12	984	0.16756		NA	2200	2700	12	0.16756	0.16758
Methylene chloride	75-09-2	13	0.0012	4.05	1.26	0.023	1.8	9.1	21	0.0012	0.0012	0.0012
Pentachloroethane	76-01-7			10.7	0.68918		NA	NA	NA	10.7	0.68918	0.68918
Styrene	100-42-5	1500	0.18	4.69	0.44496	3.5	720	1700	1700	0.18	0.18	0.18
Tetrachloroethene	127-18-4	11	0.0029	9.92	0.19583	0.058	0.64	1.5	3.4	0.0029	0.0029	0.0029
Toluene	108-88-3	650	0.59	5.45	52.5	12	240	520	520	0.59	0.59	0.59
Total Xylenes	1330-20-7		71	10	1.88	190	410	270	420	10	1.88	1.88
trans-1,2-Dichloroethene	156-60-5		0.034	0.78373	0.20894	0.68	14	69	230	0.034	0.034	0.034
trans-1,3-Dichloropropene	10061-02-6	1.1	0.0003	0.39786	0.00296		0.2	0.78	1.8	0.0003	0.0003	0.0003
trans-1,4-Dichloro-2-butene	110-57-6				0.00182		NA	0.0079	0.018	0.0079	0.00182	0.00182
Trichloroethene	79-01-6	4.6	0.0028	12.4	0.17956	0.057	3	0.053	0.11	0.0028	0.0028	0.0028
Trichlorofluoromethane	75-69-4	1100	8	16.4	0.00307		42	390	2000	8	0.00307	0.00307
Vinyl acetate	108-05-4	990	7.8	12.7	0.01295	2.3	430	430	1400	2.3	0.01295	0.01295
Vinyl chloride	75-01-4	0.28	0.00067	0.64614	0.002	0.014	0.014	0.079	0.75	0.00067	0.00067	0.00067
1,4-Dioxane	123-91-1		0.0017	2.05	0.00000543		NA	44	160	0.0017	0.00000543	0.00000543
Acetonitrile	75-05-8	1400		1.37	0.139		NA	420	1800	0.139	1.37	0.139
Isobutyl Alcohol	78-83-1		2.3	20.8	3.35		NA	13000	40000	2.3	3.35	2.3
Propiontirile	107-12-0			0.04983	0.11466		NA	NA	NA	0.04983	0.11466	0.04983

1. U.S. EPA, Soil Screening Guidance for Chen (http://risk.lsd.ornl.gov/calc_start.shtml, October 2003).
2. U.S. EPA, U.S. Region 5 Ecological Data Quality Levels, October 1999.
3. IDEM, RISC (Risk-Integrated System of Cleanups). Indiana Department of Environmental Management, Office of Environmental Response, February, Updated July, 2001.
4. U.S. EPA Region 9, Preliminary Remediation Goals, October 2002.

NA = Not applicable

TABLE A-13

TABULAR PRESENTATION OF RBSLS FOR RBTL SELECTION OF RADIONUCLIDES FOR SOIL
NSWC CRANE, CRANE, INDIANA

Parameter	Residential Soil[1] (pCi/g)	Agricultural Soil[1] (pCi/g)	Outdoor Worker Soil[1] (pCi/g)	Indoor Worker Soil[1] (pCi/g)	GW Protection DAF=20[1] (pCi/g)	GW Protection DAF=1[1] (pCi/g)	Minimum (pCi/g)
Potassium-40	1.08E-01	4.45E-02	2.71E-01	6.09E-01	NA	NA	4.45E-02
Thallium-208	2.26E+04	2.26E+04	3.65E+04	8.20E+04	NA	NA	2.26E+04
Lead-210	3.28E-01	1.87E-04	4.19E+00	7.57E+00	1.58E-02	7.92E-04	1.87E-04
Lead-210 + Daughters	1.50E-01	6.42E-05	1.23E+00	2.23E+00	1.10E-02	5.50E-04	6.42E-05
Lead-212	3.64E+03	8.01E+01	6.07E+03	1.36E+04	6.97E+07	3.49E+06	8.01E+01
Lead-214	4.63E+04	3.49E+04	7.48E+04	1.68E+05	2.85E+12	1.43E+11	3.49E+04
Bismuth-212	2.26E+04	2.24E+04	3.66E+04	8.24E+04	NA	NA	2.24E+04
Bismuth-214	8.19E+03	8.19E+03	1.32E+04	2.98E+04	NA	NA	8.19E+03
Radium-226	1.93E-01	6.77E-04	3.69E+00	7.21E+00	3.22E-01	1.61E-02	6.77E-04
Radium-226 + Daughters	1.24E-02	6.33E-04	2.55E-02	5.73E-02	3.22E-01	1.61E-02	6.33E-04
Actinium-228	7.32E+02	7.31E+02	1.18E+03	2.66E+03	NA	NA	7.31E+02
Thorium-234	1.33E+03	1.53E+01	3.25E+03	7.20E+03	8.26E+04	4.13E+03	1.53E+01
Uranium-235	2.05E-01	1.88E-03	4.13E-01	9.26E-01	7.77E-01	3.89E-02	1.88E-03
Uranium-235 + Daughters	1.95E-01	1.82E-03	3.94E-01	8.84E-01	7.77E-01	3.89E-02	1.82E-03
Cobalt-60	3.61E-02	9.02E-04	5.96E-02	1.34E-01	2.41E+00	1.21E-01	9.02E-04
Cesium-137	3.88E+00	1.23E-03	6.49E+01	1.20E+02	5.66E+01	2.83E+00	1.23E-03
Cesium-137 + Daughters	5.97E-02	1.20E-03	1.11E-01	2.51E-01	5.66E+01	2.83E+00	1.20E-03
Europium-154	4.99E-02	4.72E-02	8.49E-02	1.91E-01	NA	NA	4.72E-02
Europium-155	3.80E+00	3.74E+00	6.28E+00	1.41E+01	NA	NA	3.74E+00
Protactinium-243	3.48E+02	3.48E+02	5.63E+02	1.27E+03	NA	NA	3.48E+02

1. Radionuclide Toxicity and Preliminary Remediation Goals for Superfund
(http://epa-prgs.ornl.gov/radionuclides, October 2003)
NA = Not applicable

TABLE A-14

TABULAR PRESENTATION OF RBSLS FOR RBTL SELECTION OF RADIONUCLIDES IN WATER
NSWC CRANE, CRANE, INDIANA

Parameter	Tap Water(1) (pCi/L)
Potassium-40	1.93E+00
Thallium-208	NA
Lead-210 (46)	5.41E-02
Lead-210 + Daughters	3.75E-02
Lead-212	1.90E+00
Lead-214	1.38E+02
Bismuth-212	6.71E+01
Bismuth-214	2.48E+02
Radium-226	8.23E-04
Radium-226 + Daughters	8.16E-04
Actinium-228	2.39E+01
Thorium-234	2.06E+00
Uranium-235	6.84E-01
Uranium-235 + Daughters	6.63E-01
Cobalt-60	3.03E+00
Cesium-137	1.57E+00
Cesium-137+Daughters	1.57E+00
Europium-154	4.62E+00
Europium-155	2.51E+01
Protactinium-243	NA

1. Radionuclide Toxicity and Preliminary Remediation Goals for Superfund (http://epa-prgs.ornl.gov/radionuclides, October 2003)
NA = Not applicable

APPENDIX B

FIELD SOP TABLE OF CONTENTS

CTO315-01	Sample Labeling
CTO315-02	Sample Identification Nomenclature
CTO315-03	Sample Custody and Documentation of Field Activities
CTO315-04	Calibration and Use of Photoionization Detector
CTO315-05	Field Screening of Soil and Sediment Samples for Radioactivity
CTO315-06	Direct-Push Technology, Hand Auger Techniques, and Test Pitting to Observe and Log Subsurface Soils
CTO315-07	Borehole and Soil Sample Logging
CTO315-08	Surface and Subsurface Soil Sampling
CTO315-09	Inspection and Rehabilitation of Existing Monitoring Wells
CTO315-10	Drilling and Geologic Logging of Boreholes in Rock
CTO315-11	Monitoring Well Installation
CTO315-12	Monitoring Well Development
CTO315-13	Calibration and Care of Water Quality Meters
CTO315-14	Low-Flow Well Purging and Stabilization
CTO315-15	Monitoring Well Sampling
CTO315-16	Field Test Kit Analyses
CTO315-17	Sample Preservation, Packaging, and Shipping
CTO315-18	Measurement of Water Levels in Monitoring Wells
CTO315-19	Decontamination of Field Sampling Equipment
CTO315-20	Management of Investigation-Derived Waste
CTO315-21	Field Screening to Detect NAPL in Bedrock Cores Using the NAPL FLUTe™ System

STANDARD OPERATING PROCEDURE
NUMBER CTO315-01

SAMPLE LABELING

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures to be used for labeling and tagging sample containers. Sample labels and tags are used to document the sample ID, date, time, analysis to be performed, preservative, matrix, sampler, and the analytical laboratory. A sample label and a sample tag will be attached to each sample container. The label and tag for each container will contain identical information.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Writing utensil
Disposable medical-grade gloves (e.g. latex, nitrile)
Sample logsheets
Required sample containers: All sample containers for analysis by fix-based laboratories will be supplied and deemed certified clean by the laboratory
Preprinted sample labels and sample tags
Chain-of-custody records
Sealable polyethylene bags
Heavy-duty cooler
Ice

3.0 PROCEDURES

3.1 The following information will be printed on the labels and tags prior to field activities.

- Project number (CTO 315)
- Project location (NSWC Crane)
- Sample ID
- Preservative

- Analysis to be performed
- Matrix type
- Laboratory name

3.2 Preprinted sample labels and tags will be prepared before the team mobilizes to the field. Check to determine whether:

- One sample label and tag exists for each sample container that is to be collected for all media during the field activities.
- The information printed on each tag and label is correct.
- Extra blank labels and tags are brought to the site in case additional environmental samples or QA samples are collected that are not anticipated in the Quality Assurance Project Plan (QAPP). Additional blank labels and tags should also be brought to the site in case a sample container is broken or some of the preprinted labels or tags are accidentally lost before they are attached to a container.

3.3 Once at the field site, sample containers should have labels affixed before sampling activities begin.

3.4 Select the labeled containers that are appropriate for a given sample and fill in the date, time, and sampler's initials just before sampling begins. Use a black waterproof marker or pen.

3.5 Fill the appropriate containers with sample material. Securely close the container lids without overtightening.

3.6 Write the same date, time, and sampler's initials on the sample tag as written on the label.

3.7 Place the sample container in a ziplock plastic bag and place in a cooler containing ice.

3.8 Fill in appropriate information on the Sample Collection Log Form and the Chain-of-Custody Form.

Example sample labels and tags are attached at the end of this SOP.

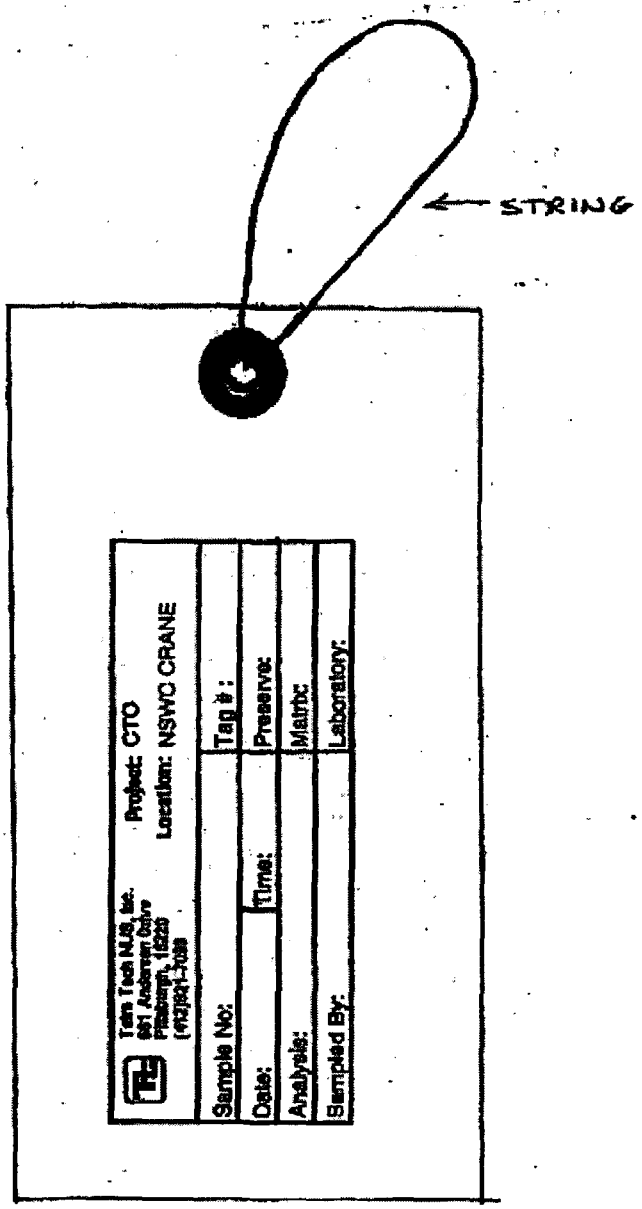
4.0 ATTACHMENTS

1. Sample Label and Tag

ATTACHMENT 1

SAMPLE LABEL AND TAG

SAMPLE LABEL AND TAG



STANDARD OPERATING PROCEDURE
NUMBER CTO315-02

SAMPLE IDENTIFICATION NOMENCLATURE

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish a consistent sample nomenclature system that will facilitate subsequent data management at the Naval Surface Warfare Center (NSWC). The sample nomenclature system has been devised such that the following objectives can be attained.

- Sorting of data by site, location, or matrix
- Maintenance of consistency (field, laboratory, and database sample numbers)
- Accommodation of all project-specific requirements
- Accommodation of laboratory sample number length constraints
- Ease of identification and direct link to site and year

The NSWC Crane Environmental Protection Department must approve any deviations from this procedure.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Pen with indelible ink
Sample tags
Sample container labels

3.0 SAMPLE IDENTIFICATION NOMENCLATURE

3.1 Monitoring Samples

All monitoring samples collected at NSWC Crane will be properly labeled with a sample label affixed to the sample container and a tag tied around the neck of the sample container. Each sample will be assigned a unique sample tracking number. The sample tracking number will consist of a four- or five-segment alpha-numeric code that identifies the sample's associated solid waste management unit (SWMU) or

associated site, sample type, location, and, for aqueous samples, where applicable, whether a sample is filtered, and/or the sample round number. For soil or sediment samples, the final four tracking numbers will identify the depth at which the soil or sediment sample was collected.

The alpha-numeric coding to be used in the NSWC Crane sample system is explained in the diagram below and the subsequent definitions:

NN	**AA**	**A or N** **2 to 5-Characters**	**NN and/or A** **Aqueous only**	**NNNN** **Soils and Sediment only**
SWMU or Site Number	Sample Type	Location	Round Identifier and/or Filtered	Depth Interval

Character Type:

A = Alpha
N = Numeric

SWMU or Site Number:

01 = Mustard Gas Burial Ground

Sample Type:

GW - Ground Water Sample from a Permanent Monitoring Well
ID - Investigation-Derived Waste Sample
SP - Seep Sample or Spring Sample
SS - Surface Soil Sample [collected from 0 to 2 feet below ground surface (bgs)]
SU - Subsurface Soil Sample (collected from greater than 2 feet bgs)

Location:

The sample location code is the well number, soil sample location, sediment sample location, or the stream sample location (i.e., surface water, springs, or seeps). The location code for each sample is listed on figures and tables in the site-specific work plan. Existing well numbers are used when unique. New wells will be designated by a SWMU or site number, followed by "MW" for permanent monitoring well, "TW" for temporary well, etc.; a "T" for Tetra Tech NUS; and numbered sequentially, by SWMU, beginning with zero one (MWT01).

Note: To keep the sample identification nomenclature to a minimum number of characters and to avoid redundancy, "MW" (monitoring well) is used for text, figures, and tables and replaced with "GW" (ground water) in the sample identification. For example, MWT01 would be GWT01.

Round Identifier and/or Filtered:

This code section will be used for aqueous samples only.

Round Identifier:

A two-digit round identifier will be used to track the number of aqueous samples (GW, SW) taken from a particular aqueous sample location. The first sample collected from a location will be assigned round identifier 01, the second 02, etc. This applies to both existing and proposed monitoring wells and surface water locations.

Filtered:

Water samples that are field filtered (dissolved analysis) will be identified with an "F" in the last code section. No entry in this segment signifies an unfiltered (total) sample.

Depth Interval:

This code section will be used for soil and sediment samples only.

The depth code is used to note the depth below ground surface (bgs) at which a soil or sediment sample is collected. The first two numbers of the four-number code specify the top interval, and the third and fourth specify the bottom interval in feet bgs (soil) or inches bgs (sediment) of the sample. The depths will be noted in whole numbers only; further detail, if needed, will be recorded on the sample log sheet, boring log, logbook, etc.

Depth (for soils, in feet bgs)

0002 = soil collected from 0 to 2 feet bgs
0204 = soil collected from 2 to 4 feet bgs
0810 = soil collected from 8 to 10 feet bgs

Depth (for sediments, in inches bgs)

0006 = sediment collected from 0 to 6 inches bgs
0612 = sediment collected from 6 to 12 inches bgs

3.1.1 Examples of Sample Nomenclature

The first ground water sample collected from existing monitoring well 01-01 for a filtered sample would be designated as 01GW0101F.

The second ground water sample collected from existing monitoring well 01T03 for an unfiltered sample would be designated as 01GWT0302.

A subsurface soil sample collected from test pit 03 at an interval of 4 to 5 feet bgs would be designated as 01SUTP030405.

3.2 Field Quality Assurance/Quality Control (QA/QC) Sample Nomenclature

Field QA/QC samples are described in the approved field sampling plan and QAPP. They will be designated using a different coding system. The QC code will consist of a three- to four-segment alpha-numeric code that identifies the sample QC type, the date the sample was collected, and the number of this type of QC sample collected on that date.

AA	NNNNNN	NN	F
QC Type	Date	Sequence Number (per day)	Filtered (aqueous only, if needed)

The QC types are identified as:

TB = Trip Blank
RB = Rinsate Blank (Equipment Blank)
FD = Field Duplicate
AB = Ambient Conditions Blank
SB = Source Water Blank

The sampling time recorded on the Chain-of-Custody Form, labels, and tags for duplicate samples will be 0000 so that the samples are "blind" to the laboratory. Notes detailing the sample number, time, date, and type will be recorded on the sample log sheets and will document the location of the duplicate sample (sample log sheets are not provided to the laboratory).

3.2.2 Examples of Field QA/QC Sample Nomenclature

The first duplicate of the day for a filtered ground water sample collected on June 3, 2000 would be designated as FD06030001F.

The third duplicate of the day taken of a subsurface soil sample collected on November 17, 2003 would be designated as FD11170303.

The first trip blank associated with samples collected on October 12, 2000 would be designated as TB10120001.

The only rinsate blank collected on November 17, 2001 would be designated as RB11170101.

STANDARD OPERATING PROCEDURE
NUMBER CTO315-03

SAMPLE CUSTODY AND DOCUMENTATION OF FIELD ACTIVITIES

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedures for sample custody and documentation of field sampling and field analyses activities.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following logbooks, forms, and labels are required.

Site logbook
Field logbook
Sample label
Chain-of-Custody Form
Custody seals
Equipment calibration log
Monitoring Well Inspection Form
Water-Level Measurement Form
Low-Flow Purge Data Sheet
Ground Water Sample Log Sheet
Soil Log Sheet
Test Pit Log Sheet

3.0 PROCEDURES

This section describes custody and documentation procedures. All entries made into the logbooks, custody documents, logs, and log sheets described in this SOP must be made in indelible ink (black is preferred). No erasures are permitted. If an incorrect entry is made, the entry will be crossed out with a single strike mark, initialed, and dated.

3.1 Site Logbook

The site logbook is a hard-bound, paginated, controlled-distribution record book in which all major on-site activities are documented. At a minimum, the following activities and events will be recorded (daily) in the site logbook:

- All field personnel present
- Arrival/departure of site visitors
- Arrival/departure of equipment
- Start or completion of sampling activities
- Daily on-site activities performed each day
- Sample pickup information
- Health and safety issues
- Weather conditions

The site logbook is initiated at the start of the first on-site activity (e.g., site visit or initial reconnaissance survey). Entries are to be made for every day that on-site activities take place.

The following information must be recorded on the cover of each site logbook:

- Project name
- Project number
- Book number
- Start date
- End date

Information recorded daily in the site logbook need not be duplicated in other field notebooks but must summarize the contents of these other notebooks and refer to specific page locations in these notebooks for detailed information (where applicable). At the completion of each day's entries, the site logbook must be signed and dated by the field operations leader (FOL).

3.2 Field Logbooks

The field logbook is a separate dedicated notebook used by field personnel to document his or her activities in the field. This notebook is hardbound and paginated.

3.3 Sample Labels

Adhesive sample container labels must be completed and applied to every sample container. Information on the label includes the project name, location, sample number, date, time, preservative, analysis, matrix, sampler's initials, and the name of the laboratory performing the analysis.

3.4 Chain-of-Custody Form

The Chain-of-Custody Form (COC) is a multi-part form that is initiated as samples are acquired and accompanies a sample (or group of samples) as it is transferred from person to person. Each COC is numbered. This form must accompany any samples collected for laboratory chemical analysis. A copy of a blank COC form is attached at the end of this SOP.

The FOL must include the name of the laboratory in the "Remarks" section to ensure that the samples are forwarded to the correct location. If more than one COC is necessary for any cooler, the FOL will indicate "Page __ of __" on each COC. The original (top) signed copy of the COC will be placed inside a large Ziploc-type bag and taped inside the lid of the shipping cooler. Once the samples are received at the laboratory, the sample custodian checks the contents of the cooler(s) against the enclosed COC(s). Any problems are noted on the enclosed COC Form (bottle breakage, discrepancies between the sample labels, COC form, etc.) and will be resolved through communication between the laboratory point-of-contact and the Task Order Manager (TOM). The COC Form is signed and retained by the laboratory and becomes part of the sample's corresponding analytical data package.

3.5 Custody Seal

The custody seal is an adhesive-backed label with a number on each seal. It is part of the chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field and sealed in coolers for transit to the laboratory. The custody seals are signed and dated by the samplers and affixed across the opening edges of each cooler (two seals per cooler) containing environmental samples. The laboratory sample custodian will examine the custody seal for evidence of tampering and will notify the TOM if evidence of tampering is observed.

3.6 Equipment Calibration Log

The Equipment Calibration Log is used to document calibration of measuring equipment (e.g., multi-parameter water-quality meter) used in the field. The Equipment Calibration Log documents that the manufacturer's instructions were followed for calibration of the equipment, including frequency and type of standard or calibration device. An Equipment Calibration Log must be maintained for each electronic measuring device requiring calibration. Entries must be made for each day the equipment is used.

3.7 Monitoring Well Inspection Form

The Monitoring Well Inspection Form is used to document the inspection of existing monitoring wells in accordance with SOP CTO315-09.

3.8 Water-Level Measurement Form

The Water-Level Measurement Form is used to document the determination of water levels in monitoring wells in accordance with SOP CTO315-18.

3.9 Low-Flow Purge Data Sheet

The Low-Flow Purge Data Sheet is used to document field measurements made while purging wells to stabilization in accordance with SOP CTO315-14.

3.10 Ground Water Sample Log Sheet

The Ground Water Sample Log Sheet is used to document the samples taken from a monitoring well at the end of low-flow well purging. This sheet is used in conjunction with SOP CTO315-15.

3.11 Soil Sample Log Sheet

The Soil Sample Log Sheets are used to document the sampling of surface and subsurface soils. This sheet is used in conjunction with SOP CTO315-08.

3.12 Test Pit Log Sheet

The Test Pit Log Sheets are used to document the physical characteristics, layering, and readings of screening instruments for soils and fill materials encountered during trenching of test pits. This sheet is used in conjunction with SOP CTO315-06.

4.0 ATTACHMENTS

1. Chain-of-Custody Record

ATTACHMENT 1
CHAIN-OF-CUSTODY RECORD

TETRA TECH NUS, INC. CHAIN OF CUSTODY | NUMBER | PAGE ____ OF _____

PROJECT NO:	SITE NAME:	PROJECT MANAGER AND PHONE NUMBER	LABORATORY NAME AND CONTACT:
SAMPLERS (SIGNATURE)		FIELD OPERATIONS LEADER AND PHONE NUMBER	ADDRESS
		CARRIER/WAYBILL NUMBER	CITY, STATE

STANDARD TAT ☐
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

CONTAINER TYPE PLASTIC (P) or GLASS (G)
PRESERVATIVE USED

DATE YEAR	TIME	SAMPLE ID	MATRIX	GRAB (G) COMP (C)	No. OF CONTAINERS	TYPE OF ANALYSIS								COMMENTS

1. RELINQUISHED BY	DATE	TIME	1. RECEIVED BY	DATE	TIME
2. RELINQUISHED BY	DATE	TIME	2. RECEIVED BY	DATE	TIME
3. RELINQUISHED BY	DATE	TIME	3. RECEIVED BY	DATE	TIME

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

3/99
FORM NO. TtNUS-001

STANDARD OPERATING PROCEDURE
NUMBER CTO315-04

CALIBRATION AND USE OF PHOTOIONIZATION DETECTOR

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes procedures for the maintenance, calibration, and use of a photoionization detector (PID). The Photovac 2020 Photoionization Air Monitor will be used during the NSWC Crane facility investigation. The procedures for its use are discussed in detail in the following sections.

2.0 GLOSSARY

Electron-volt (eV) - A unit of energy equal to the energy acquired by an electron when it passes through a potential difference of 1 volt in a vacuum.

Intrinsically Safe (I.S.) - Based on wiring, configuration, design, operation, gasketing, construction, this instrument may be employed within locations where flammable gases and/or vapors may exist.

Ionization Potential (I.P.) - The energy required to remove an electron from a molecule yielding a positively charged ion and a negatively charged free electron.

Photoionization Detector (PID) - Photoionization detector is employed as the general reference to air monitors of this type. PID's detection method employs ultraviolet (UV) radiation as an energy source. As air and contaminants are drawn through the ionization chamber, the UV light source causes the contaminant with ionization potentials equal to or less than the UV source to break into positive and negatively charge ions. The created ions are subjected to an electrostatic field. The voltage difference is measured in proportion to the calibration reference and the concentration of the contaminant is computed from the voltage.

Ultraviolet Radiation (UV) Lamp - Ultraviolet radiation is the energy source employed by the instrument to ionize collected sample gas streams. The UV lamp source is required to be equal to or greater than the ionization potential of the substance drawn through the instrument in order to create separate ionized species.

3.0 REQUIRED EQUIPMENT

Pen

Equipment Calibration Form

Photoionization detector

Isobutylene calibration gas (i.e., span gas)

Regulator

4.0 PROCEDURES

4.1 Principle of Operation

The Photovac portable photoionizer detects many organic (and a few inorganic) species. The basis for detection of this instrument is the ionization of components in gaseous streams. The incoming gas molecules are subjected to UV radiation, which is energetic enough to ionize many compounds associated with industrial activities. Molecules are transformed into charged-ion pairs, creating a current between two electrodes. Each molecule has a characteristic ionization potential, which is the energy required to remove an electron from the molecule, yielding a positively charged ion and a free electron.

This instrument measures the concentration of airborne photoionizable gases and vapors and automatically displays and records these concentrations. It does not distinguish between individual substances. Readings displayed represent the total concentration of all photoionizable chemicals present in the sample. This instrument is factory-set to display concentration in units of ppm or mg/m^3. The meter display updates itself once per second.

The 2020 also performs short-term exposure limit (STEL), time-weighted average (TWA), and PEAK calculations. Any of these results can be viewed, but only one mode may be viewed at a time.

The 2020 has six keys for alphanumeric entry and for accessing multiple functions. The keys are used to set up and calibrate 2020. They allow the user to manipulate the concentration data in various ways.

All information entered with the keys and stored in the 2020's memory is retained when the instrument is switched off. The clock and calendar continue to operate and do not need to be set each time the 2020 is turned on.

4.1.1 Displays

The 2020 has a meter display for reporting detected concentration and a display used for status/ information to guide you through configuration options. All functions of the 2020 will be controlled or reported using one of these displays.

4.1.1.1 Meter Display

The meter display is four digits. It will always be used for reporting detected concentration. When the detector and pump are off, the meter display will be blank.

In order to accommodate the range of concentrations the 2020 can detect, the meter reading will be reported using one of two resolutions. A resolution of 0.1 will be used for concentrations below 100 ppm, and a resolution of 1 will be used for concentrations above 100 ppm.

4.1.1.2 Status Display

The status display is a two- line by 16-character display. The top line is used to display status information and prompts the user for inputs. The bottom line is used for soft key names. Up to three names can be displayed for the three soft keys. If a name does not appear for a soft key, then the soft key has no associated function.

4.1.2 Keys

4.1.2.1 Fixed Keys

The three round keys below the soft keys each have a fixed function. The first key is the ON/OFF key, the middle key is the EXIT key, and the last key is the ENTER key.

The ON/OFF key is used to both turn power on and off. To turn on the 2020, press the ON/OFF key. To turn the power off, press the ON/OFF key and hold it down for 2 seconds, and then release it. This is done to prevent accidental power off.

The EXIT key provides a way of returning to the default display. In the functional map, the soft keys allow the user to advance and the EXIT key provides a way to go back. If the user is at the initial entry of the menu, EXIT will return you to the default display.

The ENTER key has a context sensitive function. When the user is operating or navigating through the function map, the ENTER key is used to exit the functions and return to the default display. When entering data such as a name, number, date, or time, ENTER is used to confirm the entry.

4.1.2.2 Soft Keys

The three soft keys on the 2020 are located directly below the status display. Each key has varying functions for configuring the 2020, editing the data logger, and controlling the display. Because only three soft keys are available, each function is broken down into a path.

4.1.2.3 Entering Text with the Soft Keys

For all information that is entered, the left, center, and right soft keys correspond to the up, down, and right arrow.

The up and down arrows are used to change the character highlighted by the cursor. The right arrow is used to advance the cursor to the next character on the right. When the cursor is advanced past the right most character, it wraps around to the first character again. To accept the changes, press the ENTER key. To ignore the change, press EXIT.

Formatting characters, such as the colon (:) in the time, the decimal (.) in a concentration, and the slash (/) in the date, are skipped when advancing the cursor.

All inputs are an eight-character input, which is displayed on the right side of the top line of the status display. The prompt, describing the input, occupies the left half of the top line. The soft keys are defined on the bottom line of the status display.

4.2 Default Display

The meter display shows the detected concentration. The resolution of the display changes with the magnitude of the reading. A reading of 0 to 99.9 will be displayed with a resolution of 0.1 ppm. A reading greater than 99.9 will be shown with a resolution of 1 ppm or 1 mg/m^3. The meter will display concentrations up to 2000 ppm or 2(99) mg/m^3.

The status display is used to display the instrument status, date, time, units, and active soft keys.

The default display provides the following information: instrument status, current detected concentration, time, date, and measurement units. The status display toggles between showing time and units and then the date.

When the display mode is MAX, the date and time correspond to the date and time the MAX concentration was recorded. In TWA mode, the time represents the number of hours and minutes during which the TWA has been accumulating. For PEAK and STEL monitoring, the date and time correspond to the current date and time.

4.3 Monitoring

4.3.1 Instrument Status

The instrument status is shown on the left of the first line of the status display and on the Table and Graph outputs. Each status has a priority assigned to it. If more than one status is in effect, then the status with the highest priority is displayed until the condition is corrected or until the option is turned off.

4.3.2 Alarms

While operating the instrument, any one of three alarm conditions can occur. To accurately identify the source of the alarm, each type of alarm has been given a unique status.

In addition to the status, the 2020 also has an audible alarm and a visual alarm LED. To conserve power, the 2020 alternates between these two alarm indicators, rather than operating both concurrently. Different alarms are identified by the frequency at which the 2020 alternates as follows: PEAK alarm, 5 times per second; STEL alarm, 2.5 times per second; and TWA alarm, 1.25 times per second.

The left soft key is used for acknowledging alarms, and is labeled "Ack." If no alarm exists, then the "Ack" key is not shown. To clear the alarm, press the "Ack" key. Once acknowledged, the alarm indicators are cleared. The alarm status will remain until the alarm condition clears.

The 2020 updates the peak concentration once every second. Following every update, the peak concentration is compared to the peak alarm level, and, if exceeded, an alarm is triggered.

If a 15-minute average concentration exceeds the selected STEL, a STEL alarm is generated.

The TWA alarm is generated when the current average concentration over an 8-hour period, since the TWA was last cleared, has exceeded the TWA exposure limit.

During calibration, all alarms are disabled. Once the calibration is complete, the alarms are re-enabled.

4.4 STEL, TWA, MAX, and PEAK Operation

The 2020's meter display can be configured to show one of four values: STEL, TWA, PEAK, and MAX.

4.4.1 Short-term Exposure Limit Mode

The STEL mode displays the concentration as a 15-minute moving average. The 2020 maintains 15 samples, each representing a 1-minute averaging interval.

Once every minute, the oldest of the 15 samples is replaced with a new 1-minute average. This moving average provides a 15-minute average of the last 15 minutes with a 1-minute update rate. Because the average is calculated using 15 one-minute averages, the meter display will only update once every minute.

The STEL is set to zero each time the instrument is turned on. Because STEL is a 15-minute moving average, there is no need to clear or reset the STEL.

STEL calculations are always being performed by the 2020. The user can display the results of the calculations by selecting "STEL" as the Display mode.

4.4.2 Time-weighted Average (TWA) Mode

The TWA accumulator sums concentrations every second until 8 hours of data have been combined. If this value exceeds the TWA alarm setting, a TWA alarm is generated. The TWA is not calculated using a moving average. Once 8 hours of data have been summed, the accumulation stops. In order to reset the TWA accumulator, press the "Clr" key.

This sum will only be complete after 8 hours, so the meter displays the current sum divided by 8 hours. While in TWA mode, the time on the status display will show the number of minutes and hours of data that TWA has accumulated. When this reaches 8 hours, the 2020 stops accumulating data and the TWA is complete.

TWA calculations are always being performed by the 2020. The user can display the results of the calculations by selecting TWA as the Display mode.

4.4.3 MAX Mode

The MAX mode displays the maximum signal, with the date and time that it was recorded. The 2020 continues to log data according to the selected averaging interval, but only the maximum detected concentration is displayed on the meter display.

The right soft key is used to clear the meter when displaying MAX. The "Clr" key only affects the reading that the meter is displaying. For example, if the MAX reading is displayed, and "Clr" is pressed, only the MAX value is cleared. The TWA is still accumulating in the background.

4.4.4 PEAK Mode

The PEAK mode displays the current detected concentration. The reading is updated once a second. In the background, the 2020 data logger is sampling the concentration and measuring minimum, maximum, and average concentrations for the selected averaging interval. At the end of every interval, one entry is placed in the data logger until the data logger is full. For CTO 166, the instrument should be operated in this mode. Operation within the other specialized modes is the responsibility of the SSO.

4.5 Set Functions

Set functions are used to set up the 2020. Three functions can be set on the 2020: Pump, Clock, and Calibration.

4.5.1 Pump

The Pump function is used to control the pump. After selecting "Set Pump," the 2020 responds by displaying the new pump status.

The detector is also turned off when the pump is turned off. This prevents the detector from being damaged when there is no sample flowing through the detector.

When the pump and the detector are off, the meter display will be blank. Turn the pump and detector off when concentration measurements are not necessary, and the 2020 will only be used for reviewing data

or generating reports. By operating the instrument with the pump and detector off when they are not needed, the lives of the battery and ultraviolet (UV) lamp will be conserved.

To set the pump:

1. Press the ENTER key. The top line of the status display changes to "Select?" The bottom line displays three soft key names: "Set," "Log," and "Disp."

2. Press the soft key below "Set."

3. The names of the soft keys change to reflect the Set options. The display now shows three devices that can be set: "Clock," "Pump," and "Cal." Press the "Pump" key.

4. The 2020 turns the pump off. If the pump was off, pressing "Pump" will turn the pump on.

5. A message will be displayed to show the status of the pump. The 2020 reverts back to the previous menu after a few seconds.

6. To return to the default display, press the ENTER key.

4.5.2 Clock

The Clock function is used to set both the current date and time.

To set the clock:

1. Press the ENTER key.

2. Press the "Set" key.

3. When the names of the soft keys change, press the "Clock" key.

   The up and down arrows are used to change the character underlined by the cursor. The right arrow is used to advance the cursor to the next character on the right. When the cursor is advanced past the right-most character, it wraps around to the first character again.

Formatting characters, such as the colon (:) in the time and the slash (/) in the date are skipped when advancing the cursor.

4. Use the "arrow keys" to enter the correct time. The time is formatted as Hour:Minute:Second.

5. Press the ENTER key to confirm the time and move to the date option.

6. When setting the date, the 2020 prompts for the current date formatted as Year/Month/Day. Use the "arrow keys" to enter the correct date.

7. Press the ENTER key to confirm the date and return to the Set options. Wait for the display to timeout or press ENTER to return to the default display.

4.5.3 Calibration (Cal)

"Cal" allows the user to set up and calibrate the 2020. There are three options under the Cal function: "Zero," "Span," and "Mem."

A calibration memory consists of a name, a response factor, and PEAK, TWA, and STEL alarm levels.

The "Zero" and "Span" keys are covered in detail in the manufacturer's operations manual for the instrument.

To edit the calibration memory, select "Mem" and then "Chng." The 2020 prompts the user with two new soft keys: "User" and "Lib."

4.5.4 Library (Lib)

Library selections simplify Cal Memory programming and provide standard response factors for approximately 70 applications. "Lib" allows the user to select an entry from a pre-programmed library. The name, response factor, and three alarm levels are all set from the library. To select a library entry to program the selected Cal Memory:

1. Select "Set," "Cal," "Mem," "Chng," and "Lib."
2. Use the "Next" and "Prev" keys to scroll through the list. See the manufacturer's manual Appendix 8.7 for a list of the library entries.

4.6 Preparing for Field Operation of the Photovac 2020

Turning The 2020 On

1. Turn the 2020 on by pressing the ON/OFF key.

2. The 2020 will display the software version number. Wait for the 2020 to proceed to the default display.

3. Allow 10 minutes for the instrument to warm up and stabilize.

4. Press the Enter Key. The default display will provide three soft key selections, "Set," "Log," and "Display."

5. Press "Set." From this option, three other soft key selections will be offered: "Pump," "Clock," and "Cal."

6. Press "Cal." This will begin the calibration sequence. The first selection is to zero the instrument.

7. Press Enter; zeroing will begin. (Note: When employing zero gas, attach and activate zero gas supply at this time.)

8. The next selection offered will be Span. Press Enter, at which time the concentration will be requested. The isobutylene calibration gas employed under general service will be marked on the side of the container. Use the soft keys to toggle into position and to log the concentration. Once the concentration is logged, press "Enter." The direction on the status display will indicate spanning. At this time, hook up the span gas with a regulator to the Photovac 2020 and open it to supply enough flow to elevate the flow rate indicator to the green indicator line (1/8 inch from the rest position).

9. Once spanning is complete, the alarms, which have been disabled during calibration, will activate, indicating that calibration is complete.

10. Document this calibration procedure using a Document of Calibration form (included in Appendix A).

This instrument is ready for general purpose application.

Calibration is to be performed daily or prior to each use, in accordance with this section.

4.7 Maintenance and Calibration Schedule

Function	Frequency
Routine Calibration	Prior to each use.
Factory Inspection and Calibration	Once a year, or when malfunctioning.
Wipe Down the Outer Casing of the Unit	After each use.
Clean UV Light Source	Every 24 hours of operation.
Sample Inlet Filter	Change on a weekly basis or as required by level of use.
Battery charging	After each use.
Clean ionization chamber	Monthly.

4.7.1 Cleaning the UV Light Source Window

1. Turn the FUNCTION switch to the OFF position. Use the 2020 multi-tool and remove the lamp housing cover. CAUTION: The UV lamp is delicate and expensive; handle carefully.

2. Tilt the lamp housing with one hand over the opening; slide the lamp out of the housing.

3. The lamp window may now be cleaned with any of the following compounds using lens paper:
   a. 11.7 eV Lamp - Dry Aluminum Oxide Powder (3.0 micron powder)
   b. All other lamps-HPLC Grade Methanol

4. Following cleaning, reassemble by first sliding the lamp back into the lamp housing. Replace the o-ring as necessary, reinstall the lamp housing cover, and tighten it using the 2020 multi-tool. (Do not over tighten.)

5. Recalibrate the instrument as per Section 4.6.

4.7.2 Cleaning the Ionization Chamber

1. Turn the FUNCTION switch to the OFF position and remove the lamp housing cover and lamp as per Section 4.7.1.

2. Using a gentle jet of compressed air, gently blow out any dust or dirt.

3. Following cleaning, reassemble by first sliding the lamp back into the lamp housing. Replace the o-ring as necessary, reinstall the lamp housing cover, and tighten it using the 2020 multi-tool. (Do not over tighten.)

4. Recalibrate the instrument as per Section 4.6.

4.8 Instrument Advantages

The Photovac 2020 is easy to use in comparison to many other types of monitoring instrumentation. Its detection limit range is in the low parts-per-million range. Response rapidly reaches 90 percent scale of the indicated concentration (less than 3 seconds for benzene). This instrument's automated performance covers multiple monitoring functions simultaneously, incorporating data logging capabilities.

4.9 Limitations of the Photovac 2020 Photoionization Monitor

- Because the 2020 is a nonspecific total gas/vapor detector, it cannot be used to identify unknown chemicals; it can only quantitate them in relationship to a calibration standard (relative response ratio).

- For appropriate application of the 2020, ionization potentials of suspected contaminants must be known.

- Because the types of compounds that the 2020 can potentially detect are only a fraction of the chemicals possibly present at a hazardous waste site or incident, a background or zero reading on this instrument does not necessarily signify the absence of air contaminants.

- The 2020 instrument can only monitor certain vapors and gases in air. Many nonvolatile liquids, toxic solids, particulates, and other toxic gases and vapors cannot be detected.

- PIDs are generally not specific. Their response to different compounds is relative to the calibration gas used. This is referred to as relative response ratio. Instrument readings may be higher or lower than the true concentration. This can be an especially serious problem when monitoring for total contaminant concentrations if several different compounds are being detected at once.

- The 2020 is a small, portable instrument that cannot be expected to yield results as accurately as laboratory instruments.

4.9.1 Variables Affecting Monitoring Data

Monitoring a hazardous waste site environment can pose a significant challenge in assessing airborne concentrations and the potential threats to site personnel. Several variables may influence both dispersion and the instrument's ability to detect actual concentrations. Some of the variables, which may impact these conditions, are as follows:

- Temperature - Changes in temperature or pressure will influence volatization and affect airborne concentrations. Additionally, an increase or decrease in temperature ranges may have an adverse effect on the instrument's ability to detect airborne concentrations.

- Humidity - Excessive levels of humidity may interfere with the accuracy of monitoring results.

- Rainfall - Through increased barometric pressure and water, rainfall may influence dispersion pathways affecting airborne emissions.

- Electromagnetic interference - High voltage sources, generators, other electrical equipment may interfere with the operation and accuracy of direct-reading monitoring instruments.

5.0 TROUBLESHOOTING

5.1 Fault Messages

When the "Fault" status is displayed, the 2020's operation is compromised.

Fault 1: Signal from zero gas is too high.

Cause: If another fault occurred while the 2020 was setting its zero point, then this fault is displayed.
Action: Ensure no faults are occurring and calibrate the 2020 again.

Cause: Contamination of sample line, sample probe, or fittings before the detector.

Action: Clean or replace the sample line, sample probe, or the inlet filter.

Cause: Span gas and zero air are switched.

Action: Ensure clean air is used to zero the 2020. If you are using gas bags, mark the calibration and zero gas bags clearly.

Cause: Ambient air is contaminated.

Action: If you are unsure about the quality of ambient air, use a supply of commercial zero grade air to zero the 2020.

Fault 2: Signal from span gas is too small.

Cause: Operator may have switched the span gas and zero air.

Action: Ensure clean air is used to zero the 2020. If you are using gas bags, mark the calibration and zero gas bags clearly.

Action: Ensure the span gas is of a reliable concentration.

Cause: UV lamp window is dirty.

Note: Do not remove the detector lamp in a hazardous location.

Action: Clean the UV lamp window.

Cause: UV lamp is failing.

Note: Do not remove or replace the detector lamp in a hazardous location.

Action: Install a new UV lamp.

Cause: Incompatible application.

Action: The concentration and sample gas are incompatible for use with the 2020.

Fault 3: UV lamp fault. UV lamp has not started.

Cause: The UV lamp has not started immediately.

Action: This fault may be seen momentarily when 2020 is first turned on. Allow 30 to 60 seconds for the UV lamp to start and the fault to clear.

Cause: The UV lamp serial number label is blocking the photocell.

Note: Do not remove or replace the detector lamp in a hazardous location.

Action: If you have a UV lamp with a white serial number label, it is possible that the label is blocking the photocell. Rotate the lamp approximately 90 degrees and then try to start the 2020 again. If the fault persists, replace the lamp.

Cause: the UV lamp is not installed.

Note: Do not remove or replace the detector lamp in a hazardous location.

Action: Install a UV lamp.

Cause: The UV lamp has failed.

Note: Do not remove or replace the detector lamp in a hazardous location.

Action: Install a new UV lamp.

Cause: Electronic problem.

Action: If a new UV lamp still generates this fault, then contact the Photovac Service Department.

Fault 4: Pump current too low or too high.

Cause: If the pump sounds labored, then the pump is operating beyond normal operating parameters.

Action: Check for an obstruction in the sample line. Make sure sample line, sample probe, or inlet filter are not plugged.

Note: Do not replace the inlet filter in a hazardous location.

Action: Replace the inlet filter.

Action: Ensure the sample outlet, located on the underside of the 2020, is not obstructed.

Cause: The UV lamp is too wide, causing flow to be restricted.

Note: Do not remove or replace the detector lamp in a hazardous location.

Action: If you have a UV lamp with a white serial number label, it is possible that the lamp is too wide for the lampholder. Contact the TtNUS equipment manager.

Cause: The 2020 has been exposed to a solvent that can pass through the inlet filter and liquid has been aspirated.

Action: Contact the TtNUS equipment manager.

Cause: The pump has failed.

Action: Contact the TtNUS equipment manager.

5.2 Specific Problems

Problem: Very low or no instrument response detected, yet compounds are known to be present.

Cause: The 2020 has not been calibrated properly.

Action: Ensure the calibration gas is of a reliable concentration and then calibrate the instrument as outlined in Section 4.6 of the User's Manual. After the instrument has been calibrated, sample the bag of calibration gas. A reading equivalent to the calibration gas should be displayed. If not, contact the TtNUS equipment manager.

Note: Do not remove or recharge the battery pack in a hazardous location.

Action: Disconnect the battery charger before calibrating the 2020.

Cause: Calibration memories have not been programmed correctly.

Action: Program all the calibration memories you require for your application. You must use the correct calibration gas and concentration for each Cal Memory.

Cause: The response factor has been set to zero.

Action: Enter the correct response factor. Refer to Appendix 8.6 for a list of response factors. If the compound is not listed in Appendix 8.6 or you are measuring gas mixtures, then enter a value of 1.0. See User's Manual provided by the manufacturer.

Cause: You are not using the correct Cal Memory.

Action: Select the correct Cal Memory for your application.

Note: It does not matter which Cal Memory is selected or which response factor is entered. The 2020's response is not specific to any one compound. The reading displayed represents the total concentration of all ionizable compounds in the sample.

Cause: Detector is leaking. A decrease in sensitivity may be due to a leak in the detector.

Note: Do not remove or replace the detection lamp in a hazardous location.

Action: Ensure the UV lamp has been installed correctly.

Action: Ensure the lamp cover has been tightened down. Do not overtighten the cover.

Action: Ensure the o-ring seal on the lamp cover is positioned correctly.

Cause: The UV lamp is too long, causing flow to be restricted.

Note: Do not remove or replace the detector lamp in a hazardous location.

Action: If you have a UV lamp with a white serial number label, it is possible that the lamp is too long for the lampholder. Replace the lamp and contact the TtNUS equipment manager.

Cause: UV lamp is too wide, causing flow to be restricted.

Note: Do not remove or replace the detector lamp in a hazardous location.

Action: If you have a UV lamp with a white serial number label, it is possible that the lamp is too wide for the lampholder. Contact the TtNUS equipment manager.

Cause: The sampling environment is extremely humid.

Action: Water vapor is not ionized by the PID, but it does scatter and absorb the light and results in a lower reading. The 2020 detector has been designed to operate under high humidity conditions. Under extreme conditions, you may notice decreased response due to humidity.

Cause: The UV lamp is failing.

Note: Do not remove or replace the detector lamp in a hazardous location.

Action: High concentration of non-ionizable compounds. Chemical compounds, such as methane, with IPs greater than the 10.6 eV scatter and absorb the UV light. Sensitivity may be decreased significantly. Application with high backgrounds of such materials may be incompatible with the 2020. Contact the Photovac Applications Group for more information.

Problem: Erroneously high readings.

Cause: Sampling environment is extremely humid.

Action: Water vapor may contain mineral salts, which carry a charge. The water vapor becomes an electrolytic solution, which becomes ionized when it enters the detector. Atmospheric water in areas around the sea or stagnant water may produce a response in the absence of contaminants. The same effect may be seen when conducting ground water investigations in areas where the water is hard because it contains a significant concentration of minerals.

Cause: The 2020 has not been calibrated properly.

Action: Ensure the calibration gas is of a reliable concentration and then calibrate the instrument as outlined in Section 4.6. After the instrument has been calibrated, sample the bag of calibration gas. A reading equivalent to the calibration gas should be displayed. If not, contact the TtNUS equipment manager.

Cause: Cal Memories have not been programmed correctly.

Action: Program all the Cal Memories you require for your application. You must use the correct calibration gas and concentration for each Cal Memory. See Section 3.4 of the User's Manual.

Cause: You are not using the correct Cal Memory.

Action: Select the correct Cal Memory for your application. See Section 3.2.2 or 3.3.2 of the User's Manual.

Note: It does not matter which Cal Memory is selected or which response factor is entered. The 2020's response is not specific to any one compound. The reading displayed represents the total concentration of all ionizable compounds in the sample.

Cause: The detector has been short circuited by foreign matter in the detector cell.

Note: Do not service the 2020 in a hazardous location.

Action: Do not touch the wire grid inside the detector cell. Use a gentle jet of compressed air to remove any dust in the detector cell.

Warning: Do not insert any object, other than the UV lamp, into the lampholder.

Cause: There is an undetermined problem.

Action: Contact the TtNUS equipment manager.

Problem: Date and time settings are not retained.

Cause: The battery pack was removed before the 2020 was turned off.

Note: Do not remove or recharge the battery pack in a hazardous location.

Action: Replace the battery pack and reset the time and date. Ensure that the 2020 has been turned off before removing the battery pack.

Cause: The 2020 has not been used for 3 months or more and the internal battery (not the external battery pack) has discharged.

Note: Do not remove or recharge the battery pack in a hazardous location.

Action: Connect the 2020 to the AC adapter and turn the 2020 on. Turn the pump off. While the 2020 is running, the internal battery is charging. Leave the instrument running for approximately 24 hours.

Problem: Instrument status shows "Over."

Cause: High concentrations of gases and vapors will cause a rapid change in signal level. The detector and associated electronics may become temporarily saturated.

Action: Wait a few seconds for the status to return to normal. PIDs are designed to detect relatively low concentrations of gases and vapors. Exposure to very high concentrations may result in a very high or maximum response.

Cause: The detector has become saturated.

Action: Move the 2020 to a location where it can sample clean air. Sample clean air until the reading stabilizes around 0.

Cause: Detector has been short circuited by foreign matter in the detector cell.

Note: Do not service the 2020 in a hazardous location.

Action: Do not touch the wire grid inside the detector cell. Use a gentle jet of compressed air to remove any dust or dirt in the detector cell.

Warning: Do not insert any object, other than the UV lamp, into the lampholder.

Cause: There is an undetermined problem.

Action: Contact the TtNUS equipment manager.

Problem: Display is blank.

Cause: Battery pack is critically low.

Note: Do not remove or recharge the battery pack in a hazardous location.

Action: Replace the battery pack or connect the 2020 to the AC adapter.

Cause: The battery pack is not connected to the instrument correctly.

Action: Ensure the battery pack connector is securely attached to the connector on the 2020.

Cause: There is an undetermined problem.

Action: Reset the 2020. You must leave the instrument on while you disconnect the battery pack. This will reset the instrument. Reconnect the battery pack and close the battery hatch. Turn on the 2020, set the time and date, and program all the calibration memories that you are using.

Action: Contact the TtNUS equipment manager.

Problem: Sample flow rate is less than 300 ml/min.

Cause: The inlet filter is plugged.

Note: Do not replace the inlet filter in a hazardous location.

Action: Replace the inlet filter.

Cause: The inlet filter has not been installed properly.

Action: Ensure that the inlet filter has been installed correctly.

Cause: The UV lamp is too long, causing flow to be restricted.

Note: Do not remove or replace the detector lamp in a hazardous location.

Action: If you have a UV lamp with a white serial number label, it is possible that the lamp is too long for the lampholder. Replace the lamp and contact the TtNUS equipment manager.

Cause: The UV lamp is too wide, causing flow to be restricted.

Action: If you have a UV lamp with a white serial number label, it is possible that the lamp is too wide for the lampholder. Contact the TtNUS Equipment Manager.

Cause: The 2020 has been exposed to a solvent that can pass through the inlet filter and liquid has been aspirated.

Action: Contact the TtNUS equipment manager.

Cause: Sample outlet is obstructed.

Action: Ensure the sample outlet is not obstructed in any way.

Cause: Pump has been damaged.

Action: Contact the TtNUS equipment manager.

Problem: Liquid has been aspirated.

Cause: The 2020 has been exposed to a solvent that can pass through the inlet filter.

Action: Contact the TtNUS equipment manager.

Problem: Corrosive gases and vapors have been sampled.

Cause: The 2020 has been exposed to corrosive gases and vapors.

Action: Corrosive gases and vapors can affect the electrodes within the detector as well as the lamp window. Prolonged exposure to corrosive materials may result in permanent fogging or etching

of the window. If the 2020 is exposed to corrosive material, contact the TtNUS equipment manager.

6.0 SHIPPING

The Photovac may be shipped as cargo or carried on as luggage if there is no calibration gas cylinder accompanying the kit. When shipping or transporting the calibration gas, a Hazardous Airbill must be completed.

7.0 REFERENCES

Photovac 2020 Photoionization Monitor User's Manual, 1995.

8.0 ATTACHMENTS

1. Equipment Calibration Log

ATTACHMENT 1
EQUIPMENT CALIBRATION LOG

Tetra Tech NUS, Inc.

EQUIPMENT CALIBRATION LOG

PROJECT NAME : _____ INSTRUMENT NAME/MODEL: LaMotte 2020

SITE NAME: _____ MANUFACTURER: _____

PROJECT No.: _____ SERIAL NUMBER: _____

Date of Calibration	Instrument I.D. Number	Person Performing Calibration	Instrument Settings		Instrument Readings		Calibration Standard (Lot No.)	Remarks and Comments
			Pre-calibration	Post-calibration	Pre-calibration	Post-calibration		

STANDARD OPERATING PROCEDURE
NUMBER CTO315-05

FIELD SCREENING OF SOIL AND SEDIMENT SAMPLES FOR RADIOACTIVITY

This Standard Operating Procedure (SOP) describes the screening of soil samples for two purposes. The first purpose is to screen excavated soil samples for gamma radiation. The results of this screening will be used to determine whether samples must be sent to Pace Analytical for gamma spectrometric analysis. The second purpose is to provide radioactivity data to meet U.S. Department of Transportation (DOT), and International Air Transport Association (IATA)/International Civil Aviation Organization (ICAO) requirements for shipment to an offsite analytical laboratory. These data determine whether samples are considered to be radioactive for shipping purposes (that is, have gross radiation levels greater than 2,000 pCi/g [74 Bq/g]), and will be used to establish the level of radioactivity to meet packaging and labeling requirements for shipment. These data may also be supplied to contract laboratories as part of the information required to meet their license activity limits.

2.0 SCOPE

2.1 Applicability

This procedure applies to the use of field radiation measurement instruments (described in Section 5.1) for determining gross levels of radioactivity of samples. Steps 6.1 through 6.3 apply to both purposes of this SOP, as described in Section 1.0. Step 6.4 addresses only the first purpose (backhoe soil screening); Steps 6.5 through 6.7 address only the second purpose (measuring radiation levels for sample shipment).

Radiation measurements that were made during the recent Phase III Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) were at background levels. Based on this knowledge and historical data collected prior to the Phase III RFI, the chance of encountering radioactive samples is believed to be low. Nevertheless, it is prudent practice to monitor for radiation in areas known to have been contaminated with radioactive materials.

The background levels measured in the Phase III RFI were orders of magnitude less than what is considered to be radioactive (2 pCi/g) by transportation standards. Therefore, the gamma screening will be used to determine whether additional field screening is required to meet transportation standards for

samples that are shipped off site. Steps 6.5 through 6.7 of this SOP address the issue of shipping regulation compliance. These steps of the procedure will apply only when a backhoe soil screening measurement (described in Section 6.4) exceeds ten times the average background radiation level.

All radioactive contamination from site operations at the NSWC Crane MGBG should derive from past disposal of thorium nitrate. Therefore, natural thorium is assumed to be the radioactive contaminant. Thorium does not migrate easily to ground water because it is retained by soil particles. Thorium is also primarily an alpha (α) particle emitter, although beta (β) and gamma (γ) emissions are radiated from thorium daughters. Alpha particle emissions are easily stopped by a water matrix. Therefore, water samples will not be screened for radioactivity to determine their radioactivity status, but they will be subject to the other screening requirements delineated below for shipping purposes.

According to DOT regulations, there is no limit on the amount of natural thorium that may be packaged for shipment when packaged correctly.

2.2 Training

Radiation surveys for determining compliance with shipping regulations are to be conducted only by qualified health physicists, health protection technicians, or designated radiological screening personnel.

3.0 DEFINITIONS AND ACRONYMS

A. DOT (U.S. Department of Transportation): The organization that regulates the transportation of radioactive materials by carriers and shippers subject to 49 CFR 173 and Subpart I.

B. IATA (International Air Transport Association)/ICAO (International Civil Aviation Organization): Organizations that regulate the air transport of radioactive materials.

C. Curie (Ci): The quantity of radioactive material in which 3.7×10^{10} atoms disintegrate (are transformed) per second. It is the traditional unit for measuring radioactivity. A smaller unit, the picoCurie (pCi), is 1.0×10^{-12} Ci or 2.22 disintegrations per minute (dpm) and is used throughout this procedure.

D. Becquerel (Bq): The quantity of radioactive material in which one atom disintegrates (is transformed) per second. It is the International System (SI) unit for measuring radioactivity. 1 Bq is equal to 2.7×10^{-11} Ci or 27 pCi or 60 dpm.

4.0 BACKGROUND, PRECAUTIONS, AND LIMITATIONS

4.1 Background

Trenching is being done for CTO 315 to determine whether a source of VOCs can be detected in the soil overburden at the MGBG. Because thorium or thorium compounds, which are mildly radioactive, were once buried at the MGBG, field radiation screening will be conducted on soils that are excavated during the VOC exploration. Backhoe soil samples that appear to have elevated radiation levels will be analyzed by gamma spectrometry to determine whether any risk concerns have been overlooked in past investigations. Step 6.4 addresses this concern.

For shipping purposes, samples with gross radiation levels greater than 2,000 pCi/g (74 Bq/g) are considered to be radioactive. Samples that are less than 2,000 pCi/g are not considered to be radioactive and may be shipped without any special labels, postings, or restrictions. Steps 6.5 through 6.7 of this screening procedure allow rapid discrimination between radioactive and non-radioactive samples, and conservatively set the shipping limit at 1,800 pCi/g rather than 2,000 pCi/g. Another element of conservatism is built into this procedure by using maximum observed radiation levels.

Screening for alpha and beta radiation should be performed on soil that is homogeneous. Measurements made for shipping, must be made on samples that have been transferred to a mixing bowl and mixed prior to measurement. When screening backhoe samples, however, the soil may not be homogeneous because the samples will not be mixed in the backhoe. This has been taken into account in the procedure.

4.2 Precautions

Steps 6.5 through 6.7 of this procedure do not cover all shipping and labeling requirements. Other shipping and labeling requirements, as well as handling and packaging requirements, are provided in SOPs CTO315-01 and CTO315-17.

If the sample is not well mixed or comprises widely varying soil textures, alpha and beta radiation measurements made on the surface of the soil may not accurately reflect the radioactivity of the entire sample. In such a situation, consult the FOL to determine whether this procedure is appropriate for the sample.

4.3 Limitations

The 1,800 pCi/g cutoff radiation level is converted to total counts per minute (cpm) above background so the analyst can know, based on direct observation and simple calculations, whether a sample is radioactive. Packaging and labeling requirements, however, also depend on radiation measurements made at the surface of the shipping container, as described in Section 6.7.

An average detector efficiency is used for computing a sample's radioactivity status in Sections 7.1 and 7.2. This is only an approximation if the actual alpha and the beta + gamma probes exhibit different efficiencies.

5.0 EQUIPMENT AND MATERIALS

5.1 Equipment and Materials

5.1.1 Equipment for Steps 6.1 through 6.4

Ludlum Model 3 Count Rate Meter with a Model 44-10 2" x 2" sodium iodide (NaI) gamma detector.

Indelible pen

Calculator

5.1.2 Equipment for Steps 6.1 through 6.3 and 6.5 through 6.7

This equipment is required only if hand held screening of backhoe soil samples with the Model 44-10 probe yields a measurement that is ten times the average background level:

Ludlum Model 3 Count Rate Meter with a Model 44-9 Pancake Geiger-Muller (G-M) Detector for "beta + gamma" measurements. Other instruments may be substituted if the instruments provide similar detection capabilities.

Ludlum Model 3 Count Rate Meter and a 43-5 50 cm squared alpha scintillator for alpha measurements. Other instruments may be substituted if the instruments provide similar detection capabilities.

Ludlum Model 12S Micro-R meter or equivalent.

Large bowl or other suitable container for spreading soil samples during screening.

Mixing rod for mixing soil samples.

Blank swipes (e.g., Whatman filter paper)

Indelible pen

Calculator

6.0 PROCEDURE

6.1 Instrument Operational Checks

6.1.1 Confirm that the instrument calibrations are current.

6.1.2 Before collecting samples, perform operational checks (including response checks using an exempt quantity source) on the instruments to be used.

6.1.3 Record instrument settings and information on Radiation Log Sheet 1 (Attachment A). When using the gamma meter only, indicate this by crossing out the β symbol on the applicable lines of Attachment A.

6.2 Instrument Background Measurements

For each instrument that will be used on a given day, perform background measurements in a background radiation setting that is in close proximity to the area being surveyed but outside the MGBG boundary and well enough removed to represent background radiation levels:

6.2.1 Holding the probe a fixed distance (4 to 6 inches) from the background soil to be screened, take a reading in three separate background locations and record these three background values on Radiation Log Sheet 1 (Attachment A). The background locations shall be outside the west, south, and east MGBG boundaries and near the midpoint of the imaginary line connecting the MGBG corner posts. When using the gamma meter only, indicate this by crossing out the β symbol on the applicable lines of Attachment A.

6.2.2 Compute the average of the background readings to obtain the average background reading for that specific instrument for the day and record the average on Attachment A.

6.3 Instrument Efficiency Measurements

6.3.1 Locate the certificate of instrument calibration or a calibration tag/sticker on each instrument.

6.3.2 Transcribe the instrument efficiencies from the certificate or sticker to Attachment A.

6.3.3 When beta + gamma and alpha measurements are to be made (see Steps 6.4.5 and 6.5 through 6.7), compute and record on Attachment A the average detector efficiency for each detector.

6.4 Gamma Screening Procedure for Soil Samples from Excavations

Using the Ludlum Model 44-10 gamma probe and associated rate meter measure the gamma radiation of backhoe soil from each backhoe swipe as follows:

6.4.1 Hold the gamma probe 4 to 6 inches from the soil to be screened as was used for the background measurements.

6.4.2 When the reading has stabilized, record the reading thus obtained and the sample location in the field log book. Make sure the approximate sample depth and location within the test pit is recorded.

6.4.3 If the single backhoe soil reading exceeds two times the average background level:

Collect a sample from that soil location in the backhoe bucket and submit it to Pace Analytical for gamma spectrometric analysis.

6.4.4 If a single soil radiation measurement does not exceed background levels, as evaluated in Step 6.4.3, take no action.

6.4.5 If a single backhoe soil measurement exceeds ten times the average background radiation level:

6.4.5.1 Remove a sample of soil from the backhoe bucket where radiation levels appear to be most elevated.

5.4.5.2 Designate the soil sample for gamma spectrometric analysis.

5.4.5.3 Proceed to Sections 6.5 through 6.7 to determine how to package the sample for shipment.

6.5 Determining the Default Radioactivity Status Limit

This Section will only be implemented if a gamma screening result exceeded ten times the daily average background measurement.

6.5.1 Determine the current Radioactivity Status Limit in accordance with Section 7.1 or 7.2, as applicable.

6.5.2 Record, on Attachment A, the current Radioactivity Status Limit.

6.6 Determination of Sample Radioactivity Status

This Section will only be implemented if a gamma screening result exceeded ten times the daily average background measurement.

CAUTION: When handling potentially contaminated environmental media or containers, use disposable (i.e., latex or nitrile) gloves at all times.

6.6.1 Record the sample number in column A of Radiation Log Sheet 1 (Attachment A).

6.6.2 Mix the sample in a large mixing bowl or other suitable container and smooth the sample surface to make it uniform in texture and appearance, with a flat surface for presentation to the radiation survey instrument.

6.6.3 Scan the sample with the Beta + Gamma probe and record the maximum observed cpm in column B of Attachment A.

6.6.4 Subtract the average Beta + Gamma background cpm from the cpm reading in step 6.6.3 and record this value in column C of Attachment A.

6.6.5 Scan the sample with the Alpha probe and record the maximum observed cpm in column D of Attachment A.

6.6.6 Subtract the average Alpha background cpm from the cpm reading in step 6.6.5 and record this value in column E of Attachment A.

6.6.7 Compute and record in column F of Attachment A, the total counts per minute for the sample.

6.6.8 Compare the cpm value in column F of Attachment A with the current Radioactive Status Limit indicated on Attachment A. If the Value in column F exceeds the current Radioactive Status Limit, the sample is radioactive and must be shipped with screening, labeling and packaging requirements as described in Section 6.7. Otherwise, the sample is not radioactive and may be shipped as a non-radioactive sample with no special labeling or packaging requirements.

6.7 Screening of Sample Coolers Containing Radioactive Samples to Determine Labeling Requirements

NOTE: This part of the procedure applies only to samples that exceed the current Radioactivity Status Limit, as determined in accordance with Section 6.6.

6.7.1 Before the screening process begins, ensure that the sample cooler is closed tightly.

6.7.2 Using the Micro-R meter, place the meter flush against any outside surface of the cooler and obtain an "on contact" mrem/hr reading of the outside surface of the sample cooler.

6.7.3 Record the maximum "on contact" reading from Step 6.7.2 in column B of the Radiation Log Sheet 2 (Attachment B).

6.7.4 With a blank swipe and while applying moderate pressure, swipe three of the six flat surfaces of the cooler for a total surface area of 300 square centimeters (100 square centimeters per swiped surface).

NOTE: 10 cm (the length of one side of a square that is 100 cm^2) is roughly the width of an adult hand.

6.7.5 Indicate on the back of Attachment B with a diagram which surfaces (e.g., top, bottom, left side) were swiped and identify with marks on the diagram where each surface was swiped.

6.7.6 Cross-reference the diagram to the cooler identified on the front of Attachment B.

6.7.7 Using the Beta + Gamma probe obtain a cpm reading of the swipe and record the maximum observed cpm reading in column C of Attachment B.

6.7.8 Subtract the Beta + Gamma average background cpm from the Beta + Gamma cpm reading of the swipe and record that value in column D of Attachment B.

6.7.9 Using the Alpha probe obtain a cpm reading of the swipe and record the maximum observed cpm reading in column E of Attachment B.

6.7.10 Subtract the Alpha average background cpm (obtained from Attachment A) from the Alpha cpm reading of the swipe and record that value in column F of Attachment B.

6.7.11 Compute the total radioactivity of the swipe in disintegrations per minute (dpm) using the equation at the top of column G on Attachment B.

6.7.12 In column G of Attachment B record the total activity of the sample, in dpm.

6.7.13 If the reading from the Micro-R meter recorded in Step 6.7.3 does NOT exceed 0.5 mrem/hour (500 uR/hr) AND if the swipe radioactivity as recorded in column G of Attachment B does NOT exceed 6,600 dpm per 300 square centimeter swipe:

6.7.13.1 Label the shipment by placing a "Radioactive" label on the outside of the cooler.

6.7.13.2 Include with the shipping papers the following notice:

"This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910";

6.7.14 If the reading from the Micro-R meter recorded in Step 6.7.3 EXCEEDS 0.5 mrem/hour (500 uR/hr) OR if the swipe radioactivity as recorded on Attachment B EXCEEDS 6,600 dpm per 300 square centimeter swipe, contact the FOL to determine shipping requirements.

7.0 CALCULATONS

7.1 Determining A Default Radioactivity Status Limit

WARNING

Two assumptions were used when converting the conservative 1,800 pCi/g radioactivity shipping limit to a default Radioactivity Status Limit in units of cpm. If these assumptions are not valid, the default limit must be adjusted according to Section 7.2. First, at least 100 grams of soil or sediment sample (8-oz jar one-fourth full) are assumed to be typically present in a sample jar. With the exception of VOC samples more than 100 grams of sample are typically bottled for shipment to a laboratory. Second, an instrument detector efficiency of 10% was assumed for both the α and the $\beta + \gamma$ probes. This efficiency is commonly observed for field screening instruments.

Based on the above assumptions, the default Radioactivity Status Limit is:

(1,800 pCi/g of sample) x (2.22 dpm/pCi) x (0.10 cpm/dpm) x (100g of sample) = 39,960 cpm above background.

If the above assumptions do not apply to this field operation, adjust the limit as described in Section 7.2.

7.2 Adjustments to the Radioactivity Status Limit When Assumptions Are Invalid

If the actual efficiency of either the α or $\beta + \gamma$ detector differs from the value assumed in Section 7.1, OR if the sample mass is less than 100 g (8-oz bottle one-fourth full), the default Radioactivity Status Limit of 39,960 cpm must be adjusted as follows:

$$\text{Radioactivity Status Limit, cpm} = 39{,}960\,\text{cpm} \times \frac{\text{Avg Percent Detector Efficiency}}{10\%} \times \frac{\text{Actual Sample Mass, g}}{100\,\text{g}}$$

where: the Avg Percent Detector Efficiency = the average efficiency for the α and the $\beta + \gamma$ probes.

For example, if the actual average detector efficiency is 15 percent (15%) and the actual sample mass is approximately 5 g (e.g., for encore samplers), the Shipping Cutoff Value will be:

$$\text{Shipping Cutoff Value, cpm} = 39{,}960\,\text{cpm} \times \frac{15\%}{10\%} \times \frac{5}{100\,\text{g}} = 2{,}997\,\text{cpm above background}$$

8.0 REFERENCES

8.1 Department of Energy, "Occupational Radiation Protection," 10 CFR 835, December 14, 1993

8.2 Department of Transportation, "Hazardous Materials Regulations," 49 CFR 172 and 173, October 1, 1994

8.3 Los Alamos National Laboratory Soil Sample Field Screening to Meet Radioactive Sample Shipping Requirements, Los Alamos National Laboratory, LANL ER-SOP-10.11, Revision 0, 3/10/98.

9.0 RECORDS

The following records will be generated when following this procedure:

- Radiation Screening Log

The following records will be generated when following other procedures as directed in this procedure.

- Field Log Book
- Daily Activity Log
- Chain-of-Custody/Request for Analysis Form

10.0 ATTACHMENTS

Attachment A - Radiation Log Sheet 1
Attachment B – Radiation Log Sheet 2

ATTACHMENT A. RADIATION LOG SHEET 1

PAGE _____ OF _____

Analyst_____ Date_____

Source Check:
Radionuclide:_____S/N:_____
Activity (dpm):_____on _____ (Date)

β + γ Ratemeter Calibration:
Model:_____
S/N: _____
Cal. due date:_____

Probe (β + γ):
Model:_____
S/N: _____

α Ratemeter Calibration:
Model:_____
S/N: _____
Cal. due date:_____

Probe (α):
Model:_____
S/N: _____

Backgrounds Determined on:_____(Date)

Background Readings (Beta + Gamma)
#1 (β + γ):_____ cpm
#2 (β + γ):_____ cpm
#3 (β + γ):_____cpm

Background Readings (Alpha)
#1 (α):_____ cpm
#2 (α):_____ cpm
#3 (α):_____ cpm

Average Background (β + γ) =_____cpm (=[#1 + #2 + #3)]/3)
Average Background (α) =_____cpm (=[#1 + #2 + #3)]/3)
Current Radioactivity Status Limit =_____cpm (from Sec. 7.1 or 7.2, as applicable)

β + γ Instrument Efficiency, Eff (cpm/dpm x 100%):_____Percent

α Instrument Efficiency, Eff (cpm/dpm x 100%):_____Percent

Average detector efficiency, Eff (cpm/dpm x 100%), [Eff_{α} + $Eff_{(\beta+\gamma)}$]/2:_____Percent

SOIL SAMPLE SCREENING FOR DETERMINING RADIOACTIVITY STATUS

A	B	C	D	E	F
SAMPLE ID	**Sample (β + γ), cpm**	**Net Sample (β + γ), cpm:** (Column B) – Background (β + γ)	**Sample (α), cpm**	**Net Sample (α), cpm:** Column D – Background (α)	**Total Radiation, cpm:** Column C + Column E

Reviewed by:_____ **Title:**_____ **Date:**_____

ATTACHMENT B. RADIATION LOG SHEET 2

PAGE _____ OF _____

ANALYST _____ **DATE**_____

Micro-R Meter Calibration:

Model: _____ **Calibration due date:** _____
S/N: _____ **Calibrated by:** _____

Source Check:
Radionuclide:_____S/N:_____ Activity (dpm):_____on _____ (Date)

β + γ Ratemeter Calibration:
Model:_____
S/N: _____
Calibration due date:_____

Probe (β + γ):
Model:_____
S/N: _____

α Ratemeter Calibration:
Model:_____
S/N: _____
Calibration due date:_____

Probe (α):
Model:_____
S/N: _____

Efficiencies:

Average β + γ Instrument Efficiency from Attachment A (Eff):_____Percent
Average α Instrument Efficiency from Attachment A (Eff):_____Percent

Backgrounds:

Average β + γ Background Reading from Attachment A:_____cpm
Average α Background Reading from Attachment A:_____cpm

SCREENING OF SAMPLE COOLERS TO DETERMINE LABELING REQUIREMENTS

A	B	C	D	E	F	G
COOLER ID	**Micro-R Meter Reading, mrem/hr**	**Sample (β + γ), cpm**	**Net Sample (β + γ), cpm:** Column C – Background (β + γ)	**Sample (α), cpm**	**Net Sample (α),cpm:** Column E – Background (α)	**Total Radiation Level, dpm:** [Column D*(100%/$Eff_{(\beta+\gamma)}$) + Column F *(100%/Eff_{α})]

Reviewed by:_____ **Title:**_____ **Date:**_____

STANDARD OPERATING PROCEDURE
NUMBER CTO315-06

DIRECT-PUSH TECHNOLOGY, HAND AUGER TECHNIQUES, AND TEST PITTING TO OBSERVE AND LOG SUBSURFACE SOILS

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures for logging and collecting surface and subsurface soils from unconsolidated overburden materials using direct-push technology (DPT), hand augering techniques, and test pitting (e.g., trenching). For this investigation, trenching will be performed using a backhoe.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Cut-resistant non-latex Impermeable Gloves
Cotton gloves
Disposable medical-grade gloves (e.g., latex, nitrile)
Writing utensil
Photoionization detector (PID) (see SOP CTO315-04)
Gross Beta/Gamma Scaler/Ratemeter (see SOP CTO315-05)
Clear acetate liners: one new liner for each soil core
Stainless steel auger buckets
Stainless steel extension rods
Two pipe wrenches
Cross handle
Required decontamination materials (see SOP CTO315-19)
Bentonite pellets

3.0 BOREHOLE ADVANCEMENT AND SOIL SAMPLING USING A GEOPROBE®

DPT will be employed to collect soil cores. DPT refers to sampling tools and sensors that are driven directly into the ground without the use of conventional rotary drilling equipment. DPT typically utilizes hydraulic pressure and/or percussion hammers to advance the sampling tools. Geoprobe® is a

manufacturer of a hydraulically powered, percussion/probing machine utilizing DPT to collect subsurface environmental samples.

3.1 Clear the area to be sampled of any surface debris (herbaceous vegetation, twigs, rocks, litter, etc.).

3.2 Place a new clear acetate liner in the detachable Macrocore core barrel and attach the coring device to the Geoprobe® rig.

3.3 Drive the macrocore sampler (lined with acetate) into the ground to a depth of 2 feet using hydraulic pressure. The 0- to 2-foot depth soil interval is considered to be the surface soil.

3.4 Retract the sampler from the borehole and remove the acetate liner and the soil core from the Macrocore barrel.

3.5 Attach the metal trough from the Geoprobe® Sampling Kit firmly to the tailgate of a vehicle. If a vehicle with a tailgate is not available, secure the trough on another suitable surface.

3.6 Place the acetate liner containing the soil core in the trough.

3.7 While wearing cut-resistant gloves (constructed of non-latex over cotton), cut the acetate liner through its entire length using the double-bladed knife that accompanies the Geoprobe® Sampling Kit. Then remove the strip of acetate from the trough to gain access to the collected soils. **CAUTION:** Do not attempt to cut the acetate liner while holding it in your hand.

3.8 Scan the entire length of the soil core for VOCs using the PID. Record the specific depth interval and the associated PID reading on the Boring Log Sheet. Collect a soil VOC sample using Encore samplers from the soil interval that had the highest PID reading. If no above-background PID readings were detected, collect the VOC sample from an interval that is discolored or displays other visual signs of being contaminated. If no visual sign of contamination is evident, collect the soil VOC sample from the center of the core interval (i.e., 1-foot depth). Details for collecting a VOC sample using the Encore sampler are included in SOP CTO315-08.

3.9 Log the soil core on the Boring Log Sheet (see SOP CTO315-07).

3.10 Place the soil core in a stainless-steel mixing bowl, homogenize, and collect the remainder of the soil sample aliquots, as described in SOP CTO315-08.

3.11 Repeat steps 3.2 through 3.11 for the next depth intervals.

3.12 The depth to bedrock should be recorded on the Boring Log and the estimated moisture content of the soil and the presence or absence of water in the boring should be noted.

3.13 If readings from the PID are all at background levels below field screening criteria, then excess soil core materials will be returned to the hole and tamped. If insufficient soil is available to fill the hole to the ground surface, then bentonite pellets mixed with the soil will be used to backfill the hole.

3.14 If screening instruments indicate that contaminants may be present in the soil materials, then all excess soil core materials will be placed in a plastic bag (or drum if larger quantities). The bag will be tagged identifying the locations and depths from where the soils came from and the date. The bag will then be placed in a 55-gallon drum and stored on site until laboratory analyses of the soil are completed and classification of the soil waste materials can be determined (see SOP CTO315-20).

3.15 If soil materials from the boring are suspected of being contaminated (see 3.14 above), the soil boring will be backfilled with bentonite pellets up to the ground surface.

3.16 Decontaminate all soil sampling equipment in accordance with SOP CTO315-19 before collecting the next sample.

4.0 BOREHOLE ADVANCEMENT AND SOIL SAMPLING USING A HAND AUGER

Hand Augers may be employed to collect soil cores where non-VOC samples will be collected. A hand augering system generally consists of a variety of all stainless steel bucket bits (i.e. cylinders 6-1/2" long and 2-3/4", 3-1/4", and 4" in diameter), a series of extension rods (available in 2', 3', 4' and 5' lengths), a cross handle. A larger diameter bucket bit is commonly used to bore a hole to the desired sampling depth and then withdrawn. In turn, the larger diameter bit is replaced with a smaller diameter bit, lowered down the hole, and slowly turned into the soil at the completion depth or refusal. The apparatus is then withdrawn and the soil sample collected.

The hand auger can be used in a wide variety of soil conditions. It can be used to sample soil, both from the surface, or to depths in excess of 12 feet. However, the presence of rock layers and the collapse of the borehole normally contribute to its limiting factors.

4.1 Attach a properly decontaminated bucket bit into a clean extension rod and further attach the cross handle to the extension rod.

4.2 Clear the area to be sampled of any surface debris (vegetation, twigs, rocks, litter, etc.)

4.3 Begin augering (periodically removing accumulated soils from the bucket bit) and add additional rod extensions as necessary. Also, note (in a field notebook or on standardized data sheets) changes in the color, texture or odor of the soil.

4.4 After reaching the desired depth, slowly and carefully withdraw the apparatus from the borehole.

4.5 Remove the soiled bucket bit from the extension rod extension and replace it with another properly decontaminated bucket bit. The bucket bit used for sampling is commonly smaller in diameter than the bucket employed to initiate the borehole.

4.6 Carefully lower the apparatus down the borehole. Care must be taken to avoid scraping the borehole sides.

4.7 Slowly turn the apparatus until the bucket bit is advanced approximately 6 inches.

4.8 Discard the top of the core (approximately 1"), which represents any loose material collected by the bucket bit before penetrating the sample material.

4.9 Scan the soil core using the PID and radiation survey instrument. Record the specific depth interval and the associated readings of the screening instruments on the Soil Boring Log Sheet.

4.10 Utilizing a properly decontaminated stainless steel trowel or disposable trowel, remove the sample material from the bucket bit and place into a properly decontaminated stainless steel mixing bowl and thoroughly homogenize the sample material prior to filling the remaining sample containers, as described in SOP CTO315-08.

4.11 Log the soil core on a Soil Boring Log Sheet (see SOP CTO315-07).

4.12 If readings from the screening instruments are all at background levels below field screening criteria, then excess soil core materials will be returned to the hole and tamped. If insufficient soil is available to fill the hole to the ground surface, then bentonite pellets mixed with the soil will be used to backfill the hole.

4.13 If screening instruments indicate that contaminants may be present in the soil materials, then all excess soil core materials will be placed in a plastic bag (or drum if larger quantities). The bag will be tagged identifying the locations and depths from where the soils came from and the date. The bag will then be placed in a 55-gallon drum and stored on site until laboratory analyses of the soil are completed and classification of the soil waste materials can be determined (see SOP CTO315-20).

4.14 If soil materials from the boring are suspected of being contaminated (see 4.12 above), the soil boring will be backfilled with bentonite pellets up to the ground surface.

4.15 Decontaminate all soil sampling equipment in accordance with SOP CTO315-19 before collecting the next sample.

5.0 EXCAVATION AND SAMPLING OF TEST PITS AND TRENCHES

5.1 Applicability

This subsection presents routine test pit or trench excavation techniques and specialized techniques that are applicable under certain conditions. During the excavation of trenches or pits at hazardous waste sites, several health and safety concerns arise which control the method of excavation. No personnel shall enter any test pit or excavation over 4 feet deep except as a last resort, and then only under direct supervision of a Competent Person (as defined in 29 CFR 1929.650 of Subpart P - Excavations). Whenever possible, all required chemical and lithological samples should be collected using the excavator bucket or other remote sampling apparatus. If entrance is still required, all test pits or excavations must be stabilized by bracing the pit sides using specifically designed wooden or steel support structures. Personnel entering the excavation may be exposed to toxic or explosive gases and oxygen-deficient environments. Any entry may constitute a Confined Space and must be done in conformance with all applicable regulations. In these cases, substantial air monitoring is required before entry, and appropriate respiratory gear and protective clothing is mandatory. There must be at least two persons present at the immediate site before entry by one of the investigators. The reader shall refer to Occupational Safety and

Health Administration (OSHA) regulations 29 CFR 1926, 29 CFR 1910.120, 29 CFR 1910.134, and 29 CFR 1910.146.

Excavations are generally not practical where a depth of more than about 15 feet is desired, and they are usually limited to a few feet below the water table. In some cases, a pumping system may be required to control water levels within the pit, providing that pumped water can be adequately stored or disposed. If data on soils at depths greater than 15 feet are required, the data are usually obtained through test borings instead of test pits.

In addition, hazardous wastes may be brought to the surface by excavation equipment. This material, whether removed from the site or returned to the subsurface, must be properly handled according to any and all applicable federal, state, and local regulations.

5.2 Test Pit and Trench Excavation

These procedures describe the methods for excavating and logging test pits and trenches excavated to determine subsurface soil and rock conditions. Test pit operations shall be logged and documented (see Attachment A).

Test pits and trenches may be excavated by hand or by power equipment to permit detailed description of the nature and contamination of the in-situ materials. The size of the excavation will depend primarily on the following:

- The purpose and extent of the exploration.
- The space required for efficient excavation.
- The chemicals of concern.
- The economics and efficiency of available equipment.

Test pits normally have a cross section that is 4 to 10 feet square; test trenches are usually 3 to 6 feet wide and may be extended for any length required to reveal conditions along a specific line. The following table, which is based on equipment efficiencies, gives a rough guide for design consideration:

Equipment	Typical Widths, in Feet
Trenching machine	2
Backhoe	2-6
Track dozer	10
Track loader	10
Excavator	10
Scraper	20

The lateral limits of excavation of trenches and the position of test pits shall be carefully marked on area base maps. If precise positioning is required to indicate the location of highly hazardous waste materials, nearby utilities, or dangerous conditions, the limits of the excavation shall be surveyed. Also, if precise determination of the depth of buried materials is needed for design or environmental assessment purposes, the elevation of the ground surface at the test pit or trench location shall also be determined by survey. If the test pit/trench will not be surveyed immediately, it shall be backfilled and its position identified with stakes placed in the ground at the margin of the excavation for later surveying.

The construction of test pits and trenches shall be planned and designed in advance as much as possible. However, field conditions may necessitate revisions to the initial plans. The final depth and construction method shall be determined by the field geologist. The actual layout of each test pit, temporary staging area, and spoils pile will be predicated based on site conditions and wind direction at the time the test pit is made. Prior to excavation, the area can be surveyed by magnetometer or metal detector to identify the presence of underground utilities or drums.

As mentioned previously, no personnel shall enter any test pit or excavation except as a last resort, and then only under direct supervision of a Competent Person. If entrance is still required, OSHA requirements must be met (e.g., walls must be braced with wooden or steel braces, ladders must be in the hole at all times, and a temporary guardrail must be placed along the surface of the hole before entry). It is emphasized that the project data needs should be structured such that required samples can be collected without requiring entrance into the excavation. For example, samples of leachate, ground water, or sidewall soils can be taken with telescoping poles, etc.

Dewatering may be required to assure the stability of the side walls, to prevent the bottom of the pit from heaving, and to keep the excavation dry. This is an important consideration for excavations in cohesionless material below the ground water table. Liquids removed as a result of dewatering operations must be handled as potentially contaminated materials. Procedures for the collection and disposal of such materials should be discussed in the site-specific project plans.

5.3 Sampling in Test Pits and Trenches

Test pits and trenches are usually logged as they are excavated. Records of each test pit/trench will be made as presented in Attachment A. These records include plan and profile sketches of the test pit/trench showing materials encountered, their depth and distribution in the pit/trench, and sample locations. These records also include safety and sample screening information.

Entry of test pits by personnel is extremely dangerous, shall be avoided unless absolutely necessary, and can occur only after all applicable Health and Safety and OSHA requirements have been met.

The final depth and type of samples obtained from each test pit will be determined at the time the test pit is excavated. Sufficient samples are usually obtained and analyzed to quantify contaminant distribution as a function of depth for each test pit. Additional samples of each waste phase and any fluids encountered in each test pit may also be collected.

In some cases, samples of soil may be extracted from the test pit for reasons other than waste sampling and chemical analysis, for instance, to obtain geotechnical information. Such information would include soil types, stratigraphy, strength, etc., and could therefore entail the collection of disturbed (grab or bulk) or relatively undisturbed (hand-carved or pushed/driven) samples, which can be tested for geotechnical properties. The purposes of such explorations are very similar to those of shallow exploratory or test borings, but often test pits offer a faster, more cost-effective method of sampling than installing borings.

5.3.1 Sampling Equipment

The following equipment is needed for obtaining samples for chemical or geotechnical analysis from test pits and trenches:

- Backhoe or other excavating machinery.
- Shovels, picks, hand augers, and stainless steel trowels/disposable trowels.

- Sample container - bucket with locking lid for large samples; appropriate bottleware for chemical or geotechnical analysis samples.

- Polyethylene bags for enclosing sample containers; buckets.

- Remote sampler consisting of 10-foot sections of steel conduit (1-inch-diameter), hose clamps and right angle adapter for conduit (see Attachment B).

5.3.2 Sampling Methods

The methods discussed in this section refer to test pit sampling from grade level.

- Excavate trench or pit in several depth increments of approximately 1 foot. After each increment, the operator will wait while the sampler inspects the test pit from grade level to decide if conditions are appropriate for sampling. (Monitoring of volatiles by the SSO will also be used to evaluate the need for sampling.)

- The backhoe operator, who will have the best view of the test pit, will immediately cease digging if:
  - Any fluid phase or ground water seepage is encountered in the test pit.
  - Any drums, other potential waste containers, obstructions or utility lines are encountered.
  - Distinct changes of material are encountered.

This action is necessary to permit proper sampling of the test pit and to prevent a breach of safety protocol. Depending upon the conditions encountered, it may be required to excavate more slowly and carefully with the backhoe.

For obtaining test pit samples from grade level, the following procedure shall be followed:

- Remove loose material to the greatest extent possible with backhoe.

- Secure walls of pit if necessary. (There is seldom any need to enter a pit or trench which would justify the expense of shoring the walls. All observations and samples should be taken from the ground surface.)

- Samples of the test pit material are to be obtained either directly from the backhoe bucket or from the material once it has been deposited on the ground. The sampler or Field Operations Leader directs the backhoe operator to remove material from the selected depth or location within the test pit/trench. The bucket is brought to the surface and moved away from the pit. The sampler and/or SSO then

approaches the bucket and monitors its contents with a PID and radiation screening instrument. The sample is collected from the center of the bucket or pile and placed in the appropriate sample containers using a decontaminated stainless steel trowel or disposable spatula. For samples are to be collected for volatile organic compounds (VOC) analysis, then EnCore™ samplers will be used to collect the samples directly from the excavated materials.

- If a composite sample is desired, several depths or locations within the pit/trench are selected and a bucket is filled from each area. It is preferable to send individual sample bottles filled from each bucket to the laboratory for compositing under the more controlled laboratory conditions. However, if compositing in the field is required, each sample container shall be filled from materials that have been transferred into a mixing bucket and homogenized. Note that homogenization/compositing is not applicable for samples to be subjected to volatile organic analysis.

- Using the remote sampler shown in Attachment B, samples can be taken at the desired depth from the side wall or bottom of the pit. The face of the pit/trench shall first be scraped (using a long-handled shovel or hoe) to remove the smeared zone that has contacted the backhoe bucket. The sample shall then be collected directly into the sample jar, by scraping with the jar edge, eliminating the need to utilize samplers and minimizing the likelihood of cross-contamination. The sample jar is then capped, removed from the assembly, and packaged for shipment.

- Complete documentation as described in SOP CTO315-08.

5.4 Backfilling of Trenches and Test Pits

All test pits and excavations must be either backfilled, covered, or otherwise protected at the end of each day. No excavations shall remain open during non-working hours unless adequately covered or otherwise protected.

Before backfilling, the onsite crew shall photograph all significant features exposed by the test pit and trench and shall include in the photograph a scale to show dimensions. Photographs of test pits shall be marked to include site number, test pit number, depth, description of feature, and date of photograph. In addition, a geologic description of each photograph shall be entered in the site logbook. All photographs shall be indexed and maintained as part of the project file for future reference.

After inspection, backfill material shall be returned to the pit under the direction of the FOL.

If a low permeability layer is penetrated (resulting in ground water flow from an upper contaminated flow zone into a lower uncontaminated flow zone), backfill material must represent original conditions or be impermeable. Backfill could consist of a soil-bentonite mix prepared in a proportion specified by the FOL (representing a permeability equal to or less than original conditions). Backfill can be covered by "clean" soil and graded to the original land contour. Revegetation of the disturbed area may also be required.

5.5 Records

The appropriate test pit log sheet (see Attachment A of this SOP) must be completed by the site geologist/sampler. All soil sampling locations should be documented by tying in the location of two or more nearby permanent landmarks (building, telephone pole, fence, etc.) or obtaining GPS coordinates; and shall be noted on the appropriate sample log sheet, site map, or field notebook. Surveying may also be necessary, depending on the project requirements.

Test pit logs (see Attachment A of this SOP) shall contain a sketch of pit conditions. In addition, at least one photograph with a scale for comparison shall be taken of each pit. Included in the photograph shall be a card showing the test pit number. Boreholes, test pits, and trenches shall be logged by the field geologist in accordance with SOP CTO315-07.

Other data to be recorded in the field logbook include the following:

- Name and location of job.
- Date of boring and excavation.
- Approximate surface elevation.
- Total depth of boring and excavation.
- Dimensions of pit.
- Method of sample acquisition.
- Type and size of samples.
- Soil and rock descriptions.
- Photographs.
- Ground water levels.
- Organic gas or methane levels.
- Other pertinent information, such as waste material encountered.

ATTACHMENT A

TEST PIT LOG SHEET

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TEST PIT LOG

Page ___ of ___

PROJECT NAME: _____ TEST PIT No.: _____
PROJECT NUMBER: _____ DATE: _____
LOCATION: _____ GEOLOGIST: _____

Depth (Ft.)	Lithology Change (Depth/Ft.)	MATERIAL DESCRIPTION: Soil/Waste Characteristics (lithology, density, color, etc.)	USCS	Remarks	PID/FID READING: Source (ppm)	PID/FID READING: BZ (ppm)

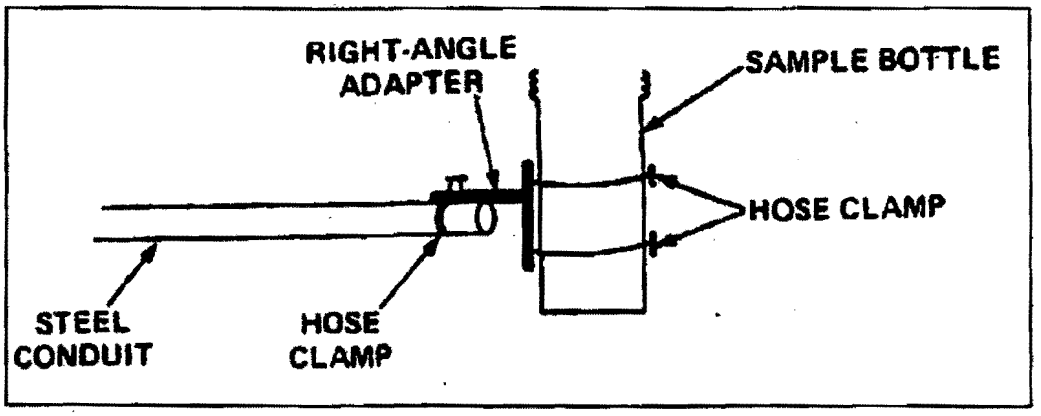
TEST PIT CROSS SECTION AND / OR PLAN VIEW

REMARKS: _____

PHOTO LOG: _____

ATTACHMENT B

REMOTE SAMPLE HOLDER FOR TEST PIT/TRENCH SAMPLING



STANDARD OPERATING PROCEDURE
NUMBER CTO315-07

BOREHOLE AND SOIL SAMPLE LOGGING

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the standard procedures and technical guidance on the logging of soil cores collected at the NSWC Crane facility.

2.0 FIELD FORMS AND EQUIPMENT

Knife
Ruler (marked in tenths and hundredths of feet)
Boring Log: An example of this form is attached (Attachment 2).
Photoionization detector (PID) (see SOP315-04)
Gross Beta/Gamma Scaler/Ratemeter (see SOP315-04)
Writing utensil

3.0 RESPONSIBILITIES

A field geologist or engineer is responsible for supervising all boring activities and assuring that each borehole is properly and completely logged.

4.0 PROCEDURES FOR BOREHOLE AND SAMPLE LOGGING

To maintain a consistent classification of soil, it is imperative that the field geologist understands and accurately uses the field classification system described in this SOP. This identification is based on visual examination and manual tests.

4.1 Unified Soil Classification System

Soils are to be classified according to the Unified Soil Classification System (USCS). This method of classification is detailed in Figure 1 (attached to this SOP).

This method of classification identifies soil types on the basis of grain size and cohesiveness.

Fine-grained soils, or fines, are smaller than the No. 200 sieve and are of two types: silt (M) and clay (C). Some classification systems define size ranges for these soil particles, but for field classification purposes, they are identified by their respective behaviors. Organic material (O) is a common component of soil but has no distinguishable size range; it is recognized by its composition. The careful study of the USCS will aid in developing the competence and consistency necessary for the classification of soils.

Coarse-grained soils will be divided into categories: rock fragments, sand, or gravel. The terms "sand" and "gravel" not only refer to the size of the soil particles but also to their depositional history. To insure accuracy in description, the term "rock fragments" will be used to indicate angular granular materials resulting from the breakup of rock. The sharp edges that are typically observed indicate little or no transport from their source area; and therefore, the term provides additional information in reconstructing the depositional environment of the soils encountered. When the term "rock fragments" is used, it will be followed by a size designation such as "(1/4 inch-1/2 inch)" or "coarse-sand size" either immediately after the entry or in the remarks column. The USCS classification would not be affected by this variation in terms.

4.2 Color

Soil colors will be described utilizing a single color descriptor preceded, when necessary, by a modifier to denote variations in shade or color mixtures. A soil could therefore be referred to as "gray" or "light gray" or "blue-gray." Because color can be utilized in correlating units between sampling locations, it is important for color descriptions to be consistent from one boring to another.

Colors must be described while the sample is still moist. Soil samples will be broken or split vertically to describe colors. Samplers tend to smear the sample surface, creating color variations between the sample interior and exterior.

The term "mottled" will be used to indicate soils irregularly marked with spots of different colors. Mottling in soils usually indicates poor aeration and lack of good drainage.

4.3 Relative Density and Consistency

To classify the relative density and/or consistency of a soil, the geologist is to first identify the soil type. Granular soils contain predominantly sands and gravels. They are noncohesive (particles do not adhere

well when compressed). Finer-grained soils (silts and clays) are cohesive (particles will adhere together when compressed).

Granular soils are given the USCS classifications GW, GP, GM, SW, SP, SM, GC, or SC (see Figure 1).

The consistency of cohesive soils is determined by performing field tests and identifying the consistency as shown in the following table.

CONSISTENCY FOR COHESIVE SOILS

Consistency	Standard Penetration Resistance (Blows per Foot)	Unconfined Compressive Strength (Tons/Sq. Foot by pocket penetration)	Field Identification
Very soft	0 to 2	Less than 0.25	Easily penetrated several inches by fist.
Soft	2 to 4	0.25 to 0.50	Easily penetrated several inches by thumb.
Medium stiff	4 to 8	0.50 to 1.0	Can be penetrated several inches by thumb with moderate effort.
Stiff	8 to 15	1.0 to 2.0	Readily indented by thumb but penetrated only with great effort.
Very stiff	15 to 30	2.0 to 4.0	Readily indented by thumbnail.
Hard	Over 30	More than 4.0	Indented with difficulty by thumbnail.

Cohesive soils are given the USCS classifications ML, MH, CL, CH, OL, or OH (see Figure 1).

The consistency of cohesive soils is determined by hand by determining the resistance to penetration by the thumb. The thumb determination methods are conducted on a selected sample of the soil, preferably the lowest 0.5 foot of the sample. The sample will be broken in half and the thumb pushed into the end of the sample to determine the consistency. Do not determine consistency by attempting to penetrate a rock fragment. If the sample is decomposed rock, it is classified as a soft decomposed rock rather than a hard soil. One of the other methods will be used in conjunction with it. The designations used to describe the consistency of cohesive soils are shown in the above-listed table.

4.4 Weight Percentages

In nature, soils consist of particles of varying size and shape and are combinations of the various grain types. The following terms are useful in the description of soil:

Terms of Identifying Proportion of the Component	Defining Range of Percentages by Weight
Trace	0 - 10 percent
Some	11 - 30 percent
Adjective form of the soil type (e.g., sandy)	31 - 50 percent

Examples:

- Silty fine sand: 50 to 69 percent fine sand, 31 to 50 percent silt.
- Medium to coarse sand, some silt: 70 to 80 percent medium to coarse sand, 11 to 30 percent silt.
- Fine sandy silt, trace clay: 50 to 68 percent silt, 31 to 49 percent fine sand, 1 to 10 percent clay.
- Clayey silt, some coarse sand: 70 to 89 percent clayey silt, 11 to 30 percent coarse sand.

4.5 Moisture

Moisture content is estimated in the field according to four categories: dry, moist, wet, and saturated. In dry soil, there appears to be little or no water. Saturated samples obviously have all the water they can hold. Moist and wet classifications are somewhat subjective and often are determined by the individual's judgment. A suggested parameter for this would be calling a soil wet if rolling it in the gloved hand or on a porous surface liberates water (i.e., dirties or muddies the surface). Whatever method is adopted for describing moisture, it is important that the method used by an individual remains consistent throughout an entire field activity.

4.6 Classification of Soil Grain Size for Chemical Analysis

To determine the gross grain size classification (e.g., clay, silt, and sand) from the USCS classification described above, the following table will be used.

Gross Soil Grain Size Classification	USCS Abbreviation	Description
Clay	CL	inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
	CH	inorganic clays of high plasticity, fat clays.
	OH	organic clays of medium to high plasticity, organic silts.
Silt	ML	inorganic silts and very fine sands, rock four, silty or clayey fine sands with slight plasticity.
	OL	organic silts and organic silty clays of low plasticity..

Gross Soil Grain Size Classification	USCS Abbreviation	Description
	MH	inorganic silts, micaceous or diatomaceous fine sand or silty soils.
Sand	SW	well graded sands, gravelly sands, little or no fines.
	SP	poorly graded sands, gravelly sands, little or no fines.
	SM	silty sands, sand-silt mixtures.
	SC	clayey sands, sand-clay mixtures.

4.7 Summary of Soil Classification

In summary, soils will be classified in a similar manner by each geologist/engineer at a project site. The hierarchy of classification is as follows:

- Density and/or consistency
- Color
- Plasticity (optional)
- Soil types
- Moisture content
- Other distinguishing features
- Grain size
- Depositional environment

4.0 ATTACHMENTS

1. Figure 1 - Unified Soil Classification System
2. Boring Log

ATTACHMENT 1

FIGURE 1 - UNIFIED SOIL CLASSIFICATION SYSTEM

Unified Soil Classification System

Coarse Grained Soils (more than half of soil > No. 200 sieve)	Gravels (More than half of coarse fraction > no. 4 sieve size)	GW	Well graded gravels or gravel-sand mixtures, little or no fines
		GP	Poorly graded gravels or gravel-sand mixtures, little or no fines
		GM	Sandy gravels, gravel-sand-silt mixtures
		GC	Clayey gravels, gravel-sand-silt mixtures
	Sands (More than half of coarse fraction < no. 4 sieve size)	SW	Well graded sands or gravelly sands, little or no fines
		SP	Poorly graded sands or gravelly sands, little or no fines
		SM	Silty sands, sand-silt mixtures
		SC	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
Fine Grained Soils (more than half of soil < No. 200 sieve)	Silts and Clays LL = < 50	ML	Inorganic silts and very fine sands, rock flour, silty fine sands or clayey silts with slight plasticity
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, lean clays
		OL	Organic silts and organic silty clays of low plasticity
	Silts and Clays LL = > 50	MH	Inorganic silts, micaceous or diatomaceous fine sand or silty soils, elastic silts
		CH	Inorganic silts of high plasticity, fat clays
		OH	Organic clays of high plasticity, organic silty clays, organic silts
Highly Organic Soils		Pt	Peat and other highly organic soils

Grain Size Chart

Classification	Range of Grain Sizes	
	U.S. Standard Sieve Size	Grain Size In Millimeters
Boulders	Above 12"	Above 305
Cobbles	12" to 3"	305 to 76.2
Gravel	3" to No. 4	76.2 to 7.76
coarse	3" to 3/4"	76.2 to 4.76
fine	3/4" to No.4	19.1 to 4.76
Sand	No. 4 to No. 200	4.76 to 0.074
coarse	No.4 to No. 10	4.76 to 2.00
medium	No. 10 to No. 40	2.00 to 0.420
fine	No. 40 to No. 200	0.420 to 0.074
Silt and Clay	Below No. 200	Below 0.074

Relative Density (SPT)

SANDS AND GRAVELS	BLOWS/FOOT
VERY LOOSE	0 – 4
LOOSE	4 – 10
MEDIUM DENSE	10 – 30
DENSE	32 – 50
VERY DENSE	OVER 50

Consistency (SPT)

SILTS AND CLAYS	BLOWS/FOOT
VERY SOFT	0 – 2
SOFT	2 – 4
MEDIUM STIFF	4 – 8
STIFF	8 – 16
VERY STIFF	16 – 22
HARD	OVER 32

ATTACHMENT 2

BORING LOG

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME: _____ BORING No.: _____
PROJECT NUMBER: _____ DATE: _____
DRILLING COMPANY: _____ GEOLOGIST: _____
DRILLING RIG: _____ DRILLER: _____

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**

* When rock coring, enter rock brokeness.
** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated response read.

Drilling Area Background (ppm): ____

Remarks: _____

Converted to Well: Yes _____ No _____ Well I.D. #: _____

STANDARD OPERATING PROCEDURE
NUMBER CTO315-08

SURFACE AND SUBSURFACE SOIL SAMPLING

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures to be used for surface and subsurface soil sampling using direct-push technology (DPT) , split-barrel samplers, or hand augers during field activities at the NSWC Crane facility. This procedure also describes the collection of samples for analysis of volatile organic compounds (VOCs) using EnCore™ samplers and the use of field screening [i.e., photoionization detector (PID) and gross beta/gamma radiation] to select the most appropriate locations and subsurface soil intervals for soil sampling.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Writing utensil with indelible ink
Disposable medical-grade gloves (i.e. latex, nitrile)
Boring log
Soil sample logsheets
Stainless-steel mixing bowls
Stainless-steel trowel or soup spoon
Disposable trowels
EnCore™ handle and samplers
Required sample containers: All sample containers including shipping coolers for analysis by fix-based laboratories will be supplied and certified clean by the laboratory
Required decontamination materials
Chain-of-custody records
Required personnel protective equipment (PPE)
PID (see SOP315-04)
Gross Beta/Gamma Scaler/Ratemeter (see SOP315-05)
Wooden stakes or pin flags
Survey tape
Marking Paint

Sealable polyethylene bags

Heavy-duty cooler

Ice

Razor knife

Geoprobe® and sampling equipment

Sample labels and tags

3.0 COLLECTION OF SOIL SAMPLES FOR VOCs

When soil cores are collected using DPT such as Geoprobe®, 2-foot soil intervals will be collected in clear acetate tubes, which can be extracted from the Geoprobe® core barrel (see SOP CTO315-06) upon retrieval at the surface.

3.1 Slit the acetate liner lengthwise with a razor knife, remove a section of the liner, and expose the length of the soil interval (see SOP CTO315-06).

3.2 Scan the soil core interval with a PID, slowly moving the intake nozzle along the length of the core where the acetate liner has been slit open. Note on the boring log the range of PID readings that are detected and the specific location(s) along the sample interval where above-background readings are encountered. If elevated volatile organics are measured via the PID, collect the VOC samples from the specific interval where the highest PID reading is measured. If no above-background PID readings are measured, then the VOC sample will be collected from a specific interval where visual signs of contamination (staining, etc.) are observed. If no above-background PID reading is measured and no discoloration or odor in the soil core indicates potential contamination, then collect the VOC sample from near the center of a core.

3.3 The 0- to 2-foot core interval will be collected as a surface soil sample. Determine where in this core interval the highest PID reading was encountered. Soil samples collected for volatile organics will be obtained directly from soil cores using four EnCore samplers for each VOC sample. These samples are to be collected by pushing the EnCore samplers directly into the soil core where the highest PID readings were measured, ensuring that the sampler is packed tight with soil and leaving no headspace between cap and container. All four EnCore sample containers will be collected as close to each other as possible. Make sure that all caps are securely fastened to the samplers and locked in place with both clips (see instructions that come with samplers). Write the sample identification on the strip labels that come with the samplers and place a label on each of the four samplers.

3.4 Place the four EnCore samplers in the ziplock pouches that come with the samplers and fill in appropriate information, including sample identification, date, time, and other information on the label. Place the four pouches in a plastic bag and place the tag on the bag, identifying the sample identification and other necessary information (see SOP CTO315-01).

3.5 Once the samples are properly labeled, bagged, and tagged, place the sample into the cooler containing ice and a trip blank. The cooler should be kept at 4°C and shipped to the analytical laboratory for preservation or extraction within 48 hours.

3.6 Fill in the required information on the Soil Sample Log Sheet (attached at the end of this SOP) and fill in the required information on the Chain-of-Custody (COC) Form.

3.7 Up to two additional subsurface soil samples will be collected from each boring. For these subsurface soil samples, the collected cores will be scanned with the PID before a specific depth is selected for VOC sampling. Choose the specific location within the collected cores that had the highest PID reading and proceed to collect four EnCore samples, as described above in 3.2 through 3.6. If readings are not elevated, samples will be collected from the center of each cored interval using the default sample depths identified in the QAPP. Place the samples in the cooler containing ice, after they have been properly labeled, bagged, and tagged.

4.0 COLLECTION OF OTHER SOIL SAMPLE ALIQUOTS

Note: A surface soil sample is collected from the 0- to 2-foot depth (i.e., one core length). Additional subsurface soil samples each consist of two 2-foot core segments.

4.1 After the VOC sample has been collected for the soil interval of interest (see 3.0 above), the remainder of the soil interval will be composited and used to fill the remainder of the sample containers. Any surface debris (e.g., herbaceous vegetation, twigs, rocks, litter, etc.) should first be removed from the top of the surface soil core. For other core intervals, the top 2 inches of each core should be discarded because it often contains material scraped from the side of the borehole and not fresh material from the bottom of the borehole.

4.2 Slide the remaining core material out of the acetate liner and into a clean, decontaminated stainless-steel mixing bowl. Mix the soil thoroughly with a stainless-steel spoon and remove

gravel, large pebbles, and other coarse materials. Fill the required sample containers in the following order:

- Containers for organic analyses
- Container for metals
- Container for Nitrate
- Container for Nitrite

4.3 Complete all required information on the sample labels (see SOP CTO315-01).

4.4 Fill in all required information on the sample tag and secure the tag to the sample container.

4.5 Place the sample container in a ziplock plastic bag and seal shut. Place the bag in a cooler containing ice and cool to 4 ± 2°C.

4.6 Record the required information on the Soil Sample Log Sheet and the COC Record form.

5.0 COLLECTION OF SOIL SAMPLES USING A HAND AUGER

5.1 Utilizing a properly decontaminated stainless steel trowel or disposable trowel, remove the sample material from the bucket bit and place into a properly decontaminated stainless steel mixing bowl . Mix the soil thoroughly and remove gravel, large pebbles, and other coarse materials. Fill the required sample containers for PCB analysis.

5.2 Complete all required information on the sample labels (see SOP CTO315-01).

5.3 Fill in all required information on the sample tag and secure the tag to the sample container.

5.4 Place the sample container in a ziplock plastic bag and seal shut. Place the bag in a cooler containing ice and cool to 4 ± 2°C.

5.5 Record the required information on the Soil Sample Log Sheet and the COC Record form.

6.0 PACKAGING AND SHIPPING OF SAMPLES

Samples will be packaged and shipped according to SOP CTO315-17.

7.0 ATTACHMENTS

1. Soil and Sediment Sample Log Sheet

ATTACHMENT 1

SOIL AND SEDIMENT SAMPLE LOG SHEET

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Page___ of ___

Project Site Name: _____
Project No.: _____

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

Sample ID No.: _____
Sample Location: _____
Sampled By: _____
C.O.C. No.: _____

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

GRAB SAMPLE DATA:

Date:	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time:			
Method:			
Monitor Reading (ppm):			

COMPOSITE SAMPLE DATA:

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

SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other

OBSERVATIONS / NOTES:

MAP:

Circle if Applicable:

MS/MSD	Duplicate ID No.:
	-

Signature(s):

STANDARD OPERATING PROCEDURE
NUMBER CTO315-09

INSPECTION AND REHABILITATION OF EXISTING MONITORING WELLS

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes procedures for the inspection and repair of existing monitoring wells at the NSWC Crane facility.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following equipment and field forms are required for inspection of existing monitoring wells.

Monitoring Well Inspection Form: A copy of the monitoring well inspection form is attached.
Writing utensil with indelible ink
Bound field logbook
Well keys
Disposable medical-grade gloves (e.g., latex, nitrile)
Photoionization detector (PID)
Electronic water-level indicator
Steel rod (about 1 inch in diameter with eye bolt at one end)
100 feet of nylon rope
Internal pipe cutter
File, v notch

3.0 INSPECTION PROCEDURES

3.1 Record the well identification (ID) information, date, and time on the Monitoring Well Inspection Form.

3.2 Record the condition of the well ID tag. Is the tag in place and legible? If not, note the discrepancies on the Monitoring Well Inspection Form.

3.3 Record the condition of the protective casing, caps, and lock. Has the casing, cap, and/or lock been tampered with or damaged? Has the well been damaged in any way or does it show signs of deterioration?

3.4 Record the condition of the concrete or gravel pads, if a pad is present. Check the condition of the pad (or the area around the well if no pad exists) and note any abnormalities. Are concrete pads cracking or heaving? If a gravel pad is present, is there any erosion or plant growth in the pad area?

3.5 Record the condition of the cement seal surrounding the protective casing. Has the seal cracked or pulled away from the protective casing? Record any visible signs of deterioration in the area of the seal.

3.6 Record the presence of depressions and/or standing water around the casing or pad.

3.7 Unlock the well cap and open the protective cover, if one exists.

3.8 Inspect and record the condition of the polyvinyl chloride (PVC) riser pipe and the surveyed reference point. The surveyed reference point is a V-notch on the top of the PVC riser pipe.

3.9 Measure the height of the protective casing and riser pipe above the ground surface. Record these readings on the inspection form to the nearest 0.01foot.

3.10 Check the existing well log to verify the total original depth of the monitoring well being inspected.

3.11 Open the well cap and use the PID to screen the air within the well opening to determine whether above-background levels of VOCs are present within the well. Refer to the Health & Safety Plan (HASP) for procedures to follow for the presence of VOCS in a well.

3.12 Lower the electronic water-level indicator probe down the well casing. If an obstruction is encountered, record the depth of the obstruction and whether the obstruction is partial or complete.

3.13 If no obstruction is encountered, continue lowering the water-level indicator down the well casing until ground water is encountered. Measure the depth to water to the nearest 0.01 foot (see SOP CTO315-18) and record the depth on the Inspection Log.

3.14 Continue lowering the indicator probe down the casing until a solid bottom is reached or an obstruction is encountered. Record the depth to the bottom of the well (from top of casing) on the Inspection Log.

3.15 If an obstruction is encountered in the casing before the well bottom is reached, record the depth of obstruction on the Inspection Log and whether the obstruction is partial or complete.

3.16 Remove the water-level indicator from the well.

3.17 If an obstruction was encountered during steps 3.12 or 3.14, lower a heavy steel rod slowly down the well casing until the obstruction is encountered. Attempt to loosen the obstruction by raising and dropping the steel rod, letting it hit the obstruction with gradually increasing force. Record whether the obstruction could be loosened.

3.18 If step 3.17 is performed, remove the steel rod from the well and remeasure the depth to the obstruction. If the obstruction has been knocked loose and settles to the bottom, then the well may still be used as a piezometer but will not be used for ground water sampling.

3.19 Close the well cap and lock, if lock is present.

3.20 Decontaminate the water-level indicator and steel rod, if used, per SOP CTO315-19.

3.21 Make recommendations on the Inspection Log, if necessary, for repair of the monitoring well. Replace lock, if needed, as soon as possible.

3.22 Perform repair of well as soon as possible.

4.0 Field Repairs to Monitoring Wells

Field repairs to monitoring wells, for the most part, will be limited to the repair of the PVC riser (inter case). If a monitoring well is damaged beyond the repair capabilities of the field crew, the NSWC Crane Environmental Department will be notified and a decision will be made to repair or replace the well using a drilling contractor.

4.1 Remove a short section of the top of the PVC riser that is broken, using an inside pipe cutter. Before the riser is cut, a clean rag will be inserted into the riser to just below the cut to prevent

cuttings from entering the well. Insert the cutter just below the damaged area and remove only the damaged section of riser. Carefully remove the rag, measure and record the length of riser removed and mark the top of the riser for water-level measurement (filing a V notch is the preferred method).

4.2 If the riser damage indicates that a riser must be added, a section of PVC may be attached to the existing riser. After removing the damaged riser (see 4.1 above), cut a new section of riser to the needed length and attach a slip coupler to one end. In most cases, the coupler will fit securely to the pipe without the need for mechanical fasteners (pop-rivets/screws). If needed, fasteners may be used, but in no case will glue be used to attach the coupler. Attach the new coupler and PVC pipe to the existing riser, mark the top for measurement purposes, and document the length of pipe added. All new materials (pipe and couplers) will be decontaminated prior to installation.

5.0 ATTACHMENTS

1. Monitoring Well Inspection Sheet

ATTACHMENT 1
MONITORING WELL INSPECTION SHEET

MONITORING WELL INSPECTION SHEET

Well ID: _____

Time: _____ **Date:** _____ **Inspector's Name:**

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible			
Well security	Condition protective case, cap, lock			
Well pad	Concrete or gravel & condition			
Well seal	Condition of...			
Area Immediately around well pad	Record any evidence of/or standing water in area of well			
Dedicated sampling equipment	Condition of...			
PVC Riser	Condition of riser & survey reference point			

Comments:

Signature(s)_____

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

NSB-NLON
Field Form
Revision: 1
January: 1999

STANDARD OPERATING PROCEDURE
NUMBER CTO315-10

DRILLING AND GEOLOGIC LOGGING OF BOREHOLES IN ROCK

1.0 PURPOSE

This procedure describes the methods and equipment necessary to drill rock borings and identify the equipment, sequence of events, and appropriate methods necessary to obtain rock cores and prepare boring logs during drilling activities. Up to five types of drilling methods will be used to drill boreholes at the NSWC Crane facility:

- Auger drilling may be used to drill through the overburden material and weathered bedrock.

Diamond bit coring techniques may be used to core through the bedrock. NX or similar size diamond core barrels will be used to collect 2- to 3-inch-diameter continuous rock core. These cores will be used to describe the lithologic characteristics and fracture distributions in the bedrock.

- Air-rotary drilling may be used to drill through the bedrock or to ream out core holes to a larger diameter to accommodate well installation.

- Rotary drilling with a water wash may be used to drill through the bedrock or to ream out core holes to a larger diameter to accommodate well installation.

- Rotosonic drilling and coring may be used to core through the bedrock. Four inch diameter rock core will be collected from these boreholes. These cores will also be used to describe the lithologic characteristics and fracture distributions in the bedrock.

2.0 RESPONSIBILITIES

Field Operations Leader (FOL) - The FOL is responsible for coordinating all on-site personnel and for providing technical assistance, when required. The FOL, or designee, will coordinate and lead all activities and will ensure the availability and maintenance of all materials and equipment. The FOL is responsible for the completion of all field activities and field and chain-of-custody documentation. The

FOL will assume custody of all samples and will ensure the proper handling and shipping of samples. The FOL is a highly experienced environmental professional who will report directly to the TtNUS Task Order Manager (TOM). Specific FOL responsibilities include the following:

- Function as a communications link among field staff members, the site quality assurance/quality control advisor, site safety officer, the site manager, and the TOM.
- Oversee the mobilization and demobilization of all field equipment and subcontractors.
- Coordinate and manage the field technical staff.
- Adhere to the work schedules provided by the TOM.
- Maintain the site logbook and field recordkeeping.
- Initiate field task modification requests, when necessary.
- Identify and resolve problems in the field, resolve difficulties in consultation with the NSWC Crane Site Manager, implement and document corrective action procedures, and provide communication between the field team and upper management.

Field Geologist - The field geologist is responsible for ensuring that standard and approved drilling procedures are followed. The field geologist will generate a detailed boring log for each borehole. This log will include a description of geologic materials, samples (if any), method of sampling, and other pertinent information and observations that may be obtained during drilling.

Drilling Subcontractor - The subcontractor operates under the supervision of the FOL. He or she is responsible for performing all work in accordance with the procedures outlined in the executed subcontract agreement.

Site Safety Officer – The site safety officer is responsible for clearing the drill site for underground and overhead utilities or other potentially hazardous obstructions.

3.0 PROCEDURES

3.1 General

The purpose of drilling boreholes is

- To determine the type, thickness, and certain physical and chemical properties of the soil, water, and rock strata that underlie the site.
- To install monitoring wells or piezometers.

All drilling and sampling equipment will be cleaned between samples and borings using appropriate decontamination procedures as outlined in SOP CTO166-17. Unless otherwise specified, it is generally advisable to drill borings at "clean" locations first and at the most contaminated locations last to reduce the risk of spreading contamination between locations. All borings must be logged by the site geologist as they proceed.

3.2 Rock Coring

Rock is cored by rotating and applying downward pressure hydraulically or with vibratory means using either diamond bit coring methods or Rotosonic techniques. A continuous core is collected in a core barrel in five to ten foot length sections called runs. Care should be taken during drilling to maximize recovery, and if necessary, shorter runs may be used to achieve this goal. Core diameter can be any size, but must be large enough to adequately evaluate the core. Reaming of the borehole may be necessary to accommodate well installation and backfill materials. After drilling the desired run length, remove the core barrel from the hole and take out the core.

Since rock structures and the occurrence of bedding planes, porosity type and distribution, and fracture patterns are among the most important items to be detected and described, take special care to obtain and record these features.

3.3 Rock Core Management and Labeling

When the core barrel has been recovered, the rock core will be carefully removed from the barrel, placed in a core tray (previously labeled "top" and "bottom" to avoid confusion), classified, and measured for percentage of recovery as well as the rock quality designation (RQD). Each core will be described, classified, and logged using a uniform system (Section 3.5 of this SOP).

Rock cores will be placed in the sequence of recovery in well-constructed wooden or cardboard boxes provided by the drilling contractor. Rock cores from two different borings will not be placed in the same core box. Partitions will be placed at the end of each core run. The depth from the surface of the boring to the top and bottom of the drill run and run number will be marked on the partitions with indelible ink. The partitions will serve to separate successive core runs and indicate depth intervals for each run. The order of placing cores will be the same in all core boxes. Rock core will be placed in the box so that, when the box is open, with the inside of the lid facing the observer, the top of the cored interval contained within the box is in the upper left corner of the box and the bottom of the cored interval is in the lower right corner of the box. The top and bottom of each core obtained and their true depths will be clearly and permanently marked on each box. The width of each row must be compatible with the core diameter to prevent lateral movement of the core in the box. Similarly, an empty space in a row will be filled with an appropriate filler material or spacers to prevent longitudinal movement of the core in the box.

The inside and outside of the core-box lid will be marked by indelible ink to show all pertinent data about the box's contents. At a minimum, the following information will be included:

Project name

- Project number
- Boring number
- Run numbers
- Footage (depths)
- Recovery
- RQD (%)
- Box number and total number of boxes for that boring (Example: Box 5 of 7)
-

For easy retrieval when core boxes are stacked, the sides and ends of the box will also be labeled and will include project name, number, boring number, top and bottom depths of core, and box number.

Before final closing of the core box, a photograph will be taken of the recovered core and the labeling on the inside cover will be taken. If moisture content is not critical, the core shall be wetted and wiped clean for the photograph. (This will help to show true colors and bedding features in the cores.)

3.4 Drilling Techniques That Generate Drill Cuttings

Some drilling methods may require classification and borehole logging based on identifying drill cuttings removed from the borehole. Such cuttings provide only general information on subsurface lithology. Some procedures that will be followed when logging cuttings are as follows:

- Obtain cutting samples at approximately 5-foot intervals and sieve and wash the cuttings to obtain a cleaner sample. Cuttings will be closely examined to determine general lithology.
- Note any change in color of drilling fluid or cuttings to estimate changes in lithology.
- Note drop or chattering of drilling tools or a change in the rate of drilling to determine fracture locations or lithologic changes.
- Observe loss or gain of drilling fluids or air (if air rotary methods are used) to identify potential fracture zones.
- Record this and any other useful information onto the boring log.

This logging provides a general description of subsurface lithology, and adequate information can be obtained through careful observation of the drilling process. It is recommended that rock core sampling methods be used at selected boring locations during the field investigation to provide detailed information to supplement the less-detailed data generated through borings drilled that generate drill cuttings.

3.5 Drill Cuttings Management and Labeling

Each 5 foot run of drill cuttings will be collected in plastic bags and logged for lithologic description. Each bag will be labeled with a magic marker with the boring number and depth interval. The cuttings will be retained for future correlation purposes and field reference until project completion, then will be discarded.

4.0 GEOLOGIC DESCRIPTION OF BOREHOLES IN ROCK

These procedures provide descriptions of the standard techniques for borehole and sample logging. These logging techniques will be used for each boring to provide consistent descriptions of subsurface lithology. While experience is the only method to develop confidence and accuracy in the description of

soil and rock, the field geologist or engineer can do a good job of classification by careful, thoughtful observation and by being consistent throughout the classification procedure.

The classification of soil and rocks is one of the most important jobs of the field geologist or engineer. To maintain a consistent flow of information, it is imperative that the field geologist or engineer understand and accurately use the field classification system described in this SOP. This identification is based on visual examination and manual tests.

4.1 Required Field Forms and Equipment

When logging soil and rock samples, the geologist or engineer should be equipped with the following:

Rock hammer
Knife
Camera
10% Dilute hydrochloric acid (HCl)
Ruler (marked in tenths and hundredths of feet)
Hand lens
Writing utensil with indelible ink
Field logbook
Disposable medical-grade gloves (e.g., latex, nitrile)
Soil/rock classification sheets
Strainer
Shovel

4.2 Classification of Rocks

Claystone - Very fine-grained rock made up of particle less than 1/256 mm in diameter. Fractures irregularly. Very smooth to touch. Generally has irregularly spaced pitting on surface of drilled cores.

Shale - A fissile, very fine-grained rock with particles less than 1/256 mm in diameter. Fractures along bedding planes.

Limestone - Rock made up predominantly of calcite ($CaCO_3$, which is mainly fossilized animal and plant debris). Effervesces strongly upon the application of dilute hydrochloric acid.

Coal – A very dark colored rock consisting mainly of organic (mainly fossilized plant debris) remains.

Others - Numerous other sedimentary rock types are present in lesser amounts in the stratigraphic record.

The local abundance of any of these rock types is dependent upon the depositional history of the area. Conglomerate, halite, gypsum, dolomite, anhydrite, lignite, etc. are some of the rock types found in lesser amounts.

In classifying a sedimentary rock, the following hierarchy will be noted: Rocks are grouped into three main divisions: sedimentary, igneous, and metamorphic. Sedimentary rocks are by far the predominant type exposed at the earth's surface and are the only type present at NSWC Crane. The following basic names are applied to the types of rocks found in sedimentary sequences:

Sandstone - Made up predominantly of granular materials ranging between 1/16 to 2 mm in diameter.

Siltstone - Made up of granular materials between 1/16 to 1/256 mm in diameter. Fractures irregularly. Medium thick to thick bedded.

4.2.1 Rock Type

As described above, there are numerous types of sedimentary rocks. In most cases, a rock will be a combination of several grain types; therefore, a modifier such as "sandy siltstone" or a "silty sandstone" can be used. The modifier indicates that a significant portion of the rock type is composed of the modifier. Other modifying descriptions can include carbonaceous, calcareous, siliceous, fossiliferous, etc.

Grain size is the basis for the classification of clastic (sandstones, siltstones, and shales) sedimentary rocks. The Udden-Wentworth classification will be assigned to sedimentary rocks (shown below). The individual boundaries are slightly different than the USGS subdivision for soil classification. For field determination of grain sizes, a scale can be used for the coarse-grained rocks. Alternatively, the division between siltstone and shale may be measurable in the field by the use of a hand lens. If the grains cannot be seen with the naked eye but are distinguishable with a hand lens, the rock is a siltstone. If the grains are not distinguishable with a hand lens, the rock is a shale.

GRAIN SIZE CLASSIFICATION FOR ROCKS

Particle Name	Grain Size Diameter
Cobbles	> 64 mm
Pebbles	4 - 64 mm
Granules	2 - 4 mm
Very Coarse Sand	1 - 2 mm
Coarse Sand	0.5 - 1 mm
Medium Sand	0.25 - 0.5 mm
Fine Sand	0.125 - 0.25 mm
Very Fine Sand	0.0625 - 0.125 mm
Silt	0.0039 - 0.0625 mm
After Wentworth, 1922	

4.2.2 Color

The color of a rock can be determined in a similar manner as for soil samples. Rock core samples will be classified while wet, when possible, and drill cuttings will be cleaned with water prior to color classifications. Since color can be utilized in correlating units between sampling locations, it is important for color descriptions to be consistent from one boring to another.

4.2.3 Bedding Thickness

The bedding thickness designations listed below will also be used for rock classification.

BEDDING THICKNESS CLASSIFICATION

Thickness (metric)	Thickness (Approximate English Equivalent)	Classification
> 1.0 meter	> 3.3'	Massive
30 cm - 1 meter	1.0' – 3.3'	Thick bedded
10 cm - 30 cm	4" - 1.0'	Medium bedded
3 cm - 10 cm	1" – 4"	Thin bedded
1 cm - 3 cm	2/5" - 1"	Very thin bedded
3 mm - 1 cm	1/8" – 2/5"	Laminated
1 mm - 3 mm	1/32" – 1/8"	Thinly laminated
< 1 mm	<1/32"	Micro laminated

(Ingram, 1954)

4.2.4 Hardness

The hardness of a rock is a function of the compaction, cementation, and mineralogical composition of the rock. A relative scale for sedimentary rock hardness is as follows:

Soft - Weathered, considerable erosion of core, easily gouged by screwdriver, scratched by fingernail. Soft rock crushes or deforms under pressure of a pressed hammer. This term is always used for the hardness of the saprolite (decomposed rock that occupies the zone between the lowest soil horizon and firm bedrock).

Medium soft - Slight erosion of core, slightly gouged by screwdriver, or breaks with crumbly edges from single hammer blow.

Medium hard - No core erosion, easily scratched by screwdriver, or breaks with sharp edges from single hammer blow.

Hard - Requires several hammer blows to break and has sharp conchoidal breaks. Cannot be scratched with screwdriver.

Note the difference in usage of the words "scratch" and "gouge." A scratch will be considered a slight depression in the rock (do not mistake the scraping off of rock flour from drilling with a scratch in the rock itself), and a gouge is much deeper.

4.2.5 Fracturing

Method of Calculating RQD
(After Deere, 1966)

Fractures should also be noted.

$$RQD\ \% = r/l \times 100$$

r = Total length of all pieces of the lithologic unit being measured that are greater than 4 inches in length and have resulted from natural breaks. Natural breaks include slickensides, joints, compaction slicks, bedding plane partings (not caused by drilling), friable zones, etc.

l = Total length of the coring run.

4.2.6 Weathering

The degree of weathering is a significant parameter that is important in determining weathering profiles and is also useful in engineering designs. The following terms can be applied to distinguish the degree of weathering:

Fresh - The rock shows little or no weathering effect. Fractures or joints have little or no staining and rock has a bright appearance.

Slight - The rock has some staining that may penetrate several centimeters into the rock. Clay filling of joints may occur. Feldspar grains may show some alteration. Oxidation and weathering may affect the degree of fracturing or brokenness of a rock. After eliminating drilling breaks, the average spacing of natural breaks is calculated and the fracturing is described by the following terms:

Very broken (V. BR.) - Less than 2-inch spacing between fractures
Broken (BR.) - 2-inch to 1-foot spacing between fractures
Blocky (BL.) - 1- to 3-foot spacing between fractures
Massive (M.) - 3- to 10-foot spacing between fractures

The structural integrity of the rock can be approximated by calculating the rock quality designation (RQD) of cores recovered. The RQD is determined by adding the total lengths of all pieces exceeding 4 inches and dividing by the total length of the coring run to obtain a percentage.

Moderate - Most of the rock, with exception of quartz grains, is stained. Rock is weakened due to weathering and can be easily broken with a hammer.

Severe - All rock including quartz grains is stained. Some of the rock is weathered to the extent of becoming a soil. Rock is very weak.

4.2.7 Other Characteristics

The following items will be included in the rock description:

Description of contact between two rock units. These can be sharp or gradational.

- Stratification (parallel, cross stratified).
- Description of any filled cavities or vugs.
- Cementation (calcareous, siliceous, hematitic).
- Description of any joints or open fractures.
- Observation of the presence of fossils.
- Notation of joints with depth, approximate angle to horizontal, any mineral filling or coating, and degree of weathering.

All information shown on the boring logs will be neat so it can be reproduced on a copy machine for report presentation. The data will be kept current to provide control of the drilling program and to indicate various areas requiring special consideration and sampling.

4.2.8 Additional Terms Used in the Description of Rock

The following terms are used to further identify rocks:

Seam - Thin (12 inches or less), probably continuous layer.

Some - Indicates significant (15 to 40 percent) amounts of the accessory material. For example, rock composed of seams of sandstone (70 percent) and shale (30 percent) would be "sandstone -- some shale seams."

Few - Indicates insignificant (0 to 15 percent) amounts of the accessory material. For example, rock composed of seam of sandstone (90 percent) and shale (10 percent) would be "sandstone -- few shale seams."

Interbedded - Used to indicate thin or very thin alternating seams of material occurring in approximately equal amounts. For example, rock composed of thin alternating seams of sandstone (50 percent) and shale (50 percent) would be "interbedded sandstone and shale."

Interlayered - Used to indicate thick alternating seams of material occurring in approximately equal amounts.

4.2.9 Abbreviations

Abbreviations may be used in the description of a rock. However, they will be kept at a minimum. Following are some of the abbreviations that may be used:

C - Coarse	Lt - Light	Yl - Yellow
Med - Medium	BR - Broken	Or - Orange
F - Fine	BL - Blocky	SS - Sandstone
V - Very	M - Massive	Sh - Shale
Sl - Slight	Br - Brown	LS - Limestone
Occ - Occasional	Bl - Black	Fgr - Fine-grained
Tr - Trace		

5.0 BORING LOGS AND DOCUMENTATION

This section describes in more detail the procedures to be used in completing boring logs in the field. Information obtained from the preceding sections will be used to complete the logs. A sample boring log is attached at the end of this SOP.

The field geologist or engineer will use this example as a guide in completing each boring log. Each boring log will be fully described by the geologist or engineer as the boring is being drilled. Every sheet contains space for 25 feet of log. Information regarding classification details is provided either on the back of the boring log or on a separate sheet, for field use. All data will be written directly on the boring log. Additional notes may be entered in a field notebook if more space is needed.

5.1 Remarks Column

The following information will be entered under the "Remarks" column and will include, but is not limited to, the following:

- Moisture - Estimate moisture content using the following terms: dry, moist, wet, and saturated. These terms are determined by the individual. Whatever method is used to determine moisture should be consistent throughout the log.

- Angularity - Describe angularity of coarse-grained particles using the terms angular, subangular, subrounded, or rounded. Refer to ASTM D 2488 or the Earth Manual for criteria for these terms.

- Particle shape - flat, elongated, or flat and elongated.

- Maximum particle size or dimension.

- Water-level observations.

- Reaction with HCl - none, weak, or strong.

Additional comments:

- Indicate presence of mica, caving of hole, when water was encountered, difficulty in drilling, loss or gain of water.

- Indicate odor and photoionization detector (PID) readings.

- Indicate any change in lithology by drawing a line through the lithology change column and indicate the depth. This will help when cross-sections are subsequently constructed.

- At the bottom of the page, indicate type of rig, drilling method, hammer size and drop, and any other useful information (i.e., borehole size, casing set, changes in drilling method).

- Vertical lines shall be drawn in the Material Description column from the bottom of each sample to the top of the next sample to indicate consistency of material from sample to sample, if the material is consistent. Horizontal lines will be drawn if there is a change in lithology, then vertical lines will be drawn to that point.

- Indicate screened interval of well, as needed, in the lithology column. Show top and bottom of screen. Other details of well construction are provided on the well construction forms.

5.2 Review

Upon completion of the borings logs, copies will be made and reviewed. Items to be reviewed include

- Checking for consistency of all logs
- Checking for conformance to the guideline
- Checking to see that all information is entered in their respective columns and spaces

Originals of the boring logs will be retained in the project files.

6.0 REFERENCES

Deere, D.U. and Miller, R.P., (1966). Engineering Classification and Index Properties for Intact Rock, Air Force Weapons Lab. Tech. Report AFWL-TR-65-116, Kirtland Base, New Mexico.

Wentworth, C.K., 1922. A Scale of Grade and Class Terms for Caustic Sediments: Jour. Geology, v. 30, p. 377-392.

Ingram, R.L., 1954. Terminology for the Thickness of Stratification and Parting Units in Sedimentary Rocks: Geological Society of America Bulletin, v. 65. p. 937-938.

7.0 ATTACHMENTS

1. Boring Log

ATTACHMENT 1

BORING LOG

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME: _____ BORING No.: _____
PROJECT NUMBER: _____ DATE: _____
DRILLING COMPANY: _____ GEOLOGIST: _____
DRILLING RIG: _____ DRILLER: _____

Sample No. and Type or RQD	Depth (FL) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/FL) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	MATERIAL DESCRIPTION: Color	MATERIAL DESCRIPTION: Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	PID/FID Reading (ppm): Sampler BZ	PID/FID Reading (ppm): Borehole**	PID/FID Reading (ppm): Driller BZ**

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): ____

Remarks: _____

Converted to Well: Yes _____ No _____ Well I.D. #: _____

STANDARD OPERATING PROCEDURE
NUMBER CTO315-11

MONITORING WELL INSTALLATION

1.0 PURPOSE

This Standard Operating Procedure (SOP) provides general guidance and information pertaining to proper design and installation of ground water monitoring wells. The methods described herein are specific for monitoring well construction at the NSWC Crane facility. Guidelines by South Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM, 1997) and the State of Indiana regulatory requirements in Article 16 Water Well Drillers of Chapter 310 of the Indiana Annotated Codes (310 IAC 16) were consulted during development of this procedure.

2.0 RESPONSIBILITIES

Field Operations Leader (FOL) - The FOL is responsible for coordinating all on-site personnel and for providing technical assistance, when required. The FOL, or designee, will coordinate and lead all activities and will ensure the availability and maintenance of all materials and equipment. The FOL is responsible for the completion of all field activities and field and chain-of-custody documentation. The FOL will assume custody of all samples and will ensure the proper handling and shipping of samples. The FOL is a highly experienced environmental professional who will report directly to the TtNUS Task Order Manager (TOM). Specific FOL responsibilities include the following:

- Function as a communications link among field staff members, the site quality assurance/quality control advisor, site safety officer, the site manager, and the TOM.
- Oversee the mobilization and demobilization of all field equipment and subcontractors.
- Coordinate and manage the field technical staff.
- Adhere to the work schedules provided by the TOM.
- Maintain the site logbook and field recordkeeping.

- Initiate field task modification requests, when necessary.

- Identify and resolve problems in the field, resolve difficulties in consultation with the NSWC Crane Site Manager, implement and document corrective action procedures, and provide communication between the field team and upper management.

Field Geologist - The field geologist supervises and documents well installation and construction performed by the driller and ensures that the screen interval for each monitoring well is properly placed to provide representative groundwater data from the monitored interval. Geotechnical engineers, field technicians, or other suitable trained personnel may also serve in this capacity.

Drilling Subcontractor - The subcontractor operates under the supervision of the FOL. He or she is responsible for performing all work in accordance with the procedures outlined in the executed subcontract agreement.

Site Safety Officer – The site safety officer is responsible for clearing the drill site for underground and overhead utilities or other potentially hazardous obstructions.

3.0 REQUIRED EQUIPMENT/ITEMS

The following list includes equipment and items required for monitoring well installation:

Health and safety equipment as required by the HASP and the site safety officer.

Well drilling and installation equipment with associated materials (typically supplied by the drilling subcontractor).

Hydrogeologic equipment (weighted engineer's tape, water-level indicator, retractable engineer's rule, electronic calculator, clipboard, mirror and flashlight for observing downhole activities, paint and ink marker for marking monitoring wells, sample jars, well installation forms, boring logs, soil sample log forms, chain-of-custody records, sample coolers with ice, and a field notebook).

Monitoring Well Construction Log for a bedrock well (Attachment 1)

4.0 WELL DESIGN AND CONSTRUCTION

Two basic types of wells may be drilled at NSWC Crane (Shallow and deep). Shallow wells include any well that is installed into the first water yielding zone encountered during drilling at a particular well location. Deep wells include any wells that are installed below the first water yielding zone encountered during drilling at a particular well location. Typically, deep wells will be installed adjacent to shallow wells in cases when a vertical profile of groundwater contamination is desired at a particular location. The well construction techniques are identical between deep and shallow wells, however, all deep wells will have a minimum 6 inch inside diameter steel isolation casing placed to the bottom of the first water yielding zone that will be cemented in place with a cement-bentonite slurry and allowed to cure for a minimum of 24 hours. Drilling will resume inside the isolation casing after the grout cures. In this manner, the potential for shallow contamination in the first water yielding zone to migrate deeper is minimized.

Monitoring well borings will be drilled using a variety of techniques including hollow stem auger, rotary, rotosonic. Specific techniques are determined based on numerous issues including expected materials encountered during drilling, well depth, diameter, access, sampling requirements, etc.

Boreholes drilled in materials that tend to collapse drilling (overburden and / or weathered or highly fractured bedrock) may require the advancing of a hollow drilling tool (hollow stem auger, temporary casing, etc) to ensure that the borehole stays open during well installation. If this is the case, the hollow drilling tool will have a minimum inside diameter of 4 inches to accommodate the installation of the well construction materials, and will be retracted as well construction materials are installed to ensure adequate backfill of materials. In all cases, the final outside diameter of all well borings will be a minimum of 5 ½ inches.

All monitoring wells will be constructed of Schedule 40, flush-joint-threaded, 2-inch inside diameter polyvinyl chloride (PVC) riser pipe and flush joint threaded, factory slotted well screen with a threaded end cap. The well screens will be factory slotted to 0.020-inch size. Each section of well casing and screen will be National Sanitation Foundation (NSF) approved. Well screens will be 10 feet long but may be longer or shorter based on the subsurface conditions that are encountered. A PVC cap will be placed on the bottom and will also be flush threaded. Other means of joining casings using glue, gaskets, pop rivets, or screws are not allowed. The screen will pass no more than 10 percent of the pack material or in-situ aquifer material.

Monitoring wells will be installed immediately upon completion of drilling, A well screen section with bottom cap and the proper amount of riser pipe will be assembled and lowered down the borehole.

Centralizers will be used as necessary to ensure that the casing and screen are centered and are aligned straight. The sand pack will be extended from 0.5 foot below the well screen to at least 1 foot above the top of the well screen. Clean silica sand of U.S. Standard Sieve Size No. 20 to 40 will be used.

A minimum 3-foot-thick bentonite pellet seal will be installed above the filter pack and allowed to hydrate for a minimum of 3 hours before grout is added above the seal. Only 100 percent, certified pure sodium bentonite will be used for well construction. As an alternative, a high solids bentonite grout can be used in lieu of the bentonite pellet to minimize downtime to allow for bentonite pellet seal hydration. The depths of backfill materials will be constantly monitored during well installation using a weighted stainless-steel or fiberglass tape measure.

The remaining annulus above the hydrated bentonite seal will be backfilled to the surface using a tremie pipe, with a 20:1 cement/bentonite grout. A maximum of 10 gallons of water per 94-pound bag of Type 1 cement will be used. The grout mixture should be blended in an above-ground rigid container or mixer to produce a thick lump-free mixture. This grout mixture will also be used for placement of steel casings in deep wells. A tremie grout will be used to install all grout unless the borehole is open and contains no standing water above the sand pack.

When the well is completed and grouted to the surface, a protective steel surface casing is placed over the top of the riser pipe. The finished well casing will extend at least 2 feet above the ground level. This casing will have a cap that can be locked to prevent vandalism. In addition, one hole is drilled just above the cement collar through the protective casing, which acts as a weep hole for the flow of water that may enter the annulus during well development, purging, or sampling. A 4 foot square and 6 inch thick concrete apron will be installed around each well. Four safety yellow barrier posts (nominal 4-inch diameter, 5 foot long steel pipes buried 2 feet deep and filled with concrete) will be cemented just outside the four corners of the concrete apron.

5.0 DOCUMENTATION OF FIELD ACTIVITIES

A critical part of monitoring well installation is recording of significant details and events in the site logbook, on field forms, and in a field logbook. Details of borehole logging are contained in SOPs CTO315-07 and -11.

6.0 ATTACHMENTS

1. Bedrock Monitoring Well Sheet

ATTACHMENT 1

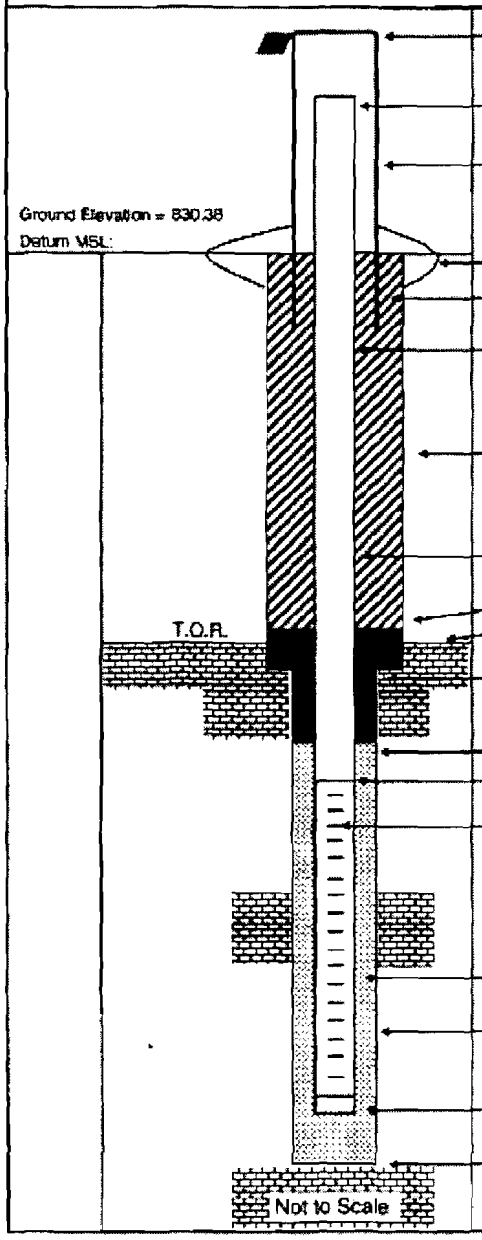
BEDROCK MONITORING WELL SHEET

Tetra Tech NUS, Inc.

BEDROCK MONITORING WELL SHEET

WELL No.: MS-53PC
PERMIT No: 638659

PROJECT:	NIROP FRIDLEY	DRILLING Co.:	BOART LONGYEAR	BORING No.:	MS-53PC
PROJECT No.:	7842 CTO 057	DRILLER:	K. SMITH	DATE COMPLETED:	10/25/99
SITE:	ANOKA PARK	DRILLING METHOD:	ROTOSONIC	NORTHING:	1077365.0
GEOLOGIST:	B. HOWZE	DEV. METHOD:	NITROGEN AIR LIFT	EASTING:	2811070.6



Elevation of Top of Casing:		
Stick Up of Casing Above Ground Surface:		
Elevation of Top of Riser:	832.64	
I.D. of Surface Casing:	8"	
Type of Surface Casing:	STEEL	
Type of Surface Seal:	CONCRETE	
I.D. of Permanent Casing:	6"	
I.D. of Riser:	2"	
Type of Riser:	CARBON STEEL	
Borehole Diameter:	9 5/8"	
Type of Backfill:	CEMENT GROUT	
Elevation / Depth Top of Seal:	830.38/	0.0
Elevation / Depth Top of Bedrock:	696.88/	133.5
Type of Seal:	CEMENT GROUT	
Elevation / Depth of Top of Fine Sand:	685.38/	145.0
Elevation / Depth of Top of Filter Pack:	681.38/	149.0
Elevation / Depth of Top of Screen:	678.98/	151.4
Type of Screen:	STAINLESS STEEL	
Slot Size x Length:	10 SLOT X 15.5'	
I.D. of Screen:	2"	
Type of Filter Pack:	No. 10-20 SAND	
Diameter of Hole in Bedrock: Core / Ream:	CORE = 5.5"	
Elevation / Depth of Bottom of Screen:	663.48/	166.9
Elevation / Total Depth of Borehole:	660.38/	170.0

STANDARD OPERATING PROCEDURE
NUMBER CTO315-12

MONITORING WELL DEVELOPMENT

1.0 PURPOSE

This Standard Operating Procedure (SOP) provides general guidance and information pertaining to proper development of new and existing monitoring wells. The methods described herein are specific for monitoring wells located at the NSWC Crane facility. Guidelines by South Division, Naval Facilities Engineering Command, (SOUTHDIV NAVFAC, 1997) and the State of Indiana regulatory requirements in Article 16 Water Well Drillers of Chapter 310 of the Indiana Annotated Codes (310 IAC 16) should be consulted.

2.0 RESPONSIBILITIES

The drilling contractor will provide adequate and operable equipment, sufficient quantities of materials, and an experienced and efficient labor force capable of developing monitoring wells. The drilling contractor personnel must have all the health and safety training required to perform the work, as specified in the health and safety plan (HASP).

3.0 REQUIRED EQUIPMENT/ITEMS

The following list includes equipment and items required for monitoring well installation:

Health and safety equipment as required by the HASP and the site safety officer.

Well development equipment with associated materials (typically supplied by the driller).

Hydrogeologic equipment (weighted engineer's tape, water-level indicator, retractable engineers rule, electronic calculator, clipboard, mirror and flashlight for observing downhole activities, paint and ink marker for marking monitoring wells, sample jars, well installation forms, and a field notebook).

Monitoring Well Development Record (see Attachment 1)

4.0 WELL DEVELOPMENT METHODS

The development of new wells will not occur until at least 48 hours after the well has been installed and grouted. This time is required so that the grout in the annulus can set and harden. The purpose of well development is to stabilize and increase the permeability of the sand pack and the well screen and to restore the permeability of the formation that may have been reduced by drilling operations. Wells are typically developed until all fine material and drilling water, if any, is removed from the well.

Sequential measurements of pH, specific conductance, turbidity, and temperature taken during development yield information (stabilized values) that sufficient development is reached. Development should proceed until criteria are met as stated in Navy Guidelines.

A surge plunger (also called a surge block) that is approximately the same diameter as the well casing will be used to agitate the water. There are two basic types of surge plungers, solid and valved surge plungers. Site-specific conditions will dictate which type will be used. In formations with low yields, a valved surge plunger may be preferred because solid plungers tend to force water out of the well at a greater rate than it will flow back in. Valved plungers are designed to produce a greater inflow than outflow of water during surging.

Surging causes water to move in and out of the screens. This movement of water pulls fine materials into the well, preventing bridging of sand particles in the gravel pack. These fine materials can then be removed by any of several methods such as submersible pumps (i.e. whale pumps), bailers, or even peristaltic pumps. Whale pumps can be used to surge and sweep the well screen as it pumps. Another alternative method for development would be to utilize a waterra (i.e. check valve method). This method allows for surging and purging of the well by moving the tubing in an up and down motion. On the downward stroke, the ball in the foot valve lifts and the tubing fills with water; and on the upward stroke the ball is set and surged ground water is forced out of the tubing and into a purge bucket.

Development should proceed until the following criteria are met:

- The well water is clear to the unaided eye.

and

- A minimum removal of five times the standing water volume in the well (to include the well screen and casing plus saturated borehole annulus, assuming 30% annular porosity).

or

- When pH measurements remain constant within 0.1 Standard Units and specific conductance and temperature vary no more than plus or minus 3 percent for at least three consecutive readings. Turbidity should also show stabilization and ideally be below 10 nephelometric turbidity units (NTUs).

or

- If the well has been purged dry at least three times while waiting 15 to 20 minutes to allow the well to recharge between pumping intervals. Recharge rates will be documented while the well is allowed to recover.

If for any reason the above criteria cannot be met, the site geologist should document the event in writing and consult with the Task Order Manager regarding an alternate plan of action.

Well development must be completed at least 24 hours before well sampling. The intent of this hiatus is to provide time for the newly installed well and backfill materials to sufficiently equilibrate to their new environment and for the new environment to re-stabilize after the disturbance of drilling. All development water should be handled in accordance with SOP CTO315-20.

5.0 ATTACHMENTS

1. Monitoring Well Development Record

ATTACHMENT 1

MONITORING WELL DEVELOPMENT RECORD

Tetra Tech NUS, Inc.

MONITORING WELL DEVELOPMENT RECORD

Page ___ of ___

Well: _____ Depth to Bottom (ft.): _____ Responsible Personnel: _____
Site: _____ Static Water Level Before (ft.): _____ Drilling Company: _____
Date Installed: _____ Static Water Level After (ft.): _____ Project Name: _____
Date Developed: _____ Screen Length (ft.): _____ Project Number: _____
Dev. Method: _____ One Well Volume (gal/L): _____ PID Readings: Bore Hole _____ ppm
Pump Type: _____ Casing ID (in.): _____ PID Readings: Breathing Zone _____ ppm

Time	Cumulative Water Volume (Gal.)	Flow Rate (mL/min.)	Water Level Readings (Ft. below TOC)	Temperature (Degrees C)	pH	Specific Conductance (Units _____)	Turbidity (NTU)	Remarks (odor, color, etc.)

STANDARD OPERATING PROCEDURE
NUMBER CTO315-13

CALIBRATION AND CARE OF WATER QUALITY METERS

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedures for the calibration and maintenance of field instruments used to measure water quality and for the proper documentation of calibration and maintenance. The YSI 600-Series Environmental Monitoring System will be used to measure pH, temperature, oxidation-reduction potential (ORP), specific conductance (SC), dissolved oxygen (DO), and turbidity in water. A LaMotte turbidity meter will be used in conjunction with the YSI to measure turbidity. The YSI meter has a multiprobe sensor that can be used in conjunction with a flow-through cell attached to a pump discharge tube to measure water-quality parameters in a ground water discharge or can be immersed in a surface water body such as a stream, pond, or drainage ditch. The LaMotte is a hand held meter that uses a multi-detector optical configuration to assure long term stability and minimize stray light and color interferences.

2.0 FIELD FORMS AND EQUIPMENT LIST

The following logbooks, forms, equipment, and supplies are required:

Site logbook
Equipment calibration log sheet
YSI Model 600 Serien and Sonde: multi-parameter water-quality meter with flow through cell
LaMotte Turbidity Meter
Equipment manual
Calibration kit
Deionized water, paper towels, spray bottle, etc.
Disposable medical-grade gloves (e.g., latex, nitrile)

3.0 PROCEDURES

This section describes the calibration procedures for the YSI Model 600 series and the LaMotte. Each meter is supplied with an instruction manual and will be on site and will be used as the calibration guidance documents. These procedures will list requirements for frequency of calibration and checks to be performed on the meter.

3.1 YSI Model 600 Series

The YSI Model 600 series and Sonde is a multi-parameter, water-quality meter that may be used to measure open water bodies (streams, ponds, springs, etc.) with the probe guard installed. With the flow through cell attached, the meter has the ability to measure water-quality parameters in ground water via a pump discharge line. By performing the measurements in the discharge line coming directly from the well, the parameters are measured before the ground water comes in contact with the atmosphere. The parameters measured by the YSI for this field effort are as follows:

- DO
- SC
- Temperature
- pH
- ORP
- Turbidity

3.1.1 Documentation

The Equipment Calibration Log is used to document calibration of measuring equipment used in the field. The Equipment Calibration Log documents that the manufacturer's instructions were followed for calibration of the equipment, including the frequency of calibration, type of standards used, and checks performed on calibration during the course of using the equipment. An Equipment Calibration Log must be maintained for each measuring device that requires calibration. Entries must be made for each day the equipment is used. A blank Equipment Calibration Log form is attached at the end of this SOP.

3.1.2 Calibration

All the parameters listed in Section 3.0 must be calibrated prior to the start of each field effort. After this initial calibration, the YSI will be checked each day that it is used. If the check shows any out-of-

specification readings, the specific probe will be recalibrated. Meter specifications can be found in the equipment manual, starting on page 248. Calibration and calibration checks will be documented in the field logbook and on the Equipment Calibration Log. The name, lot number, and expiration date for all calibration buffers and standards used will be recorded on the Equipment Calibration Log. The meter's model, serial number, and name of rental company will also be recorded on the equipment calibration form.

3.1.3 Tips for Good Calibration

- The DO calibration is a water-saturated air calibration. Make certain to loosen the calibration cup seal to allow pressure to equilibrate before calibrating.

- Make certain that sensors are completely submersed in solution and readings are stable when calibration values are entered.

- Use a small amount of calibration solution (previously used solution may be used, then discarded for this purpose) to pre-rinse the sonde.

- Fill a bucket with ambient temperature water to rinse the sonde between calibration solutions.

- Make sure to rinse and dry the probe between calibration solutions. This will reduce carry-over contamination and increase the accuracy of the calibration.

3.2 Lamotte Turbidity Meter

The Lamotte turbidity meter is a hand held meter that measures the amount of suspended matter in water using the Nephelometric method.

3.2.1 Documentation

The Equipment Calibration Log is used to document calibration of measuring equipment used in the field. The Equipment Calibration Log documents that the manufacturer's instructions were followed for calibration of the equipment, including the frequency of calibration, type of standards used, and checks performed on calibration during the course of using the equipment. An Equipment Calibration Log must be maintained for each measuring device that requires calibration. Entries must be made for each day the equipment is used. A blank Equipment Calibration Log form is attached at the end of this SOP.

3.2.2 Calibration

Turbidity must be calibrated prior to the start of each field effort. After this initial calibration, the LaMotte will be calibrated each day that it is used. If the check shows any out-of-specification readings, the meter will be recalibrated. Meter specifications can be found in the equipment manual. Calibration and calibration checks will be documented in the field logbook and on the Equipment Calibration Log. The name, lot number, and expiration date for all calibration standards used will be recorded on the Equipment Calibration Log. The meter's model, serial number, and name of rental company will also be recorded on the equipment calibration form.

3.2.2 Tips for Good Calibration

- Thoroughly clean the standard vial with a chem wipe to remove finger prints.
- Make sure that the vial is properly aligned according the manual recommendations.

4.0 MAINTENANCE

The YSI Meter and LaMotte will be rented for the duration of each brief field effort. Therefore, little field maintenance will be required. For any maintenance other than the routine cleaning, calibrating, or battery charging, the instrument should be returned to the vendor and a replacement sent immediately to the job site.

4.1 Meter Storage for the YSI

For this field effort, the meter storage will be short term, [i.e. over night or between work shifts (4-day break)]. During these breaks, the meter will be charged. One-half inch of tap or distilled water will be placed in the meter calibration cup and the cup threaded onto the sonde. The key for short-term storage of probes is to use a minimal amount of water so the calibration cup will remain at 100 percent humidity. The water level must be low enough so that none of the probes are actually immersed. Proper storage of the sonde between usage will extend its life and will also ensure that the unit is ready for use as quickly as possible for the next application.

Multi-parameter short term storage key points:

- Use enough water to provide humidity but not enough to cover the probe surfaces.

- Make sure the storage vessel is sealed to minimize evaporation.
- Check periodically to make certain that water is still present.

4.2 Probe Cleaning

- Rinse the probe thoroughly with potable water.
- Wash the probe in a mild solution of Liquinox and water and wipe with paper towels and/or cotton swabs.
- Rinse and soak the probe in deionized water.
- If stronger cleaning is required, consult Section 2.10 on page 89 of the equipment manual.

Note: Reagents that are used to calibrate and check the YSI may be hazardous. Review the health and safety plan, Appendix A of the equipment manual, and Material Safety Data Sheets (MSDSs), all of which are on file in the field trailer.

4.3 Meter Storage for the LaMotte

For this field effort, the meter storage will be short term, [i.e. over night or between work shifts (4-day break)]. Proper storage of the meter between usage will extend its life and will also ensure that the unit is ready for use as quickly as possible for the next application.

Short term storage key points:

- Make sure the storage vessel is moisture free and sealed.

4.4 Sample Vial Cleaning

- Rinse the vial thoroughly with potable water to remove sediments.
- Wipe with chem.-wipes or cotton swabs.

5.0 ATTACHMENTS

1. Documentation of Field Calibration
2. Equipment Calibration Log

ATTACHMENT 1
DOCUMENTATION OF FIELD CALIBRATION

Tetra Tech NUS, Inc.

DOCUMENTATION OF FIELD CALIBRATION

PROJECT NAME : _____ INSTRUMENT NAME/MODEL: HORIBA U-22

SITE NAME: _____ MANUFACTURER: _____

PROJECT No.: _____ SERIAL NUMBER: _____

Date of Calibration	Person Performing Calibration	INITIAL READINGS						FINAL READINGS						Calibration Standard (Lot No.)	Remarks and Comments
		PH	COND	TURB	DO	TEMP	SAL	PH	COND	TURB	DO	TEMP	SAL		

ATTACHMENT 2
EQUIPMENT CALIBRATION LOG

Tetra Tech NUS, Inc.

EQUIPMENT CALIBRATION LOG

PROJECT NAME : _____ INSTRUMENT NAME/MODEL: LaMotte 2020

SITE NAME: _____ MANUFACTURER: _____

PROJECT No.: _____ SERIAL NUMBER: _____

Date of Calibration	Instrument I.D. Number	Person Performing Calibration	Instrument Settings		Instrument Readings		Calibration Standard (Lot No.)	Remarks and Comments
			Pre-calibration	Post-calibration	Pre-calibration	Post-calibration		

STANDARD OPERATING PROCEDURE
NUMBER CTO315-14

LOW-FLOW WELL PURGING AND STABILIZATION

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedure for well purging and stabilization utilizing low-flow techniques.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following field forms and equipment are required for low-flow purging.

Low-Flow Purge Data Sheet: A copy of this form is attached at the end of this SOP.
Ground Water Sample Log Sheet: A copy of this form and instructions for its completion are included in SOP CTO315-15.
Bound field logbook
Writing utensil
Photoionization detector (PID): The procedures for the operation of the PID are found in the health and safety plan and SOP CTO315-04.
Well key
Electronic water-level indicator: The water-level indicator must have a cable of sufficient length to reach the water surface and be capable of measurements of 0.01 foot (see SOP CTO315-18).
Electronic Programmable Controller, model 400: This controller regulates air flow in a bladder pump.
Cylinder of compressed nitrogen with regulator: Compressed gas serves as the power source for the bladder pump.
Multiple parameter water-quality meter: This unit measures and displays field parameters measured in the field including pH, dissolved oxygen, oxidation-reduction potential (ORP), temperature, and specific conductance (see SOP CTO315-13).
Flow-through cell adapter for water-quality meter
LaMotte Turbidity Meter: Used to measure turbidity (see SOP CTO315-13).
Purge water containers
Graduated cylinder and stopwatch: Used to calculate flow rate.

Decontamination supplies: SOP CTO315-19 describes required decontamination supplies.

Disposable medical-grade gloves (e.g., latex, nitrile)

3.0 PROCEDURES FOR WELL PURGING

3.1 Prior to mobilizing to the site, clean, check for proper operation, and calibrate above equipment in accordance with manufacturer requirements as necessary.

3.2 Follow the steps outlined in SOP CTO315-18 to obtain a static water-level measurement of the well to be purged. Record the information on the Ground Water Sample Log Sheet and the Low-Flow Purge Data Sheet. Leave the water-level meter suspended in the well casing.

3.3 Calculate one well casing volume as follows:

1. Obtain the total depth of the well by measurement.

2. Using the static water level determined in Step 3.2 of this SOP and the total depth of the well, calculate the well casing volume using the following formula:

$$V = (0.163)(T)(r^2)$$

where:

V	=	Static casing volume of well (in gallons).
T	=	Vertical height of water column (linear feet of water).
0.163	=	A constant conversion factor that compensates for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and pi.
r	=	Inside radius of the well casing (in inches).

Note: For wells of 1-inch radius (2-inch diameter), V = 0.163 gallons per foot of water column.

3.4 Connect the pump controller to the well pump air supply (at the well cap) by following the instructions in the pump control manual. The pump controller must be turned off when it is being connected.

3.5 Connect the nitrogen cylinder to the pump controller. The nitrogen cylinder valve must be closed and the regulator line pressure set at zero pounds per square inch (psi) when it is being connected.

3.6 Following the instructions found in the water-quality meter manual, connect the flow-through cell to the pump discharge line (at the well cap).

3.7 Place the discharge tubing from the flow-through cell to direct the purge water discharge into the graduated cylinder or purge water container.

3.8 Following the instructions in the pump controller manual, start pumping water from the well.

3.9 Start with the initial pump rate set at approximately 0.1 liters per minute. Use the graduated cylinder and stopwatch to measure the pumping rate. Adjust pumping rates as necessary to prevent drawdown from exceeding 0.3 foot during purging. If no drawdown is noted, the pump rate may be increased (to a max of 0.4 liters per minute) to expedite the purging and sampling event. The pump rate will be reduced if turbidity is greater than 10 NTUs after all other field parameters have stabilized. If ground water is drawn down below the top of the well screen, purging will cease and the well will be allowed to recover before purging continues. Slow recovering wells will be identified and purged at the beginning of the workday. If possible, samples will be collected from these wells within the same 8-hour workday and no later than 24 hours after the start of purging.

The time to sample any given well will vary greatly due to the many variables associated with low flow purging and sampling:

- Stabilization of parameters
- Possible drawdown
- Analytical changes from quarter to quarter
- Varying QA sample requirements from quarter to quarter
- Variable pump rates

Normally, the time from the start of purging to the end of sampling will be between 1 and 4 hours.

3.10 Measure the well water level using the water-level meter every 5 minutes. Record the well water level on the Low-Flow Purge Data Form (attached at the end of this SOP).

3.11 Every 5 to 10 minutes, record on the Low-Flow Purge Data Form the water-quality parameters (pH, specific conductance, temperature, turbidity, oxidation-reduction potential, and dissolved oxygen) measured by the water-quality meter and turbidity meter. If the cell needs to be cleaned during purging operations, continue pumping (allow the pump to discharge into a container) and disconnect the cell. Rinse the cell with distilled water. After cleaning is completed, reconnect the flow-through cell and continue purging. Document the cell cleaning on the Low-Flow Purge Data Form.

3.12 Measure the flow rate using a graduated cylinder. Remeasure the flow rate any time the pump rate is adjusted.

3.13 During purging, check for the presence of bubbles in the flow-through cell. The presence of bubbles is an indication that connections are not tight. If bubbles are observed, check for loose connections.

3.14 Stabilization is achieved and sampling can begin when a minimum of one casing volume has been removed and three consecutive readings, taken at 5- to 10-minute intervals, are within the following limits:

- pH ± 0.1 standard units
- Specific conductance ± 3%
- Temperature ± 5%
- Turbidity less than 10 NTUs
- Dissolved oxygen ± 10%
- Oxidation-reduction potential ± 10 mV

If the above conditions have still not been met after the well has been purged for 4 hours, purging will be considered complete and sampling can begin. Record the final well stabilization parameters from the Low-Flow Purge Data From onto the Ground Water Sample Log Form.

If there is a need to leave a well during purging, there are two options:

- One, if the sampler must move for 30 minutes or less but still has a clear line of sight to the well, the sampler may leave the pump running and watch the well from a distance until he or she is able to return to the well.

- Two, if for whatever reason, the sampler must stop purging for an extended period of time or a clear line of sight cannot be maintained, the pump and cell will be shut down. All equipment and supplies will be loaded into the sample vehicle, and the well will be secured before the sampler departs.

In both cases, the time purging was stopped and restarted will be noted on the Low-Flow Purge Data Form.

3.15 Rinse the flow-through cell, the water-quality meter probes, and the turbidity cell with analyte-free water and pack the cell and meters for transport.

4.0 ATTACHMENTS

1. Low-Flow Purge Data Sheet

ATTACHMENT 1

LOW-FLOW PURGE DATA SHEET

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : _____
PROJECT NUMBER: _____
PROJECT SITE NAME: _____

WELL ID.: _____
DATE: _____
WEATHER: _____

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments

Water Quality Meter (S/N) _____
Control Box Type (S/N) _____
Turbidity Meter (S/N) _____

Pump Intake Depth _____

SIGNATURE(S): _____

PAGE___OF___

STANDARD OPERATING PROCEDURE
NUMBER CTO315-15

MONITORING WELL SAMPLING

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedure for monitoring well sampling. Low-flow sampling techniques will be used for ground water sampling at the NSWC Crane facility.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following field forms and equipment are required for low-flow sampling of monitoring wells:

Ground Water Sample Log Form: A copy of this form is attached at the end of this SOP

Bound field log book

Chain-of-Custody Form

Bladder pump

Peristaltic Pump

Surgical gloves

Labeled sample containers: Sample containers are certified clean by the laboratory supplying the sample containers.

Tag for each sample container

Plastic storage bags

Shipping containers with ice

3.0 MONITORING WELL SAMPLING PROCEDURES

3.1 Ground water sampling may be initiated when the monitoring well has been purged and stabilized in accordance with SOP CTO315-14.

3.2 Record the sample start time (using military time) on the Ground Water Sample Log Sheet. Record the field measurements for pH, (ORP), specific conductance, temperature, dissolved oxygen, and turbidity.

3.3 With the pump continuing to run, disconnect the flow-through cell from the pump discharge tube and immediately start filling sample bottles directly from the pump discharge. All sample containers will be supplied by the laboratory, and the laboratory will pre-preserve all sample containers, where appropriate.

3.4 Allow the pump discharge to flow gently down the inside of the container with minimal turbulence when filling sample containers. Avoid immersing the discharge tube into the sample as the sample container is being filled. Sample containers for volatile constituents (VOCs) must be completely filled so that no headspace exists in the container. The VOC vials will be filled to the top so that a convex meniscus is formed. Gently secure the cap, turn the vial upside down, and check to see if any air has been trapped inside the vial. If so, open the cap, reform the meniscus, and attempt again to secure the lid without trapping air in the sample. All other sample containers can have air space included when the container lid is secured.

3.5 Cap each container immediately after filling.

3.6 Record the sample time on the Ground Water Sample Log Form, the sample tag, and the sample label.

3.7 Secure the associated tag to each sample container.

3.8 Place the tagged sample container into a plastic storage bag and then into a cooler containing ice.

3.9 Enter the proper information on the Chain-of-Custody Form for each sample container (see SOP CTO315-03).

3.10 Repeat steps 3.3 through 3.9 for each sample container collected.

3.11 The pump rate should not be adjusted after sampling has commenced. If it becomes necessary to adjust the pump rate, document the change on the Ground Water Sample Log Form.

3.12 All samples will be collected into pre-preserved bottles (if required) supplied by an approved laboratory. All samples will be collected in the following sequence:

- Volatile organic compounds (VOCs)
- All other containers, when applicable (see Table 3-8 in Section 3.0 of this QAPP Addendum)

3.13 After completion of sample collection, remove the bladder pump from the well and decontaminate following the procedures in SOP CTO315-19.

3.14 Replace the outer protective well cap and lock the well.

3.15 All equipment should be cleaned and packed into the sample vehicle, along with the sample cooler for transport. Disposable gloves and other equipment should be placed in a plastic trash bag and handled as investigation-derived waste (SOP CTO315-20).

4.0 ATTACHMENTS

1. Ground Water Sample Log Sheet

ATTACHMENT 1

GROUND WATER SAMPLE LOG SHEET

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Page___ of ___

Project Site Name: _____
Project No.: _____

[] Domestic Well Data
[] Monitoring Well Data
[] Other Well Type: _____
[] QA Sample Type: _____

Sample ID No.: _____
Sample Location: _____
Sampled By: _____
C.O.C. No.: _____
Type of Sample:
[] Low Concentration
[] High Concentration

SAMPLING DATA:

Date:	Color	pH	S.C.	Temp.	Turbidity	DO	Salinity	Other
Time:	(Visual)	(S.U.)	(mS/cm)	(°C)	(NTU)	(mg/l)	(%)	
Method:								

PURGE DATA:

Date:	Volume	pH	S.C.	Temp.	Turbidity	DO	Salinity	Other
Method:								
Monitor Reading (ppm):								
Well Casing Diameter & Material								
Type:								
Total Well Depth (TD):								
Static Water Level (WL):								
One Casing Volume(gal/L):								
Start Purge (hrs):								
End Purge (hrs):								
Total Purge Time (min):								
Total Vol. Purged (gal/L):								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected

OBSERVATIONS / NOTES:

Circle If Applicable:

MS/MSD	Duplicate ID No.:

Signature(s):

STANDARD OPERATING PROCEDURE
NUMBER CTO315-16
FIELD TEST KIT ANALYSIS

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish the procedure for the field chemical analysis of parameters in ground water using field test kits. The following parameters are included in this SOP:

- Alkalinity
- Carbon Dioxide
- Dissolved Oxygen
- Ferrous Iron
- Hydrogen Sulfide
- Manganese
- Nitrite
- Sulfide

The NSWC Crane Environmental Protection Department must approve any deviations from this procedure.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Field Chemical Analytical Log Form: A copy of the Field Chemical Analytical Log Form can be found in Attachment 1 of this SOP.

Field analytical test kits, methods, and reagents: The following table presents the required analytical test kits to be used for field analysis. Specific reagents and bottle requirements are included in each procedure. Current copies of the procedures will be maintained on-site during the field program. They will be accessible during use of the Field Test Kits.

Parameter	Make	Model	Method Number	Equipment/ Method Chemistry
Alkalinity	CHEMetrics	K-9810 K-9815 K-9820	ASTM D 1067-92	CHEMets vacuum vials/HCL Titrant w/pH indicator
Carbon Dioxide	CHEMetrics	K-1910 K-1920 K-1925	ASTM D 513-82	CHEMets vacuum vials/Rhodazine D and Indigo Carmine Sodium Hydroxide w/pH indicator
Dissolved Oxygen	CHEMetrics	K-7501 K-7512	ASTM D 5543-94	CHEMets vacuum vials/Rhodazine D and Indigo Carmine
Ferrous Iron	HACH	DR-850	HACH 8146	Colorimeter / 1,10 Phenanthrolein
Hydrogen Sulfide	HACH	HS-C	HACH Proprietary/ Mod. SM 426C	Color Chart/ Effervescence through Sulfide reactive paper
Manganese	HACH	DR-850	HACH 8304	Colorimeter / Cadmium Reduction
Nitrite	HACH	DR-850	HACH 8507 Mod EPA 354.1	Colorimeter / Diazotization
Sulfide	HACH	DR-850	HACH 8131 EPA 376.2	Colorimeter / Methylene Blue

3.0 FIELD ANALYTICAL PROCEDURES

3.1 General

The procedures for each of the individual analyses will be maintained in the field during the entire sampling program. The procedures give a detailed explanation on how to perform each particular method, and include information on sampling/storage, accuracy checks, interference, reagents, and apparatus.

3.2 Quality Assurance/Quality Control Procedures

Accuracy checks shall be performed to check the performance of the reagents, the apparatus, and the analytical procedure. These accuracy checks include standard solutions, field duplicates, and reagent blank correction. The field test kit procedures detail how to perform each of the accuracy checks for each parameter.

Prior to analysis, the expiration dates of reagents will be checked. If the reagents have exceeded their shelf life, the reagents will be replaced. If deviations from the applicable analytical procedure are identified, the deviations will be corrected and the associated samples re-analyzed. If no problems are

identified with the reagents, apparatus, or procedures, interference may be present. Associated data will be qualified as estimated in the 'notes' section on the sample logsheet. Field duplicate results will be evaluated for relative percent difference (RPD). If the RPD exceeds 30 percent, the associated data will be qualified as estimated.

The following table describes the type and frequency of accuracy checks required for each parameter.

Parameter	Standard Solution	Field Duplicate	Reagent Blank Correction
Alkalinity	None	1 per 10	None
Carbon Dioxide	None	1 per 10	None
Dissolved Oxygen	None	1 per 10	None
Ferrous Iron	None	1 per 10	None
Hydrogen Sulfide	None	1 per 10	None
Manganese	None	1 per 10	None
Nitrite	1 per round	1 per 10	1 per lot
Sulfide	None	1 per 10	None

3.3 Sample Handling and Storage

Each of the field parameters requires slightly different sampling procedures and storage limitations. In order to compile these procedures and limitations into one location for reference in the field, the following table has been prepared that presents parameter-specific requirements for sampling and storage.

Parameter	Handling	Storage
Alkalinity	Avoid agitation and exposure to air	May hold for 1 hr. at 4°C with zero headspace; warm to room temperature before analysis.
Carbon Dioxide	Avoid agitation and exposure to air	May hold for 24 hr. at 4°C with zero headspace; warm to room temperature before analysis.
Dissolved Oxygen	Avoid agitation and exposure to air	Analyze immediately.
Hydrogen Sulfide	Avoid agitation and exposure to air	Analyze immediately.
Ferrous Iron	Avoid agitation and exposure to air; filter if visibly turbid	Analyze immediately; keep out of sunlight.
Manganese	Avoid agitation and exposure to air; filter if visibly turbid	Analyze immediately.

Parameter	Handling	Storage
Nitrite	Utilize standard sampling techniques	May hold for 24 hr. at 4°C; warm to room temperature before analysis.
Sulfide	Avoid agitation and exposure to air	Analyze immediately.

4.0 ATTACHMENTS

1 Field Analytical Log Sheet Geochemical Parameters

ATTACHMENT 1

FIELD ANALYTICAL LOG SHEET GEOCHEMICAL PARAMETERS

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Tetra Tech NUS, Inc

Page __ of __

Project Site Name: _____ Sample ID No.: _____
Project No.: _____ Sample Location: _____
Sampled By: _____ Duplicate: ☐
Field Analyst: _____ Blank: ☐
Field Form Checked as per QA/QC Checklist (initials): _____

SAMPLING DATA:

Date: / Time:	Color (Visual)	pH (S.U.)	S.C. (mS/cm)	Temp. (°C)	Turbidity (NTU)	DO (mg/l)	Salinity (%)	ORP (Eh) (+/- mv)
Method:								

SAMPLE COLLECTION/ANALYSIS INFORMATION:

ORP (Eh) (+/- mv)

Electrode Make & Model _____

Reference Electrode (circle one): Silver-Silver Chloride / Calomel / Hydrogen

Dissolved Oxygen:

Equipment: Chemetrics Test Kit

Concentration: _____ ppm

Range Used:	Range	Method	Concentration ppm
☐	0 to 1 ppm	K-7510	
☐	1 to 12 ppm	K-7512	

Analysis Time: _____

Equipment: HACH Digital Titrator OX-DT

Analysis Time: _____

Range Used:	Range	Sample Vol.	Cartridge	Multiplier
☐	1-5 mg/L	200 ml	0.200 N	0.01
☐	2-10 mg/L	100 ml	0.200 N	0.02

Titration Count	Multiplier		Concentration
_____	x 0.01	=	mg/L
_____	x 0.02	=	mg/L

Notes:

Carbon Dioxide:

Equipment: Chemetrics Test Kit

Concentration: _____ ppm

Range Used:	Range	Method	Concentration ppm
☐	10 to 100 ppm	K-1910	
☐	100 to 1000 ppm	K-1920	
☐	250 to 2500 ppm	K-1925	

Analysis Time: _____

Equipment: HACH Digital Titrator CA-DT

Range Used:	Range	Sample Vol.	Cartridge	Multiplier
☐	10-50 mg/L	200 ml	0.3636 N	0.1
☐	20-100 mg/L	100 ml	0.3636 N	0.2
☐	100-400 mg/L	200 ml	3.636 N	1.0
☐	200-1000 mg/L	100 ml	3.636 N	2.0

Titration Count			Concentration
_____	x 0.1	=	mg/L
_____	x 0.2	=	mg/L
_____	x 1.0	=	mg/L
_____	x 2.0	=	mg/L

Standard Additions: ☐ Titrant Molarity: _____ Digits Required: 1st.: _____ 2nd.: _____ 3rd.: _____

Notes:

Hydrogen, dissolved

Equipment: Bubble strip sampling field method

Start stripper at _____ (time)

End stripper at _____ (time)

Total stripper time _____

Pump rate _____ milliliters/minute

ATTACHMENT 1

FIELD ANALYTICAL LOG SHEET GEOCHEMICAL PARAMETERS

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

FIELD ANALYTICAL LOG SHEET GEOCHEMICAL PARAMETERS

Tetra Tech NUS, Inc. Page ___ of ___

Project Site Name: _____ Sample ID No.: _____
Project No.: _____ Sample Location: _____
Sampled By: _____ Duplicate: ☐
Field Analyst: _____ Blank: ☐

Alkalinity:

Equipment: Chemetrics Test Kit Concentration: _____ ppm

Range Used:	Range	Method	Concentration ppm
☐	10 to 100 ppm	K-9810	
☐	50 to 500 ppm	K-9815	
☐	100 to 1000 ppm	K-9820	

Analysis Time: _____

Filtered: ☐

Equipment: HACH Digital Titrator AL-DT

Range Used:	Range	Sample Vol.	Cartridge	Multiplier	Titration Count	Multiplier	Concentration
☐	10-40 mg/L	100 ml	0.1600 N	0.1	_____ & _____	x 0.1 =	mg/L
☐	40-160 mg/L	25 ml	0.1600 N	0.4	_____ & _____	x 0.4 =	mg/L
☐	100-400 mg/L	100 ml	1.600 N	1.0	_____ & _____	x 1.0 =	mg/L
☐	200-800 mg/L	50 ml	1.600 N	2.0	_____ & _____	x 2.0 =	mg/L
☐	500-2000 mg/L	20 ml	1.600 N	5.0	_____ & _____	x 5.0 =	mg/L
☐	1000-4000 mg/L	10 ml	1.600 N	10.0	_____ & _____	x 10.0 =	mg/L

Parameter:	Hydroxide	Carbonate	Bicarbonate
Relationship:			

Standard Additions: ☐ Titrant Molarity: _____ Digits Required: 1st.: _____ 2nd.: _____ 3rd.: _____

Notes:

Ferrous Iron (Fe^{2+}):

Equipment: DR-850 DR-8 __ Range: 0 - 3.00 mg/L Concentration: _____ ppm
Program/Module: 500nm 33
Analysis Time: _____

Equipment: IR-18C Color Wheel Range: 0 - 10 mg/L

Notes: Filtered: ☐

Hydrogen Sulfide (H_2S): Range: 0 - 5 mg/L

Equipment: HS-C Other: _____ Concentration: _____ ppm
Exceeded 5.0 mg/L range on color chart: ☐ Analysis Time: _____

Notes:

Sulfide (S^{2-}):

Equipment: Chemetrics Test Kit Range: 0 - 10 mg/L Concentration: _____ ppm

Range Used:	Range	Method	Concentration ppm
☐	0 to 1 ppm	K-9510	
☐	1 to 10 ppm	K-9510	

Analysis Time: _____

Filtered: ☐

Equipment: DR-850 DR-8 __ Range: 0 - 0.70 mg/L
Program/Module: 610nm 93

Notes:

ATTACHMENT 1

FIELD ANALYTICAL LOG SHEET GEOCHEMICAL PARAMETERS

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Tetra Tech NUS, Inc. **Page __ of __**

Project Site Name: _____ Sample ID No.: _____
Project No.: _____ Sample Location: _____
Sampled By: _____ Duplicate: ☐
Field Analyst: _____ Blank: ☐

Sulfate (SO_4^{2-}):

Equipment: DR-850 DR-8 __ Range: 0 - 70 mg/L Concentration: _____ ppm
Program/Module: _____ 91 Analysis Time: _____

Standard Solution: ☐ Results: _____ Filtered: ☐
Standard Additions: ☐ Digits Required: 0.1ml: _____ 0.2ml: _____ 0.3ml: _____
Notes:

Nitrate (NO_3^--N):

Equipment: DR-850 DR-8 __ Range: 0 - 0.50 mg/L (1) Concentration: _____ ppm
Program/Module: 55 Analysis Time: _____ Filtered: ☐

Standard Solution: ☐ Results: _____ Nitrite Interference Treatment: ☐ Reagent Blank Correction: ☐
Standard Additions: ☐ Digits Required: 0.1ml: _____ 0.2ml: _____ 0.3ml: _____
Alternate forms: NO_2 _____ $NaNO_2$ _____ mg/L

Notes (1): If results are over limit use dilution method at step 3, 5ml sample 10ml DI result X3, range upto 1.5mg/L

Notes:

Nitrite (NO_2^--N):

Concentration: _____ ppm
Equipment: DR-850 DR-8 __ Range: 0 - 0.350 mg/L Analysis Time: _____ Filtered: ☐
Program/Module: 62
Standard Solution: ☐ Results: _____ Reagent Blank Correction: ☐
Notes:

Manganese (Mn^{2+}):

Concentration: _____ ppm
Equipment: DR-850 DR-8 __ Range: 0 - 20.0 mg/L Analysis Time: _____ Filtered: ☐
Program/Module: 525nm 41
Standard Solution: ☐ Results: _____ Digestion: ☐ Reagent Blank Correction: ☐
Standard Additions: ☐ Digits Required: 0.1ml: _____ 0.2ml: _____ 0.3ml: _____

Equipment: HACH MN-5 Range: 0 - 3 mg/L
Notes:

QA/QC Checklist:

All data fields have been completed as necessary: ☐
Correct measurement units are cited in the SAMPLING DATA block: ☐
Values cited in the SAMPLING DATA block are consistent with the Groundwater Sample Log Sheet: ☐
Multiplication is correct for each *Multiplier* table: ☐
Final calulated concentration is within the appropriate *Range Used* block: ☐
Alkalinity *Relationship* is determined appropriatly as per manufacturer (HACH) instructions: ☐
QA/QC sample (e.g., Std. Additions, etc.) frequency is appropriate as per the project planning documents: ☐
Nitrite Interference treatment was used for Nitrate test if Nitrite was detected: ☐
Title block on each page of form is initialized by person who performed this QA/QC Checklist: ☐

STANDARD OPERATING PROCEDURE
NUMBER CTO315-17

SAMPLE PRESERVATION, PACKAGING, AND SHIPPING

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures for sample preservation, packaging, and shipping to be used in handling ground water, surface water (including seeps), soils, and sediments collected at the Mustard Gas Burial Ground (MGBG), SWMU 1/12, NSWC Crane.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Shipping labels

Custody seals

Chain-of-custody (COC) form(s)

Sample containers with preservatives: All sample containers for analysis by fixed-base laboratories will be supplied, with preservatives added (if required) and deemed certified clean by the laboratory.

Sample shipping containers (coolers): All sample shipping containers are supplied by the laboratory.

Packaging material: Bubble wrap, ZipLoc® bags, strapping tape, etc.

3.0 PROCEDURES FOR SAMPLE PRESERVATION, PACKAGING, AND SHIPPING

3.1 Table 4-13 of this QAPP establishes requirements for the preservation of aqueous samples. The laboratory provides sample containers with preservative already included (as required) for the analytical parameter for which the sample is to be analyzed. All samples will be held, stored, and shipped at 4°C. This will be accomplished through refrigeration (used to hold samples prior to shipment) and/or ice.

3.2 The sampler shall maintain custody of the samples until the samples are relinquished to another custodian or to the common carrier.

3.3 Check that each sample container is properly labeled (SOP CTO315-01), the container lid is securely fastened, and the container is sealed in a ZipLoc® bag.

3.4 If the container is glass, place the sample container into a bubble-out shipping bag and seal the bag using the self-sealing, pressure sensitive tape supplied with the bag.

3.5 Inspect the insulated shipping cooler. Check for any cracks, holes, broken handles, etc. If the cooler has a drain plug, make certain it is sealed shut, both inside and outside of the cooler. If the cooler is questionable for shipping, the cooler must be discarded.

3.6 Put ice into ZipLoc® bags and place a layer of the sealed bags on the bottom of the cooler. Place the sample containers into the shipping cooler on top of the ice in an upright position (containers will be upright, with the exception of the 40-ml vials). Place ZipLoc® bags of ice flat against the sides of the cooler. Continue filling the cooler with samples until the cooler is nearly full and the movement of the sample containers is limited.

3.7 Place a temperature blank in the cooler. Make sure that all samples identified for VOC analysis and their associated trip blank are packed in the same cooler (i.e., VOC samples and trip blank that were stored together during sampling activities can not be separated into different coolers for shipping purposes).

3.8 Add a final layer of ice sealed in ZipLoc® bags to the top of the samples just before the cooler is closed and sealed.

3.9 Place the original (top) signed copy of the COC form inside a large ZipLoc® bag. Tape the bag to the inside of the lid of the shipping cooler that contains the samples for VOC analysis.

3.10 Close the cooler and seal the cooler with approximately four wraps of strapping tape at each end of the cooler. Prior to wrapping the last wrap of strapping tape, apply a signed, numbered, and dated custody seal to each side of the cooler (one per side). Cover the custody seal with the last wrap of tape. This will provide a tamper evident custody seal system for the sample shipment.

3.11 Affix a shipping label to the top of the cooler containing samples for VOC analysis, ensuring all of the shipping information is filled in properly. Overnight (e.g., FedEx Priority Overnight) courier services will be used for all sample shipments.

3.12 All samples will be shipped to the laboratory no more than 72 hours after collection. Under no circumstances will sample hold times be exceeded (See Tables 3-7 and 3-8 of this QAPP for maximum hold times).

STANDARD OPERATING PROCEDURE
NUMBER CTO315-18

MEASUREMENT OF WATER LEVELS IN MONITORING WELLS

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes procedures for determining water levels in monitoring wells.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following equipment and field forms are required for determining water levels in monitoring wells.

Ground Water Level Measurement Form: A copy of the Ground Water Level Measurement Form is attached.
Bound field logbook
Photoionization detector (PID): Operation and calibration of the PID is discussed in SOP CTO315-04.
Well key
Writing utensil
Electronic water-level indicator: The water-level indicator must have a cable of sufficient length to reach the water surface and be capable of measurements of 0.01 foot.
Decontamination supplies: SOP CTO315-19 describes decontamination procedures including decontamination supplies.

3.0 WATER-LEVEL MEASUREMENT PROCEDURES

3.1 Check the operation of the electronic water-level indicator or interface meter.

3.2 Record the well identification (ID), date, and time (using military time) on the Ground Water-Level Measurement Form.

3.3 Unlock the well and remove the well cap.

3.4 Place the well cap on a clean piece of plastic.

3.5 Check the well for the presence of organic vapors in the 2-inch polyvinyl chloride (PVC) riser pipe as follows:

1. Calibration of the PID shall be done in accordance with the calibration procedures described in SOP CTO315-04. Calibration of the PID shall be done at the field office prior to entering the field.

2 Insert the PID sample inlet straw approximately 3 inches into the riser pipe.

3 Record the PID reading on the Ground Water Level Measurement Form. If the reading is less than concentrations specified in the site-specific HASP, proceed to step 3.6. If the reading is greater than the concentration specified in the HASP, measure the concentration in the breathing zone. If the concentration in the breathing zone is less than the concentration specified in the HASP, proceed to Step 3.6. If the reading is greater than the specified concentration, allow the riser pipe to ventilate for 10 minutes and repeat the measurement of breathing zone concentrations until the concentrations fall below the level specified in the HASP before proceeding to step 3.6.

3.6 Ensure that the water-level indicator probe has been decontaminated before use, in accordance with the procedures outlined in SOP CTO315-19.

3.7 Slowly lower the probe into the well riser pipe until an audible and/or visible signal is produced, indicating contact with the water surface.

3.8 Read the ground water-level measurement from the top of the inner casing at the surveyed reference point to the nearest 0.01 foot.

3.9 Record the water-level measurement on the Ground Water Level Measurement Form.

3.10 Wind the meter cable measuring tape back onto the spool.

3.11 Replace the well cap and lock.

3.12 Decontaminate the meter's probe and cable following the procedures outlined in SOP CTO315-19.

3.13 Containerize any decontamination fluids and PPE in accordance with the procedures described in SOP CTO315-20.

4.0 ATTACHMENTS

1. Ground Water Level Measurement Sheet

ATTACHMENT 1

GROUND WATER LEVEL MEASUREMENT SHEET

Tetra Tech NUS, Inc.

GROUNDWATER LEVEL MEASUREMENT SHEET

Project Name: _____ **Project No.:** _____
Location: _____ **Personnel:** _____
Weather Conditions: _____ **Measuring Device:** _____
Tidally Influenced: Yes ___ No ___ **Remarks:** _____

Well or Piezometer Number	Date	Time	Elevation of Reference Point (feet)*	Total Well Depth From TOC (feet)*	Water Level Indicator Reading (feet)*	Groundwater Elevation (feet)*	Comments

* All measurements to the nearest 0.01 foot

Page ___ of ___

STANDARD OPERATING PROCEDURE
NUMBER CTO315-19

DECONTAMINATION OF FIELD SAMPLING EQUIPMENT

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedures to be followed when decontaminating non-dedicated field sampling equipment during the field investigations at the NSWC Crane facility.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Waterproof pens
Non-latex rubber or plastic gloves
Cotton gloves
Field logbook
Potable water
Deionized water
LiquiNox detergent
Brushes, spray bottles, paper towels, etc.
55-gallon drum or other container to collect and transport decontamination fluids

3.0 DECONTAMINATION PROCEDURES

3.1 Don non-latex and/or cotton gloves and decontaminate sampling equipment (in accordance with the following steps) prior to field sampling and between samples.

3.2 Rinse the equipment with potable water. Rinsing may be conducted by spraying with water from a spray bottle or by dipping. Collect the potable water rinsate into a container.

3.3 Wash the equipment with a solution of LiquiNox detergent. Prepare the LiquiNox wash solution in accordance with the instructions on the LiquiNox container. Collect the LiquiNox wash solution into a container. Use brushes or sprays as appropriate for the equipment. If oily residue has

accumulated on the sampling equipment, remove the residue with a isopropanol wash and repeat the Liquinox wash.

3.4 Rinse the equipment with potable water. Rinsing may be conducted by spraying with water from a spray bottle or by dipping. Collect the potable water rinsate into a container.

3.5 Rinse the equipment with deionized water. Rinsing may be conducted by spraying with water from a spray bottle or by dipping. Collect the deionized water rinsate into a container.

3.6 Remove excess water by air drying, shaking, or by wiping with paper towels as necessary.

3.7 Document decontamination by recording it in the field logbook.

3.8 Containerized decontamination solutions will be managed in accordance with the procedures described in SOP CTO315-20 and the QAPP.

STANDARD OPERATING PROCEDURE
NUMBER CTO315-20

MANAGEMENT OF INVESTIGATION-DERIVED WASTE

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes how investigation-derived waste (IDW) will be collected, segregated, classified, and managed during the field investigations at the NSWC Crane facility. The following types of IDW will be generated during this investigation:

- Excess soil and rock materials remaining from subsurface drilling activities
- Well development water and purge water related to monitoring well installation and sampling
- Decontamination solutions
- Personal protective equipment and clothing (PPE)
- Miscellaneous trash and incidental items

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Health and safety equipment (with PPE)
Decontamination equipment
Field logbook and indelible ink pen
Plastic sheeting and/or tarps
55-gallon drums with sealable lids
IDW labels for drums
Wastewater container tanks
Plastic garbage bags

3.0 PROCEDURES

Management of IDW includes the collection, segregation, temporary storage, classification, final disposal, and documentation of the waste-handling activities.

3.1 Liquid Wastes

Liquid wastes that will be generated during the site activities include well development water, well purge water (collected during low-flow sampling), and decontamination solutions from drilling and sampling equipment. As they are collected, these wastewaters will be placed in a 300-gallon (or smaller) portable tank attached to a truck. Whenever the portable tank approaches full, it will be transported to a central location at NSWC Crane (adjacent to a Crane-designated sanitary sewer manhole). The water in the portable tank will be discharged to the sewer by gravity draining.

An accurate record will be kept by the FOL of all wastewaters that have been placed in the large holding tank. At a minimum, this information will include the following:

- The location and type of each water that has been placed in the tank (e.g., purge water from wells)
- The quantity of water from each source
- The date the wastewater was generated
- The date and time the wastewater was placed in the tank
- The person(s) present when the wastewaters were discharged to the sewer

3.2 Drill Cuttings and Cores

As cuttings are removed from borings, they will be screened for VOCs. If these results do not show above-background levels of VOCs, the cuttings materials will be mixed with bentonite and returned to the borehole when sampling activities in the hole are completed or spread on the ground in the area of the borehole. The backfill materials will be tamped as they are placed in the hole to increase density and reduce permeability of the backfill material.

If any soil materials from a screened borehole interval show evidence of contamination (based on the field screening results), then the soil material from the screened interval will be placed in a plastic trash bag (or directly in a drum if a larger quantity) and the bag will be tagged. Information included on the tag will consist of the hole from which the material came, the depth interval from which the material came, the date, and the name of the person filling out the tag. The bag will then be placed in a 55-gallon drum and sealed (more than one bag may be placed in a drum). The waste drums will be stored on site temporarily until laboratory results have been received concerning the soil samples that were collected from the suspect borehole. If the results indicate that no contamination is present in the soil samples, then the soils will be disposed on site. If the levels of contamination of any of the samples from a borehole exceed Toxicity Characteristic Leaching Procedure (TCLP) limits (using the total soil concentrations), then all

excess soil from the borehole will be considered as RCRA-hazardous and disposed off site in accordance with RCRA waste disposal regulations. Alternatively, the toxicity characteristic leaching procedure may be conducted for any constituent that could exceed the TC limits based on total concentrations.

Cuttings from well borings will be handled in the same manner as soil boring cuttings.

3.3 PPE, Pump Discharge Tubing, Direct-Push Technology (DPT) Sample Liners, and Incidental Trash

All PPE wastes, pump discharge tubes, DPT sample liners, and incidental trash materials (e.g., wrapping or packing materials from supply cartons, waste paper) will be decontaminated (if contaminated), double bagged, securely tied shut, and placed in a designated waste receptacle at NSWC Crane.

STANDARD OPERATING PROCEDURE
NUMBER CTO315-21

FIELD SCREENING TO DETECT NAPL IN BEDROCK CORES USING THE NAPL FLUTe™ SYSTEM

1.0 PURPOSE

This procedure describes screening of soil samples to detect the presence of non-aqueous phase organic liquids (NAPLs) in bedrock cores using a fabric impregnated with a color indicator that is placed in contact with the core.

2.0 SCOPE

2.1 Applicability

This procedure applies only to the detection of NAPLs. It does not quantify NAPL concentrations in environmental media such as ground water and it does not identify any NAPL that is detected. The color reaction is useful for mapping NAPL detections as a function of core depth, based on the position of NAPL detection in a bedrock core sample.

2.2 Training

Personnel using this SOP are required to review the procedure with the Task Order Manager prior to implementation.

3.0 DEFINITIONS AND ACRONYMS

DNAPL – Dense non-aqueous phase liquid
LNAPL – Light non-aqueous phase liquid
NAPL – Non-aqueous phase liquid

4.0 BACKGROUND, PRECAUTIONS AND LIMITATIONS

4.1 Background

The NAPL FLUTe™ system is essentially a polyurethane fabric that is impregnated with a chemical. When in contact with NAPLs, the chemical turns blue. The contact between NAPL in a bedrock core and the chemical is effected by the NAPL from the core wicking into the fabric. The NAPL FLUTe™ system fabric is encapsulated in a clear plastic liner and this assembly is placed over the bedrock core. The relatively air-tight plastic covering will prevent the immediate evaporation of the more volatile liquids contained in the core. In that way, any solvents, or the like, can be better mapped by the staining process of the NAPL FLUTe™ system.

4.2 Precautions

4.2.1 When extruding the core into the NAPLe FLUTe™ system as described in Section 6.0, take heavy lifting precautions and use the ground or table to support the core while it is extruded from the core barrel.

4.2.2 When using the NAPL FLUTe™ system, the correct orientation of the system is identified by stripes on the fabric. This orientation must be observed.

4.3 Limitations

The NAPL FLUTe™ system can not distinguish between one NAPL or another, and it can not distinguish whether the detected NAPL is LNAPL, DNAPL, or a mixture of LNAPL and DNAPL.

It is possible that the coring procedure described in this SOP will not recover the DNAPL/NAPL. A more definitive *in situ* technique where the NAPL FLUTe™ system is placed down the bore hole is described at the FLUTe™ web site **www.flut.com**, but is not used here.

5.0 EQUIPMENT AND MATERIALS

NAPL FLUTe™ System (includes FLUTe™ covering and clear plastic liner)

Camera (disposable or otherwise)

Ruler

6.0 PROCEDURE

Note: Monitoring of the bedrock core for VOCs after covering with the NAPL FLUTe™ system can be accomplished by slitting the covers at appropriate locations and inserting the VOC probe through the slits.

6.1 Pull the NAPL FLUTe™ cover from the reel for a length 2 ft. longer than the core to be mapped (typically 5+2 ft.) and cut it to that length.

6.2 If the stripes are on the outside, invert the cover (turn it inside out) so that the stripes are on the inside. Take care during handling not to contaminate the cover.

6.3 Tie a knot near the end of the NAPL FLUTe™ cover.

6.4 Slip he NAPL FLUTe™ cover up over the core barrel which contains the core.

6.5 Knot the normal tubular plastic cover used for containing the core at the end

6.6 Slip this plastic cover up over the NAPL FLUTe™ cover that is on the core barrel.

6.7 Prepare a table or an area on the ground that has been covered with a clean tarp for receiving the extruded core.

6.8 Using a table or the tarp-covered ground to support the end of the core, extrude the core into the bag formed by the two concentric coverings.

6.9 Once the core has been fully extruded, tie the open end of the coverings in a knot to contain the core and any fluids that may be entrained in the core.

6.10 Lay the packaged core on a tarp or other horizontal surface to allow the fluid in the core to drain onto the NAPL FLUTe™ cover. If the core contains any DNAPLs, the DNAPLs can sink to the bottom of the core bag as it lies on its side. The DNAPLs are wicked into the hydrophobic NAPL FLUTe™ cover carrying the dye to the outer (white) side of the covering for observation through the clear plastic outer covering.

6.11 Label the core bag for the core interval and the well location.

6.11 Wait at least one hour, then view the packaged core that has been lying horizontally. If any DNAPL contacts the covering, it will produce a highly visible blue or red/pink stain. If no stains are produced, it does not prove that the core does not contain any DNAPL. It only proves that the DNAPL did not contact the covering.

6.12 If the bag shows no sign of NAPL detection, reorient the core by rolling it at least 90 degrees and wait at least one more hour before concluding whether or not NAPLs have been detected.

6.13 Record the detection or failure to detect NAPL in the field log book.

6.14 If NAPLs were detected:

6.14.1 Log the approximate depth of the NAPL (relative to ground surface) and a qualitative description of the amount of staining observed.

6.14.2 Take a photograph to record the degree of staining. Include enough of the core to orient the viewer of the photographs.

Note: Placing a ruler beside the stains oriented with the long dimension of the core can help the viewer understand the size of the stains.

6.15 Remove the core coverings and discard them with the PPE.

8.0 REFERENCES

www.flut.com, NAPL FLUTe™ system web pages.

9.0 RECORDS

All observations described in Section 6.0 must be recorded in the field log book.

10.0 ATTACHMENTS

None.

Health and Safety Plan
for
Corrective Measures Study Field Work
at
Mustard Gas Burial Ground
(SWMU 01)

Naval Surface Warfare Center
Crane Division
CRANE, INDIANA

Southern Division
Naval Facilities Engineering Command
Contract Number N62467-94-D-0888

Contract Task Orders 0315

January 2004

HEALTH AND SAFETY PLAN
FOR
CORRECTIVE MEASURES STUDY FIELD WORK
AT
MUSTARD GAS BURIAL GROUND (SWMU 01)

NAVAL SURFACE WARFARE CENTER (NSWC)
CRANE, INDIANA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29406

Submitted by:
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CONTRACT NUMBER N62467-94-D-0888
CONTRACT TASK ORDER 0315

January 2004

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1.0 INTRODUCTION

Authorization: This Health and Safety Plan (HASP) and the work described within are completed under the authorization of:

Contract:	Comprehensive Long-Term Environmental Action Navy (CLEAN III)
Contract Number:	N62467-94-D-0888
Contract Task Order:	0315
Statement of Work:	The Resource Conservation and Recovery Act (RCRA) development of planning documentation for the Corrective Measures Study (CMS) at the Mustard Gas Burial Ground (MGBG). This HASP consists of one element of the planning documentation.

Application: This Health and Safety Plan (HASP) has been written to encompass site activities that are to be conducted at the Naval Surface Warfare Center Crane (NSWC Crane), located in Crane, Indiana. Specifically this HASP addresses RCRA Corrective Measures Study Field Work to be conducted at the Mustard Gas Burial Ground (MGBG) or Solid Waste Management Unit (SWMU 01).

Compliance: The elements of this HASP are intended to be in compliance with the requirements established by:

- OSHA 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response" (HAZWOPER)
- Applicable sections of 29 CFR 1926 "Safety and Health Regulations for Construction."
- Tetra Tech NUS (TtNUS) Health and Safety Program

Modifications/Changes: The following conditions are considered sufficient basis for change and will serve as triggers to institute review and possible changes to this document

- The addition of activities outside of those specified in Section 3.0, Scope of Work.
- Task Modifications to those activities specified within Section 3.0, Scope of Work.
- New information becomes available through the course of the investigation or from outside sources.

Changes to this HASP will be requested through the Task Order Manager (TOM) to the TtNUS Health and Safety Manager (HSM). It is the responsibility of the TOM to notify affected personnel of changes to this HASP.

1.1 KEY PROJECT PERSONNEL AND ORGANIZATION

This section defines responsibility for site safety and health for TtNUS and subcontractor employees engaged in onsite activities. Personnel assigned to these positions will exercise the primary responsibility for onsite health and safety. These persons will be the primary points of contact for any questions regarding the safety and health procedures and the selected control measures that are to be implemented for onsite activities.

- The TtNUS TOM is responsible for the overall direction of health and safety for this project.

- The Project Health and Safety Officer (PHSO) is responsible for developing this HASP in accordance with applicable OSHA regulations. Specific responsibilities include:

  i. Providing information regarding site contaminants and physical hazards associated with the site.
  ii. Establishing air monitoring and decontamination procedures.
  iii. Assigning personal protective equipment based on task and potential hazards.
  iv. Determining emergency response procedures and emergency contacts.
  v. Stipulating training requirements and reviewing appropriate training and medical surveillance certificates.
  vi. Providing standard work practices to minimize potential injuries and exposures associated with hazardous waste work.
  vii. Modifying this HASP, as it becomes necessary.

- The TtNUS Field Operations Leader (FOL) is responsible for implementation of the HASP with the assistance of an appointed Site Safety Officer (SSO). The FOL manages field activities, executes the work plan, and enforces safety procedures as applicable to the work plan.

- The SSO supports site activities by advising the FOL on aspects of health and safety on-site. In this capacity the SSO:

  i. Coordinating health and safety activities with the FOL.
  ii. Selecting, applies, inspects, and maintains personal protective equipment.
  iii. Establishing work zones and control points in areas of operation.
  iv. Implementing air monitoring program for onsite activities.
  v. Verifying training and medical clearance of onsite personnel status in relation to site activities.

vi. Implementing Hazard Communication, Respiratory Protection Programs, and other associated health and safety programs as they may apply to site activities.

vii. Coordinating emergency services.

viii. Providing site-specific training for onsite personnel.

ix. Investigating accidents and injuries (see Attachment I - Illness/Injury Procedure and Report Form)

x. Providing input to the PHSO regarding the need to modify, this HASP, or applicable health and safety associated documents as per site-specific requirements.

- Compliance with the requirements stipulated in this HASP is monitored by the SSO and coordinated through the TtNUS CLEAN HSM.

Note: In some cases one person may be designated responsibilities for more than one position. For example, at NSWC Crane the FOL may also be responsible for the SSO duties. This action will be performed only as credentials, experience, and availability permits.

1.2 SITE INFORMATION AND PERSONNEL ASSIGNMENTS

Site Name: NSWC Crane

Address: Code RP 3-10 Bldg 3245
300 Highway 361
Crane, Indiana 47522-5009

Client Contact: Mr. Thomas Brent
Environmental Site Manager
NSWC Crane

Phone Number: (812) 854-6160
Fax Number: (812) 854-3981
E-mail:

Alternate Contact: Ms. Chris Freeman

Phone Number: (812) 854-4423
Fax Number: (812) 854-3981
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Remediation Program Manager(RPM):

Mr. William Gates
U.S. Navy
SOUTHNAVFACENGCOM

Phone Number: (843) 820-7360
Fax Number: (843) 820-7465
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Purpose of Site Visit: This activity is divided into a multi-task operation (see Section 4.0), including surveying, monitoring well installations, groundwater sampling, and other related activities.

Project Team:

TtNUS Personnel:	Discipline/Tasks Assigned:	Phone No.
Thomas Johnston, Ph.D.	Task Order Manager	(412) 921-8615
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James K. Laffey	Project Health and Safety Officer	(412) 921-8678
Jeff Schubert	Project Geologist	(412) 921-8794
Terry Rojahn	Field Operations Leader (FOL)	(412) 921-8857
TBD	SSO/RSO	
TBD	Field Technician	
Tom Patton	Equipment Manager	(412) 859-4670

Non-TtNUS Personnel	Affiliation/Discipline/Tasks Assigned	
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TBD	Surveyor (Geographical)	
TBD	Drilling Subcontractor	
FedEx	Sample/Parcel Delivery	1(800)463-3339

Partnering Team:

PERSON / TITLE / ORGANIZATION	ADDRESS	TELEPHONE
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2.0 EMERGENCY ACTION PLAN

2.1 INTRODUCTION

This section has been developed as part of a planning effort to direct and guide field personnel in the event of an incidental or emergency release or occurrence. TtNUS will, through necessary services, include incidental response measures for incidents such as:

- Initial stage fire fighting support and prevention
- Initial spill control and containment measures and prevention
- Removal of personnel from emergency situations
- Provide initial medical support for injuries or illnesses requiring only first-aid level support
- Provide site control and security measures as necessary

Incidental response measures will only be provided to the capabilities of on-site personnel and available resources. Incidental response measures are not considered an emergency response as per 29 CFR 1910.120 (b). Incidents and situations, that are deemed to be an emergency/emergency response as defined by 29 CFR 1910.120 (b) will be handled by outside resources. From this point on in this document "Outside Emergency Response Support" is referring to NSWC Crane Emergency Response support. This emergency action plan has been structured in accordance with 29 CFR 1910.120 (l)(ii) complying with 29 CFR 1910.38 (a)

2.2 EMERGENCY PLANNING

Through the initial hazard/risk assessment effort, injuries or illnesses resulting from exposure to chemical or physical hazards or fire are the most probable emergencies that could be encountered during site activities.

To minimize and eliminate these potential emergency situations, emergency planning activities associated with this project include the following.

The SSO and/or the FOL are responsible for:

- Coordinating with NSWC Crane Emergency Services to ensure that TtNUS emergency action activities are compatible with existing facility emergency response procedures.

- Establishing and maintaining information at the project staging area (support zone) or Field Office for easy access in the event of an emergency. This information will include the following:
  - Chemical Inventory (used on-site), with Material Safety Data Sheets.
  - On-site personnel medical records (medical data sheets).
  - A logbook identifying personnel on site each day.

- Identifying a chain of command for emergency action. Due to the nature of the work to be performed a Site Safety Officer (SSO) will be present during field operations. This person will serve as the emergency coordinator should an incident or emergency arise.

- Educating site workers to the hazards and control measures associated with planned activities at the site, and to provide early recognition and prevention where possible.

- Drilling and practicing incidental response measures periodically. The SSO will guide and direct drills and will be responsible for logging, review and analysis of the drill by TtNUS and subcontractor personnel.

The use of two-way communication devices (cellular phones and radios) must be approved by the NSWC Crane Safety Office and such equipment will not be used until official permission is obtained.

2.3 EMERGENCY RECOGNITION AND PREVENTION

The primary focus of this section is the ability to recognize and control factors, which could contribute to an emergency situation/condition. The FOL, and/or the SSO will preview site work location prior to committing personnel or resources. Their actions will be as follows:

- Identify, remove, and/or barricade and physical hazards within the estimated work area.

- Identify prevalent emergency conditions and their control measures and ensure they are stated on the Safe Work Permits.

- Provide the necessary equipment to control potential emergencies (i.e., safety cans for flammable liquid storage, spill containment equipment, PPE, and emergency equipment such as fire extinguishers).

- Evaluate operations to ensure that necessary measures are taken to control and/or minimize the impact of emergency situations/conditions.

- Field Crew shall:

  - Identify, remove, or barricade physical hazards within the estimated work area.
  - Follow the guidelines for control of emergency conditions
  - Report any potential emergency situation to the FOL and/or the SSO.

2.4 SAFE DISTANCES AND PLACES OF REFUGE

Upon activation of the on-site emergency alarm system the following actions will occur:

- Operations will cease. There are no critical operations that would require personnel to remain during an emergency.
- Field personnel will note the direction of the wind.
- Based on the wind direction, personnel will move cross and up wind to either the primary or secondary safe place of refuge as determined in the field by the FOL and/or the SSO as part of daily safety meetings.
- Personnel will remain at this location until directed otherwise by the FOL and/or the SSO.

2.4.1 Safe Place of Refuge Selection

The FOL and/or the SSO shall identify a safe place of refuge (in the event of an emergency) and communicate to field personnel as part of the daily safety meeting. Selection will be based on the following considerations:

- A location providing telephone communications and or shelter.
- A location from which the field crews can provide site security restricting access to the emergency area, however, a point from which the field crew may direct emergency crews (i.e., intersection or gate, etc.).

This location should be positioned a safe distance from the operation so not to be impacted by the emergency. This distance is impacted by a number of conditions (i.e., tasks being conducted; chemical, physical, and toxicological properties; potential for fire; meteorological conditions; terrain).

2.5 DECONTAMINATION PROCEDURES/EMERGENCY MEDICAL TREATMENT

During an evacuation, decontamination procedures will be performed only if doing so does not further jeopardize the welfare of site workers. However, it is unlikely that an evacuation would occur at this site which would require workers to evacuate the site without first performing decontamination procedures.

2.5.1 Life threatening

- Engage emergency response protocol, notify outside support services.
- Remove outer PPE. Outer protective garments should be removed by assisting personnel. Removal may require the use of bandage scissors to remove the outer garments.
- Begin life saving techniques as appropriate (CPR, cooling or warming regimens, etc.).
- Wrap the injured in a blanket for transport to the hospital.

Note: One person from the field team will accompany the injured to the hospital with medical data sheets, MSDS, a copy of this HASP, and the incident forms. This person will collect as much information as possible and transfer that information to the HSM and Work Care as per the Emergency Response Protocol provided in Figure 2-4. Other personnel will engage site control/site security measures.

2.5.2 Emergency Medical Treatment

TtNUS and subcontractor personnel are only permitted to provide treatment to the level of First-Aid Training.

Emergency medical treatment will be initiated under the following guarded restrictions:

- Notify the FOL and/or the SSO of the incident.

- Take the necessary precautions to prevent direct contamination with the injured person's body fluids.

  - Use surgeons gloves when handling cuts, abrasions, bites, punctures, etc. or any part of the injured person. The use of safety glasses and surgeons masks maybe necessary if there is the potential for uncontrolled spread of body fluids.

2.6 EMERGENCY ALERTING AND ACTION/RESPONSE PROCEDURES

There are several aspects associated with emergency alerting procedures that must be taken into account at NSWC Crane. These are as follows:

- Due to the size and remoteness of the sites where field activities will be conducted communications options are limited. There are few cellular communication points located on Base where a signal may be obtained. As a result, cellular telephone communication capabilities are limited and unreliable.

- TtNUS personnel often work during holidays, off days, and after typical workday hours. Primary safe places of refuge that would normally be accessed in the event of an emergency during normal working hours will be closed during these periods.

In order to improve communications while on Base, the Base Environmental Office may allocate a Public Works/Fire/Security Radio to be used in support of this field effort. This radio will be available throughout the entire project so that filed personnel can establish a direct link to security and emergency services.

If an emergency occurs at NSWC CRANE within the TtNUS operations, the following procedures are to be initiated:

- Begin the emergency notification process by using hand signals, voice commands, air horn, or two-way radios. Describe to the FOL (who will serve as the Incident Coordinator) what has occurred and as many details as possible.

- Evacuate non-essential personnel from the incident scene and then engage initial response measures given the emergency type (i.e., spill response, fire extinguisher, first-aid) .

In the event that site personnel cannot control the incident through offensive and defensive measures, the FOL and/or SSO will enact the emergency notification procedures to secure additional outside assistance in the following manner:

Primary Means of Notification

If provided, use the emergency notification radio which will establish a direct link to security and emergency services. If not, use an on-base phone and call 1333 or 3300 (Table 2-1) and report the

emergency. Give the emergency operator the location of the emergency, the type of emergency, the number of injured, and a brief description of what occurred. Stay on the phone and follow the instructions given by the operator. The operator will then notify and dispatch the proper emergency response agencies. The Fire Dept. coordinates ambulatory service. They will provide emergency medical, ambulatory, hazardous materials response, and rescue.

Note: On-base extensions 1333 and 3300 are the primary emergency phone numbers. From an NSWC Crane phone base extensions must be preceded with "854". Off base numbers from a base phone can only be reached by dialing "990" or " 991" first. Furthermore, emergencies should be subsequently reported to the Environmental office (x6160).

Evacuate TtNUS and subcontractor personnel to the identified safe place of refuge. Conduct a head count of site personnel using the site logbook.

2.7 PPE AND EMERGENCY EQUIPMENT

A first aid kit, eye wash units, and fire extinguishers will be maintained on-site at the central decontamination unit and shall be immediately available for use in the event of an emergency. These incident response abatement items may be maintained at the exclusion zone of on-going operations as determine and communicated to the field crew through the Safe Work Permit. This will be and is at the discretion of the SSO.

2.8 EMERGENCY CONTACTS

Prior to performing work, personnel will be thoroughly briefed on the emergency procedures. A means of communication) cell phone, emergency notification radio, established kind line, etc. will be available on site. Table 2-1 provides a list of emergency contacts and their associated telephone numbers. This table must be posted on site where it is readily available to site personnel. Telephone numbers for the Base Safety Office, the Base Emergency Preparedness Coordinator, and the Base Environmental Office are listed in Table 2-1.

In addition, TtNUS personnel who are injured or become ill on the job must notify appropriate company representatives. Figure 2-4 presents the procedure for reporting an injury/illness, and the form to use for this purpose. **If the emergency involves personnel exposures to chemicals, follow the steps in Figure 2-4.**

TABLE 2-1
EMERGENCY REFERENCE
NSWC CRANE, INDIANA

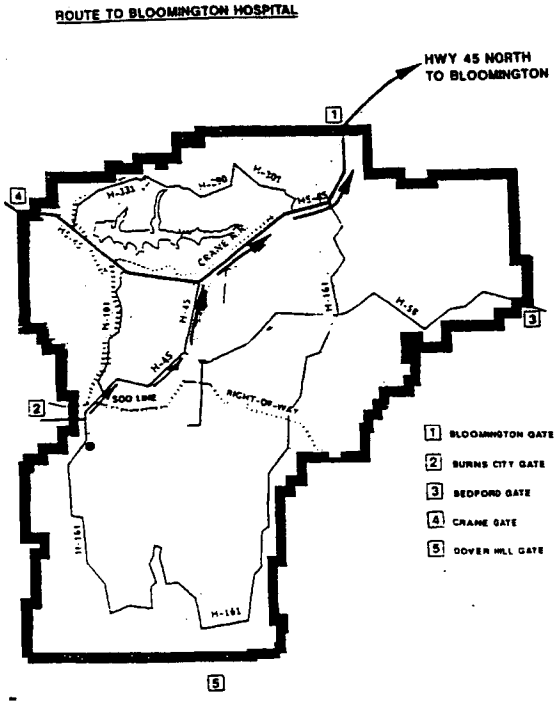
AGENCY	TELEPHONE
Base Emergency Number (Fire Department, Base Security, Ambulance)	854-3300 or 854-1333
Base Environmental Office	(812) 854-3114
Bedford Ambulance	(812) 279-6545
Bloomington Hospital (Bloomington, IN)	(812) 336-9515
Hospital, Bedford Medical Center (Bedford, IN)	(812) 275-1200
Poison Control Center	1-800-222-1222
National Response Center	1-800-424-8802
Base Contact, Thomas Brent	(812) 854-6160
Contract Task Order Manager, Tom Johnston	(412) 921-88615
TtNUS Crane Field Office Building 3245	(812) 854-0280
Field Operations Leader, Terry Rojahn On-Site Off-Site (Pittsburgh)	 (812) 854-0280 (412) 921-8131
TtNUS Office, Pittsburgh	(412) 921-7090
CLEAN Health and Safety Manager, Matthew M. Soltis, CIH, CSP	(412) 921-8912
Project Health and Safety Officer, James K. Laffey	(412) 921-8678

Note: Most phones require the number to be preceded by 991 (i.e., 991-812-854-0280) or by "99" (if 812 is left off) (i.e., 99-854-0280)

Figure 2-1

Hospital Route Map (Bloomington Gate)

**Note: The Bloomington Gate is open 24 hours.



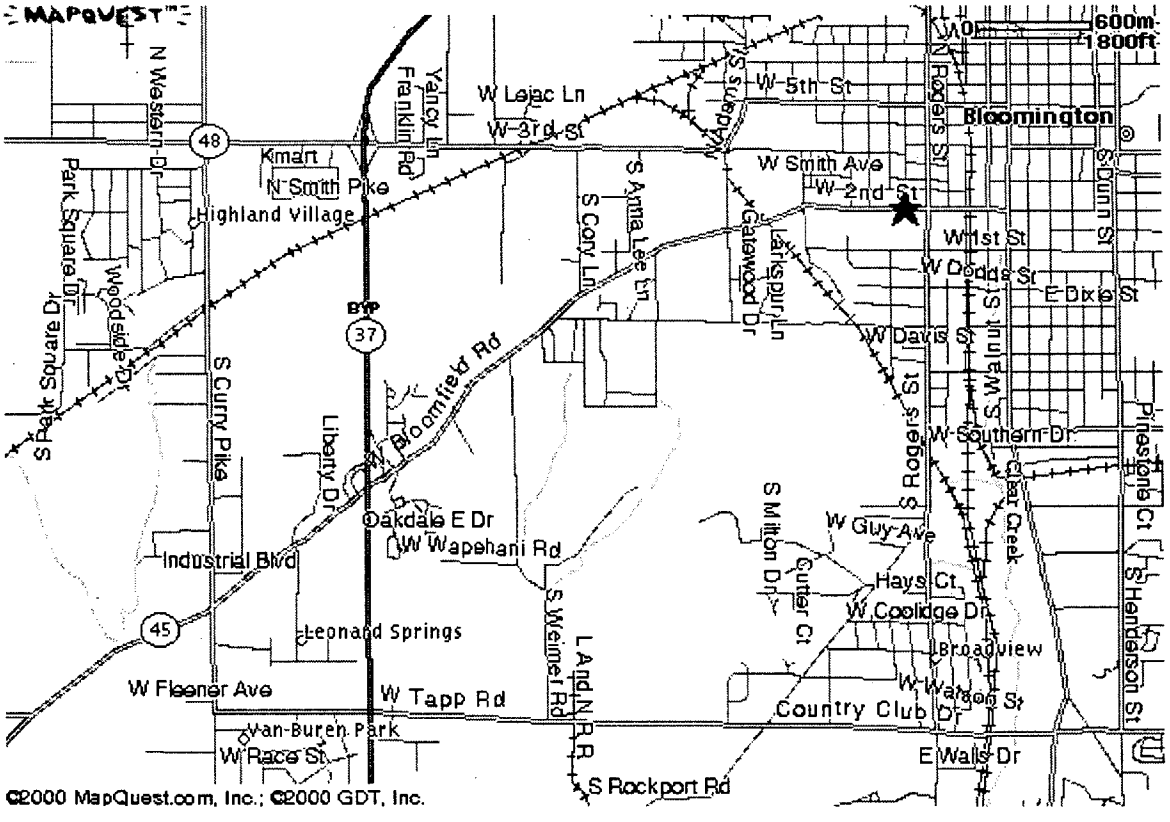
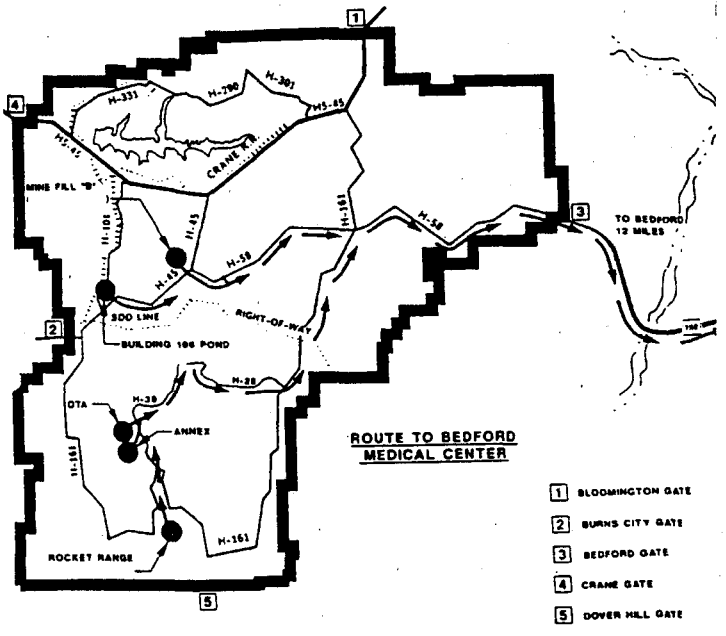


Figure 2-2

Hospital Route Map (Bedford Gate)

*Note: The Bedford Gate is open only from 0600 - 0830 and 1500 - 1800 hours; Monday through Friday.



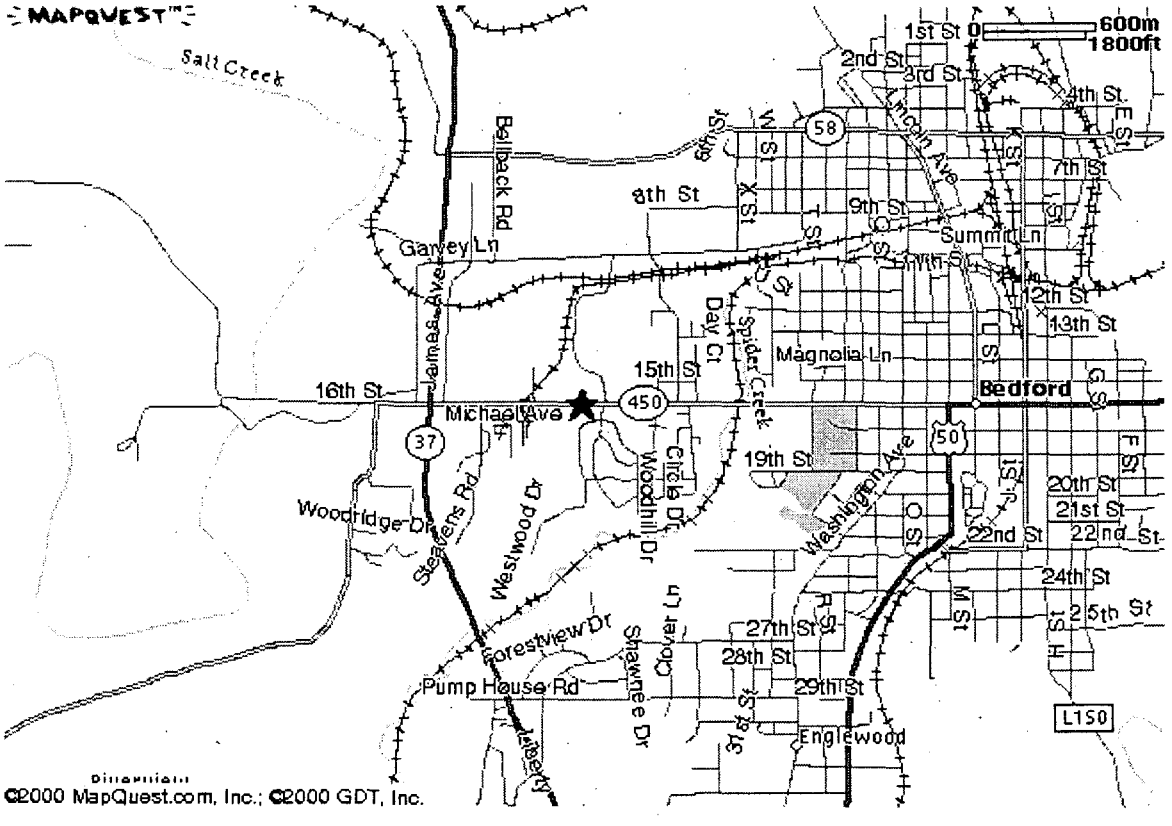


FIGURE 2-3
EMERGENCY RESPONSE PROTOCOL

The purpose of this protocol is to provide guidance for the medical management of injury situations.

In the event of a personnel injury or accident:

- Rescue, when necessary, employing proper equipment and methods.
- Give attention to emergency health problems -- breathing, cardiac function, bleeding, and shock.
- Transfer the victim to the medical facility designated in this HASP by suitable and appropriate conveyance (i.e. ambulance for serious events)
- Obtain as much exposure history as possible (a Potential Exposure report is attached).
- If the injured person is a TtNUS employee, call the medical facility and advise them that the patient(s) is/are being sent and that they can anticipate a call from the WorkCare physician. WorkCare will contact the medical facility and request specific testing which may be appropriate. WorkCare physicians will monitor the care of the victim. Site officers and personnel should not attempt to get this information, as this activity leads to confusion and misunderstanding.
- Call WorkCare at 1-800-455-6155 and enter Extension 109, or follow the voice prompt for after hours and weekend notification and be prepared to provide:
  - Any known information about the nature of the injury.
  - As much of the exposure history as was feasible to determine in the time allowed.
  - Name and phone number of the medical facility to which the victim(s) has/have been taken.
  - Name(s) of the involved TtNUS employee(s).
  - Name and phone number of an informed site officer who will be responsible for further investigations.
  - Fax appropriate information to WorkCare at (714) 456-2154.
- Contact Corporate Health and Safety Department (Matt Soltis) and Human Resources Department (Marilyn Duffy) at 1-800-245-2730, 8:00a.m. to 5:00p.m., Monday through Friday.
- As data is gathered and the scenario becomes more clearly defined, this information should be forwarded to WorkCare.

WorkCare will compile the results of data and provide a summary report of the incident. A copy of this report will be placed in each victim's medical file in addition to being distributed to appropriately designated company officials.

Each involved worker will receive a letter describing the incident but deleting any personal or individual comments. A personalized letter describing the individual findings/results will accompany this generalized summary. A copy of the personal letter will be filed in the continuing medical file maintained by WorkCare.

FIGURE 2-4 (continued)
WORKCARE
POTENTIAL EXPOSURE REPORT

Name: _____ Date of Exposure: _____

Social Security No.: _____ Age: _____ Sex: _____

Client Contact: _____ Phone No.: _____

Company Name: _____

I. **Exposing Agent**
Name of Product or Chemicals (if known): _____
_____
Characteristics (if the name is not known)
Solid Liquid Gas Fume Mist Vapor

II. **Dose Determinants**
What was individual doing? _____
How long did individual work in area before signs/symptoms developed? _____
Was protective gear being used? If yes, what was the PPE? _____
Was their skin contact? _____
Was the exposing agent inhaled? _____
Were other persons exposed? If yes, did they experience symptoms? _____

III. **Signs and Symptoms** (check off appropriate symptoms)

Immediately With Exposure:

Burning of eyes, nose, or throat
Tearing
Headache
Cough
Shortness of Breath
Chest Tightness / Pressure
Nausea / Vomiting
Dizziness
Weakness

Delayed Symptoms:

Weakness
Nausea / Vomiting
Shortness of Breath
Cough
Loss of Appetite
Abdominal Pain
Headache
Numbness / Tingling

IV. **Present Status of Symptoms** (check off appropriate symptoms)

Burning of eyes, nose, or throat
Tearing
Headache
Cough
Shortness of Breath
Chest Tightness / Pressure
Cyanosis
Nausea / Vomiting
Dizziness
Weakness
Loss of Appetite
Abdominal Pain
Numbness / Tingling

Have symptoms: (please check off appropriate response and give duration of symptoms)
Improved: _____ Worsened: _____ Remained Unchanged: _____

V. **Treatment of Symptoms** (check off appropriate response)
None: _____ Self-Medicated: _____ Physician Treated: _____

3.0 SITE BACKGROUND

3.1 FACILITY HISTORY

The NSWC Crane is located in Crane, Indiana, approximately 75 miles southwest of Indianapolis and 71 miles northwest of Louisville, Kentucky. The facility encompasses approximately 98.2 square miles (62,832 acres). NSWC Crane provides material, technical, and logistical support to the Navy for equipment, weapons systems, and expendable and non-expendable ordnance items. The facility was opened in 1941 as the Naval Ammunition Depot (NAD), Burns City, to serve as an inland munitions production and storage center. In 1943, the name was changed to NAD Crane in honor of Commodore William Montgomery Crane, the first chief of the Navy's Bureau of Ordnance. The name changed again in 1975 to Naval Weapons Support Center to reflect the facility's growing involvement in high-technology weapons system.

In 1977, the Secretary of Defense combined conventional ammunition acquisition under the responsibility of a single service. The ammunition production and storage function was assigned to the Army, and the Crane Army Ammunition Activity was established as a Crane tenant to accomplish this task for Naval ammunition. In 1992, based on changing missions and alignment, the name was changed to the Naval Surface Warfare Center Crane. The Army has assumed ordnance production, storage, and related responsibilities under the single-service management directive. Environmental activities on the installation, including permitting activities, remain the responsibility of the Navy. Although ordnance production and storage is still in existence, Crane now supplies highly technical product lines, such as microwave devices, acoustic sensors, small arms, and microelectronic technology. The Army activity is currently considered a tenant activity on the base.

3.2 SITE TO BE INVESTIGATED

The MGBG (SWMU 01) is located in the southeast corner of NSWC Crane adjacent to Road 251, which is accessible from Highway 161. The MGBG is located between storage bunkers 1409 and 1407. The site is located atop a broad ridge with gently rolling topography and approximately 5 to 10 feet of relief from the southeastern to northwestern boundary of the site. The MGBG was used between the end of WWII and 1956 for disposal of mustard munitions and other items. Several burial sites were marked or remarked in 1955 and 1956 with signs detailing the contents, or in some cases, the authority under which burial was performed. However, the signs gave little indication of the number of items actually buried. Historical documentation relative to the total amount and types of material disposed at the site is inconclusive. However, it is known that the site was used in the disposal of some chemical weapons and chemical waste.

Documentation has shown that efforts to exhume the weapons were conducted in 1974 and 1980. During these two separate excavation procedures, sixteen aerial bomb casings and a quantity of Thorium Nitrate were unearthed. Fourteen of the sixteen items (bomb cases) were empty except for mud. In addition, no trace of Mustard Gas was found in the soil surrounding the bomb cases. However, one bomb casing contained approximately ½ gallon and one bomb contained approximately 3 gallons of the mustard material. Various non-intrusive magnetometer studies have been conducted at the site to locate burial sites. In addition, three groundwater investigative projects were conducted in 1981, 1982, and 1983. The results show that the groundwater contaminants are comprised mainly of chlorinated solvents. The most recent groundwater sampling conducted in 2001 by TtNUS confirmed this. Field screening and laboratory analysis for radiation and mustard gas yielded radiation levels comparable to background levels and no detectable concentrations of mustard gas based on data collect from samples in 2001. Additionally, no UXO was encountered during implementation of UXO avoidance measures in 2001.

4.0 SCOPE OF WORK

The following describes the specific tasks that are to be conducted as part of this scope of work. Only the tasks listed below are covered by this HASP. Other tasks will be considered a considered a change in scope requiring modification of this document. In such an instance, the TOM or a designated representative will submit information describing the planned tasks, along with an request to modify. The TOM or a designated representative will submit requested modifications to this document to the HSM.

The following activities will be completed in the execution of this scope of work. These are as follows:

- Mobilization and demobilization
- Monitoring well installation (using rotosonic or hollow stem auger) and monitoring well development of new and existing wells.
- Collection of boring (rock) cores
- Multi media sampling including groundwater and Investigative Derived Waste (IDW)
- Test pitting (and sampling from the backhoe bucket)
- Hand augering (subsurface soils)
- Decontamination of equipment (sampling and heavy equipment)
- Geographical surveying

For more detailed description of these tasks, refer to the Sampling and Analysis Plan (SAP) and/or the Work Plan (WP).

5.0 TASK HAZARDS ASSESSMENTS AND CONTROL MEASURES

This section addresses the anticipated hazards, recommended control measures, air-monitoring recommendations, required Personal Protective Equipment (PPE), and decontamination measures for each planned site task. This section will be modified and incorporated into this document if new or additional tasks are performed at the site. This information is summarized in Table 5-1.

The FOL/SSO will utilize Table 5-1as the primary reference for completion of the task-specific Safe Work Permits. The Safe Work Permit is the primary tool for accomplishing safety and health reviews with field personnel prior to the initiation of any task. These permits are to be completed by the FOL/SSO and reviewed with field personnel at the beginning of each day's activities.

5.1 GENERAL SAFE WORK PRACTICES

In addition to the task-specific work practices identified on Table 5-1, the following general safe work practices are to be followed when conducting work involving known and unknown site hazards. These safe work practices establish a pattern of general precautions and measures for reducing risks associated with hazardous site operations. This list is not inclusive and may be amended as necessary.

- Eating, drinking, chewing gum or tobacco, taking medication, or smoking in contaminated or potentially contaminated areas or where the possibility for the transfer of contamination exists is prohibited.
- Wash hands and face thoroughly upon leaving a contaminated or suspected contaminated area. A thorough shower and washing must be conducted as soon as possible if excessive skin contamination occurs.
- Avoid contact with potentially contaminated substances. Do not walk through puddles, pools, mud, or other such areas. Avoid, whenever possible, kneeling on the ground or leaning or sitting on equipment. Do not place monitoring equipment on potentially contaminated surfaces.
- Be familiar with, knowledgeable of, and adhere to instructions in the site-specific HASP.
- Be aware of the location of the nearest telephone and emergency telephone numbers. See Section 2.0, Table 2-1.
- Attend briefings on anticipated hazards, equipment requirements, SWPs, emergency procedures, and communication methods before going on site.

- Plan and delineate entrance, exit, and emergency escape routes. See Section 2.0.
- Rehearse unfamiliar operations prior to implementation.
- Establish appropriate Safety Zones including Support, Contamination Reduction, and Exclusion Zones.
- Minimize the number of personnel and equipment in contaminated areas (such as the Exclusion Zone). Non-essential vehicles and equipment should remain within the Support Zone.
- Establish appropriate decontamination procedures for leaving the site.
- Immediately report injuries, illnesses, and unsafe conditions, practices, and equipment to the Site Safety Officer (SSO).
- Matches and lighters are restricted from entering in the Exclusion Zone or Contamination Reduction Zone.
- Observe coworkers for signs of toxic exposure and heat or cold stress.
- Inform co-workers of potential symptoms of illness, such as headaches, dizziness, nausea, or blurred vision.

5.2 DRILLING SAFE WORK PRACTICES

The following Safe Work Practices are to be followed when working in or around Drill Rig Operations.

5.2.1 Before Drilling

- Identify underground utilities and buried structures before drilling. Use the Utility Locating and Excavation Clearance Standard Operating Procedure.
- Drill rigs will be inspected by the SSO or designee prior to the acceptance of the equipment at the site and prior to the use of the equipment. Repairs or deficiencies identified will be corrected prior to use. The inspection will be accomplished using the Equipment Inspection Checklist. Inspection frequencies will be once every 10 day shift or following repairs.
- The work area around the point of operation will be graded to the extent possible to remove any trip hazards near or surrounding rotating equipment.

- The drillers helper will establish an equipment staging and laydown plan. The purpose of this is to keep the work area clear of clutter and slips, trips, and fall hazards. Mechanisms to secure heavy objects such as drill flights will be provided to avoid the collapse stacked equipment.

- Potentially contaminated tooling will be wrapped in polyethylene sheeting for storage and transport to the centrally located decontamination unit.

5.2.2 During Drilling

- Secure frayed or loose clothing, hair, and jewelry when working with rotating equipment.

- Minimize contact to the extent possible with contaminated tooling and environmental media.

- Support functions (sampling and screening stations) will be maintained a minimum distance from the drill rig of the height of the mast plus five feet to remove these activities from within physical hazard boundaries.

- Only qualified operators and knowledgeable ground crew personnel will participate in the operation of the drill rig.

- In order to minimize contact with potentially contaminated tooling and media and to minimize lifting hazards, multiple personnel should move auger flights and other heavy tooling.

- Only personnel absolutely essential to the work activity will be allowed in the exclusion zone. Site visitors will be escorted.

5.2.3 After Drilling

- Equipment used within the exclusion zone will undergo a complete decontamination and evaluation by the SSO to determined cleanliness prior to moving to the next location, exiting the site, or prior to down time for maintenance.

- Motorized equipment will be fueled prior to the commencement of the days activities. During fueling operations equipment will be shutdown and bonded to the fuel provider.

- When not in use drill rigs will be shutdown, emergency brakes set, and wheels chocked.

- Areas subjected to subsurface investigative methods will be restored to equal or better condition than original to remove any contamination brought to the surface and to remove any physical hazards. In situations where these hazards cannot be removed these areas will be barricaded to minimize the impact on field crews working in the area.

TABLE 5-1
TASKS/HAZARDS/CONTROL MEASURES
NAVAL SURFACE WARFARE CENTER CRANE DIVISION
CRANE, INDIANA

Tasks/Operation/ Locations	Anticipated Hazards	Recommended Control Measures	Hazard Monitoring - Type and Action Levels	Personal Protective Equipment *(Items in italics are deemed optional as conditions or the FOL or SSO require.)*	Decontamination Procedures
Mobilization/ Demobilization	***Chemical hazards:*** 1) Solutions, buffers and other chemicals brought on to the site. ***Physical hazards:*** 2) Lifting (strain/muscle pulls) 3) Pinches and compressions/Struck by 4) Slips, trips, and falls 5) Heavy equipment hazards (rotating equipment, hydraulic lines, etc.) 6) Vehicular and foot traffic 7) Ambient temperature extremes (heat/cold stress) ***Natural hazards:*** 8) Insect/animal bites and stings, poisonous plants, etc. 9) Inclement weather	1) The on-site Hazard Communication Program will be followed. All chemicals brought onto the site by Tetra Tech NUS and subcontractor personnel will be inventoried and have an MSDS on site. - All personnel will be required to review the appropriate MSDS's, prior to the use of a specified chemical substance. This direction should also be communicated on the Safe Work Permit completed for this task. - Preparing accurate Chemical Inventory List (Entries will match chemicals brought on-site, as the names appear on the MSDS) This list, which also includes quantities and storage locations will be provided to NSWC Crane Emergency Response Units. - Maintaining MSDS's in a central location, accessible to all personnel. - All containers will have labels specifying the following information: a. Chemical Identity (As it appears on the label, MSDS, and Chemical Inventory List) b. Appropriate Warning (i.e., Eye and skin irritation, flammable, etc.) c. Manufacturer's Name Address and Phone Number 2) Use machinery or multiple personnel for heavy lifts. Use proper lifting techniques - Lift with your legs, not your back, bend your knees move as close to the load as possible, and ensure good hand holds are available. - Minimize the horizontal distance to the center of the lift to your center of gravity. Minimize turning and twisting when lifting as the lower back is especially vulnerable at this time. Break lifts into steps if the vertical distance (from the start point to the placement of the lift) is excessive. Plan your lifts – Place heavy items on shelves between the waist and chest; lighter items on higher shelves. Periods of high frequency lifts or extended duration lifts should provide sufficient breaks to guard against fatigue and injury. In determining whether you can lift an item several factors must be considered, these are as follows: - Maximum weight lifted by a single person should not exceed 70 pounds. Items over 70 pounds or the amount you feel you can confidently lift up to 70 pounds should define a point where assistance in the lift is sought. - Level of demand – Weight + frequency & duration. - Area available to maneuver the lift. - Area of the lift – Work place clutter, slippery surfaces - Overall physical condition 3) Keep any machine guarding in place. Do not modify tooling without manufacturer's expressed permission. - Avoid moving parts. - Use tools or equipment where necessary to avoid contacting pinch points. - When staging equipment, insure all stacked loads, shelving, are adequately secure to avoid creating a hazard from falling objects. 4) Preview work locations for unstable/uneven terrain. - Cover, guard and barricade all open pits, ditches, and floor opening as necessary. The FOL and the SSO during site surveys and site preparation should identify these potential hazards. 5) All equipment will be - Inspected in accordance with OSHA and manufacturer's design. - Operated by knowledgeable operators and ground crew. 6) Traffic and equipment considerations are to include the following: - Establish safe zones of approach (i.e. length of boom or mast + 5 feet). - Foot and vehicular traffic routes shall be well defined - Secure all loose articles. - All self-propelled equipment shall be equipped with movement warning systems. - All activities are to be conducted consistent with the site requirements. 7) Wear appropriate clothing for weather conditions. Provide acceptable shelter and liquids for field crews. Additional information regarding heat and cold stress is provided in the TtNUS Health and Safety Guidance Manual Section 4.0. 8) Avoid nesting areas, use repellents. Report potential hazards to the SSO. 9) Suspend or terminate operations until directed otherwise by SSO.	Visual observation of work practices by the SSO to minimize potential physical hazards (i.e., improper lifting, unsecured loads, etc.).	Level D - (Minimum Requirements) - Standard field attire (Sleeved shirt; long pants) - Steel toe safety shoes or boots - *Safety glasses* - *Hardhat (when overhead hazards exists, or identified as a operation requirement)* - *Reflective vest for high traffic areas* - *Hearing protection for high noise areas, or as directed on an operation by operation scenario.*	Not required.

TABLE 5-1
TASKS/HAZARDS/CONTROL MEASURES
NAVAL SURFACE WARFARE CENTER CRANE DIVISION
CRANE, INDIANA

Tasks/Operation/ Locations	Anticipated Hazards	Recommended Control Measures	Hazard Monitoring - Type and Action Levels	Personal Protective Equipment *(Items in italics are deemed optional as conditions or the FOL or SSO require.)*	Decontamination Procedures
Decontamination of Sampling and Heavy Equipment	***Chemical hazards:*** 1) Previous analytical data identified the following compounds as contaminants of concern in the groundwater: Chlorinated Solvents - 79-34-5 1,1,2,2-Tetrachloroethane 79-01-6 Trichloroethene (TCE) Table 6-1 provides additional information about these contaminants of concern. 2) Decontamination fluids - Liquinox (detergent); isopropanol (decontamination solvent) ***Physical hazards:*** 3) Lifting (strain/muscle pulls) 4) Noise in excess of 85 dBA 5) Flying projectiles 6) Struck by 7) Slips, trips, and falls ***Natural hazards:*** 8) Inclement weather	1) and 2) Use protective equipment to minimize contact with site contaminants and hazardous decontamination fluids. Obtain manufacturer's MSDS for any decontamination fluids used on-site. Solvents may only be used in well-ventilated areas, such as outdoors. Use appropriate PPE as identified on MSDS or within this HASP. All chemicals used must be listed on the Chemical Inventory for the site, and site activities must be consistent with the Hazard Communication Program in Section 5.0 of the TtNUS Heath and Safety Guidance Manual. 3) Use multiple persons where necessary for lifting and handling heavy equipment, such as auger flights for decontamination purposes. - Use proper lifting techniques as described in Table 5-1, Mobilization/Demobilization. 4) Wear hearing protection when operating the steam cleaner. Sound pressure levels measured during the operation of similar pieces of equipment indicate a range of 87 to 93 dBA. 5) Use eye and face protective equipment when operating the steam cleaner. All other personnel must be restricted from the area. In addition to minimize hazards (flying projectiles, water lacerations and burns) associated with this operation, the following controls will be implemented - Thermostat control to regulate the temperature levels. - Visual evaluations of hoses and fittings for structural defects - Construct deflection screens as necessary to control overspray and to guard against dispersion of contaminants driven off by the spray. 6) Ensure wash and drying racks are of suitable construction to support heavier items (such as auger flights) and will secure them against falling. 7) The decontamination pad should be constructed to contain wash waters generated during decontamination procedures. Temporary decontamination pads are usually 10-30 mil polyethylene or polyvinyl chloride tarp construction. Although these items when used as a liner offer containment, they also present a slipping hazard. When these temporary liners are used, it is recommended that a light coating of sand be spread over the walking surface to provide traction. - In addition, adequate slope should be provided to the pad to permit drainage away from the object being cleaned. The collection point for wash waters should be of adequate distance that the decon workers do not have to walk through the wash waters while completing their tasks. - Hoses should be gathered when not in use to eliminate potential tripping hazards. 8) Suspend or terminate operations until directed otherwise by SSO.	Use visual observation and real-time monitoring instrumentation to ensure all equipment has been properly cleaned of contamination. Screen dried equipment with a PID/FID. If any elevated readings (i.e., above background) are observed, perform decontamination process again and re-screen. Repeat until no elevated PID/FID readings are noted. Levels of protection will be initiated based on positive detections during field operational activities.	**For Heavy Equipment** This applies to steam cleaning operations and soap/water wash and rinse procedures. Level D Minimum requirements: - Standard field attire (Long sleeve shirt; long pants) - Steel toe safety shoes or boots - Chemical resistant boot covers - Nitrile outer gloves - Safety glasses underneath a splash shield - Hearing protection (plugs or muffs) - Hooded PVC Rainsuits or PE or PVC coated Tyvek **For sampling equipment** (trowels, bailers, etc.), the following PPE is required Level D Minimum requirements - - Standard field attire (Long sleeve shirt; long pants) - Steel toe safety shoes or boots - Nitrile inner gloves (surgical gloves) - Safety glasses In the event of overspray of chemical decontamination fluids, Use PVC Rainsuits or PE or PVC coated Tyvek as necessary. **Note:** The Safe Work Permit(s) for this task will be issued at the beginning of each day to address the tasks planned for that day. As part of this task, additional PPE may be assigned to reflect site-specific conditions or special considerations or conditions associated with any identified task.	**Personnel Decontamination** will consist of removing outer layers of disposable PPE and washing the hands and face prior to performing hand to mouth activities such as eating, smoking, etc. Any reusable PPE will be go be cleaning with soap and water and allowed to dry completely. **Equipment Decontamination** - All heavy equipment decontamination will take place at a centralized decontamination pad utilizing a steam cleaner. Heavy equipment will have the wheels and tires cleaned along with any loose debris removed, prior to transporting to the central decontamination area. All site vehicles will have restricted access to exclusion zones, and have their wheels/tires sprayed off as not to track mud onto the roadways servicing this installation. Roadways shall be cleared of any debris resulting from the onsite activity. **Sampling Equipment Decontamination** Sampling equipment will be decontaminated as per the requirements in the Sampling and Analysis Plan and/or Work Plan. All equipment used in the exclusion zone will require a complete decontamination between locations and prior to removal from the site. The FOL or the SSO will be responsible for evaluating equipment arriving on-site, leaving the site, and between locations. No equipment will be authorized access, exit, or movement to another location without this evaluation.
Surveying – Geographical	***Chemical hazards:*** Exposure to site contaminants is anticipated to be unlikely given the nature of this task. ***Physical hazards:*** 1) Slips, trips, and falls 2) Ambient temperature extremes (cold stress ***Natural hazards:*** 3) Inclement weather 4) Insect/animal bites or stings, poisonous plants, etc.	1) Preview work locations and site lines for uneven and unstable terrain. Clear necessary vegetation, establish temporary means for traversing hazardous terrain (i.e., rope ladders, etc.) 2) Wear appropriate clothing for weather conditions. Acceptable shelter and liquids for field crews. 3) Suspend or terminate operations until directed otherwise by SSO 4) Avoid nesting areas, use repellents. Report potential hazards to the SSO. Relative to the time of the year this operation is conducted, certain natural hazards may have little bearing.	No air monitoring is needed given the unlikelihood that airborne contaminants will be present. The potential for exposure to site contaminants during this activity is considered minimal.	Surveying activities shall be performed in Level D protection Level D Protection consists of the following: - Standard field dress including sleeved shirt and long pants - Steel toe safety shoes or boots - Safety glasses, hard hats (if working near machinery or within brushy areas) - Snake chaps for heavily wooded area where encounters are likely. - Tyvek coveralls may be worn to provide additional protection against poisonous plants and insects, particularly ticks. Work gloves may be worn if desired. Note: The Safe Work Permit(s) for this task will be issued at the beginning of each day to address the tasks planned for that day. As part of this task, additional PPE may be assigned to reflect site-specific conditions or special considerations or conditions associated with any identified task. Protective levels may require modification should this activity be required to be conducted within a controlled zone due to an on-going operation.	Personnel Decontamination - A structured decontamination is not required as the likelihood of encountering contaminated media is considered remote. However, survey parties should inspect themselves and one another for the presence of ticks when exiting wooded areas, grassy fields, etc. This action will be Used to prevent attachment and to stop the transfer of these insects into vehicles, homes, and offices.

TABLE 5-1
TASKS/HAZARDS/CONTROL MEASURES
NAVAL SURFACE WARFARE CENTER CRANE DIVISION
CRANE, INDIANA

Tasks/ Operation/ Locations	Anticipated Hazards	Recommended Control Measures	Hazard Monitoring - Type and Action Levels	Personal Protective Equipment *(Items in italics are deemed optional as conditions or the FOL or SSO require.)*	Decontamination Procedures
Multi-media sampling, including subsurface soils from hand augering, and ground water. This task also includes collection of samples out of excavator bucket during test pit operations, and well development of existing and newly installed ground water monitoring wells.	***Chemical hazards:*** 1) Previous analytical data identified the following compounds as contaminants of concern in the groundwater: 1,1,2,2-Tetrachloroethane 79-01-6 Trichloroethene (TCE) Table 6-1 provides additional information about these contaminants of concern. 2) Transfer of contamination into clean areas ***Physical hazards:*** 3) Noise in excess of 85 dBA 4) Test Pit hazards 5) Energized systems (contact with underground or overheads utilities) 6) Lifting (strain/muscle pulls) 7) Pinches and compressions 8) Slips, trips, and falls 9) Ambient temperature extremes (heat/cold stress) 10) Vehicular and foot traffic 11) Contact with UXO 12) Radiological contamination ***Natural hazards:*** 12) Insect/animal bites and stings, poisonous plants, etc. 13) Inclement weather	1) Use real-time monitoring instrumentation, action levels, and identified PPE to control exposures to potentially contaminated media (air, water, soils, etc.). 1 2) Decontaminate all equipment and supplies between sampling locations and prior to leaving the site. See decontamination of heavy and sampling equipment for direction in this task. 3) When sampling at an operating Hollow Stem Auger or test pit excavator use hearing protection. The use of hearing protection outside of 25 feet from the rig should be incorporated under the following condition: - If you have to raise your voice to talk to someone who is within 2 feet of your location, hearing protection should be worn. 4) While sampling at test pit operations, the sample will be extracted from the bucket of the excavator. **Under no circumstances will anyone be permitted to enter the test pit(s).** The bucket will be moved away from the test pit edge (>5 feet) to permit safe access to the bucket. The sampler shall not place himself/herself between the bucket and an immovable object or the bucket and the test pit if at all possible. The operator is to disengage controls to avoid accidental contact and thereby striking the sampler. Sampling will proceed in the following manner: - Scan the bucket content using a PID/FID. - Select sample location based on elevated readings or material aspects. This task will occur concurrently with the excavation task. The hazards and controls specified for that task also apply here. - See Attachment V Utility Clearance SOP 5) All utility clearances shall be obtained, in writing, prior to subsurface activities. Prior to subsurface investigations, the locations of underground utilities will be identified and marked. 6) Use machinery or multiple personnel for heavy lifts. Use proper lifting techniques (See Lifting Mobilization/Demobilization, Table 5-1). 7) Avoid moving parts, do not remove any machine guarding. - Use tools or equipment where necessary to avoid contacting pinch points. - A remote sampling device must be used to sample drill cuttings near rotating tools. The equipment operator shall shutdown machinery if the sampler is near moving machinery parts. - Remove any snag points - Follow Safe Work Practices and permits for drilling procedures when working in and around the drill rigs. 8) Preview work locations for unstable/uneven terrain. - Ruts, roots, and other tripping hazards should be eliminated from around the rotating apparatus to minimize trips and falls when approaching the rotating tooling. - Use multiple persons and small loads to pack sampling resources to remote locations. - Construct rope ladders and other engineered assistance for traversing hills and inclines > 45°. 9) Wear appropriate clothing for weather conditions. Provide acceptable shelter and liquids for field crews. 10) Traffic and equipment considerations are to include the following: - Establish safe zones of approach (i.e. Mast or Boom + 5 feet). See Section 9 of the HASP for specific safety zones and established clearance recommendations. - All self-propelled equipment shall be equipped with movement warning systems. - When sampling along roadways, use signs to indicate men working as well flag persons, as necessary. Personnel working in and around any established traffic patterns should wear high visibility vests to increase visual recognition. 11) Work areas are outside of the MGBG where mustard gas bombs were once buried. Therefore, UXO hazards are not anticipated to be encountered. However, verification through the Base Contact will be necessary. If any suspicious items are uncovered or encountered, the area will be marked, personnel will leave the area, and appropriate site contacts will be notified. 12) Wear TLD badges when in/around Primary Burial Area 13) Avoid nesting areas, use repellents approved by the FOL. Report potential hazards to the SSO. 14) Suspend or terminate operations until directed otherwise by the SSO.	Samples will be screened for VOCs using direct read instrumentation. **VOCs Screening** A direct reading Photoionization Detector (PID) equipped with a 10.6 eV lamp, or a Flameionization Detector (FID) , will be used to screen samples and to detect the presence of any potential volatile organics. Source monitoring of the sample collection area will be conducted at regular intervals to be determined by the SSO. Positive sustained results at a source or downwind location(s) which may impact operations crew will require the following actions: - Monitor the breathing zone of at-risk and downwind Personnel. Any sustained readings (greater than 1 minute in duration) above 5 ppm in the breathing zone of the at-risk Personnel requires site activities to be suspended and site personnel to retreat to an unaffected area, notify PHSO. - Work may only resume if airborne readings in worker breathing zone return to below 5 ppm or based on the use of identified respiratory protection.	Level D protection will be utilized for the following sampling activities. Surface soils, surface water, groundwater, sediments, and seeps Level D - (Minimum Requirements) - Standard field attire (Sleeved shirt; long pants) - Steel toe safety shoes or boots - Safety glasses - Surgical style gloves *(double-layered if necessary)* *- Reflective vest for high traffic areas* *- Hardhat (when overhead hazards exists, or identified as a operation requirement)* *- Tyvek coveralls and disposable boot covers if surface contamination is present or if the potential for soiling work attire exists.* *- Hearing protection for high noise areas, or as directed on an operation by operation scenario.* **Note:** The Safe Work Permit(s) for this task will be issued at the beginning of each day to address the tasks planned for that day. As part of this task, additional PPE may be assigned to reflect site-specific conditions or special considerations or conditions associated with any identified task.	**Personnel Decontamination** Personal decontamination will vary based on the type of sampling conducted. These are as follows: Supporting subsurface investigations at the drill rig. - Decontamination will be the same as prescribed for the drilling activity Sampling surface water, groundwater, and sediments, the following provisions will apply - Upon completion of the sampling dedicated trowels, tubing, etc. will be bagged for transport back to the central decontamination area. - PPE (gloves) will be removed and also bagged for disposal. - Handi-Wipes or similar product will be used to clean hands prior to moving to the next location. **Equipment Decontamination** All equipment used in remote sampling locations will be brought back to the central decontamination area for decontamination and re-use or decontamination and gross removal of contamination prior to disposal. **Note:** Field screening instruments will be wrapped to minimize the necessary decontamination except for wiping down parts which are necessary to expose to the external environment. The equipment reference above is largely directed at hand tools. Decontamination of equipment (sampling and hand tools) will proceed as indicated in the Sampling and Analysis Plan and/or Work Plan.

TABLE 5-1
TASKS/HAZARDS/CONTROL MEASURES
NAVAL SURFACE WARFARE CENTER CRANE DIVISION
CRANE, INDIANA

Tasks/Operation/ Locations	Anticipated Hazards	Recommended Control Measures	Hazard Monitoring - Type and Action Levels	Personal Protective Equipment *(Items in italics are deemed optional as conditions or the FOL or SSO require.)*	Decontamination Procedures
Rock and Soil Boring/Monitoring Well Installation including rotosonic or HSA methods and hand augering.	***Chemical hazards:*** 1) Previous analytical data identified the following compounds as contaminants of concern in the groundwater: 79-34-5 1,1,2,2-Tetrachloroethane 79-01-6 Trichloroethene (TCE) Table 6-1 provides additional information about these contaminants of concern. 2) Transfer of contamination into clean areas or onto persons ***Physical hazards:*** 3) Hand augering hazards 4) Heavy equipment hazards (pinch/compressions points, rotating equipment, hydraulic lines, etc.) 5) Noise in excess of 85 dBA 6) Energized systems (contact with underground or overhead utilities) 7) Lifting (strain/muscle pulls) 8) Slips, trips, and falls 9) Vehicular and foot traffic 10) Ambient temperature extremes 11) Flying projectiles 12) Contact with UXO 13) Contact with radiological contamination ***Natural hazards:*** 14) Insect/animal bites and stings, poisonous plants, etc. 15) Inclement weather	1) Use real-time monitoring instrumentation, action levels, and identified PPE to control exposures to potentially contaminated media (air, water, soils, etc.). Generation of dusts should be minimized. If airborne dusts are observed, area wetting methods may be used. If area wetting methods are not feasible, activities must be suspended until dust levels subside, or until an acceptable alternative control method can be selected. -Verify monitoring well construction materials (grout, bentonite, sand, and decontamination solutions) MSDS are included in Hazard Communication Program. Ensure personnel constructing wells have reviewed the MSDS and understand potential health effects. 2) Decontaminate all equipment and supplies between boreholes and prior to leaving the site. Wrap all portable equipment to be transported across clean areas of the site to the central decontamination pad. 3) - Properly assemble soil boring equipment, keep hands and feet away from pinch points. Keep the work area clear of clutter. 4) All equipment will be: - Inspected in accordance with Federal safety and transportation guidelines, OSHA (1926.600.601.602), and manufacturer's design. All inspections will be documented using the Equipment Inspection Checklist. - Operated and supported by knowledgeable operators, and ground crew. - Used within safe work zones, with routes of approach clearly demarcated. All personnel not directly supporting this operation will remain at least 25 feet from the point of operation. See Section 9.0 of this HASP. This will be the area identified as the exclusion zone. In addition to equipment considerations, the following safe operating procedures will be incorporated: - Hydraulic masts or other projecting devices shall be at least 20 feet from overhead power sources and a minimum of 3 feet from underground utilities. - Hand signals will be established prior to the commencement of the operation. - A remote sampling device must be used to sample drill cuttings near rotating tools - Only manufacturer-approved equipment may be used in conjunction with equipment repair procedures (e.g., flight connectors). - Work areas will be kept clear of clutter. - Secure all loose articles to avoid possible entanglement during coring activities. - All self-propelled equipment shall be equipped with movement warning systems. - All personnel will be instructed in the location and operations of the emergency shut-off device(s). This device will be tested initially (and then periodically) to ensure its operational status. - Areas will be inspected prior to the movement of the drill rig and support vehicles to eliminate any physical hazards. This will be the responsibility of the FOL and/or SSO. - The drill rig and support vehicles will be moved no closer than 3 feet to unsupported side-walls of excavations and embankments. Available outriggers or other supports will used on steep terrain. 5) Hearing protection will be used during drilling operations. Boundaries will be established to limit noise hazard. Height of the mast + 5 feet or a minimum of 25 feet is normal. Excessive noise levels are being approach when you have to raise your voice to talk to someone within 2 feet of your location . 6) All drilling activities will proceed in accordance with the Utility Locating and Excavation Clearance SOP. All utility clearances will be obtained, in writing, and locations identified and marked prior to activities. Overhead utilities will also be identified. 7) Use machinery or multiple personnel for heavy lifts. Use proper lifting techniques. Prior to rock core sampling, establish procedures to safely lift and maneuver the samples. 8) Preview work locations for unstable/uneven terrain. Some locations are on steep terrain that pose fall hazards and instability of equipment. 9) Use traffic-warning signs, flag persons, and high visibility vests as determined by the SSO when working in or along traffic thoroughfares. 10) Wear appropriate clothing for weather conditions. Acceptable shelter and liquids for field crews. 11) Wear eye protection and hard hat when the drill rig is operating. Restrict all others from the area. 12) Work areas are outside of the MGBG where mustard gas bombs were once buried. Therefore, UXO hazards are not anticipated to be encountered. However, verification through the Base Contact will be necessary. If any suspicious items are uncovered or encountered, the area will be marked, personnel will leave the area, and appropriate site contacts will be notified. leave the area and notify appropriate site contacts. 13) Wear TLD badge when in/around Primary Burial Area 14) Avoid nesting areas, use repellents. Report potential hazards to the SSO. Relative to the time of the year this operation is conducted, certain natural hazards may have little bearing. 15) Suspend or terminate operations until directed otherwise by SSO.	A direct reading Photoionization Detector (PID) equipped with a 10.6 eV lamp, or a Flameionization Detector (FID) will be used to screen samples and to detect the presence of any potential volatile organics. Source monitoring of the sample collection area will be conducted at regular intervals to be determined by the SSO. Positive sustained results at a source or downwind location(s) which may impact operations crew will require the following actions: - Monitor the breathing zone of at-risk and downwind personnel. Any sustained readings (greater than 1 minute in duration) above 5 ppm in the breathing zone of the at-risk Personnel requires site activities to be suspended and site personnel to retreat to an unaffected area, notify PHSO. - Work may only resume if airborne readings in worker breathing zone return to below 5 ppm or based on the use of identified respiratory protection. Site contaminants may adhere to or be part of airborne dusts or particulates generated during site activities. Generation of dusts should be minimized to avoid inhalation of contaminated dusts or particulates. Evaluation of dust concentrations will be performed by observing work conditions for visible dust clouds. Potential exposure to contaminated dust will be controlled using water suppression, by avoiding dust plumes, or evacuating the operation area until dust subsides.	Level C - (Minimum Requirements) Initiated **Subsurface Soils - Borings and well advancement** **Screening and Sampling Staff** - Standard field attire including sleeved shirt and long pants - Steel toe safety shoes or boots - Safety glasses - Surgical style gloves *(double-layered if necessary)* - Hard hat (when overhead hazard exists) - Tyvek® coveralls; Impermeable garments if the potential exists for soiling or saturating. - Hearing protection for high noise areas - *Reflective vest for traffic areas* **Drillers** - Standard field attire including sleeved shirt and long pants - Steel toe safety shoes or boots - Safety glasses - Nitrile gloves - Hard hat (when overhead hazard exists) - Impermeable outer garments such as PVC Rain-suit or Saranex®, PE coated Tyvek® due to contact with contaminated tooling. Tyvek® coveralls with Butyl sleeves and apron is acceptable due to heat stress. - Hearing protection for high noise areas - *Reflective vest for traffic areas* **Note:** The Safe Work Permit(s) for this task will be issued at the beginning of each day to address the tasks planned for that day. As part of this task, additional PPE may be assigned to reflect site-specific conditions or special considerations or conditions associated with any identified task. Protective levels may require modification should this activity be required to be conducted within a controlled zone due to an on-going operation.	**Personnel Decontamination** Personal decontamination will vary based on the type of sampling conducted. These are as follows: Sampling surface water, groundwater, sediments, and seeps the following provisions will apply - Upon completion of the sampling dedicated tubing, etc. will be bagged for transport back to the central decontamination area. - PPE (gloves) will be washed, removed and also bagged for disposal. - Handi-Wipes or similar product will be used to clean hands prior to moving to the next location, when access to soap and water is not feasible due to the location. - In all instances hands and face washing will be conducted upon arrival back at the central decontamination unit prior to scheduled breaks and when leaving the site. **Equipment Decontamination** - All heavy equipment decontamination will take place at a centralized decontamination pad utilizing a steam cleaner. Heavy equipment will have the wheels and tires cleaned along with any loose debris removed, prior to transporting to the central decontamination area. All site vehicles will have restricted access to exclusion zones, and have their wheels/tires sprayed off as not to track mud onto the roadways servicing this installation. Roadways shall be cleared of any debris resulting from the onsite activity. **Sampling Equipment Decontamination** Sampling equipment will be decontaminated as per the requirements in the Sampling and Analysis Plan and/or Work Plan. All equipment used in the exclusion zone will require a complete decontamination between locations and prior to removal from the site. The FOL or the SSO will be responsible for evaluating equipment arriving on-site, leaving the site, and between locations. No equipment will be authorized access, exit, or movement to another location without this evaluation.

TABLE 5-1
TASKS/HAZARDS/CONTROL MEASURES
NAVAL SURFACE WARFARE CENTER CRANE DIVISION
CRANE, INDIANA

Tasks/Operation/ Locations	Anticipated Hazards	Recommended Control Measures	Hazard Monitoring - Type and Action Levels	Personal Protective Equipment *(Items in italics are deemed optional as conditions or the FOL or SSO require.)*	Decontamination Procedures
Excavation of Test Pits.	***Chemical hazards:*** 1) Previous analytical data identified the following compounds as contaminants of concern in the groundwater: 79-34-5 1,1,2,2-Tetrachloroethane 79-01-6 Trichloroethene (TCE) Table 6-1 provides additional information about each of the identified contaminants of concern. 2) Transfer of contamination into clean areas or onto persons. ***Physical hazards:*** 3) Moving machinery 4) Collapse of the excavation 5) Energized systems 6) Noise 7) Site Control - Foot and equipment traffic 8) Inclement weather and Cold Stress 9) Contact with radiological contamination	1) Based on historical information particulates or particulate bound contaminants appear to present the greatest potential inhalation hazard to chemical contaminant exposure. To minimize this potential hazard the following control measures will be instituted - Use dust suppression such as area wetting to control particulates from becoming airborne due to mechanical generation. - Use good personal hygiene practices (avoid hand to mouth contact; wash hands and face when leaving the exclusion zone) - Use identified PPE and control exposures to potentially contaminated media (e.g., air, water, soils). - Use monitoring instruments to evaluated airborne concentrations of potential site contaminants. 2) Restrict the cross-use of equipment and supplies from remedial activities, handling clean fill, and general construction services without first going through a suitable decontamination. 3) To minimize potential equipment based physical hazards, the FOL/SSO will be required to - Inspect equipment in accordance with manufacturer's design, and documented as such using Equipment Inspection Checklist (Attachment II). This checklist is to be completed for each piece of equipment used at the site included in this operation. - Ensure that these pieces of equipment are operated by knowledgeable operators and ground crew, as applicable. - Establish safe routes of approach and work zones to prevent being struck by equipment. 4) To prevent and minimize hazards associated with the collapse of excavations, the following control measures will be instituted: **- Personnel are prohibited from entering excavations.** - All supplies, excavation spoils, clean fill, and vehicular traffic will be maintained at a minimum distance of 3 feet from the excavation, or 2 feet if a sidewall restraining device is employed. 5) To avoid hazards associated with energized systems, utility clearances shall be obtained prior to any excavation activities. (See Attachment V Utility Locating and Excavation Clearance SOP) - In addition to obtaining copies of the Utility Clearances the following measures should be employed: - Excavations shall proceed with extreme caution and proceed using cable and piping locators, fiberglass probes, or other geophysical detection methods to avoid utility damage. This sweeping of the excavation must proceed to a minimum depth of 4 feet. - Overhead clearance will be maintained as follows a) <50kV; 10 feet – minimum clearance b) 50 to 345 kV; 10 feet minimum clearance + 4 inches for extra kilovolt > 50 c) 345 to 750 kV; 16 feet minimum clearance Should applicable distances not be obtainable, activities cannot be performed until electric and other utilities leading to work areas are disconnected, re-routed, and/or shielded. 6) Excessive noise levels will be controlled through the use of hearing protection. Anticipated excessive noise level operations include the following: - Heavy equipment operation including Track-hoes and multi-axle vehicles. 7) Site Control measures for Foot/Traffic and equipment considerations are to include the following: - Establish safe zones of approach (i.e. Boom Swing + 5 feet). - Secure all loose articles to avoid possible entanglement. - All equipment shall be equipped with movement warning systems. - Employ safety belts and follow the site traffic rules. - Ground personnel working within or near the swing path of the track-hoe shall wear High Visibility Reflective Vests. - Minimize the number of persons within the exclusion zone to essential personnel only. - Only the ground spotter will direct the operator concerning excavation activities. 8) All operations will be temporarily suspended during inclement weather events such as electrical storms, or conditions where visibility is reduced. 9) Wear TLD badge when in/around Primary Burial Area	A direct reading Photoionization Detector (PID) equipped with a 10.6 eV lamp, or a Flameionization Detector (FID) will be used to screen samples and to detect the presence of any potential volatile organics. Source monitoring of the sample collection area will be conducted at regular intervals to be determined by the SSO. Positive sustained results at a source or downwind location(s) which may impact operations crew will require the following actions: - Monitor the breathing zone of at-risk and downwind personnel. Any sustained readings (greater than 1 minute in duration) above 5 ppm in the breathing zone of the at-risk Personnel requires site activities to be suspended and site personnel to retreat to an unaffected area, notify PHSO. - Work may only resume if airborne readings in worker breathing zone return to below 5 ppm or based on the use of identified respiratory protection. Site contaminants may adhere to or be part of airborne dusts or particulates generated during site activities. Generation of dusts should be minimized to avoid inhalation of contaminated dusts or particulates. Evaluation of dust concentrations will be performed by observing work conditions for visible dust clouds. Potential exposure to contaminated dust will be controlled using water suppression, by avoiding dust plumes, or evacuating the operation area until dust subsides.	Test pitting operations will be initiated in Level D protection. Level D protection constitutes the following minimum protection - Standard field dress (long pants, sleeved shirts) - Steel toe safety shoes or boots - Chemical resistant over-boots - Tyvek - *Reflective vests in high traffic areas.* These following items will be incorporated during excavation operations - Nitrile gloves with a cotton liner, - Hard-hat, safety glasses, and earplugs or muffs. - *PVC or PE coated Tyvek will be incorporated if there is a potential for saturation of work attire.* **Note:** The Safe Work Permit(s) for this task (see Attachment IV) will be issued at the beginning of each day to address the tasks planned for that day. As part of this task, additional PPE may be assigned to reflect site-specific conditions or special considerations or conditions associated with any identified task or more conservative requirements identified.	**Personnel Decontamination** -Will consist of a soap/water wash and rinse for outer protective equipment (e.g., boots, gloves, PVC splash suits, etc.). This will take place at an area adjacent to the test pitting operations bordering the support zone. This decontamination procedure for Level D protection will consist of - Equipment drop - Soap/water wash and rinse of reusable PPE (e.g., overboots), as applicable - Removal and disposal of disposable PPE items (gloves, disposable boot covers, etc) - Wash hands and face, leave contamination as applicable.

6.0 HAZARD ASSESSMENT

The following section provides information regarding the chemical, physical, and natural hazards associated with the sites to be investigated and the activities that are to be conducted as part of the scope of work. Table 6-1, which is included as part of this HASP, provides information on potential chemical contaminants, including exposure limits, symptoms of exposure, physical properties, and air monitoring and sampling data.

6.1 CHEMICAL HAZARDS

The potential health hazards associated with work to be conducted at NSWC Crane include inhalation, ingestion, and dermal contact with contaminants that may be present in ground water and shallow soils. Based on the site history and prior sampling efforts, volatile organic compounds (VOCs), primarily chlorinated solvents, have been identified as the primary site contaminants, including the following substances:

CAS Number	Substance
79-34-5	1,1,2,2-Tetrachloroethane
79-01-6	Trichloroethene (TCE)

Table 6-1 provides information on these compounds that may be present at the sites to be investigated. Included is information on the toxicological, chemical, and physical properties of these substances. It is anticipated that the greatest potential for exposure to site contaminants is during intrusive activities (soil borings, sampling, etc.). Exposure to these compounds is most likely to occur through inhalation or dermal contact with contaminated soil or water, or through ingestion via hand-to-mouth contact during soil disturbance activities. For this reason, PPE and basic hygiene practices (e.g., washing face and hands before leaving site) will be extremely important. Inhalation exposure will be avoided by using appropriate PPE and engineering controls where necessary.

Other sources of potential chemical exposure are decontamination fluids (e.g., Liquinox, isopropanol), and analytical preservatives. For any substances brought onto the site, the SSO is responsible for instituting a site-specific Hazard Communication Program and for collecting the appropriate Material Safety Data Sheets (MSDS) from the chemical manufacturers/suppliers. The SSO is also responsible for completing the Safe Work Permit for the decontamination task using the appropriate MSDS and for reviewing the contents of the MSDSs and Safe Work Permit with anyone who will use these substances.

TABLE 6-1

CHEMICAL, PHYSICAL, AND TOXICOLOGICAL DATA
NSWC CRANE, CRANE, INDIANA

Substance	CAS No.	Air Monitoring/Sampling Information		Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
1,1,2,2-Tetrachloroethane	79-34-5	PID: I.P. 11.1 eV, relative response ratio unknown. FID: 100% response with FID.	Air sample using charcoal tube; carbon disulfide desorption, GC/FID detection. Sampling and analytical protocol in accordance with OSHA Method #07, or NIOSH Method #1003.	OSHA: 5 ppm (skin) ACGIH; NIOSH: 1 ppm (skin) IDLH: 100 ppm	Odor threshold for this substance is 7.3 ppm. This level in comparison to the TLV is considered poor. Air purifying elements (organic vapor/acid gas) are recommended for escape purposes only. Combination units (APR/airline respirator) are recommended for working in concentrations in excess of the TLV. **Recommended glove:** Butyl rubber 4.6 hrs; solvent dipped, unsupported. PV alcohol >8.00 hrs; Teflon >15.20 hrs; Viton >8.00 hrs	**Boiling Pt:** 296°F; 147°C **Melting Pt:** -33 to -47°F; -36 to -43.8°C **Solubility:** 0.3% **Flash Pt:** Not available **LEL/LFL:** Not available **UEL/UFL:** Not available **Vapor Density:** Not available **Vapor Pressure:** 9 mmHg @ 86°F; 30°C **Specific Gravity:** 1.59 @ 77°F; 25°C **Incompatibilities:** Strong oxidizers, alkalis, fuming sulfuric acid, and chemically active metals. When heated to decomposition temperatures will emit toxic fumes of chlorine. **Appearance and Odor:** Colorless to pale yellow liquid with a pungent chloroform like odor.	Overexposure may result in CNS effects including depression, sleepiness, hallucinations, distorted perceptions, tremors(fingers), and stupor (narcosis). Systemically, symptoms may result in nausea, vomiting, abdominal pains, and cramps. May also irritate the eyes, skin, and mucous membranes. Chronic exposures may result in dermatitis, enlarged tender liver, jaundice, hepatitis, kidney, and lung damage.
Trichloroethylene	79-01-6	PID: I.P. 9.45 eV, 89% response with PID and 10.2 eV lamp. FID: 70% Response with FID.	Air sample using charcoal tube; carbon disulfide desorption; Sampling and analytical protocol shall proceed in accordance with OSHA Method #07, or NIOSH Method #1022 or #1003.	OSHA: 50 ppm Ceiling 200 ppm ACGIH: 50 ppm STEL 100 ppm NIOSH: 25 ppm IDLH: 1000 ppm	Inadequate - Odor threshold 82 ppm. APRs with organic vapor/acid gas cartridges may be used for escape purposes. Exceedances over the exposure limits require the use of positive pressure-demand supplied air respirator. **Recommended gloves:** PV Alcohol unsupported >16.00 hrs; Silver shield >6.00 hrs; Teflon >24.00 hrs; or Viton >24.00 hrs; Nitrile (Useable time limit 0.5 hr, complete submersion for the nitrile selection)	**Boiling Pt:** 188°F; 86.7°C **Melting Pt:** -99°F; -73°C **Solubility:** 0.1% @ 77°F; 25°C **Flash Pt:** 90°F; 32°C **LEL/LFL:** 8% @ 77°F; 25°C **UEL/UFL:** 10.5 @ 77°F; 25°C **Vapor Density:** 4.53 **Vapor Pressure:** 100 mmHg @ 90°F; 32° C **Specific Gravity:** 1.46 **Incompatibilities:** Strong caustics and alkalis, chemically active metals (barium, lithium, sodium, magnesium, titanium, and beryllium) **Appearance and Odor:** Colorless liquid with a chloroform type odor. Combustible liquid, however, burns with difficulty.	Central nervous system effects including euphoria, analgesia, anesthesia, paresthesia, headaches, tremors, vertigo, and somnolence. Damage to the liver, kidneys, heart, lungs, and skin have also been reported. Contact may result in irritation to the eyes, skin, and mucous membranes. Ingestion may result in GI disturbances including nausea, and vomiting NIOSH lists this substance a potential human carcinogen.

6.2 PHYSICAL HAZARDS

In addition to the chemical hazards discussed above, the following physical hazards may be present during the performance of the site activities.

- Slips, trips, and falls
- Cuts (or other injuries associated with hand tool use)
- Lifting (strain/muscle pulls)
- Ambient temperature extremes (cold and heat stress)
- Pinches and compressions
- Heavy equipment hazards (rotating equipment, hydraulic lines, etc.)
- Energized systems (contact with underground or overhead utilities)
- Vehicular and foot traffic
- Contact with Unexploded Ordnance (UXO)
- Noise in excess of 85 dBA
- Flying projectiles

Also, in and around the Primary Burial Area of the Mustard Gas Burial Ground, available information also indicates that some radiological concern may exist. While this is considered to be unlikely, personnel performing intrusive activities in this area will be required to wear thermoluminescent (TLD) badges which will be analyzed to document any exposure, or the absence of any such radiological exposure.

Information on the associated control measures for these hazards are discussed in Table 5-1 of this HASP. Some of these hazards and the associated control measures are discussed below.

6.2.1 Slips, Trips, and Falls

Conditions such as steep terrain and/or heavy vegetation may create an increased potential for slip, trip, and fall hazards. The following points will be utilized whenever possible:

- Identify and clear a safe approach to sample points.
- Establish anchor points and rope handrails for traversing/ascending/descending angles and slopes greater than 45% grade.
- Wear footwear with an adequate traction.
- Prepare work areas by removing tripping hazards (ruts, roots, debris). This is especially critical around rotating equipment, where a fall into the rotating apparatus could be life threatening.

6.2.2 Cuts or Other Injuries Associated with Hand Tool Use

The clearing of brush and vegetation will be performed using hand tools that may include machetes, brush axes, chainsaws and chippers. Chainsaws and chipper operations are discussed in detail in Table 5-1. However, the use of hand tools has only briefly discussed. The control measures presented below will help minimize the potential for physical and cutting hazards.

- Wear leather or heavy cotton work gloves when using tools to protect against blisters, cuts, or other hand injuries.
- Wear eye protection (safety glasses with side shields) to protect the eyes from twigs, sticks, or flying debris.
- Clear the immediate cutting area of personnel (radius of the tool swing area).
- Wear long pants and long-sleeved shirts to protect against abrasions.
- Wear hard hats if work will involve areas with overhead hazards (e.g., overhanging branches).
- Wear sturdy work boots.
- Inspect hand tools [i.e., shovel handles (cracks, splinters, etc.), brush hook handles and blade attachment points, etc.)
- Ensure hand tools are sharp to facilitate cutting action. This will avoid persons forcing the tool to cut and increasing potential hazards.
- Use the proper tool for the intended purpose. This to will avoid potential injury possibly created through improper use.

6.2.3 Contact with UXO

UXO hazards are unlikely to be encountered at the proposed areas where site investigations for this scope of work are to be conducted. However given the prior uses of the site and areas nearby the proposed investigation areas, there is a remote possibility that UXO could be encountered during operations. Activities will be conducted consistent with the UXO Procedures and SOP (see Attachment VI).

- Field personnel will practice UXO avoidance techniques.
  - Do not pick-up or kick any unknown materials.
  - Notify the EOD Specialist if you encounter unknown materials.
  - Where the potential exists for UXO materials the EOD Specialist will clear access routes and work areas.

- To minimize the risk of a UXO encounter, areas to be investigated will be cleared by the Base contact to verify that no UXO hazards exist.

- Although unlikely, if UXO hazards are determined to be a concern, the test pits will be cleared down to a depth of two (2) feet and a magnetic gradiometer (down-hole instrument) or similar instrument will be lowered into the hole to clear the pit. This clearance procedure will continue until the pit has been cleared to bedrock. This will be accomplished by hand. Advancement through mechanical means may proceed within a two foot radius of the clearance boring.

The site-specific training in avoidance techniques and safe work practices will be discussed in detail during site-specific training.

6.3 NATURAL HAZARDS

Insect/animal bites and stings, poisonous plants, and inclement weather are natural hazards that may be present given the location of activities to be conducted. As previously discussed, some portions of the site include vegetated areas which increases the potential for field crews to encounter ticks, bees, mosquitoes/insects, snakes, and poisonous vegetation.

6.3.1 Insect Bites and Stings

Insect/animal bites and stings are difficult to control given the climate and environmental setting of NSWC Crane. However, in an effort to minimize this hazard the following control measures will be implemented where possible.

- Commercially available bug sprays and repellents will be used whenever possible – Pesticides analytical screening includes chlordane, endrin, lindane, methoxychlor, toxaphene and heptachlor. Commercially available repellants may be used providing they don't contain substances which appear on the analytical list for pesticide analysis. Products such as DEET should not be applied directly to the skin due to potential irritation. This product, when permitted for use, should be applied over clothing articles.

- Where possible, loose-fitting and light-colored clothing with long sleeves should be worn. This will also aid in insect control by providing a barrier between the field person and the insects and to provide easy recognition of crawling insects against the lighter background. Pant legs should be secured to the work-boots using duct tape to prevent access by ticks. Mosquito nets are also recommended for use when commercially available repellents are not permitted.

- Clothing/limited body checks for ticks and other crawling insects should be conducted upon exiting heavily vegetated areas. Workers should perform a more detailed check of themselves when showering

in the evening. Ticks prefer moist areas of the body (arm-pits, genitals, etc.) and will migrate to those locations.

- The FOL/SSO will preview access routes and work areas in an effort to identify physical hazards including nesting areas in and around the work sites. These areas will be flagged and communicated to site personnel.

- The FOL/SSO must determine if site personnel (through completion of Medical Data Sheets), suffer allergic reactions to bee and other insect stings and bites. Field crew members who are allergic to bites should have their emergency kit containing antihistamine and a preloaded syringe of epinephrine readily available.

Any allergies (insect bites, bee stings, etc.) must be reported on the Medical Data Sheet and to the SSO.

Tick and Mosquito Transmitted Illnesses And Diseases

Ticks and mosquitoes have been identified in the transmission of diseases including Lyme's disease and malaria. Warm months (Spring through early Fall) are the most predominant time for this hazard. Information concerning Lyme's Disease including recognition, evaluation, tick removal, and control is provided in the HSGM.

Malaria may occur when a mosquito or other infected insect sucks blood from an infected person, and the insect becomes the carrier to infect other hosts. The parasite reproduces within the mosquito, and is then passed on to another person through the biting action. Acute symptoms include chills accompanied by fever and general flu like symptoms. This generally terminates in a sweating stage. These symptoms may recur every 48 to 72 hours.

6.3.2 Snakes and Other Wild Animals

Indigenous animals including snakes (poisonous and non-poisonous varieties), raccoons, and other animals native to the region may be present at the site. These animals may be encountered if work locations encroach on nesting or territories claimed by these animals.

To avoid the obvious hazards conveyed as part of a direct encounter, the following actions will be taken to minimize impact on the field crews and/or operations. The FOL/SSO will preview access routes and work locations for nesting areas or signs of animal activities (tracks, foraging areas, etc.). Identified suspect areas will be communicated to the field crews. Snake chaps will be required as a precaution.

Venomous Snakes of Indiana

There are few poisonous snakes in Indiana. Indiana's poisonous snakes are all very heavy-bodied – they look "fat." They also have broad, spade-shaped heads that are distinctly wider than their narrow necks. The heads of non-venomous snakes are typically about the same width as their bodies. Such distinctions are not completely reliable, as some species such as water snakes can be rather stout, and many species of snakes will flatten their heads when bluffing, giving the head a spade-like shape as well. The pupils of the venomous snakes of Indiana are vertical slits rather than round. This distinction may not hold elsewhere, but works in this state.

Do not attempt to handle or kill a snake that you believe may be venomous. Simply keep at a safe distance and move on your way. Snakes do not actively seek out people and bite them. Given the chance, snakes will almost always try to escape an encounter. If you leave them alone, they will make every effort to leave you alone as well. Be very careful to avoid the head when handling dead snakes. A snake's reflexes can remain functional hours after death, and supposedly "dead" snakes have bitten people.

Copperhead

The most common venomous species is the copperhead, and even it has a restricted range in the hills of southern Indiana.

Appearance: The copperhead is a moderately large snake that typically measures 24 to 36 inches in length. Its head is reddish-brown in color and its body is tan. The body is marked with 15 to 19 mahogany lateral bands with darker edges that are wide on the sides and narrow on the back. The lateral bands are occasionally interrupted along the midline. Viewed from above, these bands appear hourglass shaped. Irregular brown spots are often found between the bands. The copperhead has a wedge-shaped head, sensory pits, and vertically elliptical "cat-like" pupils. The young are pale with a yellow tipped tail and are 8 to 9 inches in length.

Ecology: The copperhead is found primarily in high, dry, rocky and well-forested areas dominated by oaks and hickories. This species is very secretive and does not tolerate human presence. The copperhead is active at night the warmest part of the year and is more likely to defend itself during the evening hours. It can be found resting under logs, in cracks of foundations, and under rocks. Small rodents such as mice are its primary prey, but it also eats large moth larvae and lizards.

Timber Rattlesnakes

Timber rattlesnakes are rare and usually restricted to some of the forested hills in south central Indiana.

Appearance: These snakes are Indiana's largest, averaging 48 to 72 inches in length with a rattle on the end of their tail. They can be found in the hill country of south central Indiana. The timber rattlesnake is a thick-bodied snake with a wide head distinct from the neck, typical of our venomous snakes. The color pattern of the timber rattler is very variable, ranging from sulfur yellow and buff brown, to dark gray. Regardless of the pattern, a series of wide black cross bands line the back along the length of the body. These cross bands have been described as "blunt chevrons." Its distinctly wedge-shaped head, sensory pit, and elliptical eye slits are characteristic of all snakes in the viper family.

Ecology: The timber rattlesnake is native to heavily forested areas in the hills of southern Indiana. It feeds on small mammals and birds. The timber rattler hibernates inside the cracks and crevices of rocky hillsides. Timber rattlesnakes do not stalk their prey, but rather remain motionless and wait for their prey to move within striking distance. Populations of timber rattlesnakes are mostly limited to areas fairly isolated from human development.

Snake Bites

Initial efforts will be directed to avoid, where possible, nesting and territorial areas. However, should field personnel come in contact with these animals and receive a bite, the following actions are necessary. Obtain a detailed description of the snake. This and the bite mark will enable medical personnel administering medical aid to provide prompt and correct antidotes, as necessary. Immobilize the bite victim to the extent possible. Physical exertion will mobilize the toxins (if poisonous varieties) from the bite point systemically through the body.

Apply a pressure wrap (for extremities), just above and over the bite area. With a couple wraps of the pressure wrap in place over the bite area, apply a splint, and continue the application of the pressure wrap. The purpose for the splint is to restrict the movement of the extremity, this along with the pressure wrap will aid in restricting the toxins from leaving the site of the bite.

Seek medical attention immediately.

6.3.3 Poisonous Plants

Various plants which can cause allergic reactions may be encountered during field work. These include, poison ivy, poison oak, and poison sumac. Contact with these plants may occur when clearing vegetation

for access to work areas, or as a result of movement through these plants. An irritating, allergic reaction can occur after direct contact with the plant or indirect contact through some piece of equipment or clothing article. Oils are transferred from the plant to exposed skin, clothing, or piece of equipment. The degree of the irritating, allergic reaction can vary significantly from one person to the next.

Protective measures to control and minimize the effects of this hazard may include, but not be limited to, the following:

- Identify plants for field personnel.

  - Poison Ivy - Characterized by climbing vines, three leaf configuration ovate to elliptical in shape, deep green leaves with a reddish tint, greenish flowers, and white berries.

  - Poison Sumac - Characterized as a tall bush of the sumac family bearing compound leaves (7-13 entire leaflets), branched from a central axis, drooping, with axillary clusters of white fruit: However, these white fruits and berries may exist only during pubescent stages.

  - Poison oak - Characterized as similar to poison ivy consisting of a shrub, stems erect, 0.3 to 2.0 meters tall, leaflets consist of broad thick lobes coarsely serrated configuration, denser at the base, less so than the top.

- Protective measures may include wearing disposable garments such as Tyvek when clearing brush. These may be carefully removed and disposed of along with any oils accumulated from the plants.

- Personal Hygiene - The oils obtained from the plants will only elicit an allergic response when the person's bare skin layer is contacted. This can be aggravated when skin pores are open (perspiring), or through breaks in the skin such as cuts, nicks, scratches, etc. This can also be accomplished when using excessively hot water for cleaning the skin, which also causes pores to open. Prior to break time, lunchtime, etc. personnel should wash with cool water and soap to remove as much of the oils as possible. In heavily vegetated areas of these plants, additional measures including barrier creams and blocks may be used to prevent the oils from accessing and penetrating the skin.

These plants present an airborne sensitization hazard when burned. This is not to occur as part of this scope of work and therefore will not be addressed.

6.3.4 Inclement Weather

Project tasks under this Scope of Work will be performed outdoors. As a result, inclement weather may be encountered. In the event that adverse weather conditions arise (electrical storms, hurricanes, etc.), the FOL and/or the SSO will be responsible for temporarily suspending or terminating activities until hazardous conditions no longer exist.

7.0 AIR MONITORING

Direct reading instruments will be used at the site to evaluate the presence of detectable site contaminants and other potentially hazardous conditions. As a result, specific air monitoring measures and requirements are established in Table 5-1 pertaining to the specific hazards and tasks of an identified operation. Additionally, the Health and Safety Guidance Manual, Section 1.0, contains detailed information regarding direct reading instrumentation, as well as general calibration procedures of various instruments.

7.1 INSTRUMENTS AND USE

Instruments will be used primarily to monitor source points and worker breathing zone areas, while observing instrument action levels. Action levels are discussed in Table 5-1 as they may apply to a specific task or location.

7.1.1 Photoionization Detector

In order to accurately monitor for any substances which may present an exposure potential to site personnel, a Photoionization Detector (PID) using a lamp energy of 10.6 eV or higher will be used. This instrument will be used to monitor potential source areas (boreholes, monitoring wells, etc.) and to screen the breathing zones of employees during site activities. The PID has been selected because it is capable of detecting various organic vapors compounds, including the primary ground water contaminants identified in Section 6.1. (NOTE: A Flame Ionization Detector [FID] may be used as an alternative to the PID).

Prior to the commencement of any field activities, the background levels of the site must be determined and noted. Daily background readings will be taken away from any areas of potential contamination. These readings, any influencing conditions (i.e., weather, temperature, humidity) and site location must be documented in the field operations logbook or other site documentation (e.g., sample log sheet).

7.1.2 Hazard Monitoring Frequency

Table 5-1 presents the frequencies that hazard monitoring will be performed as well as the action levels which will initiate the use of elevated levels of protection. The SSO may decide to increases these frequencies based on instrument responses and site observations. The frequency at which monitoring is performed will not be reduced without the prior consent of the PHSO or HSM.

7.2 INSTRUMENT MAINTENANCE AND CALIBRATION

Hazard monitoring instruments will be maintained and pre-field calibrated by the TtNUS Equipment Manager. Operational checks and field calibration will be performed on the instruments each day prior to their use. Field calibration will be performed on instruments according to manufacturer's recommendations (for example, the PID must be field calibrated daily and an additional field calibration must be performed at the end of each day to determine any significant instrument drift). These operational checks and calibration efforts will be performed in a manner that complies with the employees health and safety training, the manufacturer's recommendations, and with the applicable manufacturer standard operating procedure (copies of which can be found in the Health & Safety Guidance Manual which will be maintained on site for reference). Calibration efforts must be documented. Figure 7-1 is provided for documenting these calibration efforts. This information may instead be recorded in a field operations logbook, provided that the information specified in Figure 7-1 is recorded. This required information includes the following:

- Date calibration was performed
- Individual calibrating the instrument
- Instrument name, model, and serial number
- Any relevant instrument settings and resultant readings (before and after) calibration
- Identification of the calibration standard (lot no., source concentration, supplier)
- Any relevant comments or remarks

FIGURE 7-1

DOCUMENTATION OF FIELD CALIBRATION

SITE NAME: _____ PROJECT NO.:_____

Date of Calibration	Instrument Name and Model	Instrument I.D. Number	Person Performing Calibration	Instrument Settings		Instrument Readings		Calibration Standard (Lot Number)	Remarks/ Comments
				Pre-Calibration	Post-Calibration	Pre-Calibration	Post-Calibration		

8.0 TRAINING/MEDICAL SURVEILLANCE REQUIREMENTS

8.1 INTRODUCTORY/REFRESHER/SUPERVISORY TRAINING

This section specifies health and safety training and medical surveillance requirements for both TtNUS and subcontractor personnel participating in on site activities.

8.1.1 Requirements For Field Personnel

TtNUS and subcontractor personnel who will engage in field associated activities as described in this HASP will have:

- Completed 40 hours of introductory hazardous waste site training or equivalent work experience as defined in OSHA Standard 29 CFR 1910.120(e).
- Completed 8-Hour Refresher Training, if the identified persons had introductory training more than 12 months prior to site work.
- Completed 8-hour Supervisory training in accordance with 29 CFR 1910.120(e)(4), if their assigned function will involve the supervision of subordinate personnel.

Documentation of introductory training or equivalent work experience, supervisory, and refresher training as well as site-specific training will be maintained at the site. Copies of certificates or other official documentation will be used to fulfill this requirement.

8.2 SITE-SPECIFIC TRAINING

TtNUS will provide site-specific training to TtNUS employees and subcontractor personnel who will perform work on this project.

Figure 4-1 will be used to document the provision and content of the project-specific and associated training. Site personnel will be required to sign this form prior to commencement of site activities.

Due to the complex nature of the work to be performed at NSWC Crane MGBG, the personnel selected will require cross training in various support functions and specialties. Figure 4-2 Training and Medical Surveillance Tracking form has been compiled to assist the FOL and/or the SSO in tracking the status of these persons over the course of the project. This form will assist in determining who has clearance and who may perform certain tasks or support functions based on their training and/or medical qualifications.

FIGURE 8-1

SITE-SPECIFIC TRAINING DOCUMENTATION

My signature below indicates that I am aware of the potential hazardous nature of performing investigatory activities at the NSWC Crane Mustard Gas Burial Ground located in Crane, Indiana, and that I have received site-specific training which included the elements presented below:

- Names of designated personnel and alternates responsible for site safety and health
- Safety, health, and other hazards present on site
- Use of personal protective equipment
- Safe use of engineering controls and equipment
- Safe work practices to minimize risks from hazards
- Medical surveillance requirements
- Signs and symptoms of overexposure
- Decontamination procedures
- Contents of the Health and Safety Plan
- Emergency action procedures
- Incipient response procedures
- Review of the contents of relevant Material Safety Data Sheets
- Use and application of the Safe Work Permits
- Spill containment program

I have been given the opportunity to ask questions, my questions have been answered to my satisfaction, and that I agree to abide by the procedures and policies addresses in this plan. The date of my training (introductory, refresher, and supervisory, as applicable) and my medical surveillance requirements are accurate.

Name (Printed and Signature)	Site-Specific Training Date	40-Hour Training (Date)	8-Hour Refresher Training (Date)	8-Hour Supervisory Training (Date)	Medical Exam

8.3 MEDICAL SURVEILLANCE

8.3.1 Medical Surveillance Requirements for TtNUS and Subcontractor Personnel

TtNUS and subcontractor personnel participating in project field activities will have had a physical examination. Physical examinations shall meet the minimum requirements of paragraph (f) of OSHA 29 CFR 1910.120. The physical examinations will be performed to ensure personnel are medically qualified to perform hazardous waste site work using respiratory protection.

Documentation for medical clearances will be maintained at the job site and made available, as necessary. Subcontractor personnel may use an alternative documentation for this purpose. The "Subcontractor Medical Approval Form" can be used to satisfy this requirement, or a letter from an officer of the company. The letter should state that the persons listed in the letter participate in a medical surveillance program meeting the requirements contained in paragraph (f) of Title 29 of the Code of Federal Regulations (CFR), Part 1910.120, entitled "Hazardous Waste Operations and Emergency Response." The letter should further state the following:

- The persons listed have had physical examinations under this program within the frequency as determined sufficient by their occupational health care provider
- Date of the exam
- The persons identified have been cleared, by a licensed physician, to perform hazardous waste site work and to wear positive- and negative- pressure respiratory protection.

A sample Subcontractor Medical Approval Form and form letter have been provided to eligible subcontractors in the Bid Specification package.

8.3.2 Requirements for Field Personnel

Each field team member, including subcontractors and visitors, entering the exclusion zone(s) shall be required to complete and submit a copy of the Medical Data Sheet also supplied to eligible subcontractors as part of the Bid Specifications Package and also available in Attachment III. This shall be provided to the SSO, prior to participating in site activities. The purpose of this document is to provide site personnel and emergency responders with additional information that may be necessary in order to administer medical attention.

8.4 SUBCONTRACTOR EXCEPTION

If through the execution of their contract elements the subcontractor will not enter the exclusion zone and there is no potential for exposure to site contaminants, subcontractor personnel may be exempt from the training and medical surveillance requirements with the exception of Section 8.2. Examples of subcontractors who may qualify as exempt from training and medical surveillance requirements may include surveyors who perform surveying activities in site perimeter areas or areas were there is no potential for exposure to site contaminants and support or restoration services. **Use of this Subcontractor Exception is strictly limited to the authority of the CLEAN Health and Safety Manager.**

9.0 SITE OPERATIONS AND CONTROL

Site operations and control will be facilitated through the use of established work zones and security and control of those zones. These activities will minimize the impact and spread of contaminants brought to the surface through subsurface investigative methods as well as protect personnel and visitors within these zones during ongoing operations.

9.1 WORK ZONES

TtNUS will delineate and use work zones in conjunction with decontamination procedures to prevent the spread of contaminants to other areas of the site. A three-zone approach will be used for work at this site; an Exclusion Zone, a Contamination Reduction Zone, and a Support Zone. These will be used to control access to the work areas, restricting the general public, avoiding potentials to spread any contaminants, and to protect individuals who are not cleared to enter by way of training and/or medical surveillance qualifications.

9.1.1 Exclusion Zone

An Exclusion Zone will be established at each sampling point/location. The purpose of the exclusion zone is to define a area where a more rigorous protocol for workers within what is determined to be an impact area. The impact area is that area which could be adversely impacted by either chemical, physical, or energetic hazards. Exclusion zone size and dimensions will vary based on activities. Impact areas dimensions will be influenced by the following considerations:

- Physical and topographical features of the site
- Weather conditions
- Field and analytical measurements of air and environmental contaminants
- Air dispersion calculations
- Physical, chemical and toxicological properties of the contaminants being investigated
- Tasks to be conducted
- Decontamination procedures
- Potential for exposure

As conditions change the dimensions of the exclusion zone will change. However, the following dimension represents a starting point from which the exclusion zones will be expanded:

- Monitoring well installation (rotosonic or HSA): The exclusion zone for this activity will be set at the height of the mast, plus five feet surrounding the point of operation, with a minimum of 25 feet. This distance will also apply when subsurface soil sampling from behind these type rigs.

- Monitoring well development and sampling: The exclusion zone for this activity will be set at 10 feet surrounding the well head and discharge collection container.

- Decontamination: The exclusion zone for this activity will be set at 25 feet surrounding the gross contamination wash and rinse as well as 25 feet surrounding the heavy equipment decontamination area.

- Investigative Derived Waste: IDW area will be constructed and barricaded with only authorized personnel allowed access.

Exclusion zones shall remain marked until the SSO has evaluated the restoration effort and has authorized changing the zone status.

Exclusion zones will be marked using barrier tape, traffic cones and/or drive poles. Signs will be posted to inform and direct site personnel and site visitors.

9.1.2 Contamination Reduction Zone

The contamination reduction zone will be split to represent two separate functions. The first function will be a control/supply point for supporting exclusion zone activities. The second function, which may take place a sufficient distance from the exclusion zone, is the decontamination of personnel and heavy equipment.

In order to move from the exclusion zone to a separate location the following activities will be used:

- As samplers move from location to location during sampling activities, dedicated sampling devices and PPE will be washed of gross contamination, removed, separated, and bagged. Personnel will use hygienic wipes, such as Handy Wipes, as necessary.

- Muddy over-boots and gloves may be required to go through a gross contamination wash at the exclusion zone.

- Potentially contaminated tooling will be wrapped, when necessary, for transport to the decontamination area.

- Upon completion of the assigned tasks personnel will move through the central decontamination area to clean reusable PPE and field equipment. Personnel and field equipment will be frisked at the termination of decontamination procedures. Based on ambient conditions medical evaluations will take place at the termination point of the decontamination line. These evaluations will include pulse rate, oral temperature, breathing rate to evaluate physiological demands on site personnel. As stated earlier, these evaluations will be based on ambient conditions and acclimation periods.

9.1.3 Support Zone

The Support Zone will consist of a field trailer, storage, laydown areas, or some other uncontaminated, controlled point. The Support Zone for this project will include a staging area where site vehicles can be parked, equipment will be unloaded, and where food and drink containers will be maintained. The support zones will be established in clean areas of the site.

9.2 SAFE WORK PERMITS

Exclusion Zone work conducted in support of this project will be performed using Safe Work Permits (SWP) to guide and direct field crews on a task by task basis. An example of the Safe Work Permit is included in Figure 8-1. The daily meetings conducted by the FOL/SSO will further support these work permits. The use of these permits will ensure that site-specific considerations and changing conditions are incorporated into the planning effort. SWP will require the signatures of either the FOL or the SSO. Personnel engaged in onsite activities must be made aware of the elements indicating levels of protection and precautionary measures to be used.

The use of these permits will establish and provide for reviewing protective measures and hazards associated with each operation. This HASP will be used as the primary reference for selecting levels of protection and control measures. The SWP will take precedence over the HASP when more conservative measures are required based on specific site conditions.

Upon completion of the work for which the SWP was assigned, the SWP will be turned into the FOL or the SSO. Concerns, complaints, and suggestions may be made on the reverse of the SWP for consideration by the FOL and/or the SSO.

The SWP and the HASP will serve as the primary reference for work place evaluations and audits conducted to determine if the task is being conducted under the direction conveyed by the HASP and the SWP.

9.3 SITE MAP

Once the areas of contamination, access routes, topography, dispersion routes are determined, a site map will be generated and adjusted as site conditions change. This map will be posted to illustrate up-to-date information of contaminants and adjustment of zones and access points. This map will be posted at the field support trailer.

9.4 BUDDY SYSTEM

Personnel engaged in on-site activities will practice the "buddy system" to ensure the safety of the personnel involved in this operation.

9.5 MATERIAL SAFETY DATA SHEET (MSDS) REQUIREMENTS

TtNUS personnel will provide MSDSs for the chemicals brought on-site. The contents of these documents will be reviewed by the SSO with the user(s) of the chemical substances prior to any actual use or application or the substances on-site. The MSDSs will be maintained in a central location (i.e., temporary office) and will be available for anyone to review upon request. The SSO will be responsible for implementing a site-specific Hazard Communication Program. This includes collection of MSDSs, creation and maintenance of an accurate Chemical Inventory Listing, addressing container labeling and personnel training issues, and other aspects as defined in that appendices.

9.6 COMMUNICATION

It is anticipated that site personnel will be working in close proximity during proposed field activities. In the event that site personnel are in isolated areas or are separated by significant distances, a supported means of communication between field crews will be utilized. Two-way radio communication devices, if needed, will be used only with NSWC Crane approval.

External communications will be accomplished utilizing telephones at predetermined and approved locations or through cellular phones. External communication will primarily be used for the purpose of resource and emergency resource communications. Prior to the commencement of site activities, the

FOL will determine and arrange for telephone communications, if it is determined a cellular means will not be used.

There are several aspects associated with emergency alerting procedures that must be taken into account at NSWC Crane. These are as follows:

- Due to the physical setting (size and remoteness) of the sites where field activities will be conducted, readily available means of communication are not always available.

- In addition, again based on the size of the facility and location, there are limited cellular communication points on Base where a signal may be obtained. This also limits communication capabilities.

- Lastly, due to the schedule that TtNUS, Inc. will work (10 days on; 4 days off) the potential exists for field personnel to be present during holidays, off days, and after hours. Primary safe places of refuge that would normally be accessed in the event of an emergency during normal working hours will be closed during these periods.

In order to overcome these restrictions, the Base Environmental Office may allocate a Public Works/Fire/Security Radio to be used in support of this field effort. This radio will be available throughout the project to allow field personnel to establish a direct link to NSWC security and emergency services.

9.7 SITE VISITORS

Potential site visitors that may be encountered during the performance of the field work could include the following:

- Personnel invited to observe or participate in operations by TtNUS.
- Regulatory personnel (i.e., DOD, ILEM, EPA, OSHA, etc.)
- Southern Division Navy personnel
- Other authorized visitors

Non-DOD personnel working on this project are required to gain initial access to the base by coordinating with the TtNUS TOM or designee and following established base access procedures.

Once access to the base is obtained, personnel who require access to TtNUS work sites (areas of ongoing operations) will be required to obtain permission from the FOL and the Base Contact. Upon gaining access to the work site, site visitors wishing to observe operations in progress will be required to meet the minimum requirements as stipulated below.

- Site visitors will be routed to the FOL, who will sign them into the field logbook. Information to be recorded in the logbook will include the individuals name (proper identification required), who they represent, and the purpose for the visit. **The FOL is responsible for ensuring that site visitors are escorted.**

- Site visitors will be required to produce the necessary information supporting clearance on to the site. This includes information attesting to applicable training (40-hours of HAZWOPER training required for Southern Division Navy Personnel), and medical surveillance as stipulated in Section 8.3, of this document. In addition, to enter the sites operational zones during planned activities, visitors will be required to first go through site-specific training covering the topics stipulated in Section 4.2 of this HASP.

Once the site visitors have completed the above items they will be permitted to enter the site and applicable operational areas. Visitors are required to observe the protective equipment and site restrictions in effect at the work areas visited. Visitors not meeting the requirements as stipulated in this plan for site clearance will not be permitted to enter the site operational zones during planned activities. Any incidence of unauthorized site visitation will cause on-site activities to be terminated until that visitor can be removed. Removal of unauthorized visitors will be accomplished with support form the Base Contact, if necessary. At a minimum, the Base Contact will be notified of any unauthorized visitors.

9.8 SITE SECURITY

As this activity will take place at a Navy facility, the first line of security will be provided by the base gate restricting the general public. The second line of security will take place at the work site referring interested parties to the FOL and Base Contact.

Security at the work areas will be accomplished using field personnel. This is a multiple person operation, involving multiple operational zones. TtNUS personnel will retain complete control over active operational zones.

The Base Contact will serve as the focal point for base personnel and interested parties and will serve as the primary enforcement contact.

FIGURE 9-1
SAFE WORK PERMIT

Permit No. _____ Date: _____ Time: From _____ to ____

SECTION I: General Job Scope (To be filled in by person performing work)

I. Work limited to the following (description, area, equipment used): _____

II. Names: _____

III. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector _____ _____
TtNUS

SECTION II: General Safety Requirements (To be filled in by permit issuer)

IV. Protective equipment required
Level D ☐ Level B ☐
Level C ☐ Level A ☐

Respiratory equipment required
Full face APR ☐ Escape Pack ☐
Half face APR ☐ SCBA ☐
PAPR ☐ Bottle Trailer ☐
Skid Rig ☐ None ☐

Modifications/Exceptions: _____

V.

Chemicals of Concern	Action Level(s)	Response Measures

VI. Additional Safety Equipment/Procedures

Hardhat	☐ Yes	☐ No	Hearing Protection (Plugs/Muffs)	☐ Yes	☐ No
Safety Glasses	☐ Yes	☐ No	Safety belt/harness	☐ Yes	☐ No
Chemical/splash goggles	☐ Yes	☐ No	Radio	☐ Yes	☐ No
Splash Shield	☐ Yes	☐ No	Barricades	☐ Yes	☐ No
Splash suit/coveralls (Type:_____)	☐ Yes	☐ No	Gloves (Type)	☐ Yes	☐ No
Steel toe/shank Workboots	☐ Yes	☐ No	Work/rest regimen	☐ Yes	☐ No

Modifications/Exceptions: _____

VII. Procedure review with permit acceptors

	Yes	NA		Yes	NA
Safety shower/eyewash (Location & Use)	☐	☐	Emergency alarms	☐	☐
Procedure for safe job completion	☐	☐	Evacuation routes	☐	☐
Contractor tools/equipment inspected	☐	☐	Assembly points	☐	☐

VII. Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☐
Equipment and Foot Traffic Routes Cleared and Established	☐	☐	☐
Physical Hazards Barricaded and Isolated	☐	☐	☐
Emergency Equipment Staged	☐	☐	☐

VIII. Additional Permits required (Hot work, confined space entry, excavation, etc.). ☐Yes ☐No
If yes, See SSO for appropriate permit

IX. Special instructions, precautions: _____

Permit Issued by: _____ Permit Accepted by: _____

10.0 SPILL PREVENTION AND CONTAINMENT PROGRAM

10.1 SCOPE AND APPLICATION

This program applies to the single or aggregate accumulation of bulk storage materials (over 55-gallons). As the classification of certain materials such as IDW is unknown, materials will be treated as hazardous, pending laboratory certification to the contrary. The types of materials for which this program will apply are as follows:

- Investigative Derived Wastes (IDW) such as decontamination fluids, soil cuttings, and purge and well development waters
- Resource Storage – Limited fuel and lubricant storage

10.2 POTENTIAL SPILL AREAS

Potential spill areas will be periodically monitored in an ongoing attempt to prevent and control further potential contamination of the environment. Currently, limited areas are vulnerable to this hazard including:

- Resource deployment
- Waste transfer
- Central staging

It is anticipated that IDW generated as a result of this scope of work will be containerized, labeled, and staged to await further analyses. The results of these analyses will determine the method of disposal.

10.3 CONTAINMENT AREAS

In order to facilitate leak and spill inspection and response, and to minimize potential hazards which may impact the integrity of the storage containers, the staging area for these substances will be structured as follows:

10.3.1 IDW

- 55 Gallon Drums (United Nations 1A2 configurations) – 4 Drums to a Pallet; labels and the retaining ring bolt and nut on the outside of each drum to facilitate easy access; Minimum 3 feet between each row of pallets. Size and dimensions will be restricted to the estimated volume plus 10 percent for rain

water and container displacement. The decision to construct a bermed and lined area will be the decision of project management .

- Storage Tank – Polyethylene Construction – Tank shall be placed into a bermed enclosure of sufficient size to accommodate 110% of anticipated volume (Largest container plus 10% for rainwater and container displacement).

Regardless of container types selected, the staging area will be identified as a Satellite Storage Area with proper signage, points of contact in the event of an emergency, alternate contacts, and identification of stored material (i.e, Purge or decontamination waters, soil cuttings, etc.).

An Inventory Log will be maintained by the FOL regarding types of IDW and volumes generated. An updated Inventory List will be provided by the FOL to the designated emergency response agency during days off and between shifts or phases of operations.

10.3.2 Flammable/POL Storage

Flammable Storage [i.e., fuels, decontamination solvents (Isopropanol)] and Petroleum/oil/lubricants (POL) will require proper dispensing containers and necessary storage for cumulative volumes in excess of 25 gallons. Storage and dispensing will comply with the following requirements:

- Fuels, which will be stored and dispensed from portable containers, will utilize safety cans.
- Portable hand held storage containers will be labeled per Hazard Communication requirements.
- Larger volumes stored for fueling equipment will be stored in approved mobile Above Ground Storage Tanks with secondary containment capable of holding the tank volume plus 10%.
- Portable flammable liquid storage tanks will be properly grounded and will have bonding capabilities for the transfer of loading and off-loading of its contents.
- Dispensing locations will be supported by a Fire Extinguisher positioned no closer than 50 feet from the storage tank, properly mounted and identified.
- The storage location will be well marked with proper signage, protective bumper poles and will have straight through access/egress for vehicles.

10.4 MATERIALS HANDLING

To minimize the hazards associated with moving drums and containers (i.e, lifting, pinch and compression points) material handling will be supported in the following manner:

- A drum cart with pneumatic tires will be required, if drums are used for IDW storage. This cart will be used to relocate drums within the staging and satellite storage location.

- In addition, a mechanized means such as a suitably equipped skid loader or back-hoe will be provided to move IDW containers from the field location to the staging and satellite storage location. This piece of equipment will also be used in site clearance and restoration as deemed appropriate and necessary.

Other means of material handling will be evaluated by the SSO based on their ability to minimize or eliminate material handling hazards.

10.5 LEAK AND SPILL DETECTION

To establish an early detection of potential spills or leaks, a periodic walk-around by the personnel staging or disposing of drums or in the Resource Deployment area will be conducted during working hours to visually determine that storage vessels are not leaking. If a leak is detected, the FOL will be notified and the Spill Containment/Control Response Plan as specified in Section 9.8 will be engaged. Inspections will be documented in the project logbook.

10.6 PERSONNEL TRAINING AND SPILL PREVENTION

Personnel will be instructed in the procedures for incipient spill prevention, containment, and collection of hazardous materials in the site-specific training. The FOL and/or the SSO will serve as the Spill Response Coordinators for this operation, should the need arise. Personnel through the course of this project will be drilled as part of testing the EAP.

10.7 SPILL PREVENTION AND CONTAINMENT EQUIPMENT

The following represents the minimum equipment that will be maintained at the staging areas for the purpose of supporting this Spill Containment/Control Plan.

- Sand, clean fill, vermiculite, or other non combustible absorbent (Oil-dry)
- Extra Drums (55-gallon U.N. 1A2) should the need to transfer material from leaking containers arise.
- Pumps (Gas or Electric necessary for transferring liquids from leaking containers)/tubing
- Drum Repair Kit
- Shovels, rakes, and brooms
- Container labels
- Personal Protective Equipment

- Nitrile outer gloves
- Splash Shield
- Impermeable over-boots
- Rain suit

10.8 SPILL CONTAINMENT/CONTROL RESPONSE PLAN

This section describes the procedures the TtNUS field personnel will employ upon the detection of a spill or leak.

- Notify the SSO or FOL immediately upon detection of a leak or spill. Activate emergency alerting procedures for that area to remove non-essential personnel.

- Employ the personal protective equipment stored at the staging area. Take immediate actions to stop the leak or spill by plugging or patching the container or raising the leak to the highest point in the vessel. Spread the absorbent material in the area of the spill, covering it completely.

- Transfer the material to a new vessel; collect and containerize the absorbent material. Label the new container appropriately. Await analyses for treatment and disposal options.

- Re-contain spills, including 2-inch of top cover (if over soils) impacted by the spill. Await test results for treatment or disposal options.

It is not anticipated that a spill will occur that the field crew cannot handle. Should this occur, notification of the appropriate emergency response agencies will be carried out by the FOL or SSO in accordance with the procedures specified in Section 2.0 of this HASP.

Although it is not anticipated that drums and containers of an unknown origin will be unearthed as this investigation of environmental media proceeds, this spill and containment procedure would also support that activity.

11.0 CONFINED SPACE ENTRY

It is not anticipated, under the proposed scope of work, that confined space and permit-required confined space activities will be conducted. **Therefore, personnel under the provisions of this HASP are not allowed, under any circumstances, to enter confined spaces**. A confined space is defined as an area which has one or more of the following characteristics:

- Is large enough and so configured that an employee can bodily enter and perform assigned work.
- Has limited or restricted means for entry or exit (for example, tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry).
- Is not designed for continuous employee occupancy.

A Permit-Required Confined Space is one that:

- Contains or has a potential to contain a hazardous atmosphere.
- Contains a material that has the potential to engulf an entrant.
- Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section.
- Contains any other recognized, serious, safety or health hazard.

For further information on confined space operations, consult the SSO or call the PHSO. If confined space operations are to be performed this HASP will require modification to address, detailed procedures training requirements, and emergency rescue.

12.0 MATERIALS AND DOCUMENTS

The TtNUS FOL shall ensure the following materials/documents are taken to the project site and used when required.

- A complete copy of this HASP
- Health and Safety Guidance Manual
- Incident Reports
- Medical Data Sheets
- Material Safety Data Sheets for chemicals brought on site, including decon solutions, fuels, lime, sample preservatives, calibration gases, etc.
- A full-size OSHA Job Safety and Health Poster (posted in the site trailers)
- Training/Medical Surveillance Documentation Form (Blank)
- Emergency Reference Information (Section 2.0, extra copy for posting)

12.1 MATERIALS TO BE POSTED OR MAINTAINED AT THE SITE

The following documentation is to be posted or maintained at the site for quick reference purposes. In situations where posting these documents is not feasible, (such as no office trailer), these documents should be separated and immediately accessible.

Chemical Inventory Listing (posted) - This list represents chemicals brought on-site, including decontamination solutions, sample preservations, fuel, etc.. This list should be posted in a central area.

Material Safety Data Sheets (MSDS) (maintained) - The MSDSs should also be in a central area accessible to site personnel. These documents should match the listings on the chemical inventory list for substances used on-site. It is acceptable to have these documents within a central folder and the chemical inventory as the table of contents.

The OSHA Job Safety & Health Protection Poster (posted) - this poster, as directed by 29 CFR 1903.2 (a)(1), should be conspicuously posted in places where notices to employees are normally posted. Each FOL shall ensure that this poster is not defaces, altered, or covered by other material.

Site Clearance (maintained) - This list is found within the training section of the HASP (See Figure 8-2). This list identifies site personnel, dates of training (including site-specific training), and medical surveillance. The list indicates not only clearance but also status. If personnel do not meet these requirements, they do not enter the site while site personnel are engaged in activities.

Emergency Phone Numbers and Directions to the Hospital(s) (posted) - This list of numbers and directions will be maintained at phone communications points and in each site vehicle.

Medical Data Sheets/Cards (maintained) - Medical Data Sheets will be filled out by on-site personnel and filed in a central location. The Medical Data Sheet will accompany any injury or illness requiring medical attention to the medical facility. a copy of this sheet or a wallet card will be given to personnel to be carried on their person.

Hearing Conservation Standard (29 CFR 1910.95) (posted) - this standard will be posted anytime hearing protection or other noise abatement procedures are employed.

Personnel Monitoring (maintained) - Results generated through personnel sampling (levels of airborne toxins, noise levels, etc.) will be posted to inform individuals of the results of that effort.

Placards and Labels (maintained) - Where chemical inventories have been separated because of quantities and incompatibilities, these areas will be conspicuously marked using DOT placards and acceptable (Hazard Communication 29 CFR 1910.1200(f)) labels.

The purpose of maintaining or posting this information, as stated above, is to allow site personnel quick access. Variations concerning location and methods of presentation are acceptable, providing the objection is accomplished.

13.0 GLOSSARY

ACGIH	American Conference of Governmental Industrial Hygienist
CFR	Code of Federal Regulations
CIH	Certified Industrial Hygienist
CLEAN	Comprehensive Long-Term Environmental Action Navy
cpm	counts per minute
CPR	Cardio Vascular Resuscitation
CSP	Certified Safety Professional
CTO	Contract Task Order
CWA	Chemical Warfare Agent
CWM	Chemical Warfare Material
dBA	Decibles
DI	De-Ionized Water
DO	Dissolved Oxygen
DPT	Direct Push Technology
DRI	Direct Reading Instruments
EAP	Emergency Action Plan
EOD	Explosive Ordnance Disposal
EPA	Environmental Protection Agency
eV	electron Volts
FID	Flame Ionization Detector
FOL	Field Operations Leader
HAS	Hollow Stem Auger
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HEPA	High Efficiency Particulate Air
HSM	Health and Safety Manager
IDEM	Indiana Department of Environmental Management
IDLH	Immediately Dangerous to Life and Health
IDW	Investigative Derived Waste
IP	Ionization Potential
KeV	kilo electron volts
mg/m^3	milligrams per cubic meter
MGMB	Mustard Gas Burial Grounds
MSDS	Material Safety Data Sheet
N/A	Not Available

NAD	Naval Ammunition Depot
NIOSH	National Institute Occupational Safety and Health
NSWC	Naval Surface Warfare Center
ORP	Oxidation-Reduction Potential
OSHA	Occupational Safety and Health Administration (U.S. Department of Labor)
PCE	Tetrachloroethene
PEL	Permissible Exposure Limit
PHSO	Project Health and Safety Officer
PID	Photo Ionization Detector
POL	Petroleum/oil/lubricants
PPE	Personal Protective Equipment
PPM	Parts Per Million
PVC	Poly Vinyl Chloride
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SSO	Site Safety Officer
STEL	Short Term Exposure Limit
SWMU	Solid Waste Management Unit
SWP	Safe Work Practice/Permit
SWP	Safe Work Permit
TCE	Trichloroethene
TCLP	Toxicity Characteristic Leachate Procedure
TLD	Thermoluminescent dosimeters
TOM	Task Order Manager
TtNUS	Tetra Tech NUS
TWA	Time Weighted Average
UN	United Nations
UXO	Unexploded Ordnance
WP	Work Plan

ATTACHMENT I

INJURY/ILLNESS PROCEDURE AND REPORT FORM

TETRA TECH NUS, INC.

INJURY/ILLNESS PROCEDURE
WORKER'S COMPENSATION PROGRAM

WHAT YOU SHOULD DO IF YOU ARE INJURED OR DEVELOP AN ILLNESS AS A RESULT OF YOUR EMPLOYMENT:

- If injury is minor, obtain appropriate first aid treatment.
- If injury or illness is severe or life threatening, obtain professional medical treatment at the nearest hospital emergency room.
- If incident involves a chemical exposure on a project work site, follow instructions in the Health & Safety Plan.
- Immediately report any injury or illness to your supervisor or office manager. In addition, you must contact your Human Resources representative, Marilyn Duffy at (412) 921-8475, and the Corporate Health and Safety Manager, Matt Soltis at (412) 921-8912 within 24 hours. You will be required to complete an Injury/Illness Report (attached). You may also be required to participate in a more detailed investigation from the Health Sciences Department.
- If further medical treatment is needed, The Hartford Network Referral Unit will furnish a list of network providers customized to the location of the injured employee. These providers are to be used for treatment of Worker's Compensation injuries subject to the laws of the state in which you work. Please call Marilyn Duffy at (412) 921-8475 for the number of the Referral Unit.

ADDITIONAL QUESTIONS REGARDING WORKER'S COMPENSATION:

Contact your local human resources representative, corporate health and safety coordinator, or Corporate Administration in Pasadena, California, at (626) 351-4664.

Worker's compensation is a state-mandated program that provides medical and disability benefits to employees who become disabled due to job related injury or illness. Tetra Tech, Inc. and its subsidiaries (Tetra Tech or Company) pay premiums on behalf of their employees. The type of injuries or illnesses covered and the amount of benefits paid are regulated by the state worker's compensation boards and vary from state to state. Corporate Administration in Pasadena is responsible for administering the Company's worker's compensation program. The following is a general explanation of worker's compensation provided in the event that you become injured or develop an illness as a result of your employment with Tetra Tech or any of its subsidiaries. Please be aware that the term used for worker's compensation varies from state to state.

WHO IS COVERED:

All employees of Tetra Tech, whether they are on a full-time, part-time or temporary status, working in an office or in the field, are entitled to worker's compensation benefits. All

employees must follow the above injury/illness reporting procedures. Consultants, independent contractors, and employees of subcontractors are not covered by Tetra Tech's Worker's Compensation plan.

WHAT IS COVERED:

If you are injured or develop an illness caused by your employment, worker's compensation benefits are available to you subject to the laws of the state you work in. Injuries do not have to be serious; even injuries treated by first aid practices are covered and must be reported. Please note that if you are working out-of-state and away from your home office, you are still eligible for worker's compensation benefits.

TETRA TECH, INC.

ACCIDENT AND ILLNESS INVESTIGATION REPORT

To: _____
Subsidiary Health and Safety Representative

cc: _____
Workers Compensation Administrator

Project name: _____

Project number: _____

Prepared by: _____

Position: _____

Office: _____

Telephone number: _____

Fax number: _____

Information Regarding Injured or Ill Employee

Name: _____

Home address: _____

_____

Home telephone number: _____

Occupation (regular job title): _____

Department: _____

Office: _____

Gender: M ☐ F ☐ No. of dependents: _____

Marital status: _____

Date of birth: _____

Social security number: _____

Date of Accident: _____

Time Employee Began Work: _____

Time of Accident: _____ a.m. ☐ p.m. ☐

☐ Check if time cannot be determined

Location of Incident

Street address: _____

City, state, and zip code: _____

County: _____

Was place of accident or exposure on employer's premises? Yes ☐ No ☐

Information About the Incident

What was the employee doing just before the incident occurred? Describe the activity as well as the tools, equipment, or material the employee was using. Be specific. Examples: "Climbing a ladder while carrying roofing materials"; "Spraying chlorine from hand sprayer"; "Daily computer key-entry"

What Happened? Describe how the injury occurred. Examples: "When ladder slipped on wet floor, worker fell 20 feet"; "Worker was sprayed with chlorine when gasket broke during replacement"; "Worker developed soreness in wrist over time"

This form contains information relating to employee health and must be used in a manner that protects the confidentiality of the employee to the extent possible while the information is being used for occupational safety and health purposes.

TETRA TECH, INC.

ACCIDENT AND ILLNESS INVESTIGATION REPORT (Continued)

Information About the Incident (Continued)

What was the injury or illness? Describe the part(s) of the body affected and how it was affected. Be more specific than "hurt," "pain," or "sore." Examples "Strained back"; "Chemical burn, right hand"; "Carpal tunnel syndrome, left wrist"

Describe the Object or Substance that Directly Harmed the Employee: Examples: "Concrete floor"; "Chlorine"; "Radial arm saw." If this question does not apply to the incident, write "Not applicable."

Did the employee die? Yes ☐ No ☐ Date of death: _____

Was employee performing regular job duties? Yes ☐ No ☐

Was safety equipment provided? Yes ☐ No ☐ Was safety equipment used? Yes ☐ No ☐

Note: Attach any police reports or related diagrams to this report.

Witness (Attach additional sheets for other witnesses.)

Name: _____

Company: _____

Street address: _____

City: _____ State: _____ Zip code: _____

Telephone number: _____

Medical Treatment Required? ☐ Yes ☐ No ☐ First aid only

Name of physician or health care professional: _____

If treatment was provided away from the work site, provide the information below.

Facility name: _____

Street address: _____

City: _____ State: _____ Zip code: _____

Telephone number: _____

Was the employee treated in an emergency room? ☐ Yes ☐ No

Was the employee hospitalized over night as an in-patient? ☐ Yes ☐ No

This form contains information relating to employee health and must be used in a manner that protects the confidentiality of the employee to the extent possible while the information is being used for occupational safety and health purposes.

TETRA TECH, INC.

ACCIDENT AND ILLNESS INVESTIGATION REPORT (Continued)

Corrective Action(s) Taken by Unit Reporting the Accident:

Corrective Action Still to be Taken (by whom and when):

Name of Tetra Tech employee the injury or illness was first reported to: _____

Date of Report: _____ **Time of Report:** _____

I have reviewed this investigation report and agree, to the best of my recollection, with its contents.

_____ _____
Printed Name of Injured Employee Telephone Number

_____ _____
Signature of Injured Employee Date

The signatures provided below indicate that appropriate personnel have been notified of the incident.

Title	Printed Name	Signature	Telephone Number	Date
Office Manager				
Project Manager				
Site Safety Coordinator or Office Health and Safety Representative				

This form contains information relating to employee health and must be used in a manner that protects the confidentiality of the employee to the extent possible while the information is being used for occupational safety and health purposes.

TETRA TECH, INC.

ACCIDENT AND ILLNESS INVESTIGATION REPORT (Continued)

To Be Completed by the Subsidiary Health and Safety Representative

Classification of Incident:

☐ Injury ☐ Illness

Result of Incident:

☐ First aid only

☐ Days away from work

☐ Remained at work but incident resulted in job transfer or work restriction

☐ Incident involved days away and job transfer or work restriction

☐ Medical treatment only

No. of days away from work _____

Date employee left work _____

Date employee returned to work _____

No. of days placed on restriction or job transfer: _____

OSHA Recordable Case Number _____

To Be Completed by Human Resources

Social security number: _____

Date of hire: _____ Hire date for current job: _____

Wage information: $ _____ per ☐ Hour ☐ Day ☐ Week ☐ Month

Position at time of hire: _____

Current position: _____ Shift hours: _____

State in which employee was hired: _____

Status: ☐ Full-time ☐ Part-time Hours per week: _____ Days per week: _____

Temporary job end date: _____

To Be Completed during Report to Workers Compensation Carrier

Date reported: _____ Reported by: _____

Confirmation number: _____

Name of contact: _____

Field office of claims adjuster: _____

This form contains information relating to employee health and must be used in a manner that protects the confidentiality of the employee to the extent possible while the information is being used for occupational safety and health purposes.

ATTACHMENT II

EQUIPMENT INSPECTION CHECKLIST

EQUIPMENT INSPECTION

COMPANY:_____ **UNIT NO.**_____

FREQUENCY: Inspect daily, document prior to use and as repairs are needed.

Inspection Date: ____/____/____ Time: _____ Equipment Type:_____
(e.g., bulldozer)

	Good	Need Repair	N/A
Tires or tracks	❒	❒	❒
Hoses and belts	❒	❒	❒
Cab, mirrors, safety glass	❒	❒	❒
- Turn signals, lights, brake lights, etc. (front/rear) for equipment approved for highway use?	❒	❒	❒
- Is the equipment equipped with audible back-up alarms and back-up lights?	❒	❒	❒
Horn and gauges	❒	❒	❒
Brake condition (dynamic, park, etc.)	❒	❒	❒
Fire extinguisher (Type/Rating -_____)	❒	❒	❒
Fluid Levels:			
- Engine oil	❒	❒	❒
- Transmission fluid	❒	❒	❒
- Brake fluid	❒	❒	❒
- Cooling system fluid	❒	❒	❒
- Windshield wipers	❒	❒	❒
- Hydraulic oil	❒	❒	❒
Oil leak/lube	❒	❒	❒
Coupling devices and connectors	❒	❒	❒
Exhaust system	❒	❒	❒
Blade/boom/ripper condition	❒	❒	❒
Accessways: Frame, hand holds, ladders, walkways (non-slip surfaces), guardrails?	❒	❒	❒
Power cable and/or hoist cable	❒	❒	❒
Steering (standard and emergency)	❒	❒	❒

Safety Guards:

	Yes	No
– Around rotating apparatus (belts, pulleys, sprockets, spindles, drums, flywheels, chains) all points of operations protected from accidental contact?_____	❒	❒
– Hot pipes and surfaces exposed to accidental contact?_____	❒	❒
– All emergency shut offs have been identified and communicated to the field crew?_____	❒	❒
– Have emergency shutoffs been field tested? _____	❒	❒
– Results?_____	❒	❒
– Are any structural members bent, rusted, or otherwise show signs of damage?_____	❒	❒
– Are fueling cans used with this equipment approved type safety cans?_____	❒	❒

- Have the attachments designed for use (as per manufacturer's recommendation) with this equipment been inspected and are considered suitable for use?_____ ❒ ❒

Portable Power Tools:

- Tools and Equipment in Safe Condition?_____ ❒ ❒
- Saw blades, grinding wheels free from recognizable defects (grinding wheels have been sounded)? ❒ ❒
- Portable electric tools properly grounded?_____ ❒ ❒
- Damage to electrical power cords?_____ ❒ ❒
- Blade guards in place?_____ ❒ ❒
- Components adjusted as per manufacturers recommendation?_____ ❒ ❒

Cleanliness:

- Overall condition (is the decontamination performed prior to arrival on-site considered acceptable)?_____
- Where was this equipment used prior to its arrival on site?_____
- Site Contaminants of concern at the previous site?_____
- Inside debris (coffee cups, soda cans, tools and equipment) blocking free access to foot controls?_____

Operator Qualifications (as applicable for all heavy equipment):

- Does the operator have proper licensing where applicable, (e.g., CDL)?_____
- Does the operator, understand the equipments operating instructions?_____
- Is the operator experienced with this equipment? _____
- Does the operator have emotional and/or physical limitations which would prevent him/her from performing this task in a safe manner?_____
- Is the operator 21 years of age or more?_____

Identification:

- Is a tagging system available, for positive identification, for tools removed from service?___

Additional Inspection Required Prior to Use On-Site

	Yes	No
- Does equipment emit noise levels above 90 decibels?	❒	❒
- If so, has an 8-hour noise dosimetry test been performed?	❒	❒

- Results of noise dosimetry:_____
- Defects and repairs needed:_____
- General Safety Condition: _____
- Operator or mechanic signature:_____

Approved for Use: ❒ Yes ❒ No

_____
Site Safety Officer Signature

ATTACHMENT III

MEDICAL DATA SHEET

MEDICAL DATA SHEET

This Medical Data Sheet must be completed by all on-site personnel and kept in the command post during the conduct of site operations. This data sheet will accompany any personnel when medical assistance is needed or if transport to hospital facilities is required.

Project _____

Name _____ Home Telephone _____

Address _____

Age _____ Height _____ Weight _____

Name of Next Kin _____

Drug or other Allergies _____

Particular Sensitivities _____

Do You Wear Contacts? _____

Provide a Checklist of Previous Illnesses or Exposure to Hazardous Chemicals _____

_____

_____

What medications are you presently using? _____

_____

_____

Do you have any medical restrictions? _____

_____

_____

Name, Address, and Phone Number of personal physician: _____

_____

_____

I am the individual described above. I have read and understand this HASP.

_____ _____

Signature Date

ATTACHMENT IV

SAFE WORK PERMITS

SAFE WORK PERMIT FOR
MOBILIZATION AND DEMOBILIZATION ACTIVITIES
NSWC, CRANE INDIANA

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope

I. Work limited to the following (description, area, equipment used): Mobilization and demobilization activities

II. Required Monitoring Instruments: None

III. Field Crew: _____

IV. On-site Inspection conducted ☒ Yes ☐ No Initials of Inspector _____ _____
TtNUS

SECTION II: General Safety Requirements (To be filled in by permit issuer)

V. Protective equipment required
Level D ☒ Level B ☐
Level C ☐ Level A ☐
Detailed on Reverse

Respiratory equipment required

Full face APR	☐	Escape Pack	☐
Half face APR	☐	SCBA	☐
PAPR	☐	Bottle Trailer	☐
Skid Rig	☐	None	☒

Modifications/Exceptions: Minimum requirement include sleeved shirt and long pants, safety glasses and safety footwear. Hard hats and hearing protection will be worn when working near operating equipment.

VI. Chemicals of Concern — Action Level(s) — Response Measures
None anticipated given the nature of these activities and limited contact w/ media.

VII. Additional Safety Equipment/Procedures

Hard-hat	☐ Yes	☐ No	Hearing Protection (Plugs/Muffs)	☐ Yes	☐ No
Safety Glasses	☐ Yes	☐ No	Safety belt/harness	☐ Yes	☒ No
Chemical/splash goggles	☐ Yes	☒ No	Radio	☐ Yes	☒ No
Splash Shield	☐ Yes	☒ No	Barricades	☐ Yes	☒ No
Splash suits/coveralls	☐ Yes	☒ No	Gloves (Type - Nitrile)	☐ Yes	☒ No
Steel toe Work shoes or boots	☒ Yes	☐ No	Work/rest regimen	☐ Yes	☒ No

Modifications/Exceptions: Reflective vests for high traffic areas.

VIII. Procedure review with permit acceptors

	Yes	NA		Yes	NA
Safety shower/eyewash (Location & Use)	☐	☐	Emergency alarms	☐	☐
Procedure for safe job completion	☐	☐	Evacuation routes	☐	☐
Contractor tools/equipment/PPE inspected	☐	☐	Assembly points	☐	☐

IX. Site Preparation

	Yes	NA
Utility Locating and Excavation Clearance completed	☐	☐
Vehicle and Foot Traffic Routes Cleared and Established	☐	☐
Physical Hazards Barricaded and Isolated	☐	☐
Emergency Equipment Staged	☐	☐

X. Additional Permits required (Hot work, confined space entry, excavation etc.). ☐ Yes ☒ No
If yes, complete permit required or contact Health Sciences, Pittsburgh Office

XI. Special instructions, precautions: Preview work locations to identify potential hazards (slips, trips, and falls, natural hazards, etc.) Avoid potential nesting areas, use commercially available insect repellants. Wear light colored clothing so that ticks and other biting insects can be easily visible and can be removed. Inspect clothing and body for ticks. Minimize contact with potentially contaminated media. Suspend site activities in the event of inclement weather.

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT FOR
MULTI MEDIA SAMPLING
NSWC, CRANE INDIANA

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope

I. Work limited to the following (description, area, equipment used): Multi media sampling including groundwater

II. Required Monitoring Instrument(s): FID or a PID with at least a 10.6 eV lamp

III. Field Crew: _____

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector _____ _____
TtNUS

SECTION II: General Safety Requirements (To be filled in by permit issuer)

V. Protective equipment required

Level D ☒ Level B ☐
Level C ☐ Level A ☐
Detailed on Reverse

Respiratory equipment required

Full face APR	☐	Escape Pack	☐
Half face APR	☐	SCBA	☐
PAPR	☐	Bottle Trailer	☐
Skid Rig	☐	None	☒

Modifications/Exceptions: Minimum requirement include sleeved shirt and long pants, safety footwear, and nitrile gloves.

VI.

Chemicals of Concern	Action Level(s)	Response Measures
Chlorinated Solvents	Any sustained readings above 5 ppm in worker breathing zone	Suspend site activities report to an unaffected area.

VII. Additional Safety Equipment/Procedures

Hard-hat	☐ Yes	☒ No	Hearing Protection (Plugs/Muffs)	☐ Yes	☐ No
Safety Glasses	☒ Yes	☐ No	Safety belt/harness	☐ Yes	☒ No
Chemical/splash goggles	☐ Yes	☒ No	Radio	☐ Yes	☒ No
Splash Shield	☐ Yes	☐ No	Barricades	☐ Yes	☒ No
Splash suits/coveralls	☐ Yes	☒ No	Gloves (Type – surgeon's)	☒ Yes	☐ No
Steel toe Work shoes or boots	☒ Yes	☐ No	Work/rest regimen	☐ Yes	☒ No

Modifications/Exceptions: Tyvek coverall if there is a potential for soiling work cloths and PVC or PE coated Tyvek if saturation or work cloths may occur. Wear hard hat and hearing protection when sampling from backhoe. Wear reflective vest in high traffic areas.

VIII.

Procedure review with permit acceptors	Yes	NA		Yes	NA
Safety shower/eyewash (Location & Use)	☐	☐	Emergency alarms	☐	☐
Procedure for safe job completion	☐	☐	Evacuation routes	☐	☐
Contractor tools/equipment/PPE inspected	☐	☐	Assembly points	☐	☐

IX.

Site Preparation	Yes	NA
Utility Locating and Excavation Clearance completed	☐	☐
Vehicle and Foot Traffic Routes Cleared and Established	☐	☐
Physical Hazards Barricaded and Isolated	☐	☐
Emergency Equipment Staged	☐	☐

X. Additional Permits required (Hot work, confined space entry, excavation etc.). ☐ Yes ☒ No
If Yes, complete permit required or contact Health Sciences, Pittsburgh Office

XI. Special instructions, precautions Suspicious materials or items shall be avoided and reported to the site contact. Follow TtNUS SOP's on UXO and Utility Locating/Excavation Clearance. TLDs will be required when working in and around the Primary Burial Area.

Permit Issued by: _____ Permit Accepted by: _____

Section Break (Next Page)

SAFE WORK PERMIT
DECONTAMINATION ACTIVITIES
NSWC, CRANE INDIANA

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope

I. Work limited to the following (description, area, equipment used): Decontamination of sampling and heavy equipment. Brushes and spray bottles will be used to decon small sampling equipment

II. Required Monitoring Instrument(s): None required

III. Field Crew: _____

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector _____ _____
TtNUS

SECTION II: General Safety Requirements (To be filled in by permit issuer)

IV. Protective equipment required

Level D ☒ Level B ☐
Level C ☐ Level A ☐
Detailed on Reverse

Respiratory equipment required

Full face APR	☐	Escape Pack	☐
Half face APR	☐	SCBA	☐
PAPR	☐	Bottle Trailer	☐
Skid Rig	☐	None	☒

Modifications/Exceptions: Minimum requirement include sleeved shirt and long pants, safety glasses, safety footwear, and nitrile gloves.

V.

Chemicals of Concern	Action Level(s)	Response Measures
Decon solutions	obtain/follow MSDS	obtain/follow MSDS

VI. Additional Safety Equipment/Procedures

Hard-hat	☐ Yes	☒ No	Hearing Protection (Plugs/Muffs)	☐ Yes	☐ No
Safety Glasses	☒ Yes	☐ No	Safety belt/harness	☐ Yes	☒ No
Chemical/splash goggles	☐ Yes	☒ No	Radio	☐ Yes	☒ No
Splash Shield	☐ Yes	☐ No	Barricades	☐ Yes	☒ No
Splash suits/coveralls	☐ Yes	☐ No	Gloves (Type - Nitrile)	☒ Yes	☐ No
Steel toe Work shoes or boots	☒ Yes	☐ No	Work/rest regimen	☐ Yes	☒ No

Modifications/Exceptions: PVC rain suits or PE or PVC coated Tyvek for protection against splashes and overspray. Chemical resistant boot covers if excessive liquids are generated or to protected footwear. Splash shield and hearing protection when using high pressure wash and rinse.

VII. Procedure review with permit acceptors

	Yes	NA		Yes	NA
Safety shower/eyewash (Location & Use)	☐	☐	Emergency alarms	☐	☐
Procedure for safe job completion	☐	☐	Evacuation routes	☐	☐
Contractor tools/equipment/PPE inspected	☐	☐	Assembly points	☐	☐

VIII. Site Preparation

	Yes	NA
Utility Locating and Excavation Clearance completed	☐	☐
Vehicle and Foot Traffic Routes Cleared and Established	☐	☐
Physical Hazards Barricaded and Isolated	☐	☐
Emergency Equipment Staged	☐	☐

IX. Additional Permits required (Hot work, confined space entry, excavation etc.). ☐ Yes ☒ No
If yes, complete permit required or contact Health Sciences, Pittsburgh Office

X. Special instructions, precautions: Chemical hazards with decontamination because of use of fluids such as isopropyl alcohol, methanol, etc. To minimize the potential for exposure, site personnel will use PPE and prevent contact with potentially contaminated equipment. Refer to the manufacturer's MSDS regarding PPE, handling, storage, and first-aid measures.

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT
TEST PIT EXCAVATION AND SAMPLING
NSWC, CRANE INDIANA

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope

I. Work limited to the following (description, area, equipment used): Test pit excavation and drilling activities

II. Required Monitoring Instruments: FID or a PID with at least a 10.6 eV lamp

III. Field Crew: _____

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector _____ _____
TtNUS

SECTION II: General Safety Requirements (To be filled in by permit issuer)

V. Protective equipment required
Level D ☒ Level B ☐
Level C ☐ Level A ☐
Detailed on Reverse

Respiratory equipment required
Full face APR ☐ Escape Pack ☐
Half face APR ☐ SCBA ☐
PAPR ☐ Bottle Trailer ☐
Skid Rig ☐ None ☒

Level D Minimum Requirements: Sleeved shirt and long pants, safety footwear, and nitrile gloves. Safety glasses, hard hats, and hearing protection will be worn when working near or sampling in the vicinity of the track-hoe.

Modifications/Exceptions: If concentrations or conditions surpass the specified action levels stated below.

VI. Chemicals of Concern	Action Level(s)	Response Measures
Chlorinated Solvents	Any sustained readings above 5 ppm in worker breathing zone	Suspend site activities report to an unaffected area.

VII. Additional Safety Equipment/Procedures

Hard-hat	☒ Yes	☐ No	Hearing Protection (Plugs/Muffs)	☒ Yes	☐ No
Safety Glasses	☒ Yes	☐ No	Safety belt/harness	☐ Yes	☒ No
Chemical/splash goggles	☐ Yes	☒ No	Radio	☐ Yes	☒ No
Splash Shield	☐ Yes	☒ No	Barricades	☒ Yes	☐ No
Splash suits/coveralls	☒ Yes	☐ No	Gloves (Type - Nitrile)	☒ Yes	☐ No
Steel toe work shoes or boots	☒ Yes	☐ No	Work/warming regimen	☐ Yes	☒ No

Modifications/Exceptions: Reflective vests for high traffic areas. Chemical resistant over-boots. PVC or PE coated Tyvek if saturation or work clothes may occur.

VIII. Procedure review with permit acceptors

	Yes	NA		Yes	NA
Safety shower/eyewash (Location & Use)	☐	☐	Emergency alarms	☐	☐
Daily tail gate meetings	☐	☐	Evacuation routes	☐	☐
Contractor tools/equipment/PPE inspected	☐	☐	Assembly points	☐	☐

IX. Site Preparation

	Yes	NA
Utility Locating and Excavation Clearance completed	☐	☐
Vehicle and Foot Traffic Routes Cleared and Established	☐	☐
Physical Hazards Barricaded and Isolated	☐	☐
Emergency Equipment Staged	☐	☐

X. Additional Permits required (Hot work, confined space entry) ☐ Yes ☐ No
If yes, complete permit required or contact Health Sciences, Pittsburgh Office

XI. Special instructions, precautions: Site personnel will not be permitted to enter any excavation. Equipment, personnel, and machinery will be kept away from the edges of open excavations (> 3 feet). Open excavations will be barricaded. When approaching the excavator, establish eye contact with the operator before approaching the vehicle. Only approach one the operator has given permission. Take samples from the bucket only! Follow TtNUS SOP on Utility Locating and Excavation Clearance. TLDs will be required when working in and around the Primary Burial Area.

Permit Issued by: _____ Permit Accepted by: _____

Section Break (Next Page)

SAFE WORK PERMIT FOR GEOGRAPHICAL SURVEYING NSWC, CRANE INDIANA

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope

I. Work limited to the following (description, area, equipment used): Geographical survey activities

II. Required Monitoring Instruments: None

III. Field Crew: _____

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector _____ _____
TtNUS

SECTION II: General Safety Requirements (To be filled in by permit issuer)

V. Protective equipment required

Level D ☒ Level B ☐
Level C ☐ Level A ☐
Detailed on Reverse

Respiratory equipment required

Full face APR	☐	Escape Pack	☐
Half face APR	☐	SCBA	☐
PAPR	☐	Bottle Trailer	☐
Skid Rig	☐	None	☒

Modifications/Exceptions: Minimum requirement include sleeved shirt and long pants. Steel toe safety footwear is not required for geophysical survey.

VI.

Chemicals of Concern	Action Level(s)	Response Measures
None anticipated given the nature of surveying activities and limited contact w/ media.		

VII. Additional Safety Equipment/Procedures

Hard-hat	☐ Yes	☐ No	Hearing Protection (Plugs/Muffs)	☐ Yes	☒ No
Safety Glasses	☐ Yes	☐ No	Safety belt/harness	☐ Yes	☒ No
Chemical/splash goggles	☐ Yes	☒ No	Radio	☐ Yes	☒ No
Splash Shield	☐ Yes	☒ No	Barricades	☐ Yes	☒ No
Splash suits/coveralls	☐ Yes	☐ No	Gloves (Type - _____)	☐ Yes	☐ No
Steel toe work shoes or boots	☒ Yes	☐ No	Work/rest regimen	☐ Yes	☒ No

Modifications/Exceptions: Reflective vests for high traffic areas. Tyvek coverall to protect against natural hazards (e.g., ticks). Hard hats and safety glasses at SSO discretion. If working in areas where snakes are a threat, wear snake chaps in brushy/wooded areas to protect against bites

VIII.

Procedure review with permit acceptors	Yes	NA		Yes	NA
Safety shower/eyewash (Location & Use)	☐	☐	Emergency alarms	☐	☐
Procedure for safe job completion	☐	☐	Evacuation routes	☐	☐
Contractor tools/equipment/PPE inspected	☐	☐	Assembly points	☐	☐

IX.

Site Preparation	Yes	NA
Utility Locating and Excavation Clearance Completed	☐	☐
Vehicle and Foot Traffic Routes Cleared and Established	☐	☐
Physical Hazards Barricaded and Isolated	☐	☐
Emergency Equipment Staged	☐	☐

X. Additional Permits required (Hot work, confined space entry, excavation etc.). ☐ Yes ☐ No
If yes, complete permit required or contact Health Sciences, Pittsburgh Office

XI. Special instructions, precautions: Preview work locations to identify potential hazards (slips, trips, and falls, natural hazards, etc.) Avoid potential nesting areas. Wear light colored clothing so that ticks and other biting insects can be easily visible and can be removed. Use commercially available repellants. Inspect clothing and body for ticks. Minimize contact with potentially contaminated media. Suspend site activities in the event of inclement weather.

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT
ROCK AND SOIL BORING
NSWC, CRANE INDIANA

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope

I. Work limited to the following (description, area, equipment used): Handling, sampling and staging of IDW drums.

II. Required Monitoring Instruments: PID with 10.6 eV (or higher) lamp to detect presence of VOCs

III. Field Crew: _____

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector _____ _____
TtNUS

SECTION II: General Safety Requirements (To be filled in by permit issuer)

IV. Protective equipment required

Level D ☒ Level B ☐
Level C ☐ Level A ☐
Detailed on Reverse

Respiratory equipment required

Full face APR	☐	Escape Pack	☐
Half face APR	☐	Airline/SCBA	☐
PAPR	☐	Bottle trailer	☐
Skid Rig	☐	None	☒

Modifications/Exceptions: Minimum requirement include sleeved shirt and long pants, safety shoes, hardhat, nitrile outer gloves with surgical-style inner gloves, impermeable boot covers.

VI.

Chemicals of Concern	Action Level(s)	Response Measures
Chlorinated Solvents	Any sustained readings above 5 ppm in worker breathing zone	Suspend site activities report to an unaffected area.

VI. Additional Safety Equipment/Procedures

Hard-hat	☒ Yes	☐ No	Hearing Protection (Plugs/Muffs)	☒ Yes	☐ No
Safety Glasses	☒ Yes	☐ No	Safety belt/harness	☐ Yes	☒ No
Chemical/splash goggles	☐ Yes	☐ No	Radio	☐ Yes	☒ No
Splash Shield	☐ Yes	☐ No	Barricades	☐ Yes	☐ No
Splash suits/coveralls	☒ Yes	☐ No	Gloves (Type - Nitrile)	☒ Yes	☐ No
Steel toe work shoes or boots	☒ Yes	☐ No	Work/rest regimen	☒ Yes	☐ No

Modifications/Exceptions: Tyvek coverall if there is a potential for soiling clothes.

VII. Procedure review with permit acceptors

	Yes	NA		Yes	NA
Safety shower/eyewash (Location & Use)	☐	☐	Emergency alarms	☐	☐
Procedure for safe job completion	☐	☐	Evacuation routes	☐	☐
Contractor tools/equipment/PPE inspected	☐	☐	Assembly points	☐	☐

IX. Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☐
Vehicle and Foot Traffic Routes Cleared and Established	☐	☐	☐
Physical Hazards Barricaded and Isolated	☐	☐	☐
Emergency Equipment Staged	☐	☐	☐

IX. Additional Permits required (Hot work, confined space entry, excavation etc.) ☐ Yes ☒ No
If yes, complete permit required or contact Health Sciences, Pittsburgh Office

X. Special instructions, precautions: Determine procedure for handling and sampling rock boring cores. Minimize the distance the cores must be carried. Use multiple persons or mechanical means to life the core. Watch for overhead hazards as well as pinch and compression hazards. TLDs will be required when working in and around the Primary Burial Area.

Permit Issued by: _____ Permit Accepted by: _____

Section Break (Next Page)

ATTACHMENT V

STANDARD OPERATING PROCEDURE FOR UTILITY LOCATION AND EXCAVATION CLEARANCE

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1.0 PURPOSE

Utilities such as electric service lines, natural or propane gas lines, water and sewage lines, telecommunications, and steam lines are very often in the immediate vicinity of work locations. Contact with underground or overhead utilities can have serious consequences including employee injury/fatality, property and equipment damage, substantial financial impacts, and loss of utility service to users.

The purpose of this procedure is to provide minimum requirements and technical guidelines regarding the appropriate procedures to be followed when performing subsurface and overhead utility locating services. It is the policy of Tetra Tech NUS, Inc. (TtNUS) to provide a safe and healthful work environment for the protection of our employees. The purpose of this Standard Operating Procedure (SOP) is to aid in achieving the objectives of the TtNUS Utility Locating and Clearance Policy. The TtNUS Utility Locating and Clearance Policy must be reviewed by anyone potentially involved with underground or overhead utility services.

2.0 SCOPE

This procedure applies to all TtNUS field activities where there may be potential contact with underground or overhead utilities. This procedure provides a description of the principles of operation, instrumentation, applicability, and implementability of typical methods used to determine the presence or absence of utility services. This procedure is intended to assist with work planning and scheduling, resource planning, field implementation, and subcontractor procurement. Utility locating and excavation clearance requires site-specific information prior to the development of detailed operating procedures. This guidance is not intended to provide a detailed description of methodology and instrument operation. Specialized expertise during both planning and execution of several of the geophysical methods may also be required.

3.0 GLOSSARY

Electromagnetic Induction (EMI) Survey - A geophysical exploration method whereby electromagnetic fields are induced in the ground and the resultant secondary electromagnetic fields are detected as a measure of ground conductivity.

Magnetometer – A device used for precise and sensitive measurements of magnetic fields.

Magnetic Survey – A geophysical survey method that depends on detection of magnetic anomalies caused by the presence of buried ferromagnetic objects.

Metal Detection – A geophysical survey method that is based on electromagnetic coupling caused by underground conductive objects.

Vertical Gradiometer – A magnetometer equipped with two sensors that are vertically separated by a fixed distance. It is best suited to map near surface features and is less susceptible to deep geologic features.

Ground Penetrating Radar – Ground Penetrating Radar (GPR) involves specialized radar equipment whereby a signal is sent into the ground via a transmitter. Some portion of the signal will be reflected from the subsurface material, which is then recorded with a receiver and electronically converted into a graphic picture.

4.0 RESPONSIBILITIES

Project Manager (PM)/Task Order Manager (TOM) - Responsible for ensuring that all field activities are conducted in accordance with this procedure and the TtNUS Utility Locating and Clearance Policy.

Site Manager (SM)/Field Operations Leader (FOL) - Responsible for the onsite verification that all field activities are performed in compliance with approved SOPs or as otherwise directed by the approved project plan(s).

Site Health & Safety Officer (SHSO) – Responsible to provide technical assistance and verify full compliance with this SOP and the TtNUS Utility Locating and Clearance Policy. The SHSO is also responsible for reporting any deficiencies to the Corporate Health and Safety Manager (HSM) and to the PM/TOM.

Health & Safety Manager (HSM) – Responsible for preparing, implementing, and modifying corporate health and safety policy.

Site Personnel – Responsible for understanding and implementing this SOP and the TtNUS Utility Locating and Clearance Policy.

5.0 PROCEDURES

This procedure addresses the requirements and technical procedures that must be performed to minimize the potential for contact with underground and overhead utility services. These procedures are addressed individually from a buried and overhead standpoint.

5.1 Buried Utilities

Buried utilities present a heightened concern because their location is not typically obvious by visual observation, and it is common that their presence and/or location is unknown or incorrectly known on client properties. The following procedure must be followed prior to beginning any excavation that might potentially be in the vicinity of underground utility services. In addition, the Utility Clearance Form (Attachment 3) must be completed for every location or cluster of locations where intrusive activities will occur.

Where the positive identification and de-energizing of underground utilities cannot be obtained and confirmed using the following steps, the PM/TOM is responsible for arranging for the procurement of a qualified, experienced, utility locating subcontractor who will accomplish the utility location and demarcation duties specified herein.

1. A comprehensive review must be made of any available property maps, blue lines, or as-builts prior to site activities. Interviews with local personnel familiar with the area should be performed to provide additional information concerning the location of potential underground utilities. Information regarding utility locations shall be added to project maps upon completion of this exercise.

2., A visual site inspection must be performed to compare the site plan information to actual field conditions. Any findings must be documented and the site plan/maps revised. The area(s) of proposed excavation or other subsurface activities must be marked at the site in white paint or pin flags to identify those locations of the proposed intrusive activities. The site inspection should focus on locating surface indications of potential underground utilities. Items of interest include the presence of nearby area lights, telephone service, drainage grates, fire hydrants, electrical service vaults/panels, asphalt/concrete scares and patches, and topographical depressions. Note the location of any emergency shut off switches. Any additional information regarding utility locations shall be added to project maps upon completion of this exercise and returned to the PM/TOM.

3. If the planned work is to be conducted on private property (e.g., military installations, manufacturing facilities, etc.) the FOL must identify and contact appropriate facility personnel (e.g., public works or facility engineering) before any intrusive work begins to inquire about (and comply with) property owner requirements. It is important to note that private property owners may require several days to several weeks advance notice prior to locating utilities.

4. If the work location is on public property, the state agency that performs utility clearances must be notified (see Attachment 1). State "one-call" services must be notified prior to commencing fieldwork per their requirements. Most one-call services require, by law, 48- to 72-hour advance notice prior to beginning any excavation. Such services typically assign a "ticket" number to the particular site. This ticket number must be recorded for future reference and is valid for a specific period of time, but may be extended by contacting the service again. The utility service will notify utility representatives who then mark their respective lines within the specified time frame. It should be noted that most military installations own their own utilities but may lease service and maintenance from area providers. Given this situation, "one call" systems may still be required to provide location services on military installations.

5. Utilities must be identified and their locations plainly marked using pin flags, spray paint, or other accepted means. The location of all utilities must be noted on a field sketch for future inclusion on project maps. Utility locations are to be identified using the following industry-standard color code scheme, unless the property owner or utility locator service uses a different color code:

white	excavation/subsurface investigation location
red	electrical
yellow	gas, oil, steam
orange	telephone, communications
blue	water, irrigation, slurry
green	sewer, drain

6. Where utility locations are not confirmed with a high degree of confidence through drawings, schematics, location services, etc., the work area must be thoroughly investigated prior to beginning the excavation. In these situations, utilities must be identified using such methods as passive and intrusive surveys, physical probing, or hand augering. Each method has advantages and disadvantages including complexity, applicability, and price. It also should be noted that in many states, initial excavation is required by hand to a specified depth.

7. At each location where trenching or excavating will occur using a backhoe or other heavy equipment, and where utility identifications and locations cannot be confirmed prior to groundbreaking, the soil must be probed with a hand auger or pole (tile probe) made of non-conductive material. If these efforts are not successful in clearing the excavation area of suspect utilities, hand shoveling must be performed for the perimeter of the intended excavation.

8. All utilities uncovered or undermined during excavation must be structurally supported to prevent potential damage. Unless necessary as an emergency corrective measure, TtNUS shall not make any repairs or modifications to existing utility lines without prior permission of the utility owner, property owner, and Corporate HSM. All repairs require that the line be locked-out/tagged-out prior to work.

5.2 Overhead Power Lines

If it is necessary to work within the minimum clearance distance of an overhead power line, the overhead line must be de-energized and grounded, or re-routed by the utility company or a registered electrician. If protective measures such as guarding, isolating, or insulating are provided, these precautions must be

adequate to prevent employees from contacting such lines directly with any part of their body or indirectly though conductive materials, tools, or equipment.

The following table provides the required minimum clearances for working in proximity to overhead power lines.

Nominal Voltage	Minimum Clearance
0 -50 kV	10 feet, or one mast length; whichever is greater
50+ kV	10 feet plus 4 inches for every 10 kV over 50 kV or 1.5 mast lengths; whichever is greater

6.0 UNDERGROUND LOCATING TECHNIQUES

6.1 Geophysical Methods

Geophysical methods include electromagnetic induction, magnetics, and ground penetrating radar. Additional details concerning the design and implementation of electromagnetic induction, magnetics, and ground penetrating radar surveys can be found in one or more of the TtNUS SOPs included in the References (Section 8.0).

Electromagnetic Induction

Electromagnetic Induction (EMI) line locators operate either by locating a background signal or by locating a signal introduced into the utility line using a transmitter. A utility line acts like a radio antenna, producing electrons, which can be picked up with a radiofrequency receiver. Electrical current carrying conductors have a 60HZ signal associated with them. This signal occurs in all power lines regardless of voltage. Utilities in close proximity to power lines or used as grounds may also have a 60HZ signal, which can be picked up with an EM receiver. A typical example of this type of geophysical equipment is an EM-61.

EMI locators specifically designed for utility locating use a special signal that is either indirectly induced onto a utility line by placing the transmitter above the line or directly induced using an induction clamp. The clamp induces a signal on the specific utility and is the preferred method of tracing since there is little chance of the resulting signals being interfered with. A good example of this type of equipment is the Schonstedt® MAC-51B locator. The MAC-51B performs inductively traced surveys, simple magnetic locating, and traced nonmetallic surveys.

When access can be gained inside a conduit to be traced, a flexible insulated trace wire can be used. This is very useful for non-metallic conduits but is limited by the availability of gaining access inside the pipe.

Magnetics

Magnetic locators operate by detecting the relative amounts of buried ferrous metal. They are incapable of locating or identifying nonferrous utility lines but can be very useful for locating underground storage tanks (UST's), steel utility lines, and buried electrical lines. A typical example of this type of equipment is the Schonstedt® GA-52Cx locator. The GA-52Cx is capable of locating 4-inch steel pipe up to 8 feet deep.

Non-ferrous lines are often located by using a typical plumbing tool (snake) fed through the line. A signal is then introduced to the snake that is then traced.

Ground Penetrating Radar

Ground Penetrating Radar (GPR) involves specialized radar equipment whereby a signal is sent into the ground via a transmitter. Some portion of the signal will be reflected from the subsurface material, which is then recorded with a receiver and electronically converted into a graphic picture. In general, an object which is harder than the surrounding soil will reflect a stronger signal. Utilities, tunnels, UST's, and footings will reflect a stronger signal than the surrounding soil. Although this surface detection method may determine the location of a utility, this method does not specifically identify utilities (i.e., water vs. gas, electrical vs. telephone); hence, verification may be necessary using other methods. This method is somewhat limited when used in areas with clay soil types or with a high water table.

6.2 Passive Detection Surveys

Acoustic Surveys

Acoustic location methods are generally most applicable to waterlines or gas lines. A highly sensitive Acoustic Receiver listens for background sounds of water flowing (at joints, leaks, etc.) or to sounds introduced into the water main using a transducer. Acoustics may also be applicable to determine the location of plastic gas lines.

Thermal Imaging

Thermal (i.e., infrared) imaging is a passive method for detecting the heat emitted by an object. Electronics in the infrared camera convert subtle heat differentials into a visual image on the viewfinder or a monitor. The operator does not look for an exact temperature; rather they look for heat anomalies (either elevated or suppressed temperatures) characteristic of a potential utility line.

The thermal fingerprint of underground utilities results from differences in temperature between the atmosphere and the fluid present in a pipe or the heat generated by electrical resistance. In addition, infrared scanners may be capable of detecting differences in the compaction, temperature and moisture content of underground utility trenches. High-performance thermal imagery can detect temperature differences to hundredths of a degree.

6.3 Intrusive Detection Surveys

Vacuum Excavation

Vacuum excavation is used to physically expose utility services. The process involves removing the surface material over approximately a 1' x 1' area at the site location. The air-vacuum process proceeds with the simultaneous action of compressed air-jets to loosen soil and vacuum extraction of the resulting debris. This process ensures the integrity of the utility line during the excavation process, as no hammers, blades, or heavy mechanical equipment comes into contact with the utility line, eliminating the risk of damage to utilities. The process continues until the utility is uncovered. Vacuum excavation can be used at the proposed site location to excavate below the "utility window" which is usually 8 feet.

Hand-auger Surveys

When the identification and location of underground utilities cannot be positively confirmed through document reviews and/or other methods, borings must be hand-augered for all locations where there is a potential to impact buried utilities. The minimum hand-auger depth that must be reached is to be determined considering the geographical location of the work site. This approach recognizes that the

placement of buried utilities is influenced by frost line depths that vary by geographical region. Attachment 2 presents frost line depths for the regions of the contiguous United States. At a minimum, hand-auger depths must be at least to the frost line depth plus two (2) feet, but never less than 4 feet below ground surface (bgs). For augering, the hole must be reamed by hand to at least the diameter of the drill rig auger or bit prior to drilling. For soil gas surveys, the survey probe shall be placed as close as possible to the cleared hand-auger. It is important to note that a post-hole digger must not be used in place of a hand-auger.

Tile Probe Surveys

For some soil types, site conditions, and excavation requirements, tile probes may be used instead of or in addition to hand-augers. Tile probes must be performed to the same depth requirements as hand-augers. Depending upon the site conditions and intended probe usage, tile probes should be made of non-conductive material such as fiberglass.

7.0 INTRUSIVE ACTIVITIES SUMMARY

The following list summarizes the activities that must be performed prior to beginning subsurface activities:

1. Map and mark all subsurface locations and excavation boundaries using white paint or markers specified by the client or property owner.

2. Notify the property owner and/or client that the locations are marked. At this point, drawings of locations or excavation boundaries shall be provided to the property owner and/or client so they may initiate (if applicable) utility clearance.

   Note: Drawings with confirmed locations should be provided to the property owner and/or client as soon as possible to reduce potential time delays.

3. Notify "One Call" service. If possible, arrange for an appointment to show the One Call representative the subsurface locations or excavation boundaries in person. This will provide a better location designation to the utilities they represent. You should have additional drawings should you need to provide plot plans to the One Call service.

4. Complete Attachment 3, Utility Clearance Form. This form should be completed for each excavation location. In situations where multiple subsurface locations exist within the close proximity of one another, one form may be used for multiple locations provided those locations are noted on the Utility Clearance Form. Upon completion, the Utility Clearance Form and revised/annotated utility location map becomes part of the project file.

8.0 REFERENCES

TtNUS Utility Locating and Clearance Policy
TtNUS SOP GH-3.1; Resistivity and Electromagnetic Induction
TtNUS SOP GH-3.2; Magnetic and Metal Detection Surveys
TtNUS SOP GH-3.4; Ground-penetrating Radar Surveys

ATTACHMENT 1
LISTING OF UNDERGROUND UTILITY CLEARANCE RESOURCES

ALABAMA
Alabama Line Location (800) 292-8525

Tucson Blue Stake Center (800) 782-5348

Alaska
Locate Call Center of Alaska Inc. (800) 478-3121

Arizona
Arizona Blue Stake Inc. (800) 782-5348

Arkansas
Arkansas One Call System Inc. (800) 482-8998

California
Underground Service Alert North (800) 227-2600

Underground Service Alert South (800) 227-2600

Colorado
Utility Notification Center of Colorado
(800) 922-1987

Connecticut
Call Before You Dig (800) 922-4455

Delaware
Miss Utility of Delmarva
(800) 282-8555

District of Columbia
Miss Utility (800) 257-7777

Florida
Call Sunshine (800) 432-4770

Georgia
Utilities Protection Center Inc.
(800) 282-7411

Idaho
Palouse Empire Underground Coordinating Council
(800) 882-1974

Utilities Underground Location Center
(800) 424-5555

Kootenai Country Utility Coordinating Council
(800) 428-4950

Shoshone County One Call (800) 398-3285

Dig Line (800) 342-1585

One Call Concepts (800) 626-4950

Illinois
Julie Inc. (800) 892-0123

Digger (Chicago Utility Alert Network)
(312) 744-7000

Indiana
Indiana Underground Plant Protection Services
(800) 382-5544

Iowa
Underground Plant Location Service Inc.
(800) 292-8989

Kansas
Kansas One-Call Center (800) 344-7233

Kentucky
Kentucky Underground Protection Inc.
(800) 752-6007

Louisiana
Louisiana One Call (800) 272-3020

Maine
Dig Safe – Maine (800) 225-4977

Maryland
Miss Utility (800) 257-777

Miss Utility of Delmarva (800) 282-8555

Massachusetts
Dig Safe – Massachusetts (800) 322-4844

Michigan
Miss Dig System (800) 482-7171

Minnesota
Gopher State One Call (800) 252-1166

Mississippi
Mississippi One-Call System Inc. (800) 227-6477

Missouri
Missouri One Call System Inc. (800) 344-7483

Montana
Utilities Underground Location Center
(800) 424-5555

Montana One Call Center (800) 551-8344

Nebraska
Diggers Hotline of Nebraska (800) 331-5666

Nevada
Underground Service Alert North (800) 227-2600

New Hampshire
Dig Safe – New Hampshire (800) 225-4977

New Jersey
New Jersey One Call (800) 272-1000

New Mexico
New Mexico One Call System Inc.
(800) 321-ALERT

Las Cruces-Dona Utility Council (505) 526-0400

New York
Underground Facilities Protection Organization
(800) 962-7962

New York City: Long Island One Call Center
(800) 272-4480

North Carolina
The North Carolina One-Call Center Inc.
(800) 632-4949

North Dakota
Utilities Underground Location Center
(800) 795-0555

Ohio
Ohio Utilities Protection Service
(800) 362-2764

Oil & Gas Producers Underground Protection Service
(800) 925-0988

Oklahoma
Call Okie (800) 522-6543

Oregon
Utilities Underground Location Center
(800) 424-5555

Douglas Utilities Coordinating Council
(503) 673-6676

Josephine Utilities Coordinating Council
(503) 476-6676

Rogue Basin Utility Coordinating Council
(503) 779-6676

Utilities Notification Center
(800) 332-2344

Pennsylvania
Pennsylvania One Call System Inc.
(800) 242-1776

Rhode Island
Dig Safe – Rhode Island (800) 225-4977

South Carolina
Palmetto Utility Protection Service Inc.
(800) 922-0983

South Dakota
South Dakota One Call (800) 781-7474

Tennessee
Tennessee One-Call System (800) 351-1111

Texas
Texas One Call System (800) 245-4545

Texas Excavation Safety System (800) 344-8377

Lone Star Notification Center (800) 669-8344

Utah
Blue Stakes Location Center (800) 662-4111

Vermont
Dig Safe – Vermont (800) 225-4977

Virginia
Miss Utility of Virginia (800) 552-7001

Miss Utility (800) 257-7777

Miss Utility of Delmarva (800) 441-8355

Washington
Utilities Underground Location Center
(800) 424-5555

Grays Harbor & Pacific County
Utility Coordinating Council
(206) 535-3550

Utilities County of Cowlitz County
(360) 425-2506

Chelan-Douglas Utilities Coordinating Council
(509) 663-6111

Upper Yakima County
Underground Utilities Council
(800) 553-4344

Inland Empire Utility Coordinating Council
(509) 456-8000

Palouse Empire Utilities Coordinating Council
(800) 822-1974

Utilities Notification Center (800) 332-2344

West Virginia
Miss Utility of West Virginia Inc. (800) 245-4848

Wisconsin
Diggers Hotline Inc. (800) 242-8511

Wyoming
West Park Utility Coordinating Council
(307) 587-4800

Call-In Dig-In Safety Council (800) 300-9811

Fremont County Utility Coordinating Council
(800) 489-8023

Central Wyoming Utilities Coordinating Council
(800) 759-8035

Southwest Wyoming One Call (307) 362-8888

Carbon County Utility
Utility Coordinating Council (307) 324-6666

Albany County Utility Coordinating Council
(307) 742-3615

Southeast Wyoming Utilities Coordinating Council
(307) 638-6666

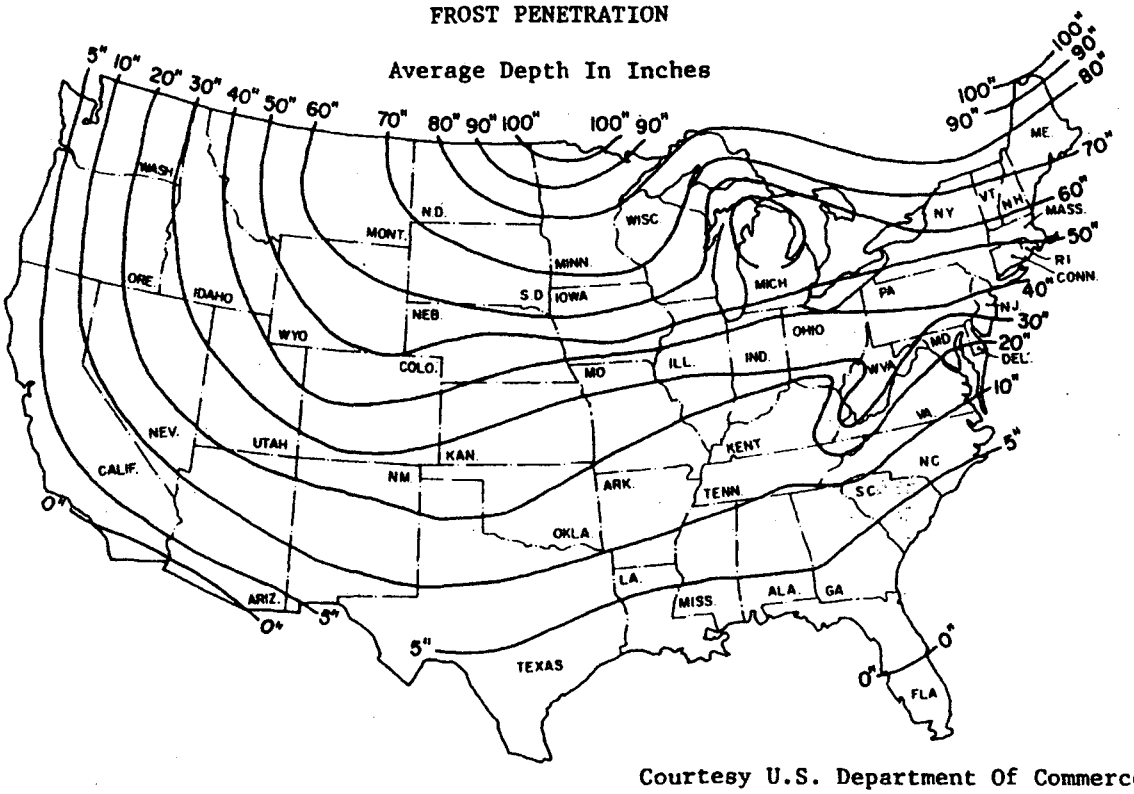
Wyoming One-Call
(800) 348-1030

Utilities Underground Location Center
(800) 454-5555

Converse County Utility Coordination Council
(800) 562-5561

ATTACHMENT 2

FROST LINE PENETRATION DEPTHS BY GEOGRAPHIC LOCATION



Courtesy U.S. Department Of Commerce

ATTACHMENT 3
UTILITY CLEARANCE FORM

Client: _____ Project Name: _____

Project No.: _____ Completed By: _____

Location Name: _____ Work Date: _____

Excavation Method/Overhead Equipment: _____

1. Underground Utilities — Circle One

a)	Review of existing maps?	yes	no	N/A
b)	Interview local personnel?	yes	no	N/A
c)	Site visit and inspection?	yes	no	N/A
d)	Excavation areas marked in the field?	yes	no	N/A
e)	Utilities located in the field?	yes	no	N/A
f)	Located utilities marked/added to site maps?	yes	no	N/A
g)	Client contact notified Name _____ Telephone: _____ Date: _____	yes	no	N/A
g)	State One-Call agency called? Caller: _____ Ticket Number: _____ Date: _____	yes	no	N/A
h)	Geophysical survey performed? Survey performed by: _____ Method: _____ Date: _____	yes	no	N/A
i)	Hand augering performed? Augering completed by: _____ Total depth: _____ feet Date: _____	yes	no	N/A
j)	Trench/excavation probed? Probing completed by: _____ Depth/frequency: _____ Date: _____	yes	no	N/A

2. Overhead Utilities — Present Absent

a)	Determination of nominal voltage	yes	no	N/A
b)	Marked on site maps	yes	no	N/A
c)	Necessary to lockout/insulate/re-route	yes	no	N/A
d)	Document procedures used to lockout/insulate/re-route	yes	no	N/A

e) Minimum acceptable clearance (SOP Section 5.2): _____

3. Notes:

_____

_____

_____

Approval:

_____ _____

Site Manager/Field Operations Leader Date

c: PM/Project File
Program File

ATTACHMENT VI

STANDARD OPERATING PROCEDURE FOR UNEXPLODED ORDNANCE

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1.0 GENERAL

This Standard Operating Procedure (SOP) was prepared in accordance with applicable U.S. Army Corps of Engineers procedures and policies governing field activities requiring Unexploded Ordnance (UXO) and Chemical Warfare Material (CWM) operations. All personnel conducting operations under this SOP must read and understand applicable parts of references listed in paragraph 9.1 below prior to commencing any work described within this SOP. Other documents supporting this SOP include project-specific Work Plans and Health and Safety Plans which are prepared for the purpose of accomplishing work that contain a UXO or CWM component.

2.0 PURPOSE

This SOP applies to all operations involving UXO and/or CWM support during field operations at various sites where Tetra Tech NUS (TtNUS) personnel are present. It provides procedural requirements for any activity involving UXO and CWM, as well as detailed procedures for the location, identification, documentation, and emergency response actions pertaining to UXO/CWM activities.

3.0 APPLICABILITY

This SOP applies to persons who may visit any site where TtNUS is performing work that involve some UXO or CWM component. Compliance the content of this SOP is mandatory for all TtNUS personnel, subcontractors, and visitors to any site where UXO/CWM activities are in progress.

4.0 RESPONSIBILITIES

Project Manager

Effective implementation of this SOP at the project level will be the ultimate responsibility of the assigned TtNUS Project Manager. The Project Manager is responsible for ensuring that all applicable rules and regulations are complied with, and that all necessary safety precautions are taken to conduct operations in accordance with this SOP. To fulfill this responsibility, the assigned Project Manager is required to ensure that appropriately-qualified technical staff are involved in all stages of project planning and field work, as well as for ensuring that appropriate resources are marshaled and used on his/her assigned projects. For projects involving UXO and/or CWM, this will involve ensuring that a suitably qualified and experienced UXO technician and a site Health and Safety Officers are part of the project team. In some cases, the assigned UXO Technician may also serve as the project site Health and Safety Officer.

It is also the responsibility of the Project Manager to ensure that all personnel conducting field activities in accordance with this SOP have proper training (including hazard control briefings) and, if required, the proper certifications for the job being performed.

UXO Technician

A suitably qualified and experienced UXO Technician will be included as part of the project team where these types of concern are known or suspected to exist. The UXO Technician will be primarily responsible for advising the Project Manager on all UXO/CWM matters, including on the measures that will be necessary to effectively implement and adhere to this SOP. Other specific duties will include:

- Providing technical expertise and input into project planning activities and documents such as the project-specific Work Plan and Health and Safety Plan
- Clearing worksite areas of UXO/CWM concerns prior to the initiation of any other onsite activities

- Participating in the development and conductance of site specific training sessions and daily tailgate meetings to communicate UXO/CWM matters to the field personnel
- Maintaining a sound familiarity with the contents of this SOP, the contents of the references listed in section 9.1, and keeping current with new information and technology pertinent to UXO/CWM matters

Site Health and Safety Officer
A suitably qualified and experienced health and safety professional will be assigned to all projects that involve fieldwork. Project-specific responsibilities will include:

- Effectively implementing the requirements and restrictions specified in the project-specific Health and Safety Plan
- Ensuring that all personnel participating in onsite activities have satisfied all appropriate medical and training qualifications prior to participating in any onsite intrusive activities.
- Conduct initial site-specific health and safety training for all personnel participating in onsite activities prior to their participation in any onsite intrusive activities.
- Conduct tail-gate safety briefings prior to the initiation of all tasks, but not less than daily.
- On certain projects, these duties may be assigned to the UXO Technician. This would be considered acceptable on field projects where the predominant concern is contact with UXO and/or CWM, and minimal health concerns or requirements (e.g., chemical exposures or monitoring) exist.

Corporate Health and Safety Manager
Perform periodic project audits and evaluations to determine the ongoing effectiveness of this SOP to address UXO/CWM concerns, and review and evaluate this SOP to determine any revisions that are appropriate.

5.0 LOCATION OF OPERATIONS

Activities where UXO and/or CWM concerns may exist may be encountered in support of various TtNUS contracts, with potential project sites located throughout the continental United States and abroad. Wherever the installation/site is located, it will be necessary to ensure that project planning activities include collecting available historical information that may be pertinent to these issues, as well as identifying and addressing contract/client-specific requirements and any location-specific requirements (e.g., State, local-level, or host-nation requirements). A detailed site description, discussion of known and/or suspected contamination sources, and results of previous studies will be provided to field personnel as part of their field mobilization and initial site-specific training activities.

The initial project evaluation must involve the performance of a preliminary risk assessment, including the investigation of probable contaminants, potential transport pathways, the identification of potential receptors, and a preliminary evaluation of human health and environmental concerns. Preliminary identification of applicable or relevant and appropriate requirements (ARARs) will also be made available to field personnel conducting activities at the installation.

6.0 PERSONNEL QUALIFICATIONS AND REQUIREMENTS

6.1 Personnel Qualifications: Qualifications of those personnel actively involved in UXO/CWM operations shall be as follows:

a. UXO personnel shall be graduates of the U.S. Naval Explosive Ordnance Disposal (EOD) School, Indian Head, Maryland.

b. The Senior UXO Supervisor (SUXOS) for the operation will have been awarded the Master EOD Badge and have served at least 15 years in military EOD assignments, of which more than 10 years were in a supervisory position.

c. UXO personnel are responsible for maintaining current status with training and medical surveillance requirements, as specified in the project-specifc Health and Safety Plans and OSHA 29 CFR 1010.120, paragraphs (e) and (f).

6.2 Personnel Requirements: During any activity where the possibility that UXO and or CWM may be encountered (no matter how remote), the following requirements will be met:

a. One UXO-qualified technician will be required to support each field team engaged in operations in areas that might contain UXO/CWM.

b. One UXO-qualified technician will be present at the site during all activities to provide UXO/CWM support in the event their services are required.

7.0 PERSONNEL LIMITS

The activities to be conducted under most contracts will not normally be conducted in areas requiring maximum personnel limitations except for intrusive UXO activities. Work will not be permitted unless at least two persons are present in the work area. The provisions of 29 CFR 1910.120 concerning personnel qualifications and requirements will be followed while working on-site. Any additional personnel limitation requirements specified by the client or the project work location (e.g., state, local ordnance, host nation, etc.) will also be identified and adhered to at all times.

7.1 Personnel Limits for UXO Operations:

a. UXO Avoidance Operations – Two UXO Technicians (one UXO Technician III and one UXO Technician II)

b. UXO Intrusive Operations - Three UXO Technicians (one UXO Technician III and two UXO Technician II)

8.0 MATERIAL LIMITS

The properties and configurations of specific explosive materials are not addressed in this SOP. That level of detail is required to be addressed in project-specific Work Plans and Health and Safety Plans. This SOP must be maintained onsite along with these project-specific documents to aid in appropriate communication and implementation activities. Bulk liquids to be used for decontamination of equipment will be maintained in 2-gallon containers or less. Material Safety Data Sheets (MSDSs) will be kept on file in the TtNUS Command Post for any chemical substances brought to the project site by TtNUS and TtNUS subcontractor personnel. This is addressed in greater detail in section 5. of the TtNUS Health and Safety Guidance Manual.

9.0 SAFETY REQUIREMENTS

9.1 Referenced Safety Requirements: The safety requirements that apply to the UXO/CWM operations covered under this SOP are:

a. OSHA 29 CFR 1910.120 and 1926.65 – Hazardous Waste Operations and Emergency Response (HAZWOPER). Available online at: http://www.osha.gov/pls/oshaweb/owasrch.search_form?p_doc_type=STANDARDS&p_toc_level=0&p_keyvalue=OSHA_Std_toc.html

b. US Army Corps of Engineers Engineering Regulation 385-1-92, *Safety and Occupational Health Document Requirements for Hazardous, Toxic and Radioactive Waste (HTRW) and Ordnance and Explosive Waste (OE) Activities.*

c. US Army Corps of Engineers Engineering Regulation (ER) 385-1-96, *Safety and Health Requirements.* Available on line at: http://www.usace.army.mil/publications/eng-manuals/em385-1-1/toc.htm.

d. US Army Corps of Engineers Engineering Pamphlet (EP) 1110-1-18, *Ordnance and Explosive (OE) Response.*

e. US Army Corps of Engineers Engineering Pamphlet (EP) 75-1-2, *Unexploded Ordnance Support for Hazardous, Toxic and Radioactive Waste and Construction Activities.*

f. US Army Corps of Engineers Engineering Pamphlet (EP) 75-1-3, *Chemical Warfare Material Response.*

g. US Army Technical Manual 9-1300-206 (TM 9-1300-206), *Ammunition and Explosive Hazards.*

h. Technical Manual 60A-1-1-31, *Explosive Ordnance Disposal Procedures, General Information on EOD Disposal Procedures.*

9.2 Specific Safety Requirements:

a. All site operations will be suspended if any site worker encounters an item of suspected UXO/CWM. Site work will remain suspended until the item is inspected and cleared by the UXO Technician.

b. All site operations will be suspended if so ordered by an authorized client representative (i.e., Installation Range Control and/or Safety Office).

c. A minimum of two UXO-qualified technicians will be present during all UXO-related activities.

d. Standard work practices as outlined in project-specific Health and Safety Plans and/or Work Plans will be observed.

9.3 Inherent UXO/CWM Hazards: UXO/CWM operations have inherent safety and health risks associated with the various field activities conducted. All planned activities will be conducted in accordance with the requirements of the references listed in Section 9.1 above, as safety is the primary consideration in all UXO/CWM activities. Every effort should be made to determine all hazards associated with the site through a thorough research of archives, past site/range uses, and any other available information. Some of the hazards to consider are:

a. Propellant, Explosives, and Pyrotechnics (PEP)
b. Depleted Uranium (DU)
c. White Phosphorus (WP)
d. Corrosive chemicals (acids and bases) and decontamination agents
e. Toxic gases, liquids and solids
f. Corroded and damaged containers, munitions bodies, drums, etc.
g. Fuze conditions
h. Etiological agents

10.0 PERSONAL PROTECTIVE EQUIPMENT (PPE)

Task-specific PPE will be identified in project-specific Health and Safety Plans. Typical PPE for project sites where the principle concern is for UXO/CWM will include the items listed below. Items marked with an asterisk (*) will be available and will be used as specified in the Health and Safety Plan and/or as determined by the TtNUS Site Health and Safety Officer.

a. Safety glasses

b. Safety shoes (and protective over boots or steel-toed rubber boots). NOTE: During geophysical survey operations, the UXO technicians will not wear steel-toed boots as they interfere with the magnetometer survey; however, around heavy equipment and activities where foot and overhead hazards may exist, steel-toed boots and hard hats will be worn.

c. Cotton clothing (with protective coveralls*)

d. Gloves (type to be specified for each project task in the Health and Safety Plan and/or by the site Health and Safety Officer)

e. Respiratory protection equipment* (29CFR1910.134)

f. Hearing protection*

g. Hard hats*

11.0 EMERGENCY RESPONSE AND CONTINGENCY PLANS

11. Emergency Contacts: The identification of (and means to communicate with) appropriate local emergency response agencies must be identified as part of project planning/mobilization activities, and these agencies must be contacted prior to the initiation of any onsite work. These initial communications must determine the capabilitities of these agencies to respond to foreseeable emergency situations, their willingness to respond, and their locations/driving directions/phone numbers. These details must be specified in the project-specific Health and Safety Plan and posted in the site Command Center/Field office.

At a minimum, the names and means of communication (phone number, radio frequency, etc.) of the following parties must be included in the project-specific Emergency Contacts procedure:

a. Local Emergency Fire Response that will respond (i.e., local Fire Department)

b. Emergency Medical Assistance (Hospital, Emergency Room, and ambulance service that will respond)

c. Installation Safety Office or other client safety/emergency response contact

d. Installation EOD Office/Detachment

e. Installation Environmental Office

The senior TtNUS managing employee onsite (Project Manager, Site Manager, Site Supervisor, Field Operations Leader) is responsible for initiating these calls in the event of an emergency where such support is needed. If the Project Manager is not onsite at the time of an emergency event, he/she must be added to the above list of contacts.

In the event of an emergency, all site personnel will be evacuated to a predetermined location away from the work place. Emergency Response Planning will be addressed in the project-specific Health and Safety Plan and will be in accordance with either 29 CFR 1910.38(a) or 1910.120(l). TtNUS will utilize the Installations Base Fire Protection and Emergency Services in emergencies or potential emergencies.

11.2 Contingency Plans: The following contingency plans will be implemented:

a. Pre-Planning – Upon arrival at the site/installation, the TtNUS Field Operations Leader (FOL) and/or the Site Safety Officer will meet with the Base or local Fire Protection Department, Base Security Personnel or local Police Department, and onsite and/or offsite Emergency services to notify them of the activities that are to be undertaken, when, and where. All site personnel will be required to follow established base/local emergency procedures and will rely on base/local services to handle emergency calls when needed.

b. Emergency Escape Procedures and Assignments – Upon notification of a site emergency that requires evacuation, all site personnel will proceed to predetermined locations based on emergency location and wind direction. An alternate assembly point will be designated in case personnel cannot reach these locations without danger to their lives and health. These primary and alternate escape routes and meeting places will be designated during the daily hazard control briefing. Personnel will be trained to remain at the assembly points until directed to either resume work or to leave the site.

c. Procedures to Account for Site Personnel – The site work force is typically small enough that accounting for personnel will not be a problem via visual head counting. On projects with larger field team sizes, roll calls will be taken using the daily sign in logs, logbook entries, or the tail-gate briefing sheets. Accounting for personnel will be the Field Operations Leader's responsibility.

d. Rescue and Medical Duties – TtNUS personnel will not be authorized to participate in emergency rescue operations. Typical first aid response equipment that is to be on hand at a project site includes suitable first aid kit, an emergency eye wash station, and Class ABC fire extinguishers.

e. Activation of Emergency Response Procedures - Should an emergency occur which requires the support of outside services, the appropriate contacts will be made by the senior TtNUS managing employee onsite (Project Manager, Site Manager, Site Supervisor, Field Operations Leader). A list of appropriate contacts will be posted at the Command Post. Cellular phones, land-line phones, or hand-held radios will be the primary means of communication.

f. Airborne Chemical Release Contingency Plan –

(1) Chemical Release Monitoring – every member of the site team will be responsible for observing and reporting any gross chemical releases or conditions that could lead to releases. Air monitoring will be performed as described in the project-specific Work Plans and Health and Safety Plans.

(2) Responses to Measured Airborne Chemical Releases – the readings on monitoring instrumentation will be compared to the action levels specified in the project-specific Work Plans and Health and Safety Plans. The primary purpose of appropriate real-time monitoring instruments will be monitor worker breathing zone areas for the protection of employee health. The project-specific Health and Safety Plan will specify actions that are to be taken in the event that monitoring instrument readings indicate that detected

concentrations may represent a health threat to onsite workers. Area and perimeter monitoring as well as sample screening activities may also be called for in the Work Plan or Health and Safety Plan, but these are *secondary* purposes for the use of these instruments.

Unless otherwise specified in a project-specific Health and Safety Plan, the following monitoring instrument action levels and response measures will be observed on UXO/CWA sites:

Parameter	Action Level
Total Organic Vapors	Any sustained level above background
Airborne particulates	Readings >2.5 mg/m^3
Flammable Vapors	10% of the Lower Explosive Limit (LEL)

If such levels are noted at site perimeters or adjacent to neighboring residential or commercial property, the TtNUS Field Operations Leader and/or the Site Safety Officer will notify the appropriate client or base contacts.

g. Liquid Release Monitoring – All field team members will be responsible for observing and reporting any liquid chemical releases or conditions that could lead to a release. If field operations on site result in a release of liquid chemicals in the absence of vapors, field personnel will attempt to contain the liquid by means of berms constructed with available equipment. If the work team cannot control the spill, they will leave the area for the assembly point quickly, without panic. The TtNUS Field Operations Leader and/or the Site Safety Officer will notify the appropriate client/base contact. This is not considered to be a significant probability during operations. However, in the unlikely instance that it should occur, field personnel may effect these types of defensive efforts, providing that such a response does not appear to present a chemical overexposure or other personal health or safety threat.

12.0 TYPICAL CLIENT/FACILITY SAFETY POINTS OF CONTACT

The following positions are typically encountered on UXO/CWA projects. Communication and coordination with these positions should be implemented and maintained throughout all project activities (from pre-field operations planning through to project close-out).

a. Installation Safety Management Office

b. Installation Ordnance Officer and/or EOD Officer

c. Installation Radiation Officer

d. Installation Environmental Office

13.0 TOOLS AND EQUIPMENT

Tools and equipment necessary to safely and effectively accomplish the objectives of a project will be detailed in the project-specific Work Plans and Health and Safety Plans. Items commonly required for UXO/CWM operations are presented below:

13.1 Personal Protective Equipment

a. Respiratory Protective Equipment (i.e., air purifying or air supplied devices)

b. Dermal (chemical resistant) protective equipment (e.g., coveralls, gloves, eye and face protection)

c. Physical safety PPE (hard hats, hearing protection, safety glasses, safety shoes, etc.)

13.2 Air Monitoring Equipment

a. Explosive/O_2 Meter (Combustible Gas Indicator)

b. Direct reading Organic Vapor Analyzer (PID or FID)

c. Direct reading particulate meter

d. Radiation Survey Meters and TLD Badges

13.3 Geophysical/Hydrology Survey Instrumentation

a. Magnetometers (Cesium Vapor, Schonstedt)

b. Electromagnetic Terrain Conductivity Meter (EM-31)

c. Time-Domain Electromagnetic All-Metals Detector (EM-61)

d. Water Level Indicator/Recorder

e. pH/Temperature/Conductivity Meter for water samples (Horiba, etc.

f. Survey Equipment (transit, tripod, level, etc.) as required

13.4 UXO Support Equipment

a. Schonstedt Magnetic Locators (GA-52Cx or equivalent passive instrument) will be used for UXO surface survey during UXO activities. The GA-52Cx detects the magnetic field of any ferromagnetic object.

b. Schonstedt MG-220 Magnetic Gradiometer (Down-Hole Magnetometer or equivalent will be used to conduct down hole UXO checks. The MG-220 detects the magnetic field of any ferromagnetic object as it is lowered into a borehole.

c. Marking tape, pin flags, stakes, utility spray paints, etc.

13.5 CWM Support Equipment

a. Chemical Agent Identification Kits (M18A2 Kit)

b. ICAMs (Individual Chemical Agent Monitor)

13.6 Decontamination Equipment

As required by the level of protection for each site. See Site Health and Safety Plan for specifics.

13.7 Hand Tools/ Miscellaneous Equipment

As may be required.

14.0 ENVIRONMENTAL CONCERNS

The field operations covered by this SOP will be performed in such a manner as to minimize the effects of pollution of air, water, or land and to control noise and dust emissions within reasonable limits.

Every effort will be made to:

a. Protect the land areas and to preserve them in their existing condition.

b. Protect water resources, including measures for run-off or run-off controls if applicable.

c. Implement sediment control measures, where warranted. These measures will also be implemented to control erosion.

Usually, field operations will generate solid and liquid waste (Investigative Derived Waste – IDW) requiring onsite handling and possible offsite disposal. The major types of waste to be generated, their environmental concerns, and their handling and disposition are summarized below:

a. Personal and equipment decontamination containers disposed offsite following a thorough decontamination. Liquid waste will be included with well purging and development fluids.

b. Personal Protective Equipment (PPE) will be double-bagged and will be the responsibility of TtNUS to dispose of according to applicable regulations. Disposal will normally be offsite.

It is not anticipated that any chemical releases will occur during the field activities.

The MSDSs for chemicals being brought onto the installation for use in field operations will be listed on a site-specific Chemical Inventory and maintained at the TtNUS Field Command Post. Copies of these documents are to be made available to client and offsite representatives who may be called upon to respond to an emergency event.

15.0 UXO/CWM PROCEDURES FOR FIELD OPERATIONS

15.1 General – field procedures for work on any installation can include any or all of the following tasks:

a. Initial entry into suspect areas

b. CWM operations

c. Surface and subsurface sampling

d. Monitoring well installation

e. Exploratory trenching

f. Geophysical surveys

g. Other miscellaneous operations

15.2 Initial Entry – initial entry into suspect areas require an UXO-qualified technician with a magnetometer (GA-52Cx) to screen a path into the area. The screened area is marked with lanes using either pin flags with plastic pins or marking tape. Suspect items on the surface and subsurface magnetic anomalies will be marked, usually with a different color tape or flag, and will be avoided by team members. The site where the work is to be conducted will be thoroughly screened for UXO/CWM contamination prior to any work commencing. All personnel will stay within the cleared areas and not venture out into areas not screened. If an area that has magnetic anomalies cannot be avoided, the UXO-qualified technician will hand excavate down to the anomaly to check to see if a hazard exists. Before excavation begins, the immediate area will be cleared of non-essential personnel outside of what could be a fragmentation zone (as determined by the UXO Technician). If the excavation reveals a hazard, the emergency notification procedures in paragraph 11.0 will apply.

15.3 CWM Operations - prior to conducting CWM operations, an Emergency Response Plan as required by 29CFR1910.120 and DA Pam 50-6 will be developed and implemented. Most of the information required to develop this plan should be obtained from the installation safety office; however, as a minimum, the following elements will be addressed:

a. Pre-emergency planning and procedures for reporting incidents to appropriate government agencies for potential chemical exposure, person injuries, fire/explosions, environmental spills and releases, and discovery of radioactive materials.
b. Personnel roles, lines of authority, communications.
c. Posted instructions and list of emergency contacts: physicians, nearby notified medical facility, fire and police departments, ambulance service, state/local/federal environmental agencies, Certified Industrial Hygienist (CIH), and installation commander.
d. Emergency recognition and prevention.
e. Site topography, layout and prevailing weather conditions.
f. Criteria and procedures for site evacuation (emergency alerting procedures/employee alarm system, emergency PPE and equipment, safe distance, place of refuge (assembly area), evacuation routes, site security and control).
g. Specific procedures for decontamination and medical treatment of injured personnel.
h. Route maps to nearest pre-notified medical facility.
i. Criteria for initiating community alert program, contacts and responsibilities.
j. Critique of emergency responses and follow-up.
k. Material Safety Data Sheets (MSDS) for each hazardous substance anticipated to be encountered on site would be made accessible to site personnel at all times.

15.4 Sampling – sampling will be conducted in accordance with established protocols and methodologies. Site-specific sampling requirements will be presented in the project-specific Work Plans and/or in other project-specific documents such as Field Sampling and Analysis Plans and Quality Assurance Plans.

Prior to initiating any sampling activities, an UXO-qualified technician will screen sites potentially contaminated with UXO/CWM. A magnetometer will be used to screen entry into a suspect area as in paragraph 15.2 above. Lanes will be marked and suspect items and subsurface anomalies will be identified and avoided. The immediate sampling area will be surface-screened prior to the introduction of the sampling team into the area.

Prior to any subsurface intrusive sampling, another check with a magnetometer needs to be accomplished. The GA-52Cx Magnetic Locator (magnetometer) can be used for collecting

subsurface samples not greater than 0.5 feet. If excavation of a borehole or hand auguring hole is to exceed this depth, a MG-220 Magnetic Gradiometer (down hole magnetometer) shall be utilized with readings taken at two feet depth intervals.

If an anomaly is detected, the location will be marked and avoided. If appropriate and acceptable, an alternate sampling location (in a cleared area) will be designated. If the sampling location cannot be relocated them the UXO-qualified technician will hand excavate down to the anomaly to determine if it is hazardous. If it is not hazardous, the object will be set aside and the sampling event will continue. If the object has been determined to be hazardous or suspect, the sampling team will move out of the area and the emergency procedures listed in paragraph 11.0 will be implemented.

15.5 Monitoring Well Installation – the area within a 50-foot radius of the borehole and the off- road access path will be screened with the GA-52Cx magnetometer and be cleared of all metal objects. Once this is accomplished, the areas around borehole sites will be marked using colored marking tape and/or pin flags. Heavy equipment such as front-end loaders, backhoes, and bulldozers will not be used to develop or establish drill sites. The following action will be followed:

a. The GA-52Cx magnetometer will be used directly over the borehole site to check for buried items down to 0.5 feet. After a surface check, the UXO-qualified technician will hand auger down to a depth of two feet and check down the hole using the MG-220 magnetometer.

b. Once the hand-auguring hole has been cleared, the drill rig will be positioned over the proposed borehole. Drilling will commence to a depth of four feet, the drill auger will be removed from the borehole, the drill crew chief and UXO personnel will make observations of the soil from the core barrel and the soil removed from the hole by hand auger (if needed). The drilling log and lithologic log will be maintained in accordance with standard practices, noting any metal objects that may be found.

c. The drilling derrick will be secured and drill rig moved to a position at least 20 feet from the borehole.

d. The borehole will be checked again with the MG-220 magnetometer.

e. If UXO or magnetic anomaly is present, the borehole will be abandoned and another location selected. The new borehole should be at least six feet from the original borehole. If a UXO or anomaly is not detected and the clearance is given, the drill rig shall be positioned back over the borehole, and drilling will proceed to the next depth (6 feet).

f. Repeat above steps at intervals of 2 feet, until a depth of ten feet is reached. At the ten-foot interval, a magnetometer reading shall be taken with the MG-220 set on the maximum sensitivity. The instrument will detect larger objects (approaching 100 lbs.) that could be expected to penetrate to depths of 10 feet or more.

g. After reaching the depth of ten feet, the above steps will be repeated at intervals of 4 feet, until the desired depth is reached.

15.6 Exploratory Trenching and Excavation – at times, exploratory trenching may be required to determine the lateral extent of a landfill, burial pit, or subsurface geophysical anomaly. Trenching and excavation to uncover a subsurface area will be conducted using a backhoe, an excavator, or sometimes a front-end loader. **Any trenching or excavation activities (regardless of depth) must be done in accordance with OSHA 29 Subpart P requirements, which must be considered and addressed in the project-specific Health and Safety Plan.**

On project sites where excavation activities are within the scope of work *and* a UXO/CWM concern exists, the following additional procedures will be utilized to conduct these operations:

a. The surface of the area to be trenched or excavated will first be swept with the GA-52Cx magnetometer. Anomalies will be hand excavated to determine if hazardous.

b. No more than 0.5 feet of surface soil will then be gingerly removed (scraped) from the area of concern.

c. The heavy equipment will be removed at least 20 feet away from the area, and the area will be checked with the MG-220 magnetometer. If the area is a trench, the entire length of the trench will be checked with the MG-220 and the excavation can continue two feet at a time. If the area is a wide-open area, it can once again be checked with the GA-52Cx, but only 0.5 feet of soil removal can be excavated at a time.

d. Anomalies will continue to be uncovered by hand excavation until the desired results are obtained and the trench/area is abandoned and refilled.

e. Excavation will continue another 2 feet if using the MG220 or 0.5 feet if using the GA-52Cx magnetometer. Once again after the proper depth of soil is excavated, the heavy equipment is removed from the area (>20 feet) and the area is rechecked with the magnetometer. If excavation depths reach 4 feet, suitable means of access/egress must be provided (e.g., ladders) and atmospheric monitoring must be performed prior to any entries.

f. The above procedures are followed until the desired depth is reached and/or the desired results are obtained.

Once the area or trench has been cleared, excavation can continue to the proper depth before the equipment is again moved away (at least 20 feet) and the area/trench.

15.7 Geophysical Surveys – there are several instruments that can be used to conduct geophysical surveys. The GA-52Cx (Schonstedt) and the MG-220 are magnetometers and are passive instruments. The Geonics Terrain Conductivity Meter (EM-31) is an active instrument and is commonly used to measure subsurface terrain conductivity. This information can be used geophysical surveys, as well as for locating voids, discontinuities in soil structures such as boundaries of disposal pits and buried conducting objects. An Ordnance Safety Analysis of the Geonics Model EM-61 Non-Contacting Terrain Conductivity Meter was conducted by the Naval Surface Warfare Center at the request of TtNUS in April 1993. The analysis concluded, in summary, that the "Geonics EM-61 poses no ordnance safety hazard when operated in the normal survey mode, where the device is held at hip height." However, the Geonics EM-61 should not be used with the boom on the ground if ordnance is present or suspected.

When using the magnetometer or the EM-61, a UXO-qualified technician will conduct a surface sweep of the area to be surveyed to ensure that no surface ordnance or other hazards exist. The magnetometer is a passive instrument; therefore, no special ordnance safety precautions are required.

Manufacture recommended procedures for the EM-61 must be followed to ensure safe operation during the geophysical survey. Standard survey protocols and quality assurance methods will also be required during survey operations.

15.8 Miscellaneous Operations – due to the potential of UXO/CWM materials being encountered during field activities, UXO support will be provided at all site locations. UXO support will be

provided for any and all field activities that are in areas suspected to contain UXO and/or CWM. These areas also include those areas covered with water and creeks, canals, etc.

Operations that involve the inspection, hazard classification, segregation, and final disposal of UXO and UXO-related scrap will not be covered in this SOP. The demilitarization of UXO and UXO-related scrap is not authorized unless specific work plans, SOPs, health and safety plans and other established procedures are written and approved addressing these operations.

16.0 HAZARD CONTROL BRIEF

A Health and Safety Hazard Control Briefing (i.e., tailgate meetings) will be conducted daily prior to the start of onsite activities. The briefing will be detailed and will cover the information in the Safe Work Permits for the anticipated tasks for the day, as well as applicable portions of this SOP. Additional briefings will be conducted as necessary for tasks that become necessary during the course of a workday, if they were not covered in the morning briefing. These briefings are in addition to (not in place of) the site-specific health and safety training that is required for all onsite personnel prior to their participation in any onsite, intrusive activities.

The following information will be given during the daily briefings:

a. Overview of task(s) to be performed and review of appropriate Safe Work Permits with task participants.

b. Overview of the day's objectives, as well as general site hazards

   - Unexploded Ordnance Hazards
   - Chemical Warfare Agents and Materials
   - Physical Hazards

c. Overview of Standard Work Practices pertinent to the day's planned activities

d. Review of any worker incidents or near-miss events, including a review of corrective/preventive measures to prevent recurrence

e. Overview of Emergency Response Actions, evacuation routes and assembly points

17.0 SECURITY

Field activities under various TtNUS contracts are typically unclassified and normal security measures apply in accordance with above references (paragraph 9.1 above). TtNUS personnel and their subcontractors will check in with the appropriate client/installation's security office and may be issued security badges for entry into certain work areas. This SOP will not cover special security requirements for projects involving UXO/CWM as most installations have established policies and procedures on reporting and securing recovered items that are UXO and/or CWM. The TtNUS Project Manager will incorporate all security procedures required by the installation into the site work plan.