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FINAL BASEWIDE PENNSYLVANIA BEDROCK BACKGROUND GROUNDWATER EVALUATION REPORT NSA CRANE IN

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TETRA TECH

FINAL

Basewide Pennsylvanian Bedrock Background Groundwater Evaluation Report

Naval Support Activity Crane

Crane, Indiana

Naval Facilities Engineering Command Midwest

Contract Number N62470-08-D-1001

Contract Task Order F279

September 2013

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FINAL
BASEWIDE
PENNSYLVANIAN BEDROCK
BACKGROUND GROUNDWATER
EVALUATION REPORT

NAVAL SUPPORT ACTIVITY CRANE
CRANE, INDIANA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
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ABBREVIATIONS AND ACRONYMS

ABG	Ammunition Burning Grounds
AOC	Area of Concern
ASD	Applied Science Department
B&R Environmental	Brown and Root Environmental
bgs	below ground surface
CLEAN	Comprehensive Long-Term Environmental Action Navy
COC	Chemical of concern
COPC	Chemical of potential concern
CTO	Contract Task Order
DoD	Department of Defense
DQI	Data quality indicator
EAD	Explosive Actuating Device
FOD	Frequency of detection
IA	Initial Assessment
IAS	Initial Assessment Study
IDEM	Indiana Department of Environmental Management
IGS	Indiana Geological Survey
KM	Kaplan-Meier
NACIP	Navy Assessment and Control of Installation Pollutants
NAD	Naval Ammunition Depot
NAD83	North American Datum of 1983
NAVD88	North American Vertical Datum of 1988
NAVFAC	Naval Facilities Engineering Command
NEESA	Naval Energy and Environmental Support Activity
NSA	Naval Support Activity
NSWC	Naval Surface Warfare Center
ORP	Oxidation-Reduction Potential
Plz	Pennsylvanian bedrock (lower zone)
Pmz	Pennsylvanian bedrock (middle zone)
Puz	Pennsylvanian bedrock (upper zone)
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SP	Special Program
SWMU	Solid Waste Management Unit

TAL	Target Analyte List
Tetra Tech	Tetra Tech, Inc.
µg/L	Micrograms per liter
USACE	United States Army Corps of Engineers
U.S. EPA	United States Environmental Protection Agency
UTL	Upper tolerance limit
WES	Waterways Experiment Station

1.0 INTRODUCTION

This report presents results and conclusions of the Basewide Pennsylvanian Bedrock Background Groundwater Evaluation at Naval Support Activity (NSA) Crane, Crane, Indiana. This report has been prepared for the U.S. Department of the Navy by Tetra Tech, Inc., for the Naval Facilities Engineering Command (NAVFAC) Midwest under Contract Task Order (CTO) F279 of the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract Number N62470-08-D-1001.

This background groundwater evaluation was conducted to support applicable Resource Conservation and Recovery Act (RCRA) Corrective Action requirements, including RCRA Facility Investigations (RFIs) and other related environmental investigations to be conducted at NSA Crane under the Navy's Installation Restoration Program. The environmental investigations are the basis for determining whether groundwater conditions at a particular SMWU represent unacceptable risks to human health if exposure occurs. The background groundwater evaluation provides data on metals concentrations in groundwater in the Pennsylvanian-age aquifer at NSA Crane not impacted by site operations at Solid Waste Management Units (SWMUs) or Areas of Concern (AOCs). The first step when evaluating the risk of inorganic chemicals is generally a comparison of the chemical concentrations measured in site groundwater to their background concentrations. Background concentrations are those concentrations that would be naturally occurring in the absence of impact from site operations. These comparisons are made because many inorganic chemicals occur naturally in the environment. Concentrations associated with specific SWMUs may then be compared with background concentrations to determine if a contaminant release has potentially occurred as a result of the site operations. In accordance with RCRA (U.S. EPA, 1989a) and risk assessment guidance (U.S. EPA, 1989b), if measured site concentrations are not significantly greater than background concentrations, it may be inferred that an operationally related release of those contaminants has not occurred, and the site investigation is often terminated at that point if inorganics are the only issue. If site concentrations exceed background concentrations, additional assessment and/or remediation may be warranted.

1.1 PURPOSE AND SCOPE

This evaluation was initiated because metals in groundwater in Pennsylvanian-age bedrock throughout NSA Crane have consistently been identified as chemicals of concern (COCs), but the concentrations are generally consistent across NSA Crane. Based on the ubiquity of the specific metals detected and the similarity of concentrations, a problem statement was developed for this evaluation: Are metals concentrations detected in groundwater from Pennsylvanian bedrock at various SWMUs and AOCs at

NSA Crane representative of natural background levels, or are they attributable, either directly or indirectly, to contaminant releases associated with SWMU or AOC operations or other past uses? If chemicals are released to the environment, groundwater metals concentrations can potentially increase as a result. This could occur as direct contamination if released chemicals migrate directly to groundwater or indirectly if organic chemicals released to the environment alter the local geochemical conditions [e.g., pH and oxidation-reduction (redox) potential] to increase the rate of leaching of inorganic constituents from the geologic matrix of the bedrock. In general, a reduction in pH or redox potential increases the potential for leaching. Each inorganic constituent in the geologic matrix, usually in the form of metal salts or chemical complexes, is affected differently by a given change in geochemical conditions. Another factor for consideration is that Pennsylvanian-age bedrock at NSA Crane is relatively high in organic carbon and that this naturally occurring carbon could lead to the same geochemical conditions conducive to metals leaching as a chemical contaminant release.

The primary objective of this evaluation was to establish a statistically based data set of concentrations of inorganic constituents in groundwater in Pennsylvanian-age bedrock at NSA Crane for comparison with site data to determine whether detected constituents are site-related or background conditions and to identify chemicals of potential concern (COPCs) to be further evaluated in a risk assessment. The secondary objective of this investigation was to compile the background data so that a minimum detectable concentration difference between contaminated groundwater and background groundwater data sets could be computed for individual site investigations. The intent was that the background data set would enable the detection of concentration differences between data sets equal to two standard deviations of the background metal concentrations.

The background data set presented in this report is intended to be a benchmark to which past, current, and future NSA Crane SWMU and AOC investigation groundwater data will be compared. The background data set is to be applied to investigations of groundwater in Pennsylvanian-age bedrock at NSA Crane. Furthermore, the data set is intended to be representative of and comparable for total metals concentrations rather than dissolved metals concentrations from filtered samples. Total metals values represents the sum of metals concentrations in the dissolved and suspended solids phases of a groundwater sample that are recoverable by standard sample digestion processes for environmental investigations. This evaluation has been limited to the metals analyzed for [i.e., Target Analyte Metals (TAL) metals and tin], as these are the metals evaluated in RFIs at NSA Crane.

This evaluation was an observational study that used available groundwater data from RFIs that have been conducted throughout NSA Crane to date. Because the data sets from these RFIs were validated

and used for decision-making purposes, no data collection was conducted specifically for the purpose of characterizing basewide groundwater conditions.

1.2 REPORT ORGANIZATION

The remaining sections of this report are organized as follows:

- Section 2.0 provides a description of NSA Crane physical characteristics, brief summaries of the SWMUs and AOCs at the facility, and the geology and hydrogeology of the Pennsylvanian-age bedrock at NSA Crane.

- Section 3.0 describes the methodology used in this evaluation. It includes the data set development methodology, including monitoring well selection and rationale, and the statistical methodology for evaluation of the data set.

- Section 4.0 provides the results of the evaluation and a methodology for use of the findings of this report for data comparisons in future site investigations.

2.0 BACKGROUND INFORMATION

This section provides a discussion of site characteristics at the NSA Crane facility, including site location, physiography, topography, and land use; site history; and, geology and hydrogeology. It also includes a discussion of previous background and Pennsylvania bedrock studies.

2.1 FACILITY LOCATION AND DESCRIPTION

NSA Crane is situated in a rural area of south-central Indiana. NSA Crane is located in the southern portion of Indiana, approximately 75 miles southwest of Indianapolis, 60 miles northwest of Louisville, Kentucky, and immediately east of Burns City and Crane Village, Indiana. NSA Crane encompasses approximately 62,463 acres or approximately 98 square miles of the northern portion of Martin County and smaller portions of Greene, Daviess, and Lawrence Counties. A location map of the NSA Crane facility is presented as Figure 2-1.

NSA Crane is located in the unglaciated area of the Crawford Upland Physiographic Province of the Southern Hills and Lowlands Region of Indiana. This province is characterized as a rugged, highly vegetated, dissected plateau bounded by the Mitchell Plain Physiographic Province to the east and the Wabash Lowland Physiographic Province to the west (Murphy and Wade, 1998). The terrain of NSA Crane is predominantly rolling, with moderately incised stream valleys throughout and occasional flat areas in the central and northern portions of the facility. Ground surface elevations across NSA Crane range from approximately 500 feet to 850 feet relative to the North American Vertical Datum of 1988 (NAVD88).

2.2 FACILITY HISTORY

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

Initial environmental investigations performed at NSA Crane were the Initial Assessment (IA) (U.S. Army, 1978) and Initial Assessment Study (IAS) (NEESA, 1983). The purpose of the IA was to investigate potential contaminant releases to the environment from past operations and to determine the potential of these releases to migrate beyond the facility boundaries. It was completed in 1977 and consisted of a records search and interviews with former and present employees at NSA Crane. The intent of the IAS was to identify and assess sites posing a potential threat to human health and the environment from past hazardous materials operations. It began in response to the Navy Assessment and Control of Installation Pollutants (NACIP) Program and was completed in 1983 by the Naval Energy and Environmental Support Agency (NEESA) with assistance from the Ordnance Environmental Support Agency and United States Army Corps of Engineers (USACE) Waterways Experiment Station (WES). Although none of the sites investigated were determined to represent immediate human health or environmental threats, 14 sites were recommended for further study to evaluate potential long-term impacts.

Based on these initial assessments and subsequent investigations, 34 SWMUs and a small number of AOCs requiring environmental investigation have been identified at NSA Crane. Figure 2-2 shows the locations of the SWMUs with currently active or completed environmental corrective actions. Because NSA Crane operates under a RCRA Part B permit, investigation and remediation activities at the SWMUs are conducted under RCRA corrective action, administered by Indiana Department of Environmental Management (IDEM).

2.3 GEOLOGY

The geology at NSA Crane is generally characterized by thin overburden deposits overlying bedrock. The overburden deposits at NSA Crane generally consist of two types, Quaternary-age unconsolidated deposits and unconsolidated residual soil derived from underlying bedrock. With the exception of minor outwash and lacustrine deposits in the northwestern comer of the facility, NSA Crane was unglaciated during the Pleistocene epoch. Bedrock underlying NSA Crane consists of sedimentary rocks from the Lower Pennsylvanian-age Raccoon Creek Group and Upper Mississippian-age Stephensport and West Baden Groups.

2.3.1 Unconsolidated Deposits

The Quaternary-age deposits consist of alluvial (stream-derived sediments), colluvial (sediments deposited at the foot of a slope via gravity), and glacial outwash deposits consisting of silt, sand, and

gravel; lacustrine deposits consisting of clay, silt, and sand; and loess deposits consisting of clay and silt. Unconsolidated deposits at NSA Crane can be found as deep as 65 feet bgs (Nohrstedt et al., 1998).

Soils at NSA Crane were derived from underlying sedimentary rocks of the Lower Pennsylvanian Raccoon Creek Group and Upper Mississippian Stephensport and West Baden Groups and consist of clay, silt, sand, and fragmented and/or weathered bedrock.

2.3.2 Bedrock

NSA Crane is located on the eastern edge of the Illinois Structural Basin. The Pennsylvanian- and Mississippian-age bedrocks dip to the west-southwest and southwest at approximately 30 to 35 feet per mile (Kvale, 1992). Bedrock underlying NSA Crane consists of sedimentary rocks from the Lower Pennsylvanian-age Raccoon Creek Group and Upper Mississippian-age Stephensport and West Baden Groups. Figure 2-1 shows the geology of Indiana, and Figure 2-3 shows the surficial geology of NSA Crane. A generalized stratigraphic column of bedrock in the NSA Crane area is shown on Figure 2-4. The Lower Pennsylvanian-age bedrock (Raccoon Creek Group) at the facility primarily consists of interbedded sandstone, siltstone, shale, and coal with total thicknesses varying from 0 to more than 300 feet (Fisher, 1996). The underlying Missisippian-age bedrock consists of limestone, shale, and sandstone (Murphy and Wade, 1995 and Palmer, 1969). The Raccoon Group lies unconformably on the Mississippian-age bedrock units; the relief of the unconformity has been measured to be as much as 100 feet (Kvale, 1992).

Pennsylvanian-age bedrock is the uppermost bedrock unit across most of NSA Crane, with approximately 74 percent (46,280 acres or 72 square miles) of NSA Crane covered by the Raccoon Creek Group. Mississippian-age bedrock is principally exposed in the major drainages in the eastern half of NSA Crane, where streams have eroded the Pennsylvanian-age bedrock caprock. A large number of SWMUs are located on ridges or other topographically high areas, primarily on Pennsylvanian-age bedrock. One exception to this generalization is the Ammunition Burning Ground (ABG), which is located over Mississippian bedrock (Fisher, 1996).

The Raccoon Creek Group at NSA Crane is interpreted to be interbedded clastic sediments of the Mansfield Formation (Kvale, 1994). The sedimentary facies of the Mansfield Formation at NSA Crane have been interpreted to be of tide-dominated estuarine depositional environments (Kvale, 1992). The Mansfield Formation at NSA Crane is characterized by abundant shale and siltstone with thinly interbedded sandstone and mudstone and thin discontinuous coal units (Kvale, 1994; Shaver et al., 1986). The lower section of the Mansfield Formation is dominated by sandstone (Shaver et al., 1986).

2.4 HYDROGEOLOGY

At NSA Crane, groundwater is encountered in surficial unconsolidated units and the underlying bedrock; however, the occurrence of groundwater in the overburden is limited to Quaternary-age units in the northwestern corner of NSA Crane and in alluvial deposits along the major drainages or water bodies. Commonly, groundwater is not encountered in the overburden along ridges or hillslopes, where only a thin residuum of soil is present. If present, groundwater in the overburden in these areas occurs as isolated perched zones.

Groundwater in bedrock at NSA Crane occurs in the Pennsylvanian and Mississippian units. Because shallow bedrock at NSA Crane is primarily Pennsylvanian-age units and the majority of investigations are within these units, this evaluation is limited to Pennsylvanian-age bedrock units. Groundwater in the Pennsylvanian-age bedrock is present in the secondary porosity of the rock units (i.e., jointing, fractures, or bedding contacts), with groundwater entering the bedrock through infiltration. Groundwater flow in the shallow bedrock generally mimics topography, with flow toward the crop line, and groundwater discharging to gullies or hillslopes on the sides of ridges or to surface soils and gradually evaporates. Groundwater in deeper zones flows to regional groundwater discharge areas or base levels; the direction of flow in the deeper zones may be different than in shallow zones.

Groundwater in Pennsylvanian-age bedrock occurs in several individual zones at different depths in the formation sequence. The zones are generally distinguished by marked head elevation differences and are generally isolated from one another vertically by less permeable shale or siltstone units. The zones are typically grouped into three water-bearing zones in the Pennsylvanian-age rock units: upper (Puz), middle (Pmz), and lower zones (Plz). At individual sites, the first encountered water-bearing zone is identified as the Puz; subsequent zones encountered with depth are identified as the Pmz and Plz, accordingly. These zones have not been correlated across NSA Crane, except for cases where sites are in close proximity. For example, a water-bearing zone identified as Puz at one site may correlate stratigraphically with a zone identified as Pmz at an adjacent site. For the purposes of this evaluation, the statistical analyses were performed for the entire data set for wells screened in the Pennsylvanian-age, regardless of zone identification (i.e., Puz, Pmz, or Plz). The rationale for this was primarily that the groundwater geochemistry of the Pennsylvanian-age water-bearing zones was considered to be similar between zones, given the similar lithologies. This also allows for a larger data set and as a result less uncertainty in the statistical evaluation.

2.5 PREVIOUS BACKGROUND AND PENNSYLVANIAN BEDROCK STUDIES

Background concentrations of select inorganics in soils at NSA Crane were evaluated during a base-wide background soils investigation in 2001 (Tetra Tech, 2001). The objective of the investigation was to identify and chemically characterize native soils based on three factors: depositional environment, grain size, and depth. A total of 16 soil types were identified and evaluated in the report, based on combinations of these three factors. Four depositional environments were identified at NSA Crane, based on the mapped geologic parent material: Pennsylvanian bedrock, Mississippian bedrock, alluvium, and loess. Three predominant grain sizes (clay, silt, and sand) and two depths (surface and subsurface) were also identified as factors possibly contributing to soil chemical characteristics. Soil samples were collected to establish representative background metals concentrations for each of the 16 soil types. The background soil data sets can be used for direct comparison of site data to background data descriptive statistics [minimum, maximum, and average values in a data set as well as upper tolerance limit (UTL) values] or through direct comparison of background and site data distributions using a statistical comparison.

Multiple studies have been conducted at NSA Crane related to characterization of Pennsylvanian-age bedrock and groundwater. These studies, however, have focused principally on the hydrogeological properties and sedimentology of the Pennsylvanian-age aquifers. These studies were completed by the Indiana Geological Survey (with cooperation from USACE WES) and include those by Barnhill (1992); Barnhill and Hansley (1993); Fisher (1996); Fisher, Barnhill, and Revenaugh (1998); and, Kvale (1994).

An assessment of metals in bedrock groundwater in southern Indiana was conducted by the Indiana Geological Survey (IGS) in 1989 to evaluate concentrations of lead exceeding U.S. EPA guidelines in a number of domestic wells in southern Indiana. The study attempted to relate water chemistry to aquifer mineralogy and chemistry through association of analytical results with lithology. The study covered three bedrock regions in southern Indiana. Region 1 included an area where wells were completed in the Devonian-Mississippian-age New Albany Shale, Region 2 covered an area with wells completed in Mississippian-age Salem and/or St. Louis Limestones, and Region 3 covered an area with wells completed in Mississippian and/or Pennsylvanian-age rock in the Wabash Lowland Physiographic Province. Three areas in Region 3 were tested. These areas (Epsom, Odon-Elnora, and Linton) are located in Daviess and Greene Counties. These areas in Region 3 were selected based on mining activities, both surface and subsurface and historical and current (as of 1988). Twenty-eight wells were identified in the study as being screened solely in Pennsylvanian-age bedrock.

Analyses in the 1989 IGS study included metals (arsenic, barium, cadmium, calcium, chromium, iron, lead, magnesium, manganese, mercury, potassium, selenium, silver, sodium, strontium, and zinc), chloride, fluoride, nitrate, sulfate, total dissolved solids, hardness, alkalinity, bicarbonate and carbonate, as well as water quality parameters of pH, temperature, specific conductance, dissolved oxygen, and Eh. Appendix A includes the 1989 IGS study results for Region 3, which includes the wells in Pennsylvanian-age bedrock (shown as highlighted).

The results of the IGS study were not included in the data set for this evaluation. The samples collected for the 1989 IGS study were field-filtered prior to sample preservation; therefore, the study results represent dissolved metals. As environmental investigations and risk assessments at NSA Crane are based on unfiltered samples results (i.e., total metals), the results of the IGS study were not considered comparable and could not be included in the data set for this evaluation.

In addition, several chemical (arsenic, iron, and manganese) and geochemical [pH and oxidation-reduction potential (ORP)] parameters were plotted for the 1989 IGS study data against the NSA Crane background data set (discussed in detail in Sections 3 and 4 of this report). The plots are provided in Appendix A. The plots indicate that the two data sets represent two separate populations, based on the clustering of the data. The pH values of the NSA Crane are also lower than those from the 1989 IGS study. The pH can directly influence potential solubility of metals, with lower pH generally promoting leaching of metals (discussed in Section 3.1). These differences in the data sets further support exclusion of the 1989 IGS study data from the current evaluation.

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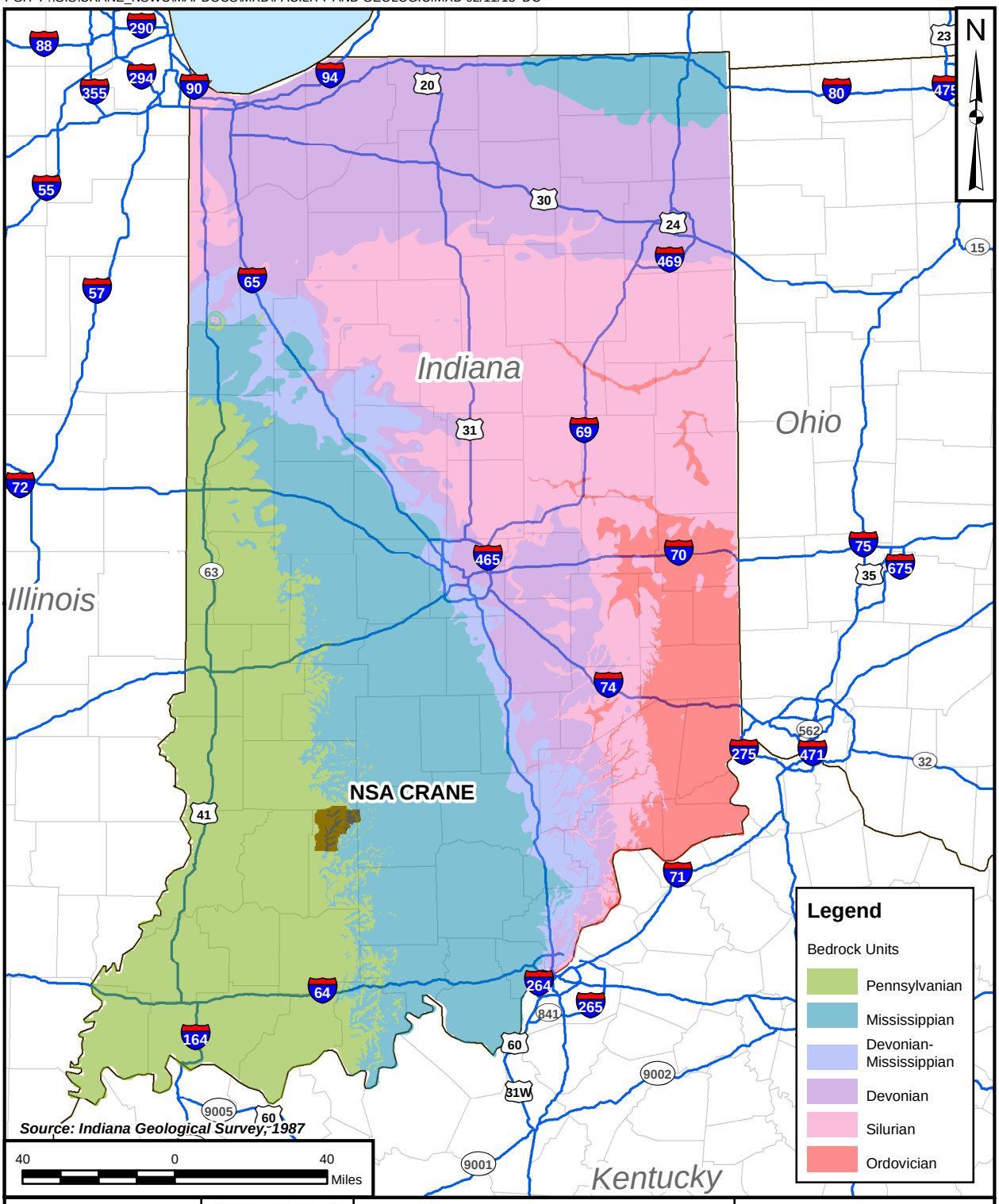

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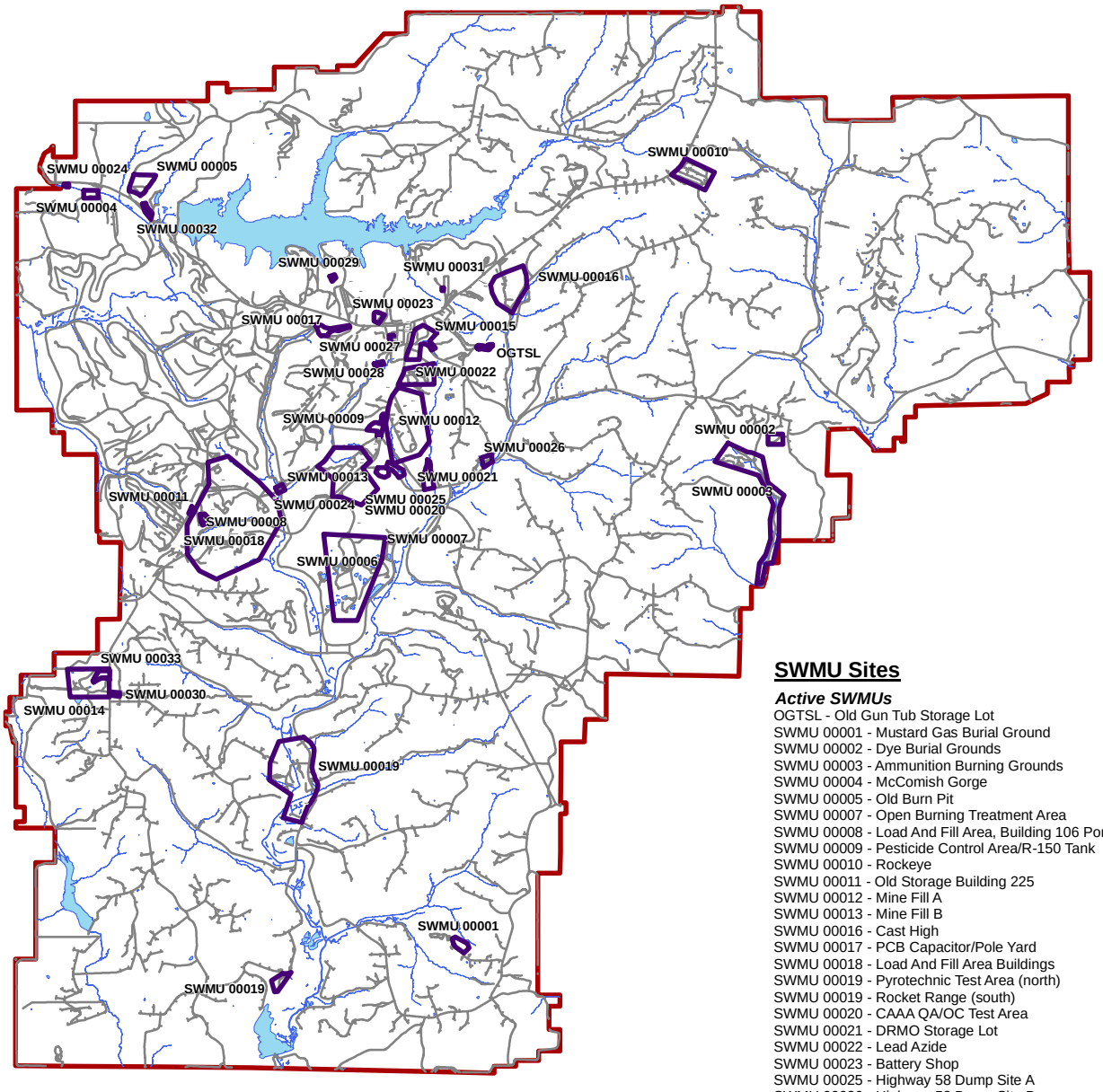

SWMU Sites

Active SWMUs

OGTSL - Old Gun Tub Storage Lot
SWMU 00001 - Mustard Gas Burial Ground
SWMU 00002 - Dye Burial Grounds
SWMU 00003 - Ammunition Burning Grounds
SWMU 00004 - McComish Gorge
SWMU 00005 - Old Burn Pit
SWMU 00007 - Open Burning Treatment Area
SWMU 00008 - Load And Fill Area, Building 106 Pond
SWMU 00009 - Pesticide Control Area/R-150 Tank
SWMU 00010 - Rockeye
SWMU 00011 - Old Storage Building 225
SWMU 00012 - Mine Fill A
SWMU 00013 - Mine Fill B
SWMU 00016 - Cast High
SWMU 00017 - PCB Capacitor/Pole Yard
SWMU 00018 - Load And Fill Area Buildings
SWMU 00019 - Pyrotechnic Test Area (north)
SWMU 00019 - Rocket Range (south)
SWMU 00020 - CAAA QA/OC Test Area
SWMU 00021 - DRMO Storage Lot
SWMU 00022 - Lead Azide
SWMU 00023 - Battery Shop
SWMU 00025 - Highway 58 Dump Site A
SWMU 00026 - Highway 58 Dump Site B
SWMU 00027 - Illuminant Building 126*
SWMU 00028 - Maintenance Shop, Building 1820
SWMU 00029 - PCP Dip Tank, Building 56
SWMU 00032 - Tank Farm

Requiring No Further Action

SWMU 00006 - Demolition Area
SWMU 00014 - Sanitary Waste Landfill
SWMU 00015 - Roads and Grounds Area
SWMU 00024 - Sludge Drying Bed A
SWMU 00024 - Sludge Drying Bed B
SWMU 00030 - Land Farm
SWMU 00031 - Compressed Gas Cylinder Site
SWMU 00033 - Bioremediation Facility

Legend

- Road
- SWMU Boundary
- Base Boundary
- Water

2 0 2 Miles

* SWMU 00027 is enlarged to include Pyrotechnic Production Area.

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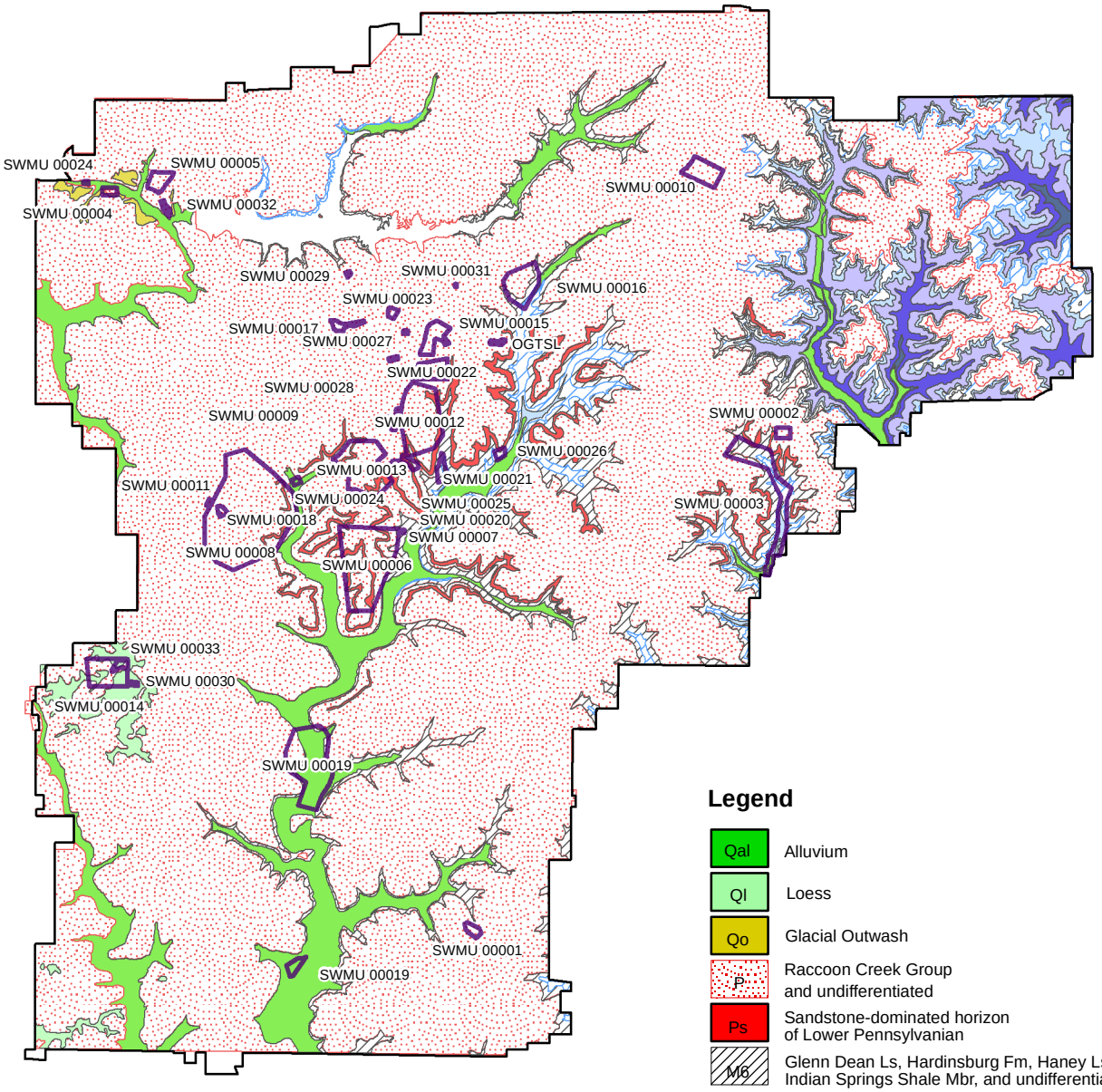

(Modified from Blunck, 1995)

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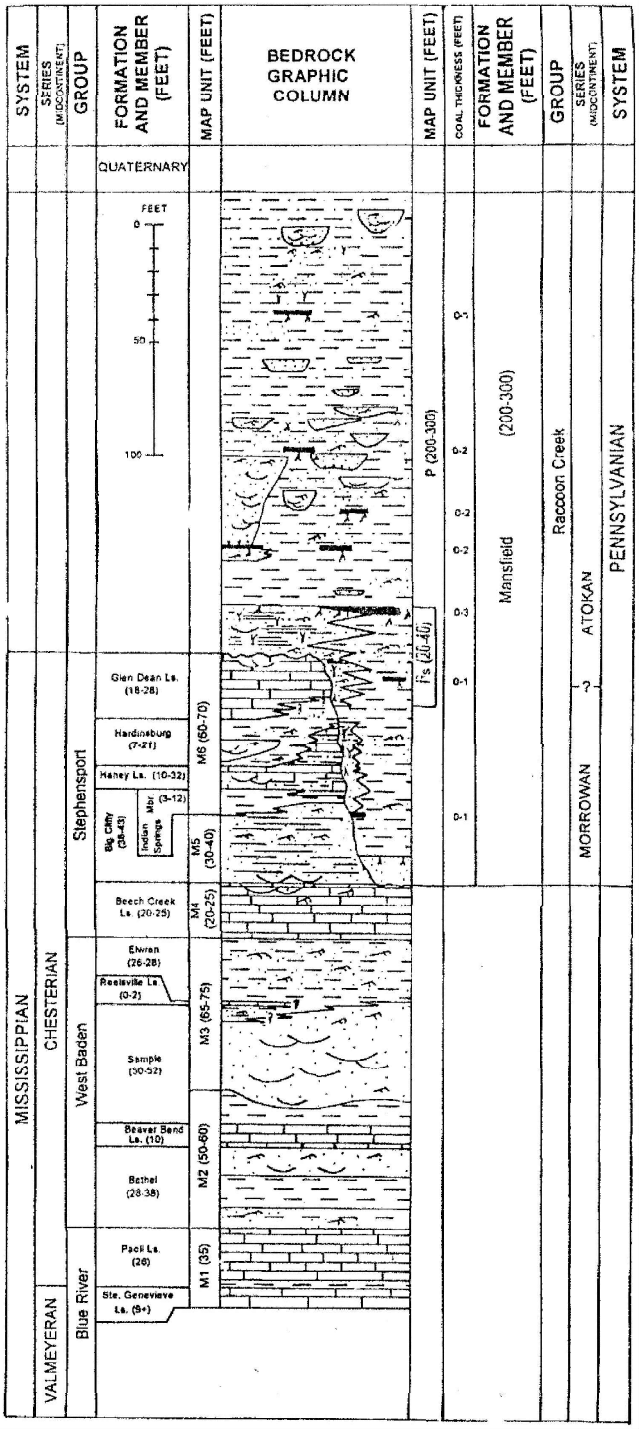

Source: Kvale, 1992; Kvale, 1994

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3.0 METHODOLOGY

This section presents a discussion of the selection and rationale of the groundwater data set and methods used in the statistical evaluation of the background data.

3.1 DATA SET SELECTION AND RATIONALE

The data set for the background evaluation included data from existing monitoring wells installed in Pennsylvanian-age bedrock at NSA Crane. No new wells were installed and no samples were collected for this evaluation.

The background areas and locations for inclusion in the data set were selected to ensure that the data used represented natural conditions that are unaffected by site-specific operations. The criteria used to ensure representativeness, followed by a brief description, were as follows:

- Groundwater monitoring wells screened within Pennsylvanian-age bedrock. The wells may be screened in any of the three water-bearing zones (upper, middle, or lower), but the entire screened interval must be within the Pennsylvanian bedrock.

- Located hydraulically upgradient of or vertically separated from potential site contaminant releases from a site that has been identified as a potential source of either inorganic or organic contaminants. Although organic contaminants are not the subject of this evaluation, the presence of organic contaminants in groundwater could potentially alter chemical oxidation-reduction conditions and cause metals to leach from the geologic matrix that would otherwise not leach or would not leach as rapidly. Background well locations were identified by reviewing existing RFI reports and related information, specifically groundwater elevation contour and flow depictions.

- Metals concentration data spanning several years of sampling to ensure that a thoroughly representative cross-section of groundwater chemistry is included in the statistical analysis.

- Metals concentration data representing as much area of NSA Crane as possible to ensure that spatial variations in the Pennsylvanian aquifer are represented and minimize potential no spatial correlation.

Information regarding monitoring wells at NSA Crane was reviewed to: (1) identify wells screened in the Pennsylvanian bedrock and (2) determine the wells located in hydraulically upgradient locations and not

affected by site-specific operations or contamination. The principal sources of information were RFI reports for individual SWMUs. Twenty-one wells in nine SWMUs were identified that met the criteria discussed above. Well construction information for these wells is provided in Table 3-1, and the locations of these wells are shown on Figure 3-1. Boring logs and well construction diagrams for the wells are provided in Appendix B. Seventeen of the wells selected are screened in the Puz. One well (12MWT33) is screened in the Pmz, and three wells (01-06, 10C52, and 13MWT28) are screened in the Plz. The four wells from SWMU 09 did not have a zone identified in the investigation reports; however, based on the shallow depths of the screened intervals (less than 25 feet bgs), it is assumed that these wells are screened in the Puz.

Background groundwater data are available for NSA Crane from 1981 to 2012. The quality of the metals data collected by the U.S. Army Corps of Engineers prior to 2000, however, has been questioned by U.S. EPA Region 5. Therefore, this data was eliminated from consideration for this evaluation. Data from filtered samples (i.e., dissolved results) and data for field duplicates, which are only used for quality control purposes, were also eliminated from consideration. Table 3-2 presents the data set used for this evaluation. Results from 29 groundwater samples were included in this evaluation. The numbers of metals per sample varied depending on the SWMU-specific requirements for data quality objectives and intended use of the data; therefore, the number of total metals results varies by metal. Because the data were collected over approximately 12 years, the data are considered to encompass natural variations in groundwater chemistry.

In addition, metals may be susceptible to leaching depending on geochemical conditions, particularly pH. Therefore, to evaluate whether a correlation exists between concentrations and pH, the concentrations of individual metals for the background groundwater data were plotted against the measured pH values for the samples. The plots are provided in Appendix C. No correlations with pH were observed in the data. Therefore, no further consideration was given to pH in this evaluation.

The following subsections discuss the SWMUs with wells included in the data set. Potentiometric surface maps for individual SWMUs are provided in Appendix D.

3.1.1 SWMU 01, Mustard Gas Burial Ground

One well from SWMU 01 was selected for inclusion in the background data set, 01-06. SWMU 01 is located in the southeastern portion of NSA Crane (Figure 2-2). SWMU 01 was originally a 2-acre area surrounded by a fence. This area was used between the end of World War II and 1956 for disposal of hazardous materials. Disposal was in the form of shallow burials (pits), typically within 6 feet of the

ground surface. These burials occurred in a small area within the 2-acre site. The smaller area is approximately 0.2 acres in size and is called the Primary Burial Area. Additional information related to past operations, environmental investigation history, and COCs is available in the RFI documents for SWMU 01 (Tetra Tech NUS, 2004).

The location of well 01-06 is shown on Figure 3-1. The potentiometric surface map from the RFI is provided in Appendix D. Well 01-06 is situated northeast of SWMU 01. Groundwater flow in the Plz at SWMU 01 is to the southwest. The screened interval of well 01-06 is separated vertically from the Puz at SWMU 01. No other potential sites have been identified in the Plz upgradient of this well.

3.1.2 SWMU 08, Building 106 Pond

One well from SWMU 08 was selected for inclusion in the background data set, 08MWT07. SWMU 08 is located in the west-central portion of NSA Crane (Figure 2-2). SWMU 08 includes Building 106, which was used for the phosphatizing of steel and a cleaning process that consisted of a caustic wash, a degreaser, and an acid wash. SWMU 08 also includes Building 107, which was originally used to refinish wooden and metal boxes. Overflow and floor drainage from Buildings 106 and 107 flowed into the Building 106 Pond. Additional information related to past operations, environmental investigation history, and COCs is available in the RFI documents for SWMU 08 (Tetra Tech NUS, 2008).

The location of well 08MWT07 is shown on Figure 3-1. The potentiometric surface map from the RFI is provided in Appendix D. Well 08MWT07 is situated in the north-central portion of SWMU 08. Groundwater flow is to the southeast. Well 08MWT07 is cross gradient to upgradient of potential site-related contamination at SWMU 08, and no other potential sites have been identified in the vicinity of this well.

3.1.3 SWMU 09, Pesticide Control Area/R-150 Tank

Four wells from SWMU 09 were selected for inclusion in the background data set, 09-10, 09-WTP6, 09T01, and 09T05. SWMU 09 is located in the central portion of NSA Crane, on the western side of Highway 45 (Figure 2-2). Former Building 55, Building 2189, and the R-150 Tank Area, were originally defined as SWMU 09. Following initial RFI activities, the actual location of Former Building 55 (the pesticide control building) was discovered to be further south than thought, and three other potential source areas of contamination were also identified in the southern section of SWMU 9. Subsequently, the area was subdivided into three areas for the purposes of investigation: SWMU 09 Pesticide Control/R-150 Tank Area, SWMU 09 North, and SWMU 09 South. Additional information related to past

operations, environmental investigation history, and COCs is available in the RFI documents for SWMU 09 (Tetra Tech NUS, 2005a, and Tetra Tech, 2013).

The locations of these wells are shown on Figure 3-1. In Table 3-1, the screened interval is identified as "Pennsylvanian" only. The water-bearing zones of these wells were not identified in the RFI; however, based on the relatively shallow well depths (i.e., less than 25 feet bgs), these wells are interpreted to be screened in the Puz. The potentiometric surface map from the RFI (Tetra Tech NUS, 2005a) is provided in Appendix D.

The four wells are situated along a ridgeline that trends north-south, with groundwater flow to the west and southwest across SWMU 09, away from the ridgeline. The wells are upgradient of potential site-related contamination at SWMU 09, and no other potential sites have been identified in the vicinity of these wells.

3.1.4 SWMU 10, Rockeye

One well from SWMU 10, 10C52, was selected for inclusion in the background data set. SWMU 10 is located in the northeastern portion of NSA Crane, on the eastern side of Highway 45 (Figure 2-2). Rockeye, an operational ammunition facility, is a 10-acre site located on a flattened ridge crest that separates the Sulphur Creek and Turkey Creek drainage basins. Additional information related to operations, environmental investigation history, and COCs is available in the RFI for SWMU 10 (Tetra Tech NUS, 2005a).

The location of well 10C52 is shown on Figure 3-1. The potentiometric surface map from the RFI is provided in Appendix D. Well 10C52 is situated at the southeastern corner of SWMU 10. Groundwater flow is to the north and west across SWMU 10, and there is a northeastern component of flow in the area of 10C52, toward a tributary to Sulphur Creek. Well 10C52 is upgradient of potential site-related contamination at SWMU 10, and no other potential sites have been identified upgradient of this well.

3.1.5 SWMU 12, Mine Fill A

Four wells from SWMU 12 were selected for inclusion in the background data set, 12MWT25, 12MWT26, 12MWT27, and 12MWT33. SWMU 12 is located in the central portion of NSA Crane, on the eastern side of Highway 45 (Figure 2-2). Mine Fill A was used for the production of large mines, depth charges, rocket heads, aerial bombs, and projectiles. Mine Fill A also includes a battery and soil disposal area that is located at the extreme southern end of the SWMU. Additional information related to past operations,

environmental investigation history, and COCs is available in the RFI and other corrective action documents for SWMU 12 (Tetra Tech NUS, 2010a, 2011a, and 2011b).

The locations of the SWMU 12 wells are shown on Figure 3-1. The potentiometric surface maps for the Puz and Pmz at SWMU 12 from the RFI (Tetra Tech NUS, 2011a) are provided in Appendix D.

Mine Fill A is located on top of a ridge that was flattened to some extent in the 1940s in preparation for site development (roads, rail lines, buildings, parking lots). The four wells are situated in the northernmost area of the north-south trending ridge. Groundwater flow in the Puz and Pmz at SWMU 12 is to the southeast, with components to the east and southwest, away from the ridgeline. The wells are upgradient of potential site-related contamination at SWMU 12, and no other potential sites have been identified in the vicinity of these wells.

3.1.6 SWMU 13, Mine Fill B

Three wells from SWMU 13 were selected for inclusion in the background data set, 13MWT01, 13MWT03, and 13MWT28. Mine Fill B is located in the central portion of NSA Crane, on the western side of Highway 45 (Figure 2-2). Mine Fill B was used for the preparation of nitrate and the production of large mines, depth charges, rocket heads, aerial bombs, and projectiles. Additional information related to past operations, environmental investigation history, and COCs is available in the RFI and other corrective action documents for SWMU 13 (Tetra Tech NUS, 2007, 2010b, and 2011c).

The locations of the SWMU 13 wells are shown on Figure 3-1. The potentiometric surface maps for the Puz and Plz at SWMU 13 from the RFI (Tetra Tech, 2007) are provided in Appendix D.

Mine Fill B lies on top of a ridge that was flattened to some extent in the 1940s in preparation for the construction of buildings, roads, and associated parking and staging areas. The four wells are situated in the northeasternmost area of Mine Fill B, along Highway 45. Groundwater flow in the Puz at SWMU 13 is to the southwest, with components to the northwest and southeast, away from the ridgeline. The wells are upgradient of potential site-related contamination at SWMU 13, and no other potential sites have been identified in the vicinity of these wells.

3.1.7 SWMU 16, Cast High Explosives Fill/Building 146 Incinerator

Two wells from SWMU 16 were selected for inclusion in the background data set, 16MW02 and 16MWT17. SWMU 16 is located in the north-central portion of NSA Crane, on the southern side of

Highway 45 (Figure 2-2). Building 146, the largest building at SWMU 16, was an explosives fill and pressure washout facility. Additional information related to past operations, environmental investigation history, and COCs is available in the RFI and other corrective action documents for SWMU 16 (Tetra Tech NUS, 2005b, 2010c, and 2011d).

The locations of the SWMU 16 wells are shown on Figure 3-1. The potentiometric surface map for the Puz at SWMU 16 from the RFI (Tetra Tech NUS, 2011d) is provided in Appendix D.

SWMU 16 is situated along a northwest-southeast trending ridge, and the selected wells are situated in the northwestern portion of SWMU 16. Groundwater flow in the Puz at SWMU 16 is to the southeast, with components to the northeast and southwest, away from the ridgeline. The wells are upgradient of potential site-related contamination at SWMU 16, and no other potential sites have been identified upgradient of these wells.

3.1.8 SWMU 18, Load and Fill Area

SWMU 18 is located in the west-central portion of NSA Crane, encompasses approximately 1 square mile, and includes over 100 buildings (Figure 2-2). Projectile load and fill operations, powder operations, and propellant testing have been conducted at SWMU 18 since the early 1940s and continued throughout its operational history. Load and fill operations were conducted in the northern portion of SWMU 18, principally in Buildings 101, 102, 103, 104, 105, and 189 and also in Buildings 200 and 198 in the southern portion of SWMU 18. The remaining area of the southern portion of SWMU 18 was used for research, development, and testing and was referred to as the Applied Science Department Complex. Current operations within SWMU 18 include renovation, rework, and loading of munitions items; research and development; and testing. Due to its large size, SWMU 18 was subdivided into the following 10 subareas based on similar operations or use and geographic proximity to facilitate more efficient and effective investigation:

- Subarea A: Building 105 Area
- Subarea B: Buildings 101, 102, and 103 Area
- Subarea C: Inert Operation Area
- Subarea D: Special Program (SP) Area
- Subarea E: Building 104 Area
- Subarea F: Buildings 2084, 2085, and 2540 Area
- Subarea G: ASD I Area
- Subarea H: Building 198 Area

- Subarea I: Building 200 Area
- Subarea J: ASD II Area

RFI activities were conducted at SWMU 18 in 2011. Additional characterization of media in several subareas is pending.

Four wells from SWMU 18 were selected for inclusion in the background data set, 18AMWT001, 18DMWT001, 18GMWT004, and 18IMWT001. The locations of these wells are shown on Figures 3-1. Preliminary potentiometric surface maps from the RFI conducted in 2011 (in preparation) are provided in Appendix D.

Highway 45 generally bisects SWMU 18 into northern and southern areas along two east-west trending ridges. The tops of the ridges are generally cleared and level, whereas the slopes are wooded and steep, with buildings within SWMU 18 generally situated along the two east-west trending ridges. Groundwater flow in the Puz in the four subareas with wells included in the background evaluation generally follows topography. The wells are upgradient of potential site-related contamination at SWMU 18, and no other potential sites have been identified upgradient of these wells.

3.1.9 SWMU 22, Lead Azide Pond

One well from SWMU 22, 22MWT001, was selected for inclusion in the background dataset. SWMU 22 is located in the central portion of NSA Crane, east of Highway 45, and is referred to as the Explosive Actuated Device (EAD)/Booster Area or the "Backline." The Booster Area was designed and constructed to load 5-inch rockets during World War II. EADs were loaded with explosives such as lead azide, lead styphnate, tetryl, RDX, and black powder. Building 136 was used for the propellant portion, Building 138 was the pressing building for warheads, and Building 2520 was the final assembly building. The area is currently operated by the Army and is involved in the production of small explosive charges and fuse maintenance. The buildings associated with the Backline are planned to be demolished in 2011. An unlined retention pond previously located at the northern end of the Backline, received overflow wastewater from sumps associated with the process buildings. The retention pond was removed in 1981. RFI activities were conducted at SWMU 22 in 2011, 2012, and 2013. Preparation of the RFI Report is pending.

The location of the well from SWMU 22 is shown on Figure 3-1. A preliminary potentiometric surface map from the RFI activities conducted in 2012 is provided in Appendix D.

SWMU 22 is situated on a portion of the top of a flattened topographic high, and well 22MWT001 is situated in the northwestern portion of SWMU22, north of Building 138. Groundwater flow in the Puz at SWMU 22 is to the south toward the drainages. The well is upgradient of potential site-related contamination at SWMU 22. No other potential sites have been identified upgradient of these well; however, a potentially impacted area may exist northeast of Building 138 (and northeast of well 22MWT006), in an area not previously investigated. Well 22MWT006 was excluded from the statistical evaluation based on potential impacts from this area.

3.2 DATA USABILITY

The background data set were collected from environmental investigations at NSA Crane in accordance with IDEM- and U.S. EPA-approved work plans. The following sections discuss data sampling and analyses and data quality reviews as they relate to data usability for this evaluation.

3.2.1 Sampling and Analyses

The groundwater samples included in this evaluation were collected using low-flow purging and sampling techniques to minimize turbidity. Groundwater samples were analyzed using SW-846 Methods 6010 or 6020 (all metals except mercury) or Method 7470 (mercury only), depending on the investigation with which the samples are associated. Method 6020 is generally less prone to analytical interferences than Method 6010, and it is also generally more sensitive than Method 6010, depending on the metal being analyzed. The precision and accuracy of the data are comparable for the two methods, and mixing of data from two analytical methods was considered to be acceptable for this evaluation.

Specific sampling methods and analyses and additional information related to sampling and analysis may be found in the SWMU-specific documents listed in the reference section if this report.

3.2.2 Data Quality Review

The data quality objectives and requirements for the data used in this evaluation were investigation specific and established for each investigation. Data collected for environmental investigations underwent data quality review to ensure the usability of the data. The review includes data verification and validation. Verification is a process used to ensure that contractual requirements were satisfied. Validation is a comparison of data quality indicators (DQIs) to prescribed acceptance criteria to assess analytical method performance. The DQIs used are measures to assess the bias and precision of the analytical calibrations and sample analyses. Together, verification and validation are the first steps in evaluating data completeness, accuracy, sensitivity, comparability, and representativeness. The data

review process culminated with a data usability assessment presented in the SWMU-specific report during which the final usability of the data is established relative to the intended data use. All data used in this background evaluation have undergone data quality review for individual SWMU investigations and are considered acceptable for use in this evaluation.

Additional information regarding data quality is provided in the following subsections.

3.2.2.1 Data Validation

As part of their respective environmental investigations, the groundwater analytical data were subjected to data validation and a data usability evaluation, which included assessments of bias, precision, representativeness, comparability, completeness, and sensitivity. Data validation is an objective systematic process in which analytical data are reviewed to ascertain the validity of the reported results and to identify for the data user some possible limitations of these results. Data usability considers the data validation outputs but includes additional assessments that consider whether the data are usable for the intended purpose.

Data validation was performed for all samples analyzed. Data validation was completed in accordance with the procedures for data validation as outlined in Navy guidance (NFESC, 1999 and DOD, 2009). The data from investigations were validated in accordance with U.S. EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, as amended (1993 and 2004). The results of the validation process were summarized in technical memoranda describing qualified analytical results. All data validation documentation is currently retained on file by Tetra Tech. Investigation reports also may include copies of the validation memoranda.

The data used for this evaluation are considered usable based on the results of data validation.

3.2.2.2 Bias, Accuracy, and Precision Evaluation

Bias and accuracy of the background groundwater data were found to be acceptable for their intended investigation-specific use; therefore, the data were used without qualification for this background evaluation.

3.2.2.3 Analytical Sensitivity

In general, the investigation-specific detection limits were achieved; therefore, groundwater data from selected background wells was used without regard to the detection limits that were attained. Table 4-1 presents minimum and maximum detection limits attained.

3.2.2.4 Data Comparability, Completeness, and Representativeness

Sampling methods, sample preservation, and sample storage practices that preserved the integrity of the groundwater samples were consistent from one investigation to another. The samples selected for this background groundwater evaluation were collected from wells screened in the upper, middle, and lower water-bearing zones within the Pennsylvanian bedrock and are therefore considered representative of the entire aquifer. Analytical methods based on similar techniques and exhibiting similar performance characteristics were used for all environmental investigations from which background groundwater data were used. These factors ensured that all groundwater data collected from the background locations are comparable and representative of the Pennsylvanian bedrock groundwater. This representativeness spans several years and a large spatial expanse within the NSA Crane boundary, and the data set is therefore considered a comprehensive set of background groundwater quality data that can be applied to environmental groundwater investigations of Pennsylvanian bedrock groundwater.

3.3 STATISTICAL ANALYSIS

A series of statistical analyses were conducted to determine a representative background data set for groundwater data from the selected Pennsylvanian aquifer wells. The conclusions of the statistical analysis are presented in Section 4, and the methodology and full results of the analysis are discussed in detail in Appendix E.

Table 3-2 presents the concentrations of metals (total) in samples from the Pennsylvanian aquifer wells selected for this background evaluation. For the statistical evaluation, the concentration of each metal in the data set was considered to carry equal weight in terms of characterizing the concentration distribution of metals in the Pennsylvanian aquifer. Concentrations less than detection limits (i.e., non-detect values) were replaced with the value of the detection limit.

TABLE 3-1

MONITORING WELL INFORMATION
BASEWIDE PENNSYLVANIAN BEDROCK BACKGROUND GROUNDWATER EVALUATION
NSA CRANE, INDIANA

Monitoring Well[1]	Date of Installation	Coordinates[2]		Elevation (feet NAVD88)		Total Depth[3] (feet bgs)	Screened Interval (feet bgs)		Water-Bearing Zone
		Northing	Easting	Ground	Ref. Point		Top	Bottom	
SWMU 01 - Mustard Gas Burial Ground									
01-06 (WES-1-6-82)	11/10/1982	3045143.95	1327648.67	595.38	597.98	93.05	75.0	84.4	Pennsylvanian (Lower)
SWMU 08 - Building 106 Pond									
08MWT07	5/13/2005	1306840.18	3014993.62	699.73	701.31	33.0	18.0	33.0	Pennsylvanian (Upper)
SWMU 09 - Pesticide Control Area /R-150 Tank									
09-10 (WES-9-10-83)	8/18/1983	1312055.42	3025373.75	723.83	726.51	27.0	11.5	20.6	Pennsylvanian[4]
09-WTP6 (WES-WTP6-86)	7/28/1986	1312307.48	3025423.99	733.10	735.09	26.7	20.7	25.7	Pennsylvanian[4]
09T01	12/04/2000	1312804.34	3025759.95	737.56	740.02	26.0	11.0	26.0	Pennsylvanian[4]
09T05	12/04/2000	1311681.50	3025540.48	716.73	719.19	17.0	7.0	17.0	Pennsylvanian[4]
SWMU 10 - Rockeye									
10C52 (WES-10-52C-88)	06/08/1989	1326218.319	3044737.357	809.42	811.73	83.0	58.0	68.0	Pennsylvanian (Lower)
SWMU 12 - Mine Fill A									
12MWT25	09/12/2004	1313924.59	3026269.42	746.55	748.66	26.0	15.0	25.0	Pennsylvanian (Upper)
12MWT26	09/12/2004	1313638.57	3025981.12	741.64	743.72	25.0	14.0	24.0	Pennsylvanian (Upper)
12MWT27	09/02/2004	1313736.63	3026477.23	738.42	740.52	26.0	15.0	25.0	Pennsylvanian (Upper)
12MWT33	09/02/2004	1313725.86	3026481.26	738.32	740.49	95.0	74.0	94.0	Pennsylvanian (Middle)
SWMU 13 - Mine Fill B									
13MWT01	03/30/2003	1310541.57	3025015.94	713.10	715.34	15.0	5.0	15.0	Pennsylvanian (Upper)
13MWT03	03/30/2003	1310240.95	3024891.66	718.34	721.10	15.0	5.0	15.0	Pennsylvanian (Upper)
13MWT28	11/19/2003	1309678.62	3024066.67	703.54	705.55	88.0	78.0	88.0	Pennsylvanian (Lower)
SWMU 16 - Cast High									
16MW02 (WES-14-02-83)	1983	1321319.90	3032647.27	763.69	766.54	25.8	11.4	20.4	Pennsylvanian (Upper)
16MWT17	11/08/2003	1321235.88	3032675.07	764.78	766.53	24.0	14.0	24.0	Pennsylvanian (Upper)
SWMU 18 - Load and Fill Area									
18AMWT001	12/05/2011	1309581.89	3015573.81	684.49	687.08	24.0	13.0	23.0	Pennsylvanian (Upper)
18DMWT001	11/07/2011	1307840.00	3016101.97	681.01	683.78	18.5	8.0	18.0	Pennsylvanian (Upper)
18GMWT004	12/16/2011	1305244.05	3016493.37	654.09	656.72	28.5	17.0	27.0	Pennsylvanian (Upper)
18IMWT001	11/22/2011	1304198.16	3015031.33	695.63	698.06	31.0	21.0	31.0	Pennsylvanian (Upper)
SWMU 22 - Lead Azide Pond									
22MWT01	05/11/2012	1315811.32	3027409.14	766.47	768.74	25.0	15.0	25.0	Pennsylvanian (Upper)

NOTES
(1) Original well designation in parantheses.
(2) Indiana State Plane Coordinate System, NAD83.
(3) Total boring depth.
(4) Pennsylvanian = zone not specified; assumed to be Pennsylvanian (Upper).

bgs = below ground surface.
NAD83 = North American Datum if 1983.
NAVD88 = North American Vertical Datum of 1988.

TABLE 3-2

ANALYTICAL DATA SET
BASEWIDE PENNSYLVANIA BEDROCK BACKGROUND GROUNDWATER EVALUATION
NSA CRANE, INDIANA

SWMU/WELL	WATER-BEARING ZONE	SAMPLE DATE	ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CALCIUM	CHROMIUM	COBALT	COPPER
SWMU 01 - Mustard Gas Burial Ground												
01-06	Plz	09/04/2001	40.2 U	1.6 U	3.2 U	21.3	0.4 U	0.3 U	170000	0.6 U	1 U	0.9 U
SWMU 08 - Building 106 Pond												
08MWT07	Puz	06/02/2005	463 J	0.2 U	0.45 U	19.5 J	0.05 U	0.08 J	9640 J	0.58 J	5.3 J	2.1 U
SWMU 09 - Pesticide Control Area/R-150 Tank												
09-10	Puz	01/31/2001	200 U	1 U	0.75	68.4	1 U	1 U	25800	5 U	3 U	2 U
09T01	Puz	01/31/2001	200 U	1 U	2.9	52.6	1 U	1 U	39400	5 U	3 U	4.4
09T05	Puz	01/30/2001	200 U	1 U	1.5	90.7	1 U	1 U	24000	5 U	18.2	2
09-WTP6	Puz	01/23/2001	200 U	1 U	1 U	19.3	1 U	1 U	59300	5 U	3 U	2 U
SWMU 10 - Rockeye												
10C52	Plz	01/18/2001	200 U	1 U	1 U	17.9	1 U	1 U	17000	5 U	3 U	2 U
SWMU 12 - Mine Fill A												
12MWT25	Puz	10/10/2004	479	0.085 U	1.1 J	26.2 J	0.1 J	0.14 U	216000 J	1.4 U	53.2 J	3 J
		02/04/2005	192 J	0.085 U	0.27 U	21.8 J	0.04 U	0.04 U	125000 J	0.74 U	12.9 J	3.4 J
12MWT26	Puz	09/26/2004	565 J	0.24 U	2.3 J	38.4 J	0.07 U	0.11 U	92600 J	1.7 J	31.3 J	0.84 J
		02/17/2005	126 J	0.54 U	0.67 U	12.8 U	0.03 U	0.13 U	77900 J	0.72 U	5.6 J	3.5 J
12MWT27	Puz	09/25/2004	323 J	0.22 U	0.58 U	39.1 J	0.03 U	0.05 U	21200 J	1.2 J	11.2 J	0.67 J
		02/07/2005	205 J	0.1 U	0.22 U	20.6 J	0.02 U	0.04 U	16300 J	0.62 U	1.2 U	2 J
12MWT33	Pmz	09/26/2004	37.1 U	0.52 U	2.7 J	13.2 J	1.3 J	0.039 U	61100 J	0.52 U	44.4 J	0.7 J
		02/18/2005	200 J	0.085 U	1.2 U	15.6 U	2.2 J	0.18 U	56400 J	0.76 U	40 J	2.5 J
SWMU 13 - Mine Fill B												
13MWT01	Puz	04/26/2003	598 J	0.24 U	0.23 U	55.4 J	1.2 U	0.18 U	9720 J	0.2 U	36 J	2.9 J
		11/23/2003	699 J	0.02 U	0.17 U	46.8 J	1.2 U	0.06 U	7190 J	0.73 U	29.9 J	1.4 U
13MWT03	Puz	04/26/2003	3990 J	0.13 U	1 J	74.5 J	1.2 U	0.82 U	34800 J	7.1 J	48.8 J	5.6 J
		11/11/2003	627 J	0.02 U	0.31 U	62.1 J	1.8 U	0.37 U	26100 J	1.4 U	25 J	3.2 J
13MWT28	Plz	12/07/2003	6270 J	2.9 J	15.2 J	65.3 J	0.27 U	0.04 U	10600 J	11.7 J	2 J	1.4 U
SWMU 16 - Cast High												
16MW02	Puz	04/24/2003	85.6	0.1 U	0.16 U	21.6 J	0.42 U	0.31 U	99400 J	0.43 U	12.9 J	0.87 J
		05/11/2003	60.6 U	0.03 U	0.33 U	18 J	0.34 U	0.22 U	97300 J	0.29 U	9.2 J	0.15 U
		10/25/2003	8.3 U	0.02 U	0.66 J	17.8 J	0.06 U	0.04 U	212000 J	0.17 U	18.7 J	0.12 U
16MWT17	Puz	12/05/2003	187 J	0.05 U	1.3 U	42.7 J	0.69 U	0.53 U	42200 J	0.39 U	64.4 J	0.56 U
SWMU 18 - Load and Fill Area												
18AMWT001	Puz	01/20/2012	3110 J	2 UJ	1.5 U	35.6	3.01	0.462 J	12300	0.816 J	62	12.3
18DMWT001	Puz	01/17/2012	28.5 J	2 U	1.5 U	75.6	0.5 U	0.5 U	43900	1 U	2.5 U	2 U
18GMWT004	Puz	01/19/2012	6210 J	4 UJ	8.61 J	74.6 J	1.16 J	1 U	24200 J	11.4 J	34 J	21.6 J
18IMWT001	Puz	01/23/2012	8500	4 U	8.28	97.5	0.591 J	1 U	61000	26.2	27.2	16.6
SWMU 22 - Lead Azide Pond												
22MWT01	Puz	05/22/2012	NA	NA	1.4	34.2	NA	0.9	NA	4	NA	NA

TABLE 3-2

ANALYTICAL DATA SET
BASEWIDE PENNSYLVANIA BEDROCK BACKGROUND GROUNDWATER EVALUATION
NSA CRANE, INDIANA

SWMU/WELL	WATER-BEARING ZONE	SAMPLE DATE	IRON	LEAD	MAGNESIUM	MANGANESE	MERCURY	NICKEL	POTASSIUM	SELENIUM	SILVER
SWMU 01 - Mustard Gas Burial Ground											
01-06	Plz	09/04/2001	398	1.6 U	156000	37.9	0.1 U	2.6	2790	0.8 U	3
SWMU 01 - Mustard Gas Burial Ground											
08MWT07	Puz	06/02/2005	681 J	0.54 J	6750 J	93.9 J	0.03 U	7.8 J	518 J	0.33 J	0.028 U
SWMU 09 - Pesticide Control Area/R-150 Tank											
09-10	Puz	01/31/2001	136	1 U	10600 J	164	0.2 U	10 U	5000 U	1 U	3 UJ
09T01	Puz	01/31/2001	144	1 U	26500 J	34.8	0.2 U	10 U	5000 U	1 U	3 UJ
09T05	Puz	01/30/2001	100 U	1 U	21900 J	178	0.2 U	51.2	5000 U	1 U	3 UJ
09-WTP6	Puz	01/23/2001	149	1 U	19800 J	15	0.2 U	10 U	5000 U	1.1 J	3 U
SWMU 10 - Rockeye											
10C52	Plz	01/18/2001	22200	1 U	11800 J	897	0.2 U	10 U	5000 U	1 U	3 U
SWMU 12 - Mine Fill A											
12MWT25	Puz	10/10/2004	1920 J	0.66 U	229000 J	4910 J	0.042 U	103 J	5320 J	3.4 J	0.03 U
		02/04/2005	1110 J	0.425 U	153000 J	2200 J	0.03 U	32 J	3320 J	1.9 J	0.028 U
12MWT26	Puz	09/26/2004	2990 J	0.53 U	70000 J	2520 J	0.14 U	60.1 J	3740 J	0.28 U	0.028 U
		02/17/2005	2010 J	0.157 U	50000 J	1020 J	0.051 U	12.8 J	1630 J	0.99 J	0.028 U
12MWT27	Puz	09/25/2004	482 J	0.37 U	16400 J	701 J	0.03 U	30.7 J	3710 J	0.61 U	0.028 U
		02/07/2005	396 J	0.42 U	16500 J	160 J	0.03 U	7.3 J	1080 J	0.37 U	0.028 U
12MWT33	Pmz	09/26/2004	41800 J	0.34 U	33500 J	3010 J	0.043 U	131 J	4520 J	0.094 U	0.028 U
		02/18/2005	41700 J	1 U	27200 J	1680 J	0.05 U	110 J	4770 J	0.31 U	0.028 U
SWMU 13 - Mine Fill B											
13MWT01	Puz	04/26/2003	135 J	1.4 U	6790 J	689 J	0.16 J	26.6 J	494 J	0.17 U	0.18 U
		11/23/2003	61.7 U	1.2 U	5850 J	566 U	0.39	21.1 J	403 J	0.05 U	0.03 U
13MWT03	Puz	04/26/2003	1910 J	2 U	17000 J	302 J	0.02 U	99.7 J	2860 J	0.32 U	0.43 U
		11/11/2003	344 U	0.67 U	15800 J	211 J	0.02 U	76.3 J	1040 J	0.04 U	0.03 U
13MWT28	Plz	12/07/2003	2460 J	2.5 U	2950 J	66.7 J	0.007 U	7.1 J	3670 J	4.1 J	0.03 U
SWMU 16 - Cast High											
16MW02	Puz	04/24/2003	287 J	0.21 U	6240 J	916 J	0.02 U	34.2 J	738 J	0.05 U	0.09 U
		05/11/2003	415 J	0.28 U	6480 J	864 J	0.2 U	27 J	3390 U	0.06 U	0.04 U
		10/25/2003	13700 J	0.18 U	35200 J	2440 J	0.02 U	36.7 J	2640 J	0.04 U	0.03 U
16MWT17	Puz	12/05/2003	27000 J	0.24 U	16700 J	5940 J	0.007 U	125 J	5380 J	0.07 U	0.03 U
SWMU 18 - Load and Fill Area											
18AMWT001	Puz	01/20/2012	1970 J	0.75 U	5510	1270	0.2 U	76.1	2230	1.25 U	0.5 U
18DMWT001	Puz	01/17/2012	12.7 J	0.75 U	15100	6.89	0.2 U	1.56 J	1170 J	1.25 U	0.5 U
18GMWT004	Puz	01/19/2012	11300 J	11.7 J	10800 J	1180 J	0.2 UJ	88.1 J	5000 J	2.5 UJ	1 U
18IMWT001	Puz	01/23/2012	22500	15.5	37100	1890	0.2 U	55.8	5370	2.5 U	1 U
SWMU 22 - Lead Azide Pond											
22MWT01	Puz	05/22/2012	NA	3.2	NA	NA	0.18 U	NA	NA	0.45 J	0.06 U

TABLE 3-2

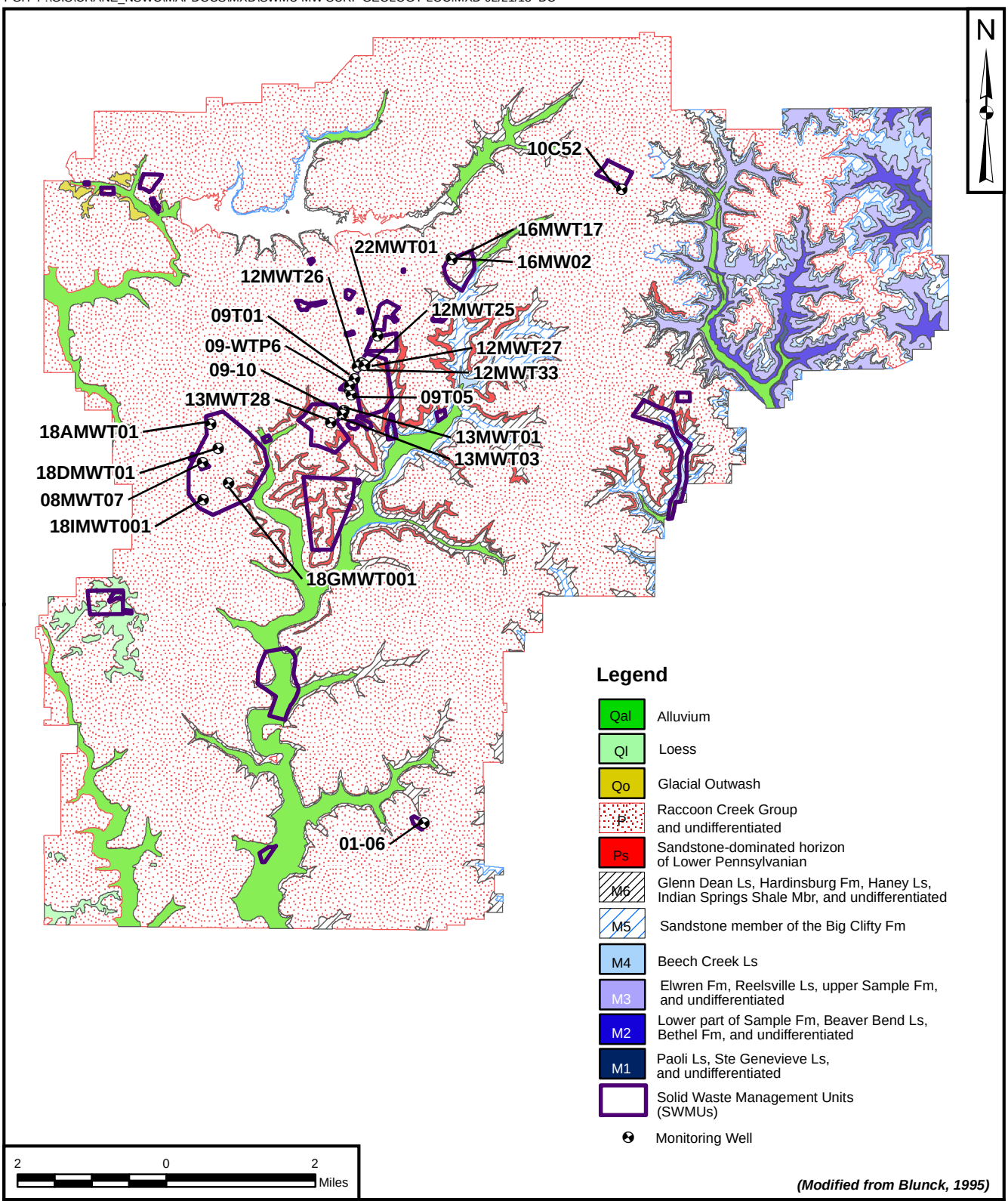
ANALYTICAL DATA SET
BASEWIDE PENNSYLVANIA BEDROCK BACKGROUND GROUNDWATER EVALUATION
NSA CRANE, INDIANA

SWMU/WELL	WATER-BEARING ZONE	SAMPLE DATE	SODIUM	THALLIUM	TIN	VANADIUM	ZINC
SWMU 01 - Mustard Gas Burial Ground							
01-06	Plz	09/04/2001	17200	5	190 U	3 U	1.1 U
SWMU 01 - Mustard Gas Burial Ground							
08MWT07	Puz	06/02/2005	36500 J	0.26 U	0.1 U	1.14 U	12.4 J
SWMU 09 - Pesticide Control Area/R-150 Tank							
09-10	Puz	01/31/2001	57600 J	1 U	10 U	2 U	10 U
09T01	Puz	01/31/2001	134000 J	1 U	10 U	2.1	10 U
09T05	Puz	01/30/2001	102000 J	1 U	10 U	2 U	25.4
09-WTP6	Puz	01/23/2001	48900 J	1 U	10 U	2 U	13.2
SWMU 10 - Rockeye							
10C52	Plz	01/18/2001	15700 J	1 U	10 U	2 U	10 U
SWMU 12 - Mine Fill A							
12MWT25	Puz	10/10/2004	152000 J	0.08 J	0.24 U	1.14 U	20.8 J
		02/04/2005	116000 J	0.08 U	0.09 U	1.14 U	26.1 J
12MWT26	Puz	09/26/2004	165000 J	0.043 U	0.06 U	1.14 U	12.1 J
		02/17/2005	143000 J	0.06 U	0.33 U	1.14 U	8 J
12MWT27	Puz	09/25/2004	53600 J	0.043 U	0.69 U	1.14 U	11.3 J
		02/07/2005	39200 J	0.043 U	0.15 U	1.14 U	3.3 U
12MWT33	Pmz	09/26/2004	40300 J	0.043 U	0.048 U	1.14 U	96 J
		02/18/2005	32200 J	0.043 U	0.38 U	1.14 U	128 J
SWMU 13 - Mine Fill B							
13MWT01	Puz	04/26/2003	24300 J	0.11 U	0.1 U	0.08 U	29.7 J
		11/23/2003	26100 J	0.08 U	0.1 U	0.06 U	29.9 J
13MWT03	Puz	04/26/2003	37400 J	0.23 U	0.34 U	5.8 J	161 J
		11/11/2003	40700 J	0.04 U	0.1 U	0.76 U	97.7 J
13MWT28	Plz	12/07/2003	124000 J	0.06 U	0.63 U	12.5 J	6.7 J
SWMU 16 - Cast High							
16MW02	Puz	04/24/2003	18000 J	0.1 U	0.06 U	0.3 U	50 J
		05/11/2003	17900 J	0.11 U	0.07 U	0.35 U	42.9 J
		10/25/2003	20200 J	0.08 U	0.1 U	0.09 U	15.8 J
16MWT17	Puz	12/05/2003	61300 J	0.12 U	0.1 U	0.17 U	122 J
SWMU 18 - Load and Fill Area							
18AMWT001	Puz	01/20/2012	10100	1 U	NA	2.5 U	63.1
18DMWT001	Puz	01/17/2012	34300	1 U	NA	2.5 U	2.16 J
18GMWT004	Puz	01/19/2012	89300	2 U	NA	7.47 J	78.2 J
18IMWT001	Puz	01/23/2012	50300	2 U	NA	17.9	85
SWMU 22 - Lead Azide Pond							
22MWT01	Puz	05/22/2012	NA	NA	NA	NA	NA

NOTES
Results are for total metals (i.e., unfiltered samples) in micrograms per liter (µg/L).
NA = Parameter not analyzed.

J - Indicates that the parameter was detected but the concentration is considered an estimate due to imprecision.
U - Indicates that the parameter was not detected at the numerical detection limit.
UJ - Indicates that the parameter was not detected and the result is estimated.
Plz - Pennsylvanian (lower zone).
Pmz - Pennsylvanian (middle zone).
Puz - Pennsylvanian (upper zone).

PGH P:\GIS\CRANE_NSWC\MAPDOCS\MXD\SWMU MW SURF GEOLOGY LOC.MXD 02/21/13 DC



(Modified from Blunck, 1995)

DRAWN BY: D. COUCH	DATE: 01/28/13	MONITORING WELL LOCATION MAP NSA CRANE CRANE, INDIANA	CONTRACT NUMBER: F279
CHECKED BY	DATE		APPROVED BY: ___ DATE: ___
REVISED BY	DATE		APPROVED BY: ___ DATE: ___
SCALE: AS NOTED		NAVFAC	FIGURE NO.: 3 - 1 REV: 0

4.0 EVALUATION OF BACKGROUND CONCENTRATIONS

This section presents the results of the statistical evaluation performed to establish the background data set for metals in groundwater within the Pennsylvanian bedrock at NSA Crane. It also discusses use of the background data set in future investigations.

4.1 STATISTICAL EVALUATION SUMMARY

Table 4-1 presents the results of the statistical evaluation of metals in background groundwater at NSA Crane. The calculated UTLs represent the background concentrations for groundwater within the Pennsylvanian bedrock.

4.2 COMPARISON OF SITE TO BACKGROUND CONCENTRATIONS

For comparisons of site data to background data, either site-wide tests or individual comparison tests will be used to compare site concentrations to background concentrations. Site-wide tests are used to compare an average (for normal distributions)/median (for non-parametric distributions) site concentration to an average/median background concentration. Individual comparison tests are used to compare individual site concentrations to a representative background concentration. Site-wide comparisons are generally the preferred method of comparison. If site-wide comparisons cannot be used, then the alternative is to use individual comparison tests.

Site-wide comparison tests require that the site and background media data sets being compared meet certain general assumptions. General requirements are that a specific minimum number of samples be included in the site and background data sets so that there is sufficient confidence in the test conclusions. A sample size calculation will be conducted prior to usage to ensure the desired level of confidence is reached. The sample size determination will be in accordance with the project data quality objectives, Navy guidance, or other appropriate methods. Enough site data are to be collected to evaluate the null hypothesis that site conditions are not representative of background conditions against the alternative hypothesis that site conditions are representative of background, with alpha and beta error levels of 0.05, and a minimum detectable difference of two background standard deviations. If enough site data to meet the criterion for site-wide comparisons cannot be obtained, the alternative is to perform a separate comparison of each site sample to background using individual comparison tests.

U.S. EPA's ProUCL, Version 4.1.1, calculates multiple background values and accounts for non-detected concentrations. One of the background threshold values calculated by ProUCL is a 95-percent UTL.

UTLs were established for each metal based on the null hypothesis that individual site concentrations are within the background concentration range. For individual comparisons, concentrations of each metal from each site sample are compared to a UTL for that metal that represents a statistically derived upper limit on the average background concentration. Table 4-1 presents the 95-percent UTLs for groundwater from the Pennsylvanian aquifer at NSA Crane. (The data input for ProUCL used to calculate the UTLs is provided in Appendix E.)

TABLE 4-1

SUMMARY STATISTICS
BASEWIDE PENNSYLVANIAN BEDROCK BACKGROUND GROUNDWATER EVALUATION
NSA CRANE, INDIANA

PARAMETER[1]	FOD	RANGE OF DETECTION LIMITS	MINIMUM DETECTED CONCENTRATION	MAXIMUM DETECTED CONCENTRATION	MEAN[3]	STANDARD DEVIATION[3]	DATA DISTRIBUTION[2]	UTL[4,5]
ALUMINUM	19/28	8.3 - 200	28.5	8,500	1192	2220	Log-Normal	6,183
ANTIMONY	1/28	0.02 - 4	2.9	2.9	NA[5]	NA[5]	Assumed Nonparametric	NA [6]
ARSENIC	12/29	0.16 - 3.2	0.66	15.2	2	3.2	Assumed Nonparametric	9.1
BARIUM	27/29	12.8 - 15.6	13.2	97.5	41.3	24.9	Log-Normal	96.9
BERYLLIUM	6/28	0.02 - 1.8	0.1	3.01	0.40	0.70	Assumed Nonparametric	2.0 [7]
CADMIUM	3/29	0.039 - 1	0.08	0.9	0.14	0.19	Assumed Nonparametric	0.55 [7]
CALCIUM	28/28	NA	7,190	216,000	39300	58500	Log-Normal	216,000
CHROMIUM	9/29	0.17 - 5	0.58	26.2	2.7	5.3	Assumed Nonparametric	14.6 [7]
COBALT	21/28	1 - 3	2	64.4	21.7	19.5	Nonparametric	65.5
COPPER	17/28	0.12 - 2.1	0.67	21.6	3.4	5	Log-Normal	14.6
IRON	25/28	61.7 - 344	12.7	41,800	7070	12200	Log-Normal	34,500
LEAD	4/29	0.157 - 2.5	0.54	15.5	1.5	3.4	Assumed Nonparametric	9.0 [7]
MAGNESIUM	28/28	NA	2,950	229,000	19400	53700	Log-Normal	229,000
MANGANESE	27/28	566 - 566	6.89	5940	1200	1460	Log-Normal	4,470
MERCURY	2/29	0.007 - 0.2	0.16	0.39	0.17	0.04	Assumed Nonparametric	NA [6]
NICKEL	24/28	10 - 10	1.56	131	44.6	40.4	Log-Normal	135
POTASSIUM	22/28	3,390 - 5,000	403	5,380	2690	1670	Nonparametric	6,450
SELENIUM	7/29	0.04 - 2.5	0.33	4.1	0.70	0.91	Assumed Nonparametric	2.7 [7]
SILVER	0/29	0.028 - 3	NA	NA	NA	NA	Assumed Nonparametric	NA [6]
SODIUM	28/28	NA	10,100	165,000	45800	46900	Log-Normal	165,000
THALLIUM	1/28	0.04 - 5	0.08	0.08	NA[5]	NA[5]	Assumed Nonparametric	NA [6]
TIN	0/24	0.048 - 190	NA	NA	NA	NA	Assumed Nonparametric	NA [6]
VANADIUM	5/28	0.06 - 3	2.1	17.9	3.4	3.6	Assumed Nonparametric	11.4 [7]
ZINC	23/28	1.1 - 10	2.16	161	41.2	44.2	Log-Normal	140

NOTES
(1) Results for total metals (i.e., unfiltered samples)in micrograms per liter (µg/L).
(2) Data distribution determined using Shaprio Wilk Test with a 5-percent significance level.
(3) When non-detects are present the Kaplain-Meier mean and standard deviation are presented. The geometric mean is presented if the data are all detect and follow a log-normal distribution. 'Otherwise the arithmetic mean and standard deviation are presented.
(4) UTLs are presented using three significant figures if the value is greater than 10; otherwise, two significant figures are presented.
(5) UTLs were calculated using ProUCL, Version 4.1.1. For assumed nonparametric, the 95-percent KM UTL is presented.
(6) There is two or less detected concentrations. Computing sumary statistics is not approporiate.
(7) ProUCL warns that there may not be enough detected concentrations for the calculations to be reliable enough to draw conclusions.

Rationale for UTL Selected from ProUCL Output
If all data detected and data distribution are not Normal, use Nonparamtric 95-percent UTL with 95-percent Coverage.
If any data are non-detect, use 95-percent Kaplain Meier UTL with 95-percent Coverage.

FOD = Frequency of detection.
KM = Kaplan-Meier.
UTL = Upper tolerance limit.
NA = Not applicable.

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APPENDIX A

1989 INDIANA GEOLOGICAL SURVEY

STUDY INFORMATION

APPENDIX A-1

PAGES FROM APPENDIX A

FROM

1989 INDIANA GEOLOGICAL SURVEY STUDY

(HIGHLIGHTING ADDED;

INDICATES PENNSYLVANIAN-AGE BEDROCK WELL)

Appendix A: Water Chemistry in Region 3 (Odon-Elnora Area)

Well ID	Date	Temp Thrmometr	DO	TEMP Thrmistr	SpC	pH	Eh Zobell	Eh Sample	Alkalinity	HCO3-	CO3=
	UNITS:	°C	mg/L	°C	1 µmho		mV	mV	eq CaCO3	ppm	ppm
	DET LIM:		.1		(25 °C)						
	PRECISION:	±0.1	±.1	±0.1		±.01	±1	±1	±0.1%		
105	08-Aug-88	15.0	0.58	15.5	910	8.37	152	90	509	573	24
106	08-Aug-88	15.6	0.50	16.3	2916	8.89	148	-31	1204	1440	14
107	08-Aug-88	15.7	0.59	16.3	532	8.10	144	-135	297	362	0
108	09-Aug-88	15.5	1.18	16.0	1174	8.93	153	133	657	764	18
109	09-Aug-88	14.9	0.63	15.4	726	7.88	150	-188	407	497	0
110	09-Aug-88	15.4	0.86	15.9	491	8.04	141	-182	267	326	0
111	09-Aug-88	16.0	7.90	16.5	266	6.65	145	191	23	29	0
112	09-Aug-88	17.6	2.50	18.4	561	7.80	143	88	302	369	0
113	09-Aug-88	14.9	0.61	15.4	482	8.24	140	-258	269	325	1
114	10-Aug-88	15.5	0.42	16.0	601	8.02	156	-168	312	369	6
115	10-Aug-88	15.4	0.49	16.1	2401	8.39	155	-36	1331	1600	12
116	10-Aug-88	16.0	0.52	16.6	1501	9.18	151	-154	708	798	32
117	10-Aug-88	16.0	0.49	16.7	495	7.55	146	-283	270	329	0
118	10-Aug-88	15.1	0.65	15.6	562	8.50	138	128	318	380	4
119	10-Aug-88	15.0	3.81	15.5	443	6.67	137	275	128	156	0
120	11-Aug-88	15.5	0.43	15.9	837	8.64	153	-233	484	575	8
121	11-Aug-88	16.4	0.87	16.9	1066	9.18	148	72	585	660	26
122	11-Aug-88	15.4	4.4	15.8	552	7.26	142	-110	293	357	0
123	11-Aug-88	16.0	0.74	16.9	609	8.23	135	156	327	391	4
124	14-Aug-88	15.9	0.49	16.5	339	6.99	150	-146	190	232	0
125	14-Aug-88	15.9	0.44	16.4	725	8.33	143	-252	404	493	0
126	15-Aug-88	16.1	0.11	16.6	1268	9.17	153	-328	651	739	27
127	15-Aug-88	16.2	0.59	16.8	640	6.43	144	-71	138	169	0
128	15-Aug-88	16.0	0.45	16.6	395	7.51	132	-146	210	256	0
129	15-Aug-88	15.9	0.61	16.6	536	7.30	125	-89	304	371	0
130	15-Aug-88	16.8	0.4	17.4	652	7.44	128	106	376	459	0
131	16-Aug-88	15.8	6.85	16.3	169	6.08	146	211	74	11	0
132	16-Aug-88	17.8	0.47	18.4	1229	9.29	134	75	609	618	61
133	16-Aug-88	16.0	0.41	16.6	1248	9.33	128	54	692	833	6
134	16-Aug-88	15.7	0.49	16.3	733	8.42	127	78	468	571	0
135	16-Aug-88	16.4	0.39	16.9	605	7.34	122	-190	336	397	7
136	16-Aug-88	15.8	4	16.3	776	8.39	126	126	429	524	0
137	17-Aug-88	16.5	0.39	16.9	480	7.24	168	-31	273	333	0
138	17-Aug-88	15.3	0.42	15.8	500	7.48	154	-128	263	321	0
139	17-Aug-88	15.5	0.51	15.9	482	7.36	158	-167	217	265	0
140	17-Aug-88	15.0	3.82	15.5	492	7.14	145	237	228	278	0
141	17-Aug-88	16.2	0.4	16.7	935	9.00	145	-75	519	593	20
142	13-Sep-88	14.9	0.49	15.3	150	6.34	183	-10	82	100	0
143	13-Sep-88	14.8	0.50	15.2	409	6.94	174	-120	223	272	0
144	13-Sep-88	16.4	6.90	16.8	300	5.80	172	273	48	59	0
145	13-Sep-88	16.2	0.30	16.6	1202	7.41	170	-207	389	475	0
146	13-Sep-88	15.3	0.31	15.7	905	7.14	170	-90	298	363	0
147	13-Sep-88	15.4	0.28	15.7	1004	7.19	173	-189	261	319	0
148	13-Sep-88	15.6	0.21	15.3	750	8.13	174	-154	416	506	1
149	14-Sep-88	15.7	0.32	16.2	3660	8.60	183	33	1057	1251	19
150	14-Sep-88	16.4	0.17	17.0	1501	8.63	175	-223	470	559	7
151	14-Sep-88	15.6	0.30	15.9	713	8.40	172	-282	409	484	7

Appendix A: Water Chemistry in Region 3 (Odon-Elnora Area)

Well ID	Date	Temp Thrmometr	DO	TEMP Thrmistr	SpC	pH	Eh Zobell	Eh Sample	Alkalinity	HCO3-	CO3=
	UNITS:	°C	mg/L	°C	1 µmho		mV	mV	eq CaCO3	ppm	ppm
	DET LIM:		.1		(25 °C)						
	PRECISION:	±0.1	±.1	±0.1		±.01	±1	±1	±0.1%		
152	14-Sep-88	15.6	0.29	16.0	563	7.10	174	-158	312	381	0
153	14-Sep-88	14.6	0.53	15.0	515	7.38	174	-148	225	275	0
154	14-Sep-88	15.6	0.17	15.9	547	7.03	174	-147	300	366	0
155	14-Sep-88	15.6	0.40	15.9	2248	8.12	176	-260	624	762	0
156	18-Sep-88	16.2	8.21	16.6	568	6.91	186	249	282	344	0
157	18-Sep-88	14.8	0.28	15.1	623	7.34	184	-152	343	419	0
158	20-Sep-88	15.6	0.51	16.0	480	6.96	183	-78	265	323	0
159	20-Sep-88	15.8	0.42	16.1	507	7.14	174	-83	275	335	0
160	20-Sep-88	16.3	3.08	16.6	608	7.67	172	152	335	409	0
161	20-Sep-88	14.9	0.62	15.2	439	6.88	172	141	245	299	0
162	20-Sep-88	15.4	0.22	15.8	425	6.97	176	-115	238	290	0
163	21-Sep-88	14.9	0.19	15.2	407	7.14	191	-126	240	293	0
164	21-Sep-88	16.6	0.2	16.9	894	7.67	187	-208	392	479	0
165	21-Sep-88	16.3	0.19	16.5	458	7.14	187	-141	213	260	0
166	21-Sep-88	14.6	0.21	14.9	1090	7.58	179	-85	427	521	0
167	21-Sep-88	14.8	2.86	15.1	422	6.62	178	216	162	198	0
168	21-Sep-88	15.0	8.11	15.4	307	5.99	176	254	49	60	0
	MEAN	15.7	1.34	16.2	797	7.67	158	-47	370	440	5
	STD DEV	0.6	2.08	0.7	614	0.86	19	162	242	285	11
	MAX	17.8	8.21	18.4	3660	9.33	191	275	1331	1600	61
	MIN	14.6	0.11	14.9	150	5.80	122	-328	23	11	0

Appendix A: Water Chemistry in Region 3 (Odon-Elnora Area)

Well ID	Cl-	NO3-	SO4-	F-	Ca	Mg	K	Na	Fe	Zn	Pb	Sr	Ba
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppb	ppb	ppb	ppm	ppm
	1	1	1	.1	.02	.02	.03	.09	3	2	2	.06	.04
105	5	3	<1	2.7	0.964	0.282	5.208	275.3	15	5	5	0.018	0.057
106	25	4	<1	7.6	1.911	1.012	12.43	688.2	26	51	8	0.185	0.121
107	1	<1	12	0.7	10.37	3.038	6.319	116.8	35	<2	3	0.165	0.110
108	13	<1	<1	5.5	3.051	1.353	2.902	331.6	<3	10	<2	0.035	0.038
109	3	18	<1	2.3	6.697	3.718	4.510	187.2	434	363	4	0.144	0.428
110	2	<1	8	0.1	7.887	1.880	3.147	104.8	284	<2	2	0.071	0.156
111	64	76	6	0.1	17.42	7.539	1.433	38.11	37	30	6	0.030	0.060
112	5	1	15	0.2	73.65	19.63	0.419	5.231	21	5	3	0.078	0.034
113	2	<1	<1	1.3	8.898	2.364	1.713	102.5	243	89	3	0.040	0.084
114	2	<1	20	0.8	13.05	3.091	2.972	126.9	95	25	2	0.119	0.080
115	59	<1	<1	4.8	2.373	0.889	5.524	574.3	29	<2	<2	0.139	0.195
116	25	<1	<1	6.0	1.393	0.411	3.042	398.2	16	<2	<2	0.036	0.055
117	2	37	<1	0.5	42.55	13.63	1.748	37.93	1315	108	<2	0.218	0.159
118	2	<1	10	1.2	5.337	1.351	2.517	137.6	14	52	2	0.064	0.138
119	20	41	35	0.2	48.30	1.304	1.224	18.44	7	9	<2	0.084	0.033
120	9	<1	5	1.7	3.923	1.298	2.902	246.6	35	<2	<2	0.083	0.145
121	12	<1	4	3.1	0.269	0.107	2.238	340.0	<3	30	<2	0.015	0.019
122	6	<1	3	0.8	39.53	19.17	3.497	40.26	183	244	<2	0.406	0.613
123	6	<1	13	0.5	12.77	4.595	2.273	129.7	4	69	<2	0.081	0.149
124	2	<1	<1	0.6	13.84	5.792	2.797	46.51	2543	415	<2	0.106	0.210
125	4	<1	<1	1.6	6.352	2.242	2.587	176.2	36	75	<2	0.075	0.069
126	44	<1	<1	3.2	0.773	0.227	2.727	388.9	80	<2	3	0.028	0.052
127	6	<1	177	0.1	59.69	15.05	3.147	37.73	2884	53	6	0.150	0.019
128	1	<1	2	0.8	8.513	4.451	2.657	59.82	40	<2	<2	0.137	0.100
129	1	<1	<1	0.9	37.30	22.01	3.951	34.61	82	17	2	0.488	0.713
130	21	<1	<1	1.0	7.420	2.517	3.636	170.6	13	199	<2	0.080	0.106
131	38	36	<1	0.1	21.73	9.998	1.223	22.17	8	31	<2	0.036	0.049
132	34	<1	<1	2.5	1.071	0.477	2.552	358.3	9	3	<2	0.031	0.034
133	9	<1	<1	3.6	0.774	0.286	2.552	360.9	24	<2	<2	0.031	0.028
134	29	<1	<1	1.5	4.696	1.319	3.811	236.0	21	18	5	0.110	0.067
135	2	<1	<1	0.9	60.91	26.91	2.483	19.92	381	<2	<2	0.609	0.812
136	3	<1	2	1.6	3.754	2.692	2.797	189.2	<3	63	<2	0.090	0.076
137	1	<1	<1	0.5	54.51	17.03	1.532	14.81	102	24	2	0.291	0.844
138	1	<1	<1	0.2	53.83	18.74	0.847	9.751	270	158	<2	0.170	0.259
139	1	<1	<1	0.3	53.71	18.14	1.452	10.83	1661	423	<2	0.251	0.403
140	5	12	32	0.7	65.05	21.67	1.230	1.724	<3	7	<2	0.855	0.092
141	3	<1	<1	2.4	1.103	0.357	2.822	250.2	34	16	<2	0.027	0.032
142	2	<1	2	0.1	12.58	5.683	0.870	13.70	2740	11	<2	0.065	0.073
143	9	<1	32	0.2	59.08	21.92	0.620	9.637	3445	6	<2	0.458	0.519
144	15	68	50	<0.1	28.00	12.61	1.351	32.22	49	13	<2	0.046	0.054
145	215	<1	37	0.6	57.64	20.46	3.736	285.4	4156	230	<2	0.516	0.591
146	86	<1	6	0.4	56.35	23.82	3.625	96.15	424	<2	<2	0.158	0.178
147	210	<1	60	0.4	71.06	35.43	4.875	183.9	6456	645	<2	0.281	0.331
148	26	<1	11	0.9	8.129	3.025	3.226	189.4	128	16	<2	0.111	0.137
149	484	<1	98	7.3	4.054	3.551	5.457	791.9	41	22	<2	0.075	0.087
150	184	<1	5	1.3	20.96	9.158	3.123	344.0	43	66	6	0.448	0.518
151	19	<1	2	1.2	12.54	6.162	2.058	178.1	199	9	<2	0.169	0.194

Appendix A: Water Chemistry in Region 3 (Odon-Elnora Area)

Well ID	Cl-	NO3-	SO4-	F-	Ca	Mg	K	Na	Fe	Zn	Pb	Sr	Ba
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppb	ppb	ppb	ppm	ppm
	1	1	1	.1	.02	.02	.03	.09	3	2	2	.06	.04
152	2	<1	<1	0.3	51.51	19.97	1.933	41.69	1746	329	<2	0.183	0.212
153	2	<1	6	0.6	54.34	22.24	1.862	39.81	1009	9	7	0.168	0.173
154	11	<1	<1	0.4	41.41	11.95	2.289	41.70	2031	160	<2	0.159	0.166
155	318	<1	18	2.8	38.59	15.46	3.346	562.5	676	16	<2	0.251	0.261
156	12	31	27	0.2	89.05	31.49	1.212	4.474	15	3	<2	0.454	0.025
157	6	<1	<1	1.3	29.03	14.64	3.168	97.08	471	<2	<2	0.836	0.979
158	2	<1	2	0.7	39.44	21.91	3.067	25.07	430	27	<2	0.513	0.255
159	1	<1	<1	0.7	49.49	0.729	2.663	24.14	272	<2	<2	0.676	0.462
160	2	<1	3	1.6	12.57	8.323	3.823	118.8	32	193	<2	0.297	0.148
161	1	<1	7	0.5	54.36	24.81	1.586	9.906	33	289	<2	0.316	0.372
162	1	<1	4	0.4	49.36	22.57	1.308	10.00	880	23	<2	0.224	0.349
163	1	<1	<1	0.4	43.99	17.30	1.509	31.13	1170	595	<2	0.209	0.641
164	60	<1	<1	2.4	28.47	12.11	3.644	175.8	1160	346	<2	0.636	0.570
165	10	<1	26	0.1	57.60	22.89	1.154	2.739	5278	231	<2	0.139	0.052
166	106	<1	21	2.1	30.86	9.834	2.812	247.7	158	4	3	0.260	0.486
167	10	35	12	0.3	45.73	16.96	0.889	11.31	7	91	<2	0.157	0.037
168	11	65	32	0.1	27.99	10.38	0.928	5.928	14	77	<2	0.070	0.021
	36	7	13	1.4	28.59	10.66	2.765	154.1	688	94	<2	0.210	0.227
	81	17	27	1.7	23.73	9.291	1.754	174.3	1303	146	2	0.200	0.232
	484	76	177	7.6	89.05	35.43	12.43	791.9	6456	645	8	0.855	0.979
	1	<1	<1	<0.1	0.269	0.107	0.419	1.724	<3	<2	<2	0.015	0.019

Appendix A: Water Chemistry in Region 3 (Odon-Elnora Area)

Well ID	Mn	Cr	Cd	As	Hg	Ag	Se	ANION SUM	CATION SUM	EPM BALANCE	TDS	HARDNESS	TDS/SpC RATIO
	ppb	ppb	ppb	ppb	ppb	ppb	ppb	meq/L	meq/L	%	ppm	ppm	
	3	2	2	2	0.5	1	2						
								±1%	±1%				
105	3	<2	<2	<2	<.5	<1	<2	10.5	12.2	7.4	889	4	1.0
106	6	<2	<2	<2	<.5	<1	<2	25.2	30.4	9.3	2194	9	0.8
107	6	<2	<2	<2	<.5	<1	<2	6.3	6.0	-1.9	513	38	1.0
108	6	<2	<2	<2	<.5	<1	<2	13.8	14.8	3.4	1140	13	1.0
109	24	<2	<2	<2	<.5	<1	<2	8.7	8.9	1.7	724	32	1.0
110	15	<2	<2	<2	<.5	<1	<2	5.6	5.2	-3.3	454	27	0.9
111	7	<2	<2	2	<.5	<1	<2	3.6	3.2	-6.7	242	74	0.9
112	47	<2	<2	2	<.5	<1	<2	6.5	5.5	-8.3	492	265	0.9
113	22	<2	<2	2	<.5	<1	<2	5.5	5.2	-3.1	447	32	0.9
114	21	<2	<2	<2	<.5	<1	<2	6.8	6.5	-1.8	544	45	0.9
115	7	<2	<2	<2	<.5	<1	<2	28.5	25.3	-5.9	2259	10	0.9
116	7	<2	<2	<2	<.5	<1	<2	15.2	17.5	7.1	1264	5	0.8
117	47	<2	<2	21	<.5	<1	<2	6.1	5.0	-9.5	487	162	1.0
118	26	<2	<2	<2	<.5	<1	<2	6.7	6.4	-2.1	545	19	1.0
119	22	<2	<2	2	<.5	<1	<2	4.5	3.4	-14.8	324	126	0.7
120	10	<2	<2	<2	<.5	<1	<2	10.1	11.1	4.6	854	15	1.0
121	10	<2	<2	<2	<.5	<1	<2	12.3	14.9	9.5	1049	1	1.0
122	63	<2	4	<2	<.5	<1	<2	6.1	5.4	-6.1	471	177	0.9
123	26	<2	<2	<2	<.5	<1	<2	7.0	6.7	-2.0	564	51	0.9
124	114	<2	<2	<2	<.5	<1	<2	3.9	3.4	-6.4	307	58	0.9
125	62	<2	<2	<2	<.5	<1	<2	8.3	8.2	-0.3	687	25	0.9
126	26	<2	<2	<2	<.5	<1	<2	14.4	17.1	8.3	1206	3	1.0
127	395	<2	<2	<2	<.5	<1	<2	6.6	6.1	-4.1	471	211	0.7
128	44	<2	<2	25	<.5	<1	<2	4.3	3.5	-10.9	361	40	0.9
129	47	<2	<2	<2	<.5	<1	<2	6.2	5.3	-7.4	472	183	0.9
130	37	<2	<2	<2	<.5	<1	<2	8.2	8.1	-0.5	666	29	1.0
131	3	<2	<2	4	<.5	<1	<2	3.1	2.9	-3.9	183	95	1.1
132	3	3	<2	<2	<.5	<1	<2	13.3	15.7	8.5	1079	5	0.9
133	7	5	<2	<2	<.5	<1	<2	14.3	15.8	5.1	1216	3	1.0
134	9	3	<2	<2	<.5	<1	<2	10.3	10.7	2.2	848	17	1.2
135	20	<2	<2	5	<.5	<1	<2	6.8	6.2	-4.7	524	263	0.9
136	<3	3	<2	<2	<.5	<1	<2	8.8	8.7	-0.4	729	20	0.9
137	<3	2	<2	<2	<.5	<1	<2	5.5	4.8	-6.6	424	206	0.9
138	<3	2	<2	2	<.5	<1	<2	5.3	4.7	-6.0	408	211	0.8
139	<3	3	<2	2	<.5	<1	<2	4.4	4.8	4.5	355	209	0.7
140	<3	4	<2	<2	<.5	<1	<2	5.6	5.2	-4.3	419	251	0.9
141	<3	5	<2	2	<.5	<1	<2	10.6	11.0	2.0	875	4	0.9
142	170	<2	<2	5	<.5	<1	<2	1.8	1.9	3.3	145	55	1.0
143	205	<2	<2	12	<.5	<1	<2	5.4	5.4	0.1	421	238	1.0
144	5	<2	<2	5	<.5	<1	<2	3.5	3.9	4.4	272	122	0.9
145	62	<2	<2	4	<.5	<1	<2	14.7	17.3	8.3	1105	228	0.9
146	78	<2	<2	2	<.5	<1	<2	8.5	9.1	3.1	638	239	0.7
147	100	<2	<2	5	<.5	<1	<2	12.4	15.0	9.3	897	323	0.9
148	3	4	<2	<2	<.5	<1	<2	9.3	9.0	-1.9	749	33	1.0
149	3	4	2	3	<.5	<1	23	37.2	35.1	-3.0	2691	25	0.7
150	11	3	2	5	<.5	<1	<2	14.8	16.9	6.6	1140	90	0.7
151	9	<2	<2	4	0.5	<1	<2	8.8	9.0	0.8	717	57	1.0

Appendix A: Water Chemistry in Region 3 (Odon-Elnora Area)

Well ID	Mn	Cr	Cd	As	Hg	Ag	Se	ANION SUM	CATION SUM	EPM BALANCE	TDS	HARDNESS	TDS/SpC RATIO
	ppb	ppb	ppb	ppb	ppb	ppb	ppb	meq/L	meq/L	%	ppm	ppm	
	3	2	2	2	Ø.5	1	2						
								±1%	±1%				
152	48	<2	<2	4	<.5	<1	<2	6.3	6.2	-1.Ø	5Ø5	211	Ø.9
153	63	<2	<2	7	<.5	<1	<2	4.7	6.4	15.Ø	41Ø	227	Ø.8
154	76	<2	<2	<2	<.5	<1	<2	6.3	5.Ø	-11.3	477	153	Ø.9
155	47	<2	<2	4	<.5	<1	<2	22.Ø	27.8	11.7	1726	16Ø	Ø.8
156	21	<2	<2	<2	<.5	<1	<2	7.Ø	7.3	1.7	54Ø	352	1.Ø
157	72	<2	<2	3Ø	<.5	<1	<2	7.1	7.Ø	-Ø.6	6Ø2	133	1.Ø
158	96	<2	<2	<2	<.5	<1	<2	5.4	5.Ø	-4.4	419	188	Ø.9
159	115	<2	<2	<2	<.5	<1	<2	5.6	3.7	-2Ø.2	415	127	Ø.8
16Ø	26	<2	<2	<2	<.5	<1	<2	6.9	6.6	-2.3	559	66	Ø.9
161	141	<2	<2	<2	<.5	<1	<2	5.1	5.3	1.5	399	238	Ø.9
162	257	<2	<2	<2	<.5	<1	<2	4.9	4.9	-Ø.4	381	216	Ø.9
163	69	<2	<2	<2	<.5	<1	<2	4.9	5.1	2.5	391	181	1.Ø
164	27	<2	<2	8	<.5	<1	<2	9.7	1Ø.3	2.9	772	121	Ø.9
165	231	<2	<2	3	<.5	<1	<2	5.1	5.2	1.Ø	39Ø	238	Ø.9
166	25	<2	<2	2	<.5	<1	<2	12.1	13.2	4.6	943	117	Ø.9
167	4	<2	2	<2	<.5	<1	<2	4.3	4.2	-1.6	33Ø	184	Ø.8
168	4	<2	<2	<2	<.5	<1	<2	3.Ø	2.5	-8.3	213	113	Ø.7
	49	<2	<2	3	<.5	NA	<2	8.8	9.1	-Ø.4	7Ø2	115	
	71	1	1	6	Ø	NA	3	6.1	6.8	6.5	485	95	
	395	5	4	3Ø	1	NA	23	37.2	35.1	15.Ø	2691	352	
	<3	<2	<2	Ø	<.5	NA	<2	1.8	1.9	-2Ø.2	145	1	

Appendix a: Water Chemistry in Region 3 (Linton Area)

Well ID	Date	Temp Thrmometr	DO	TEMP Thrmistr	SpC	pH	Eh Zobell	Eh Sample	Alkalinity	HCO3-	CO3=
	UNITS:	°C	mg/L	°C	1 µmho		mV	mV	eq CaCO3	ppm	ppm
	DET LIM:		.1		(25 °C)						
	PRECISION:	±Ø.1	±.1	±Ø.1		±.Ø1	±1	±1	±Ø.1%		
169	26-Sep-88	15.7	Ø.22	16.1	3418	8.12	183	-178	1147	137Ø	15
17Ø	26-Sep-88	15.3	Ø.19	15.6	3112	8.34	18Ø	12Ø	1Ø47	1251	13
171	26-Sep-88	15.4	Ø.32	15.8	1387	7.92	176	-171	317	387	Ø
172	26-Sep-88	15.9	Ø.5Ø	16.3	7Ø6	7.22	177	132	391	477	Ø
173	26-Sep-88	15.6	Ø.2Ø	16.Ø	82Ø	8.37	179	-116	471	56Ø	7
174	26-Sep-88	15.7	Ø.39	16.Ø	5915	7.96	179	-159	1382	1686	Ø
MEAN		15.5	1.42	15.9	2238	7.7Ø	179	-17	686	827	5
STD DEV		Ø.3	2.73	Ø.3	187Ø	Ø.78	2	166	463	559	6
MAX		15.9	8.11	16.3	5915	8.37	183	254	1382	1686	15
MIN		15.Ø	Ø.19	15.4	3Ø7	5.99	176	-178	49	6Ø	Ø

Appendix a: Water Chemistry in Region 3 (Linton Area)

Well ID	Cl-	NO3-	SO4-	F-	Ca	Mg	K	Na	Fe	Zn	Pb	Sr	Ba
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppb	ppb	ppb	ppm	ppm
	1	1	1	.1	.02	.02	.03	.09	3	2	2	.06	.04
169	545	3	<1	7.6	8.016	3.380	6.356	259.9	131	130	6	1.293	0.644
170	508	<1	5	6.3	5.591	2.926	5.844	900.7	32	24	6	0.850	0.495
171	3	<1	401	0.3	25.99	19.27	4.414	326.9	368	8	11	0.997	0.043
172	3	2	20	0.3	44.30	18.75	9.161	101.6	61	20	<2	1.822	1.439
173	4	<1	1	0.5	2.063	0.649	1.443	216.2	112	16	<2	0.034	0.099
174	1293	5	<1	4.4	16.60	6.348	9.197	2187	162	235	5	2.407	4.295
MEAN	338	11	66	2.8	18.65	8.815	5.335	571.2	126	73	4	1.068	1.005
STD DEV	451	22	137	3.0	13.95	7.045	3.077	711.3	111	78	4	0.804	1.420
MAX	1293	65	401	7.6	44.30	19.27	9.197	2187	368	235	11	2.407	4.295
MIN	3	<1	<1	0.1	2.063	0.649	0.928	5.928	14	8	0	0.034	0.021

Appendix a: Water Chemistry in Region 3 (Linton Area)

Well ID	Mn	Cr	Cd	As	Hg	Ag	Se	ANION SUM	CATION SUM	EPM BALANCE	TDS	HARDNESS	TDS/SpC RATIO
	ppb 3	ppb 2	ppb 2	ppb 2	ppb Ø.5	ppb 1	ppb 2	meq/L ±1%	meq/L ±1%	%	ppm	ppm	
169	12	<2	2	4	<.5	<1	<2	38.8	12.2	-52.2	2225	34	Ø.7
17Ø	3	<2	<2	5	<.5	<1	<2	35.7	39.9	5.5	27Ø5	26	Ø.9
171	33	<2	3	55	<.5	<1	<2	14.8	17.3	7.7	1224	144	Ø.9
172	35	<2	<2	<2	<.5	2	<2	8.4	8.5	Ø.6	681	188	1.Ø
173	17	<2	<2	<2	<.5	<1	<2	9.6	9.6	Ø.Ø	794	8	1.Ø
174	9	<2	5	<2	<.5	<1	52	64.4	96.9	2Ø.1	5267	68	Ø.9
MEAN	16	NA	1	9	NA	<1	7	25.Ø	26.7	-3.8	1873	83	Ø.8
STD DEV	12	NA	2	19	NA	1	18	2Ø.6	3Ø.7	21.3	16Ø8	62	Ø.1
MAX	35	NA	5	55	NA	2	52	64.4	96.9	2Ø.1	5267	188	1.Ø
MIN	3	NA	<2	<2	NA	<1	<2	3.Ø	2.5	-52.2	213	8	Ø.7

Appendix A: Water Chemistry in Region 3 (Epsom Area)

Well ID	Date	Temp Thrmometr	DO	TEMP Thrmistr	SpC	pH	Eh Zobell	Eh Sample	Alkalinity	HCO3-	CO3=
	UNITS:	°C	mg/L	°C	1 µmho		mV	mV	eq CaCO3	ppm	ppm
	DET LIM:		.1		(25 °C)						
	PRECISION:	±0.1	±.1	±0.1		±.01	±1	±1	±0.1%		
175	28-Sep-88	14.8	0.69	15.1	582	6.82	179	-95	325	396	0
176	28-Sep-88	15.5	0.18	15.8	2378	8.63	177	113	955	1119	23
177	30-Sep-88	15.8	0.22	16.1	1164	8.96	183	136	582	664	23
178	30-Sep-88	16.2	0.26	16.6	3357	8.43	179	117	1107	1324	13
179	30-Sep-88	15.5	0.27	15.8	1888	8.71	179	90	873	1022	22
180	02-Oct-88	16.1	0.23	16.5	4808	7.97	183	-87	1390	1685	6
181	02-Oct-88	15.9	0.58	16.3	674	6.89	183	-54	317	387	0
182	02-Oct-88	15.6	0.30	16.1	3038	8.21	183	109	1106	1320	15
183	02-Oct-88	16.0	0.26	16.4	929	7.57	187	-112	558	678	1
184	03-Oct-88	15.5	0.38	16.0	2999	7.71	193	-146	806	984	0
185	03-Oct-88	17.2	0.34	17.4	940	8.27	188	111	487	576	9
186	03-Oct-88	16.6	0.39	16.9	3436	8.20	187	-238	1259	1512	12
187	03-Oct-88	16.8	0.70	17.1	2147	8.56	185	126	875	1026	21
188	03-Oct-88	15.4	0.30	15.7	1651	8.67	184	135	674	789	16
189	03-Oct-88	16.5	0.34	16.9	6586	7.93	184	-99	1210	1476	0
190	04-Oct-88	15.9	0.34	16.3	1504	8.36	200	-99	745	893	8
191	04-Oct-88	16.4	0.23	16.8	3857	7.84	197	-32	952	1161	0
192	04-Oct-88	14.8	0.52	15.1	1928	8.34	193	-138	848	1023	6
193	04-Oct-88	16.9	0.31	17.4	2884	8.37	188	-138	1370	1632	19
194	04-Oct-88	15.0	0.53	15.3	961	7.83	188	-61	307	375	0
195	04-Oct-88	15.8	0.70	16.1	888	7.42	189	-167	374	456	0
196	05-Oct-88	16.6	0.25	16.9	2402	8.56	200	12	1205	1426	22
197	05-Oct-88	16.3	0.52	16.6	734	7.19	196	-86	354	432	0
198	05-Oct-88	16.5	0.35	16.9	841	8.29	194	-170	449	526	11
199	05-Oct-88	16.4	3.98	16.6	722	8.18	188	149	418	503	3
200	05-Oct-88	15.9	0.20	15.6	916	7.51	190	-110	428	523	0
MEAN		16.0	0.51	16.3	2085	8.05	188	-28	768	920	9
STD DEV		0.6	0.71	0.6	1447	0.55	6	118	348	417	9
MAX		17.2	3.98	17.4	6586	8.96	200	149	1390	1685	23
MIN		14.8	0.18	15.1	582	6.82	177	-238	307	375	0

Appendix A: Water Chemistry in Region 3 (Epsom Area)

Well ID	Cl-	NO3-	SO4-	F-	Ca	Mg	K	Na	Fe	Zn	Pb	Sr	Ba
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppb	ppb	ppb	ppm	ppm
	1	1	1	.1	.02	.02	.03	.09	3	2	2	.06	.04
175	2	<1	1	0.7	46.94	18.69	3.615	45.62	1231	60	<2	0.642	0.963
176	269	<1	<1	8.1	3.234	1.247	3.496	712.1	19	11	<2	0.370	0.233
177	46	<1	<1	4.1	4.024	0.462	1.889	337.5	10	<2	<2	0.090	0.099
178	433	<1	<1	10.7	2.591	2.101	4.844	915.8	6	22	<2	0.694	0.400
179	126	<1	<1	9.5	1.275	0.872	2.901	584.7	20	6	<2	0.246	0.192
180	942	<1	<1	3.3	6.881	4.697	8.017	1307	38	26	3	1.529	0.824
181	2	<1	60	0.4	3.314	3.130	3.258	155.9	175	2	3	0.242	0.123
182	452	<1	<1	2.5	1.245	2.274	4.856	912.3	27	42	3	0.598	0.532
183	20	<1	<1	2.3	0.672	0.391	1.848	290.2	88	22	<2	0.069	0.095
184	515	<1	<1	1.0	8.545	6.680	8.044	792.4	153	102	<2	0.889	0.497
185	<1	<1	14	1.8	1.187	0.689	2.631	219.9	11	67	3	0.068	0.045
186	400	<1	<1	2.8	5.058	2.701	5.516	832.1	82	42	3	0.802	0.242
187	185	<1	<1	4.5	1.301	0.967	2.979	632.4	77	24	<2	0.288	0.084
188	135	<1	1	3.4	2.651	1.216	2.443	450.5	26	29	<2	0.195	0.089
189	1475	3	21	2.9	13.55	13.04	9.631	1381	42	40	15	4.428	2.992
190	102	<1	3	3.5	3.285	1.578	2.728	405.6	35	23	<2	0.250	0.093
191	700	<1	<1	1.5	7.594	4.862	7.080	1017	32	142	3	0.951	0.232
192	195	<1	<1	3.0	2.893	0.885	2.697	621.3	33	74	2	0.256	0.091
193	250	<1	<1	5.3	2.658	1.365	4.467	870.0	29	59	3	0.521	0.152
194	1	<1	204	0.5	1.257	0.474	1.463	217.7	42	324	13	0.097	0.033
195	2	<1	134	0.7	35.30	13.10	2.012	154.4	677	50	6	0.261	0.037
196	158	<1	<1	6.5	2.493	1.229	2.684	723.3	58	35	4	0.333	0.098
197	3	<1	67	0.6	45.32	31.77	10.12	78.75	105	839	4	3.009	0.391
198	32	<1	<1	1.4	3.249	3.057	1.934	213.8	49	62	3	0.205	0.048
199	3	<1	<1	0.9	4.105	2.757	1.467	178.2	12	122	2	0.149	0.040
200	50	<1	14	0.8	11.59	5.979	1.479	202.3	78	21	2	0.230	0.070
MEAN	250	<1	20	3.2	8.547	4.854	4.004	548.1	121	86	3	0.670	0.334
STD DEV	341	1	47	2.8	12.78	6.988	2.512	371.1	256	163	4	0.961	0.582
MAX	1475	3	204	10.7	46.94	31.77	10.12	1381	1231	839	15	4.428	2.992
MIN	<1	<1	<1	0.4	0.672	0.391	1.463	45.62	6	<2	<2	0.068	0.033

Appendix A: Water Chemistry in Region 3 (Epsom Area)

Well ID	Mn	Cr	Cd	As	Hg	Ag	Se	ANION SUM	CATION SUM	EPM BALANCE	TDS	HARDNESS	TDS/SpC RATIO
	ppb 3	ppb 2	ppb 2	ppb 2	ppb Ø.5	ppb 1	ppb 2	meq/L	meq/L	%	ppm	ppm	
								±1%	±1%				
175	126	<2	<2	<2	<.5	<1	<2	6.6	6.1	-4.5	518	194	Ø.9
176	<3	<2	<2	<2	<.5	<1	<2	27.1	31.3	7.2	2140	13	Ø.9
177	7	<2	<2	<2	<.5	<1	<2	13.1	15.Ø	6.5	1Ø8Ø	12	Ø.9
178	<3	<2	<2	<2	<.5	<1	<2	34.9	4Ø.3	7.1	27Ø7	15	Ø.8
179	7	3	<2	<2	<.5	<1	<2	21.5	25.7	8.8	1769	7	Ø.9
18Ø	<3	3	<2	<2	<.5	<1	<2	54.5	57.8	2.9	3965	36	Ø.8
181	17	2	<2	<2	<.5	<1	<2	7.7	7.3	-2.3	615	21	Ø.9
182	5	4	<2	<2	<.5	<1	<2	35.Ø	4Ø.1	6.8	2711	12	Ø.9
183	9	3	<2	<2	<.5	<1	<2	11.8	12.7	3.7	995	3	1.1
184	9	<2	<2	<2	<.5	<1	<2	3Ø.7	35.7	7.5	2317	49	Ø.8
185	5	<2	<2	<2	<.5	<1	<2	1Ø.1	9.8	-1.9	826	6	Ø.9
186	1Ø	<2	<2	3	<.5	<1	<2	36.6	36.8	Ø.3	2776	24	Ø.8
187	7	6	<2	4	<.5	<1	<2	23.Ø	27.7	9.4	1879	7	Ø.9
188	7	3	<2	3	<.5	<1	<2	17.5	19.9	6.5	1405	12	Ø.9
189	1Ø	2	5	16	<.5	<1	<2	66.4	62.2	-3.3	4419	87	Ø.7
19Ø	7	<2	<2	12	<.5	<1	<2	18.Ø	18.Ø	-Ø.1	1435	15	1.Ø
191	<3	<2	<2	14	<.5	<1	<2	38.8	45.2	7.6	2914	39	Ø.8
192	7	<2	<2	<2	<.5	<1	<2	22.6	27.3	9.4	1855	11	1.Ø
193	<3	2	<2	2	<.5	<1	<2	34.7	38.2	4.8	2788	12	1.Ø
194	4	<2	<2	4	<.5	<1	<2	1Ø.4	9.6	-4.1	8Ø6	5	Ø.8
195	7	2	<2	3	<.5	<1	<2	1Ø.3	9.7	-3.5	8Ø1	142	Ø.9
196	6	2	<2	2	<.5	<1	<2	28.9	31.8	4.7	2344	11	1.Ø
197	<3	3	<2	2	<.5	<1	<2	8.6	8.7	Ø.5	675	244	Ø.9
198	18	<2	<2	<2	<.5	<1	<2	1Ø.Ø	9.8	-1.Ø	793	21	Ø.9
199	17	<2	<2	<2	<.5	<1	<2	8.5	8.2	-1.5	697	22	1.Ø
2ØØ	19	<2	<2	2	<.5	<1	<2	1Ø.3	9.9	-1.8	81Ø	53	Ø.9
MEAN	12	1	<2	3	NA	NA	NA	23.Ø	24.8	2.7	1771	41	Ø.9
STD DEV	23	2	1	4	NA	NA	NA	15.Ø	15.9	4.6	1Ø55	59	Ø.1
MAX	126	6	5	16	NA	NA	NA	66.4	62.2	9.4	4419	244	1.1
MIN	<3	<2	<2	<2	NA	NA	NA	6.6	6.1	-4.5	518	3	Ø.7

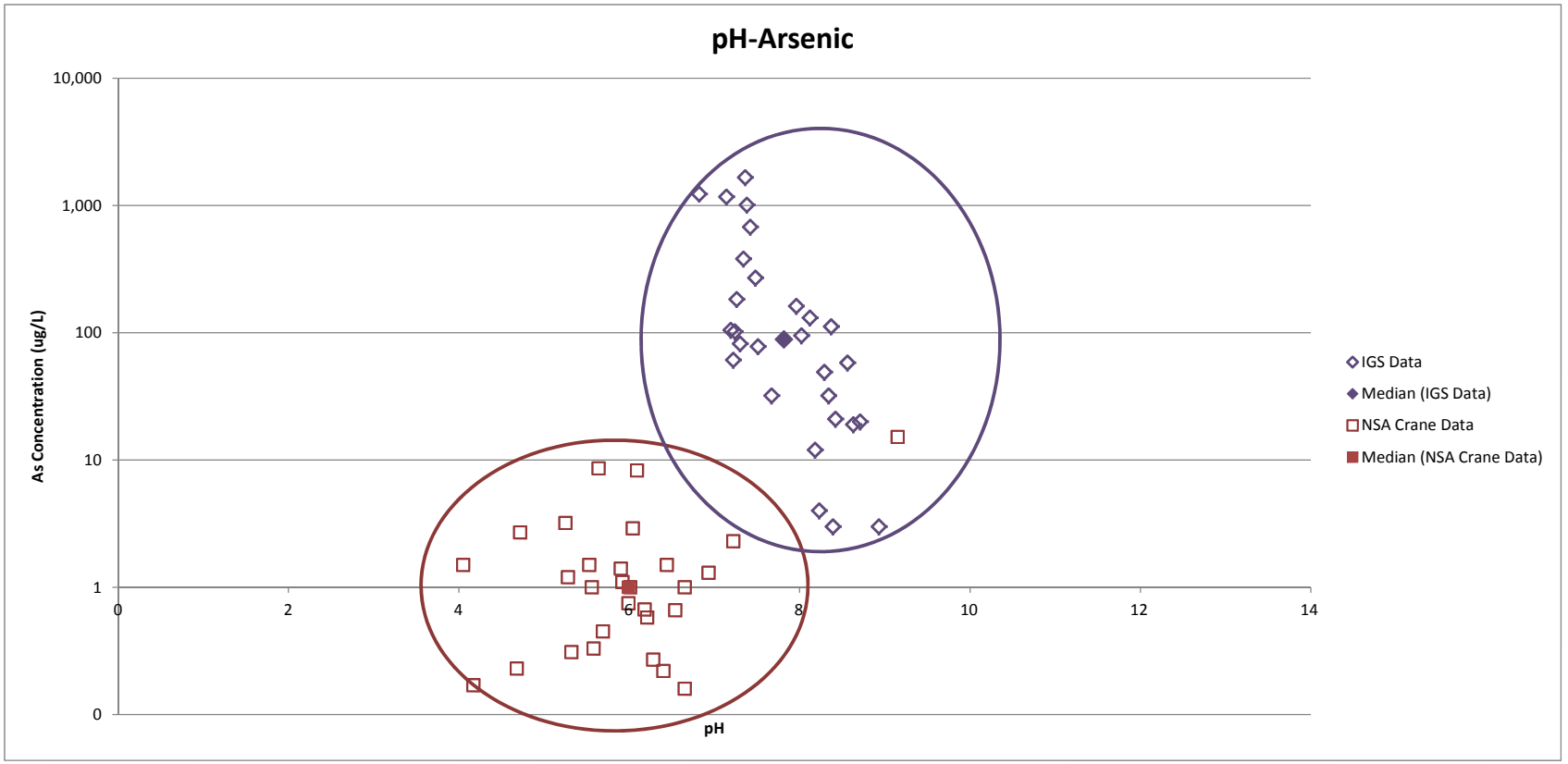
APPENDIX A-2

PLOTS OF

1989 INDIANA GEOLOGICAL SURVEY STUDY DATA SET

TO

NSA CRANE BACKGROUND DATA SET


pH-Arsenic
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1,000
100
10
1
0
As Concentration (ug/L)
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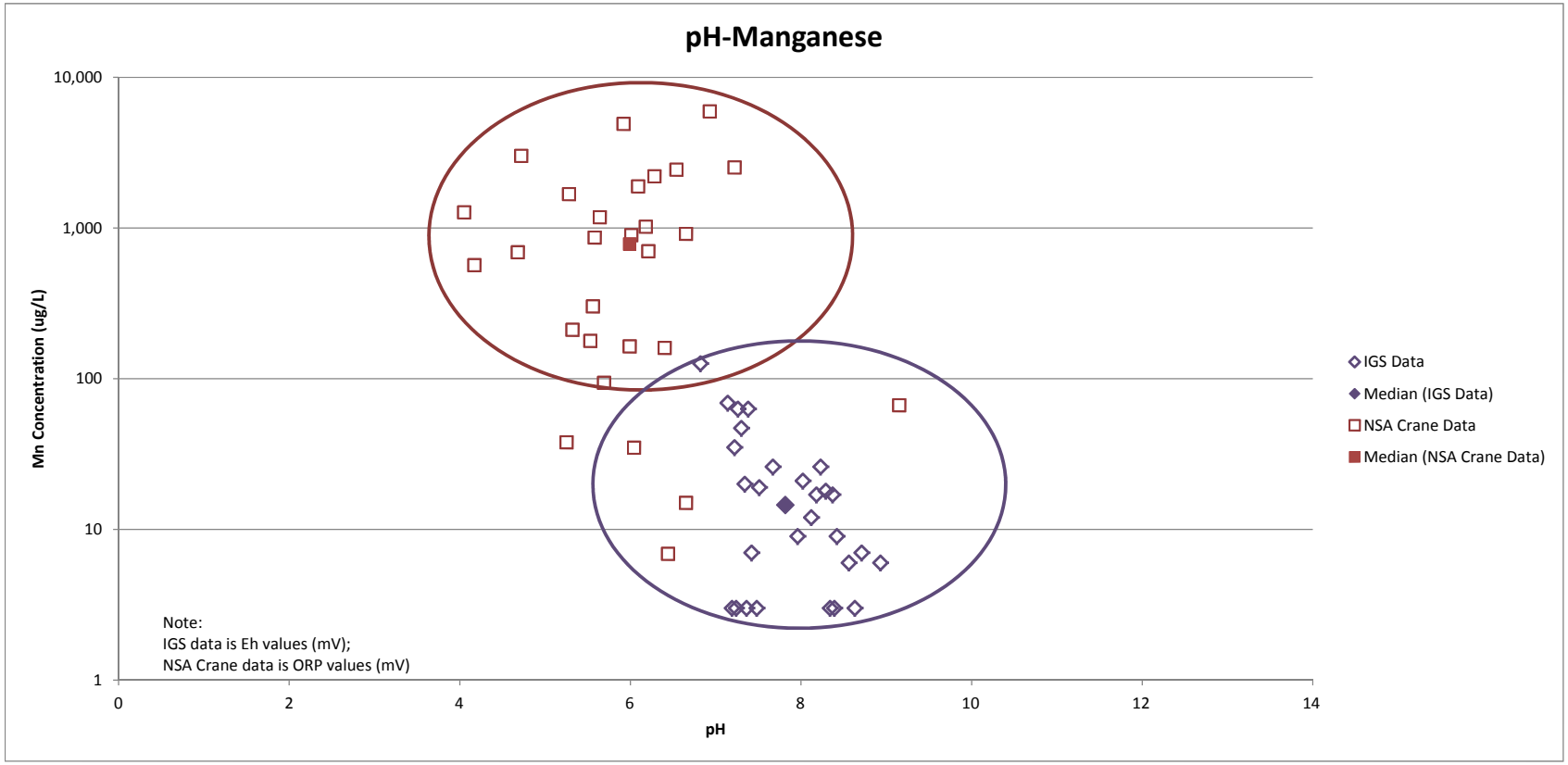
2
4
6
8
10
12
14
pH
IGS Data
Median (IGS Data)
NSA Crane Data
Median (NSA Crane Data)


pH-Manganese
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10
1
Mn Concentration (ug/L)
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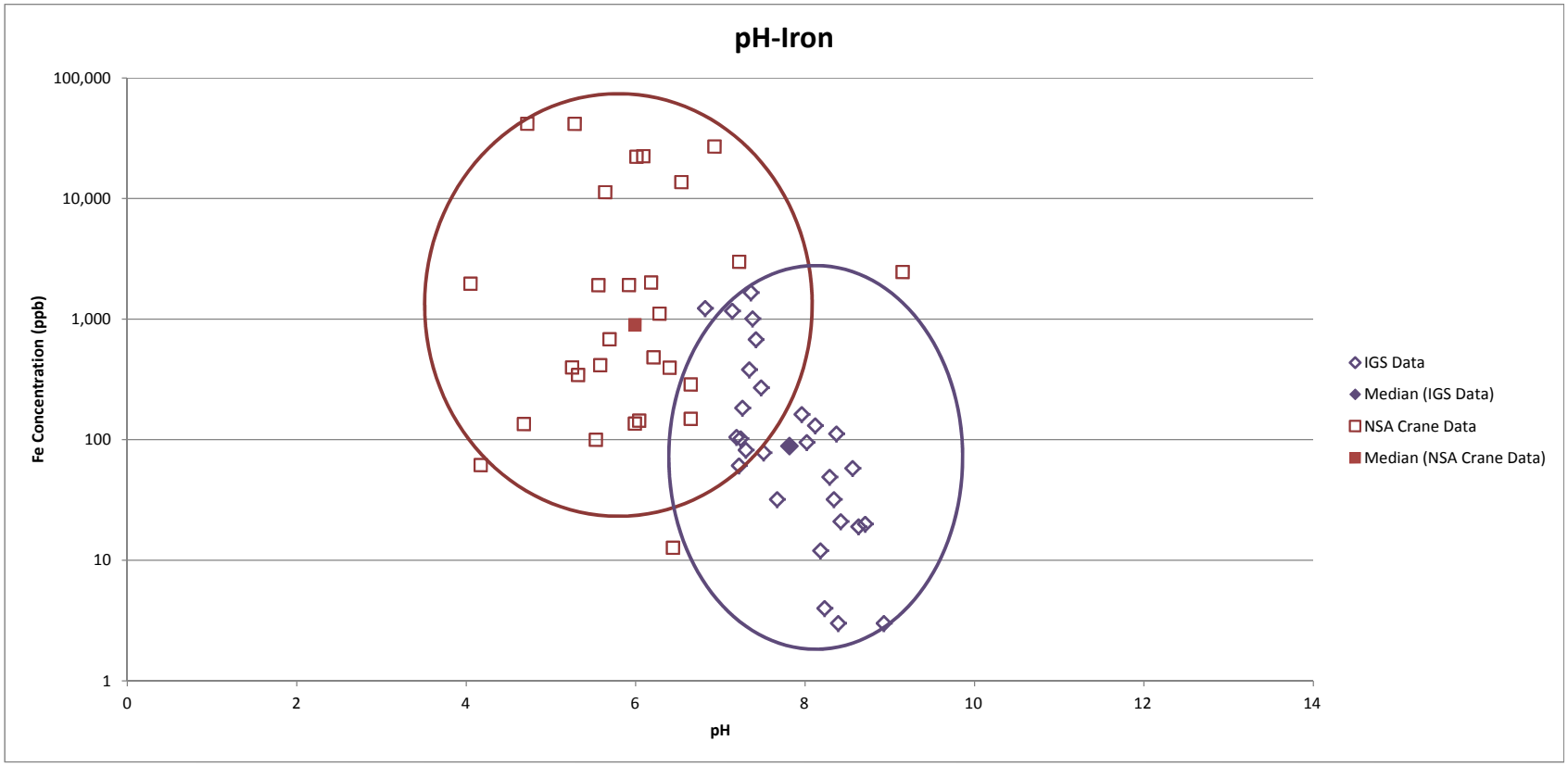
2
4
6
8
10
12
14
pH
Note:
IGS data is Eh values (mV);
NSA Crane data is ORP values (mV)
IGS Data
Median (IGS Data)
NSA Crane Data
Median (NSA Crane Data)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1,000
100
10
1
Fe Concentration (ppb)
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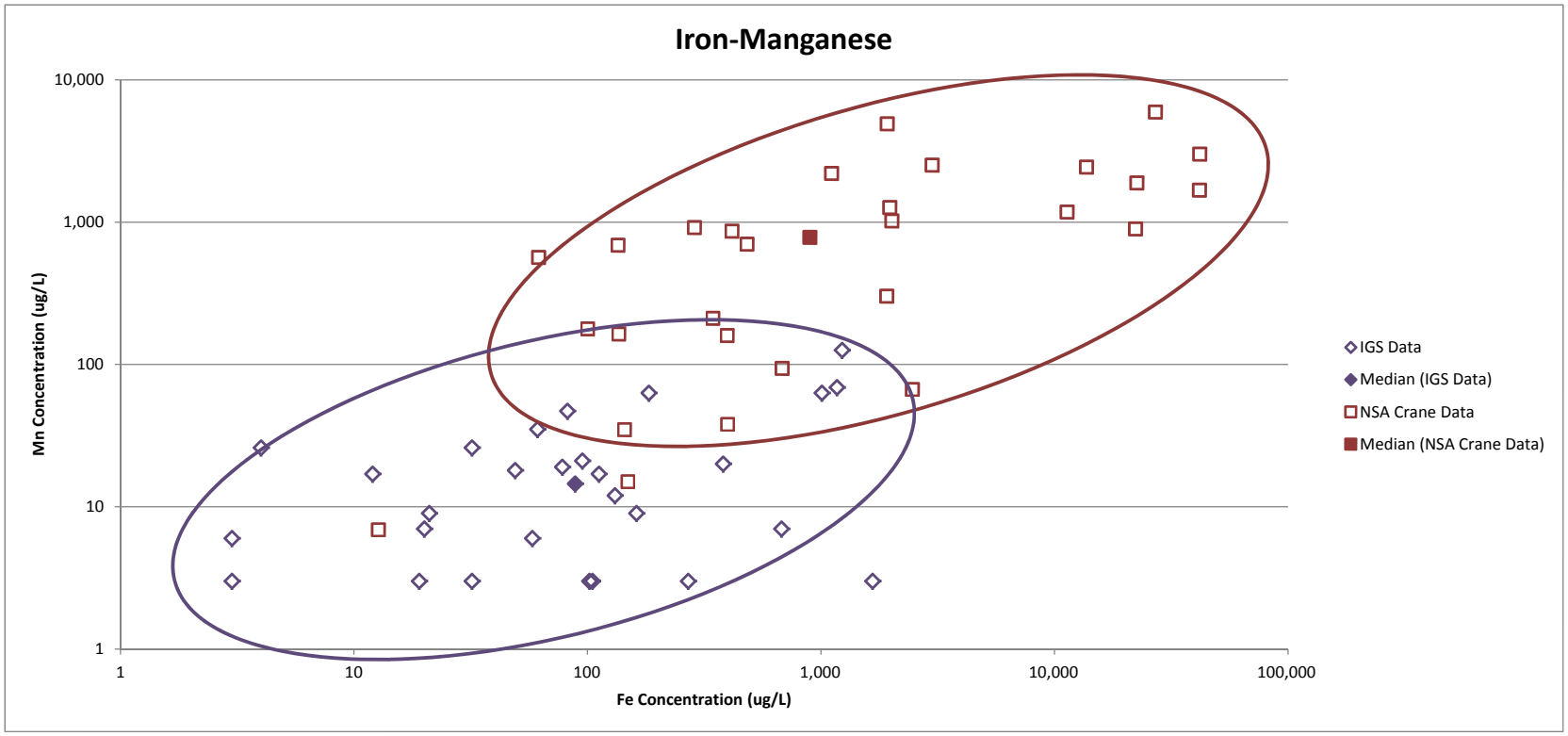
2
4
6
8
10
12
14
pH
IGS Data
Median (IGS Data)
NSA Crane Data
Median (NSA Crane Data)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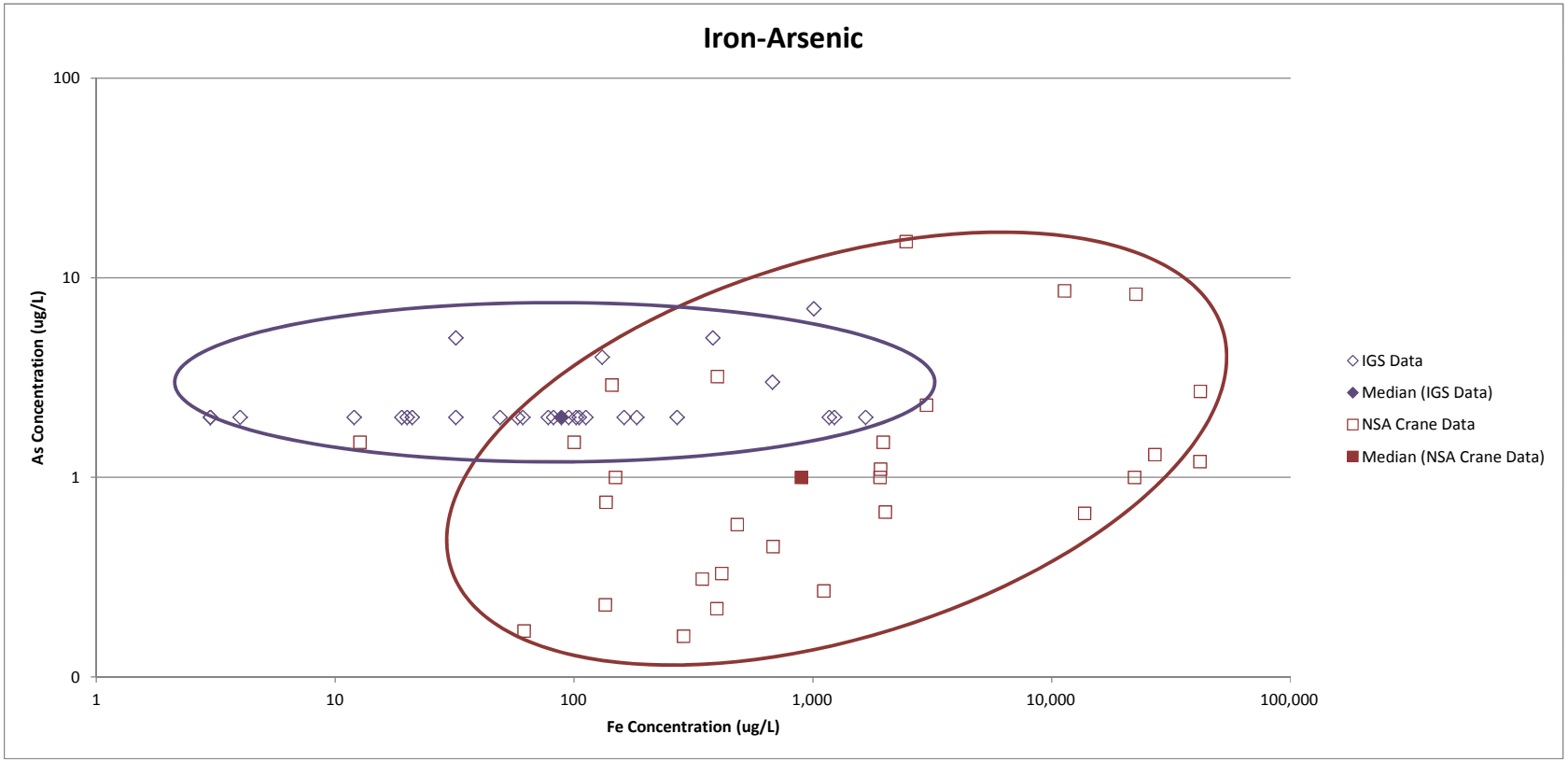
10
1
Mn Concentration (ug/L)
1
10
100
1,000
10,000
100,000
Fe Concentration (ug/L)
IGS Data
Median (IGS Data)
NSA Crane Data
Median (NSA Crane Data)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As Concentration (ug/L)
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10
100
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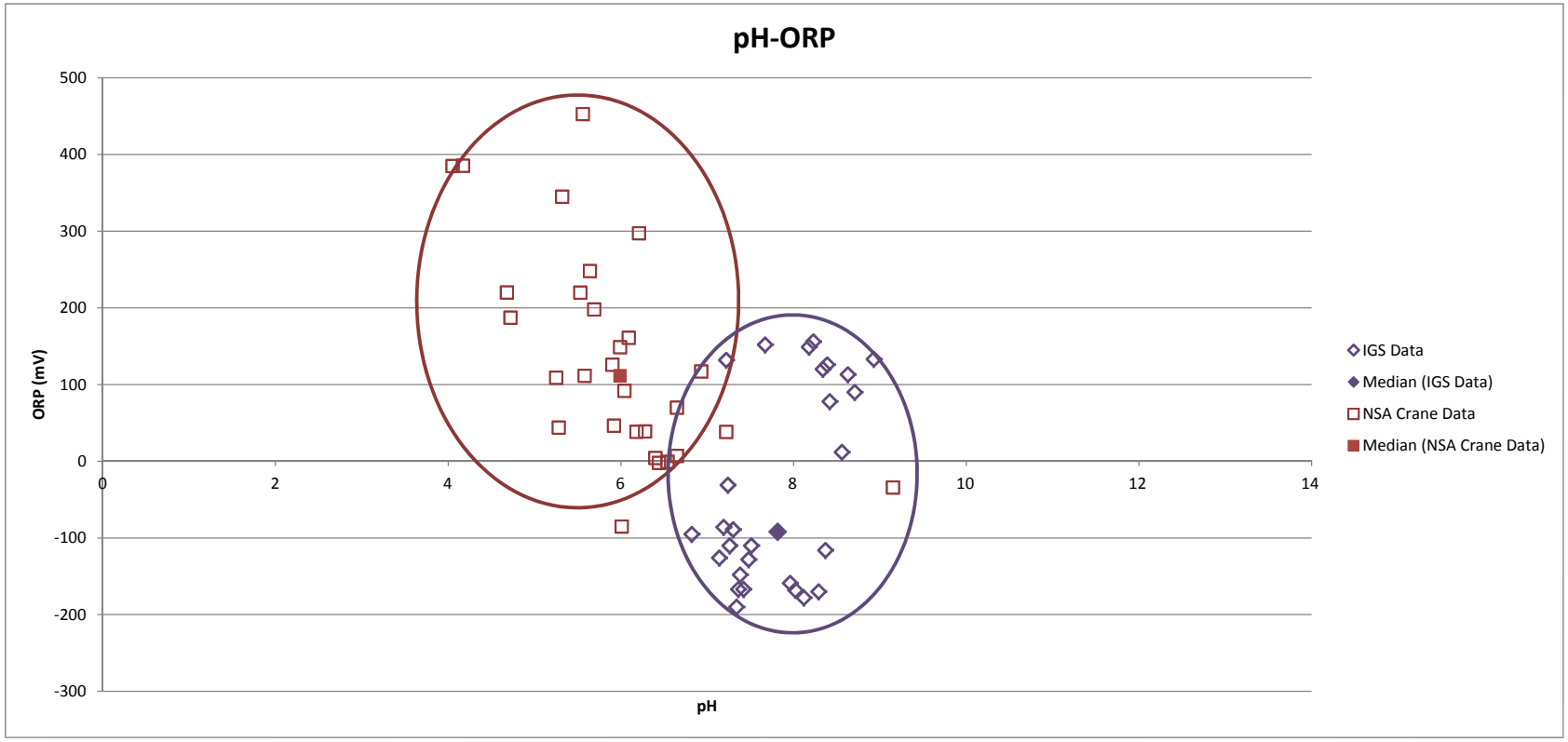
100,000
Fe Concentration (ug/L)
IGS Data
Median (IGS Data)
NSA Crane Data
Median (NSA Crane Data)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400
300
200
100
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-100
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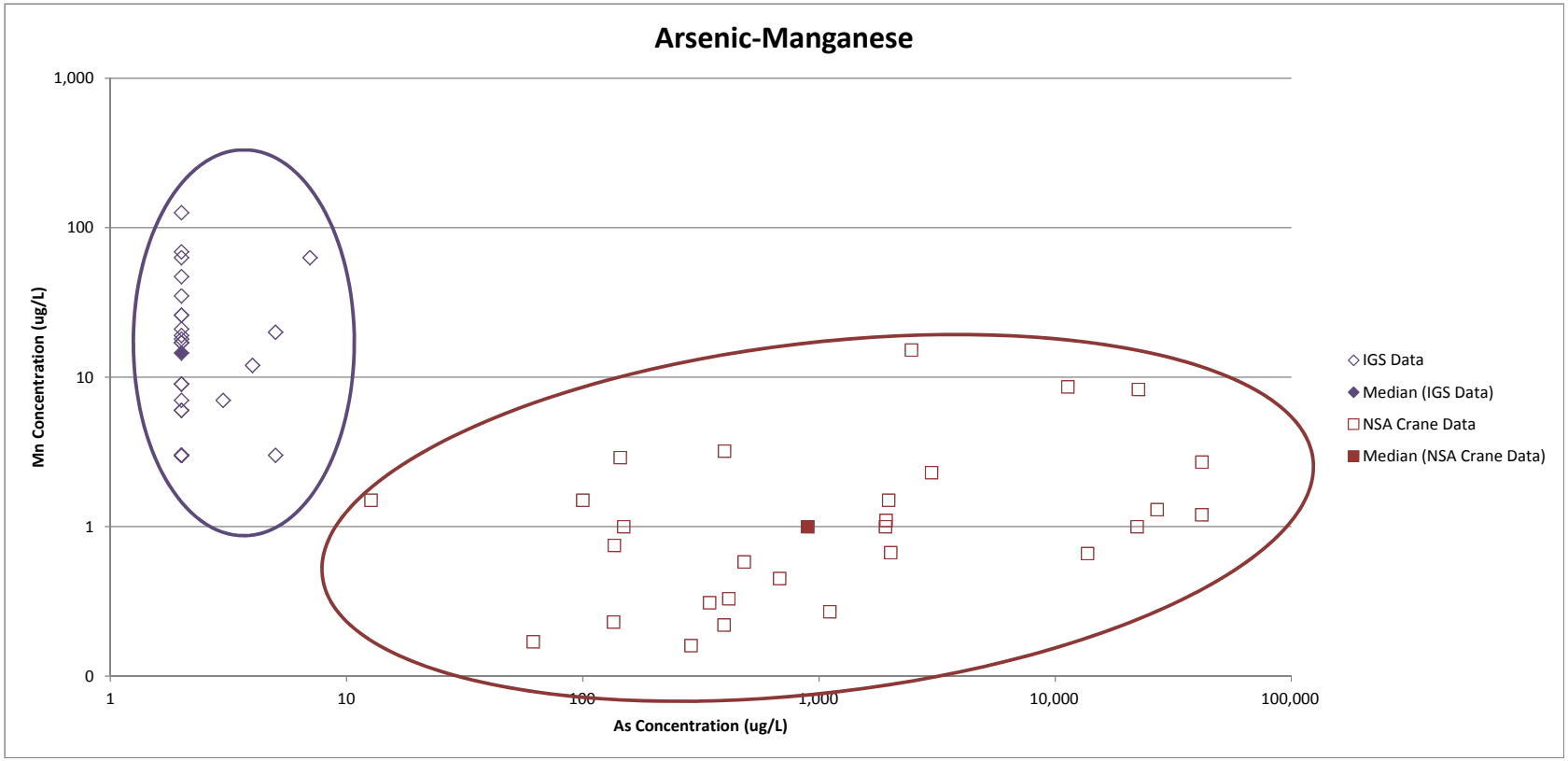
6
8
10
12
14
pH
IGS Data
Median (IGS Data)
NSA Crane Data
Median (NSA Crane Data)


Arsenic-Manganese
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100
10
1
0
Mn Concentration (ug/L)
1
10
100
1,000
10,000
100,000
As Concentration (ug/L)
IGS Data
Median (IGS Data)
NSA Crane Data
Median (NSA Crane Data)

APPENDIX B

BORING LOGS
AND
WELL CONSTRUCTION DIAGRAMS

BORING LOG
FIELD DATA

Project NWSC Groundwater Study Site Crane, IN Date 10 November 82
Location Mustard Gas Burial Grounds Job No. 441-G150.13GR21/22
Drill Rig Failing Inspector J. Dunbar Operator D. Taylor Surface El 596.02 Boring No. WES-1-6-82

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
	10 Nov			0.0	1.5			6-3/4"Rock Bit			6" Casing-Stickup 0.5'
		0.0	11.7	0.0	26.0			5-5/8"Rock Bit			Siltstone: reddish brown, grey,
											soft, weathered, dry
		11.7	23.5								Shale: grey, soft-medium, dry
		23.5	26.0								Shale: dark grey, black, dry
	10 Nov			0.0	50.0			5-5/8"Rock Bit			Air compressor filter went out
											and pumped large quantity of oil
											into hole. Traded air compressors
											and moved drilling rig 10 ft west
											to drill another boring. Grouted
											up contaminated hole.
		26.0	27.2								Coal: black, soft
		27.2	35.2								Shale: grey, soft
		35.2	36.0								Coal: black, soft
	11 Nov	36.0	54.5	50.0	90.0			5-5/8"Rock Bit			Sandstone: brown, red, fine-
											grained, 75% quartz sand, hard

WORKING DRAFT

BORING LOG
FIELD DATA

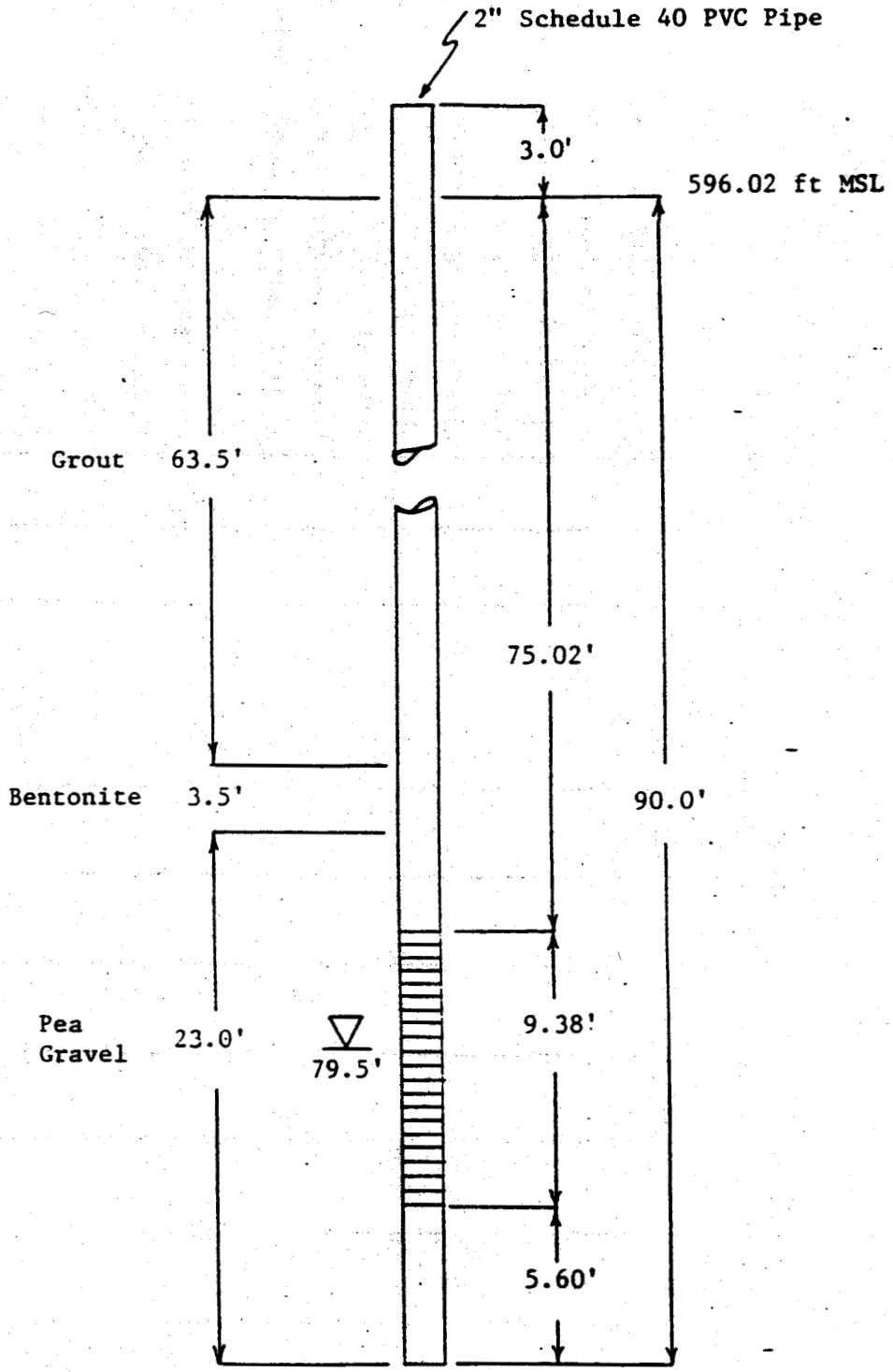
Project _____ Site _____ Date _____

Location _____ Job No. _____

Drill Rig _____ Inspector _____ Operator _____ Surface El _____ Boring No. WES-1-6-82

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
											Damp spot at 42 and 49 ft
											No water overnight
		54.5	82.5								Limestone: grey, white, hard
		82.5	88.5								Shale: grey, soft
		88.5	89.5								Limestone: grey, hard
		89.5	90.0								Shale: grey, soft
											Water at 79.5 ft - Blew water
											from hole several times and will
											monitor depth in morning before
											installing screen.
	12 Nov										Water level at 69.87 ft -
											installed well screen

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED



▽ Water depth at time of drilling

Well Screen

NWSC, Crane, Indiana
Mustard Gas Burial Grounds
Well Completion
Boring Number: WES-1-6-82

WORKING DRAFT

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE SWMU 8 BORING No.: 08MWT007
PROJECT NUMBER: N1245 DATE: 5-13-05
DRILLING COMPANY: Bowser Morner GEOLOGIST: Jeff Schubert
DRILLING RIG: CME 550X-ATV DRILLER: Jim Walsh

Sample No. and Type or ROD	Depth (Ft.) or Run No.	Blows / 6" or ROD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS	Remarks	PID/FID Reading (ppm) Sample Zone	Breathing Zone	Well Head	Drill Floor
	1	10/22	12"	6"			brown sandy topsoil			0	0	0	0
SS1	2	9/4	/24"	2'			brown sand with trace of gravel						
SS2	3	2/3	18"				brown to gray clayey silt						
	4	4/6	24"				(dry to slightly moist)						
SS3	5	4/4	22"										
	6	6/6	/24"	6'									
SS4	7	4/5	22"				brown sand and pieces of weathered sandstone						
	8	32/50	/24"	8'			top of bedrock						
			0				Augered to 10' bgs and set temporary casing						
	10												
C1		10%	5'/5'				fine to medium sandstone tan to light gray with orange bands of oxidation (iron staining)						
	15						rock broken, especially in 10-15' interval						
C2		10%	3'/5'										
	20			20'									
C3		70%	5'/5'				medium sandstone, orange because of iron staining angled bedding laminations						
	25												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

~ Drilling Area

Remarks:

Background (ppm): 0

Converted to Well: Yes ✓ No ____ Well I.D. #: 08MWT007

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC Crane SWMU 8 BORING No.: 08MWT007
PROJECT NUMBER: N1245 DATE: 5-13-05
DRILLING COMPANY: Bowser Morner GEOLOGIST: Jeff Schubert
DRILLING RIG: CME 550X-ATV DRILLER: Jim Walsh

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	Borehole**	Cuttings	Drilling Area
	26						Same as above			0	0	0	0
C4		90%	2'/5'										
	30			30'									
C5			3'/5'				gray to black, siltstone, coal, and shale, very broken up						
	35			35'									
					35' = total depth of boring								
					reamed hole to 33' bgs and packed ground up shale into last 2' of corehole with roller bit								

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0

Converted to Well: Yes ✓ No Well I.D. #: 08MWT007

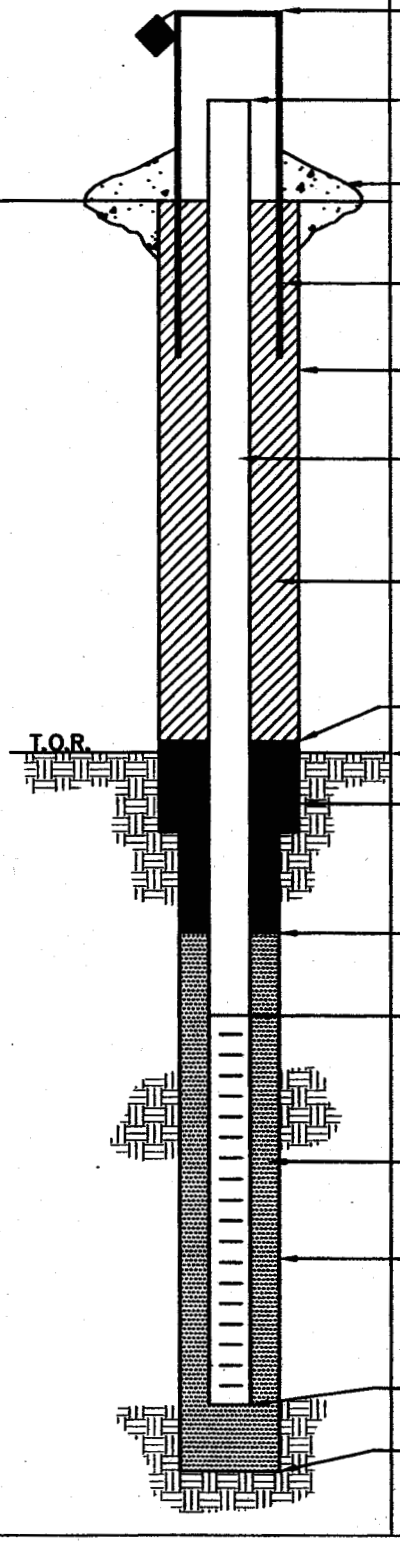
WELL NO.: 08MWT007

Tetra Tech NUS, Inc.

BEDROCK

MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK

PROJECT: NSWC CRANE	LOCATION: SWMU 8	DRILLER: Bowser Morner	
PROJECT NO.: N1245	BORING: 08MWT007	DRILLING METHOD: HSA / AI	
DATE BEGUN: 5-13-05	DATE COMPLETED: 5-13-05		
FIELD GEOLOGIST: Jeff Schubert		DEVELOPMENT METHOD:	
GROUND ELEVATION: 699.73	DATUM: NAVD 88		



ELEVATION/HEIGHT OF TOP OF SURFACE CASING: 701.34 / 1.61

ELEVATION/HEIGHT TOP OF RISER: 701.31 / 1.58

TYPE OF SURFACE SEAL: 4' x 4' x 6" concrete pad with 4 barrier posts

I.D. OF SURFACE CASING: 4" x 4" square steel protective casing with hinged top

DIAMETER OF HOLE: 8 inches from 0 to 9 ft bgs

RISER PIPE I.D.: 2 inches

TYPE OF RISER PIPE: PVC

TYPE OF BACKFILL: cement-bentonite grout

ELEVATION/DEPTH TOP OF SEAL: 695.73, 4.0

ELEVATION/DEPTH TOP OF BEDROCK: 689.73 / 10.0

TYPE OF SEAL: bentonite chips, medium

ELEVATION/DEPTH TOP OF SAND: 683.73, 16.0

ELEVATION/DEPTH TOP OF SCREEN: 681.73 / 18.0

TYPE OF SCREEN: PVC

SLOT SIZE x LENGTH: 0.010 inches / 15.0 feet

I.D. SCREEN: 2 inches

TYPE OF SAND PACK: Silica Sand No. 10-20 U.S. Standard Sieve Size

DIAMETER OF HOLE IN BEDROCK:

CORE/REAM: 2" / 6" from 10 ft to 35 feet bgs; 2" core only from 33 to 35 ft bgs

ELEVATION/DEPTH BOTTOM SCREEN: 666.73 / 33.0

ELEVATION/DEPTH BOTTOM OF SAND: 666.73 / 33.0

ELEVATION/DEPTH BOTTOM OF HOLE: 664.73 / 35.0

BACKFILL MATERIAL BELOW SAND: 2 ft of ground up clay/shale dust produced into the 2" core hole with the roller bit

ACAD:FORM_MWINBR.dwg 07/20/99 INL

WORKING DRAFT

BORING LOG
FIELD DATA

Project NWSC Ground-Water Study Site Crane, IN Date 18 Aug 1983

Location Pest Control Area Job No. 441-G150.13GR21/22

Drill Rig Failing Inspector J. Dunbar Operator C. Drake Surface El 727.48 Boring No. WES-9-10-83

SAMPLE NUMBER	DATE TAKEN 1983	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
	18 Aug	0.0	11.6	0.0	11.6			6"Folding Auger			Clay(CL): brown, stiff, slightly damp, thinly bedded, sandy-less than 5% fine to coarse-grained.
	18 Aug	11.6	13.8	11.6	27.0			6"Rock Bit			Sandstone: brown, very fine-grained, soft, weathered.
		13.8	16.0								Sandstone and clay: brown, soft weathered, thinly bedded, very fine-grained.
		16.0	17.3								Siltstone: brown, soft, wet at 16 ft.
		17.3	19.2								Sandstone: brown, soft, very fine-grained.
		19.2	25.8								Shale: dark grey, soft, thinly bedded with sandstone lenses.

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WORKING DRAFT

BORING LOG
FIELD DATA

Project _____ Site _____ Date _____

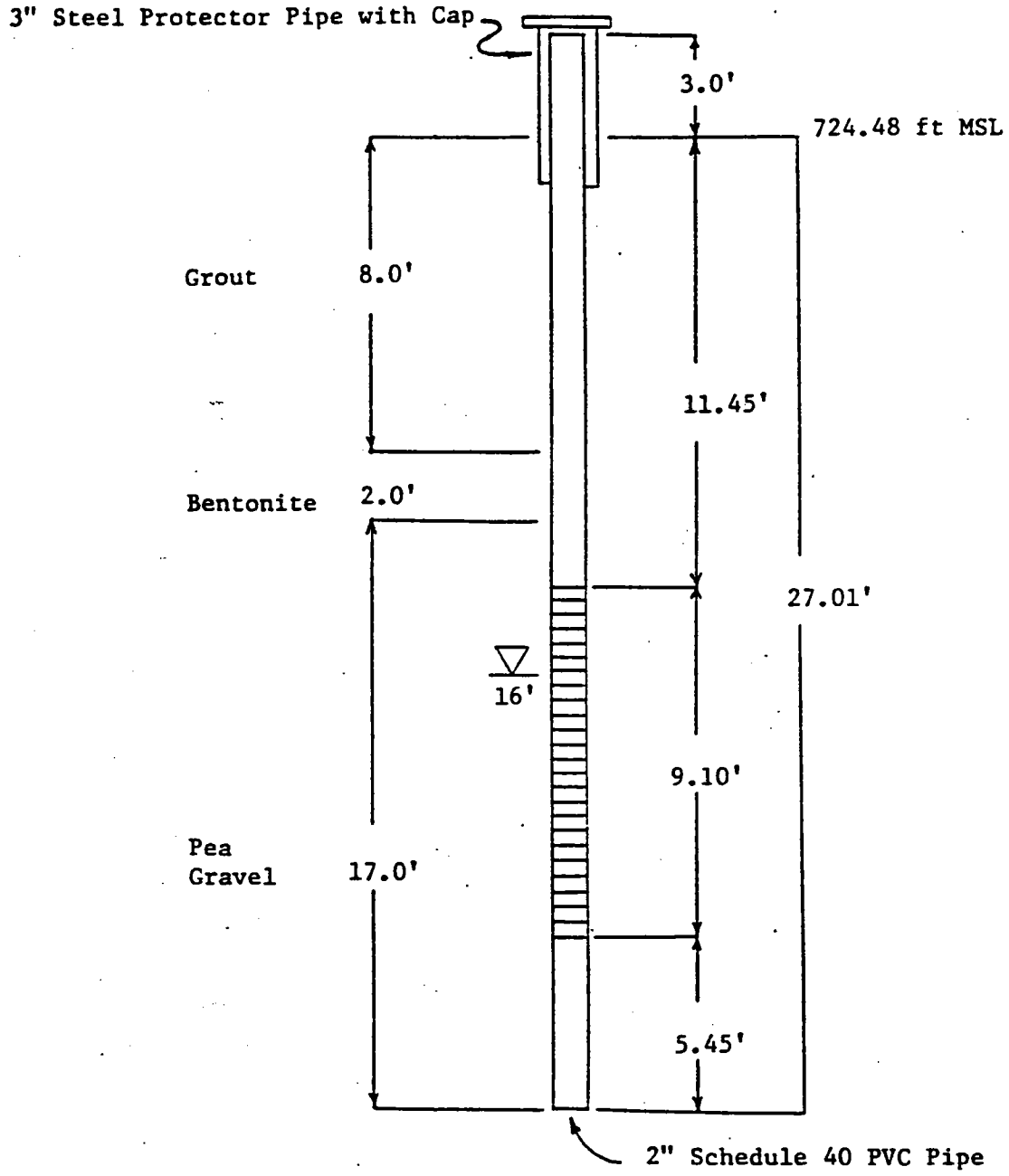
Location _____ Job No. _____

Drill Rig _____ Inspector _____ Operator _____ Surface El _____ Boring No. WES-9-10-83

SAMPLE NUMBER	DATE TAKEN	STRATUM FROM	STRATUM TO	DRIVE FROM	DRIVE TO	SAMPLE FROM	SAMPLE TO	TYPE OF SAMPLER			CLASSIFICATION AND REMARKS
		25.8	27.0								Sandstone: brown, very fine-grained,
											soft.
	18 Aug										Installed monitoring well.

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

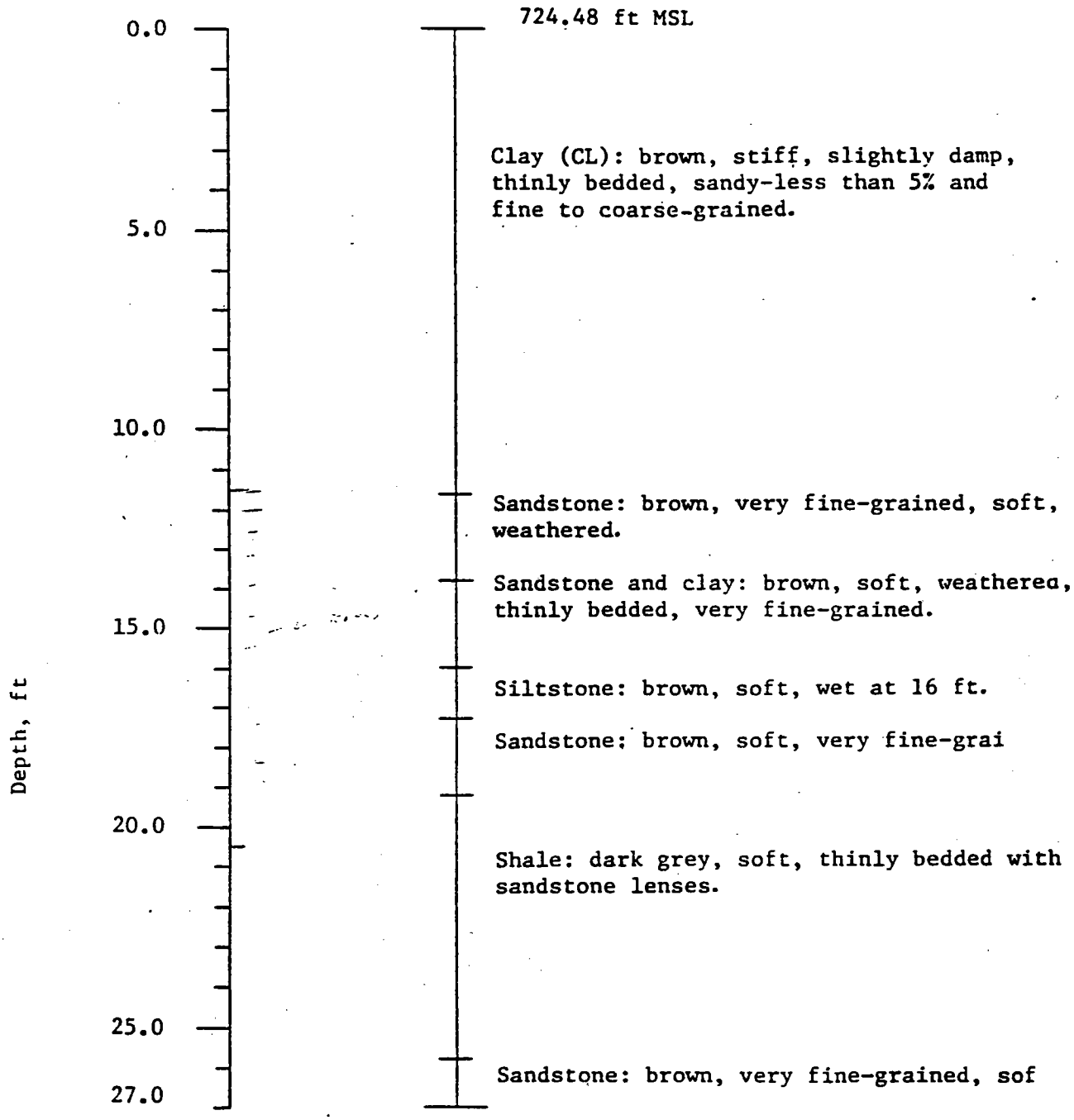
Sheet 2 of ___ Sheets



▽ Water Depth at Time of Drilling

▤ Well Screen

NWSC, Crane, Indiana
Pest Control Area
Well Completion
Boring Number: WES-9-10-83



NWSC, Crane, Indiana
Pest Control Area
Lithology
Boring Number: WES-9-10-83

NWS Groundwater Study

1. LOCATION: Site 9' Pest Control - Waste Storage Tank
2. DRILLING AGENCY: WES
3. HOLE NO.: WES-WT67-06
4. NAME OF DRILLER: Dan Taylor
5. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
6. THICKNESS OF OVERBURDEN
7. DEPTH DRILLED INTO ROCK
8. TOTAL DEPTH OF HOLE: 26.7'
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED 7/26/96 COMPLETED 7/29/
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING
19. SIGNATURE OF INSPECTOR: Geologist Richard W. Hunt

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0		Ls Rk. (Parking Lot Surface)			Started drilling w/ 8" dia folding auger. Took spl. where poss. blo w a 3" push tube & cleaned hole w/ 8" auger.
	1		Silty clay (CL) y Br w/ Gr mottling, V firm, sl. moist, num Fe incrusted nodules (1/4" dia) in upper zone OCC was ss frags, sdy w/depth		Jar Spl #1	
	2					
	3					
	4					
	5				Jar Spl #2	
	6					
	7					
	8					
	9					Set 9.8' of Temporary 6" steel casing. + Cle.. hole to 10.2' w/ air
	10		Top of highly was SS (See Next sheet)			

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PROJECT

2. LOCATION (Coordinates or Station)	12. MANUFACTURER'S DESIGNATION OF DRILL
3. DRILLING AGENCY	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
4. HOLE NO. (As shown on drawing title and file number)	14. TOTAL NUMBER CORE BOXES
5. NAME OF DRILLER	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	16. DATE HOLE: STARTED / COMPLETED
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	10		Sandstone, yBr rBr, vf-f, highly wea, arid, mod hd friable, num largely flattened soft to firm clay inclus + occ sub-angular clay + th bd claystone inclus (Zip-up clast?). The clay inclus range from <1" to >4" in size, are lim incrusted + are isolated within the SS matrix at random (produces a conglomeratic appearance). The clay inclus represent from 30 to 50% of the rk mass vol	10.2		Started coring w/a 4 x 5½" core bbl at 10.2'
				Run 1	Jar: SP1 @ 3	
	11			1.5/2.3	Rec'd Run	
				.02		
	12			12.5		
				Run 2		
	13					
	14			4.3/4.3		
	15				Jar: SP2-4	
	16			16.8		
	17					
	18			5.0/5.0		
	19					
	20					

NG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT
AR 71

(TRANSLUCENT)

3. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and this number)	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED / COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	20		SS, highly wea (Cont.)			
					Jar Spl 5	
	21					
				21.8		
	22			Run 3		
			Coal, blk, hd, blocky, brittle.			
	23			4.9/4.9		
	24		Sandstone, lt gr, vf mass, hd, sl. friable, abundant carbonized plant inclus that give an effect to the core like rootlets extending downward from the overlying coal bed.			
	25		Eo° Jt is ¼" open at top 1 in strj, becomes tight and rides out w/depth		Jar Spl 6	Set well screen between 20.7 + 25.7 ft. (See well drawing for details)
	26		Bot of hole is at top of sh ss w/vugs.	26.7		
			Bot. Depth 26.7'			
	27					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT

1. LOCATION (Coordinates or Station)	12. MANUFACTURER'S DESIGNATION OF DRILL
2. DRILLING AGENCY	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
3. HOLE NO. (As shown on drawing title and file number)	14. TOTAL NUMBER CORE BOXES
4. NAME OF DRILLER	15. ELEVATION GROUND WATER
5. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.	16. DATE HOLE: STARTED / COMPLETED
6. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
7. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING
8. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Additional data, water loss, depth of weathering, etc., if significant) g
			WES-WTGP-86			Piezometer Plan
			2.5' (Approx El-726.0)			(Background well
			0.0' Ground surface			PVC Pipe to a
						Depth of 6.7'
						Teflon Pipe bel
						8.7'
						Set well screen
						on 7/28/86
			Grout mixture			water level on
						7/29/86 - 13.9'
			water level - 14.0'			(from Top Riser)
			8/14/86 (From Top Riser)			Developed well
						on 7/31/86
						The procedure f
						developing t
						is describe c
						plan for WES
						WTP-86.
			16.7'			
			Bentonite Pellets			
			18.7'			
			Filter Gravel (Proc size)			The equipme
						was steam cle
			20.7'			prior to use.
			Well Screen			
			25.7'			
			Trap			
			26.7'			

ENG. FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT

(TRANSLUCENT)

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: 7141 CTO 10
DRILLING COMPANY: Bowser Morner
DRILLING RIG: B-59
BORING NUMBER: 09TO1A
DATE: 12-3-00
GEOLOGIST: MATT COCHRAN
DRILLER: A WOLF

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	Sample BZ	Borehole **	Driller BZ **
							SEE BORING						
							LOGS 9SB01,02+						
							03 FOR LITHOLOGY						
						BRN	SANDSTONE		WEATHERED				
						↓	↓		EASY DRILLING				
				* SWL ▼ 12.8 12-4-00					DRILL RATE 15 SEC / FOOT				
									* SWL ON 12-4, AT BEGINNING OF DAY				
	19	50/0"	.1 /		SOFT	BRN	SANDSTONE		ATTEMPTED	NA	NA	NA	NA
S1			2.0						SPOON,				
	21								REFUSAL, NO ACL REACTION				
	24				SOFT	GREY	SILTSTONE		MODERATE WEATHERING				

* 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): NA

Remarks: DRILLED W/ HSA TO 24', WILL ATTEMPT TO CORE W/ AIR, MAY GET POOR RECOVERY SINCE ROCK IS SOFT.

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: 7141 CTO 10
DRILLING COMPANY: Bowser Morner
DRILLING RIG: B-59
BORING NUMBER: 09 TO1A
DATE: 12-3-00
GEOLOGIST: MATT COCHRAN
DRILLER: A. WOLF

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**
									FE. STAINED ALONG BEDDING				
									VERY THIN SHALY BEDDING TOP 1'				
									SANDY BEDDING PLANES TOP 1' CORE				
			9.8/						27-33' LIKE CONGLOMERATE				
C-1			10.0						W/ CLAYSTONE CONCRETIONS				
9.0/		40%							BROKEN THRU CORE				
10.0									RUN LOOKS				
				33					DAMP				
	34					BLACK	COAL		LOW % FRACTS (SEVERAL, THRU CORE)				
							TD 34'						
									H_2O @ 20.7 BGS AFTER 1 HOUR.				

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area

Remarks: H_2O LEVEL AFTER CORE RUN = 21.2' BGS. Background (ppm): NA
DECIDED TO BLOW HOLE. MADE 2-3 GPM. COULD HEAR TRICKLE OF WATER DOWN ANNULUS AFTER HOLE PURGED

Converted to Well: Yes _____ No ✓ Well I.D. #: _____

OFFSET RIG + DRILLED 2ND BORING TO EVALUATE PRESENCE OF H_2O AT DEPTHS ABOVE CHALK. HOLE BACKFILLED W/ CEMENT/BENT GROUT

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: 7141 CTO 10
DRILLING COMPANY: Bowser Morner
DRILLING RIG: B-59
BORING NUMBER: 09T01B
DATE: 12-3-00
GEOLOGIST: MATT COCHRAN
DRILLER: A. WOLF

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 *	** PID/FID Reading (ppm): Remarks	Sample	Sample BZ	Borehole*	Driller BZ*
							SEE BORING LOGS						
							9SB01, 02 + 03						
							FOR LITHOLOGY						
				*SWL 8.20 12-4-00			ROCK @ 8'		* SWL ON 12-4-00 OF 8.20 BGS WHEN DRILLED TO END OF 1ST RUN				
	9				SOFT	LT BRN	SANDSTONE (SILTY)		DRILL RATE 1 FOOT/MIN. BROKEN NO REACTION TO HCL, DAMP-MOIST. V. THIN BEDDING @ 12, 13.5, 15, + 17.5; FRACTS ALONG BEDDING W. FE. STAINING.				
C-1			9.1/										
8.5		85%	2.0						BEDDING IS HORIZ MODERATE WEATHERING ON FRACTS, OTHERWISE SLIGHT WEATHERING.				
10													
	19								MORE SANDY @ @ 18'-20' BROKEN.				
					SOFT	LT BRN	SANDSTONE (SILTY)		NO REACTION TO HCL. V. THIN BEDDING @ 20, 21.5; FRACTS ALONG BEDDING. FE STAINING @ 20, DAMP-MOIST				
C-2													
7.0		100%	7.0/										
7.0			7.0										
						GREY BROWN							

* 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): 0

Remarks: SPUN 6" CASING TO 9', PLACED BENTONITE SEAL PRIOR TO SETTING CASING
CORED W NX WIRELINE

Converted to Well: Yes _____ No _____ Well I.D. #: 09T01

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: 7141 CTO 10
DRILLING COMPANY: Bowser Morner
DRILLING RIG: B-59
BORING NUMBER: 09TO1B
DATE: 12-3-00
GEOLOGIST: MATT COCHRAN
DRILLER: A. WOLF

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 *	PID/FID Reading (ppm): Remarks	Sample	Sampler BZ	Borehole**	Driller BZ**
	26						TD 26'						
							SEE BORING LOG		REAMED HOLE TO TD + PUMPED 2 GALLONS H_2O OUT AFTER 20 MIN STANDBY				
							09TO1A FOR						
							LITHOLOGY BELOW		SANDSTONE UNIT TO BE SCREENED				
							26'.		OVER ENTIRE SATURATED THICKNESS, SANDSTONE IS SEPERATE H_2O ZONE FROM UNDERLYING UNIT				

* 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): 0

Remarks: STOPPED @ 26' ON 12-3-00, SWL ON 12-4 = 8.20 BGS.
** FID NOT WORKING ON 12-3. WORKING PROPERLY ON 12-4 (MALFUNCTIONING POSSIBLY DUE TO CONDENSATION)

Converted to Well: Yes ✓ No _____ Well I.D. #: 09TO1

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: 7141 CTO 010
DRILLING COMPANY: Bowser Morner
DRILLING RIG: GEOPROBE
BORING NUMBER: 095B01
DATE: 11-30-00
GEOLOGIST: BOB BALKOVEC
DRILLER: TED KEEN

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	Sample BZ	Borehole**	Driller BZ**
	1			0'-10'	LOOSE	DRK GRAY	TOP 8" GRAVEL W/ SAND	GM			0.0		0.0
	2				↓	↓	AND TOPSOIL	↓		0.0			
	3				SLSTIFF	LT. BRN	WITH 14" CUTTER RANGE	SC		0.0			
S-1 1057	4		2'-4'		↓	↓	↓	↓		0.0		0.0	
	5				STIFF	GRAY	CLAY TRACE	CL		0.0			
	6					GRAY				0.0			
	7									0.0			
S-2 1104	8		4'-4'							0.0		0.0	
	9				V. STIFF					0.0			
S-3 1111	10		2'-2'							0.0		0.0	
				TD 10'									
					Sampled 095B010002 @ 1115								
							VOC'S TAKEN FROM 1'-2'						
					Sampled 095B010410 @ 1120								

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: 10' 14' TOT

Drilling Area Background (ppm): 0.0

Converted to Well: Yes _____ No X Well I.D. #: _____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: 7141 CTO 010
DRILLING COMPANY: Bowser Morner
DRILLING RIG: GEOPROBE

BORING NUMBER: 045B02
DATE: 11-30-00
GEOLOGIST: BOB BALKOVEC
DRILLER: TOD KEEFER

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/RD Reading (ppm): Backgrd	Backgrd BZ	Borehole **	Drillar BZ **
	1			0 1 10	LOOSE	BRN GRAY	TOP 4" GRAVEL W/ SAND +	GM		0.0	0.0		0.0
	2				↓	↓	TOP SOIL	↓					
	3				STIFF	LT BR.	BOTT 16" SILTY CLAY	CL					
S-1 1246	4		30" / 4'		↓	↓	↓					0.0	
	5				SL. SOFT	GRAY	TOP 18" SILTY CLAY			0.0			
	6				↓		BOTT			0.0			
	7				STIFF		28" FINE SAND + CLAY			0.0			
S-2 1252	8		4' / 4'	1-1-1-1	↓	↓	BOTT 2" WEATHERED S.S.			0.0	↓	0.0	↓
	9						REFUSAL @ 9'						
S-3 1257	10		0 / 2'										
					Sampled 045B02 0007 @ 1249								
							VOC'S TAKEN from 1'-7'						
					Sampled 045B02 0603 @ 1300				TRIP BLANK 0003				

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: 5' 4' 17' 207

Drilling Area Background (ppm): 0.0

Converted to Well: Yes _____ No X Well I.D. #: _____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: 7141 CTO 010
DRILLING COMPANY: Bowser Morner
DRILLING RIG: GEOPROBE

BORING NUMBER: 095B03
DATE: 11-30-00
GEOLOGIST: BOB BALKOVEC
DRILLER: TED KEEN

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**
	1				SL SOFT	DK BR	TOP 4" SILTY CLAY W/	CL		0.0	0.0		0.0
	2				↓		ORGANICS T. FINE - GRAINED SAND						
	3				STIFF	YELL OR	BOTT 27" SILTY CLAY						
S1 1344	4		31"	4'			↓			↓		0.0	
	5						TOP 1' SILTY CLAY			0.0			
	6						↓			↓			
	7				↓	↓	BOTT 1.5' FINE SANDY CLAY	↓		↓	↓	0.0	↓
S2 1350	8		25"	25'			W/ WEATHERED S.S.						
	9						REFUSAL @ 6.5'						
	10												
					Sampled 095B03 0003 @ 1315								
							VOC'S COLLECTED FROM 1'-2'						
							COLLECTED W/ MINI-CORE & FOIL BOUND AND PUT ON DRY ICE						
					Sampled 095B03 0406 @ 1355								

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: 6.5'

Drilling Area Background (ppm): 0.0

Converted to Well: Yes _____ No X Well I.D. #: _____

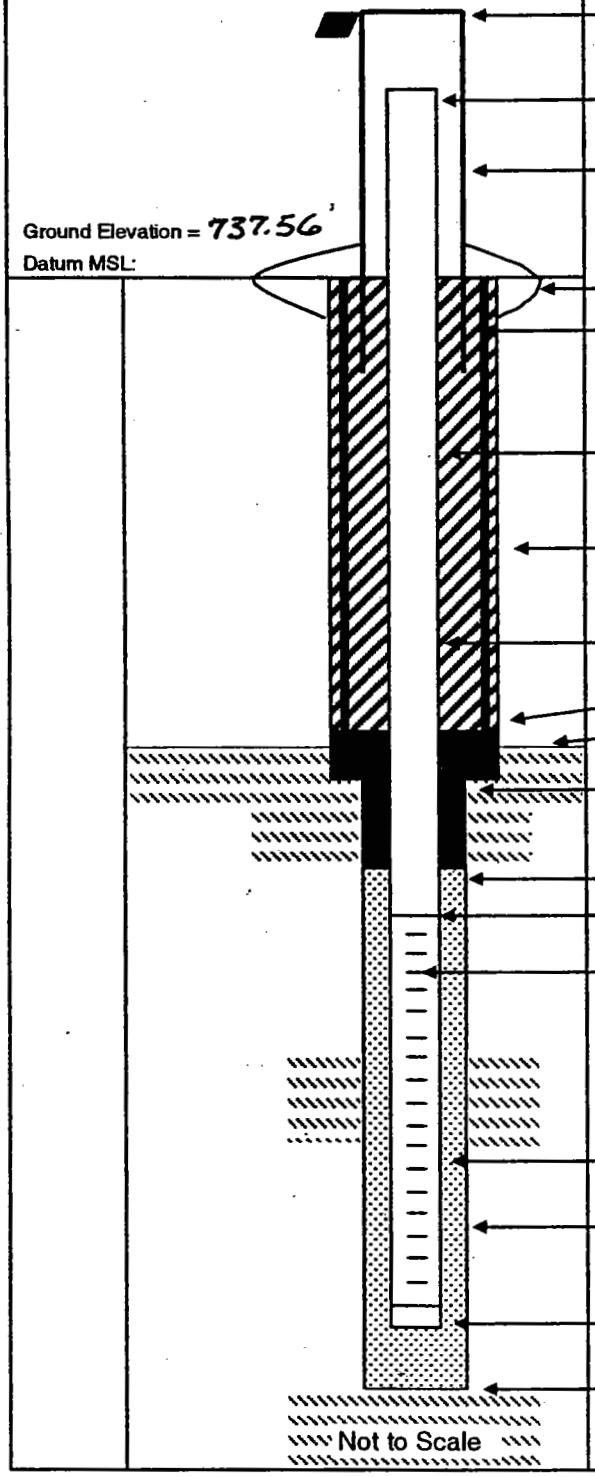
Tetra Tech NUS, Inc.

BEDROCK

MONITORING WELL SHEET

WELL No.: 09T01

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	09T01B
PROJECT No.:	7141 CTO 010	DRILLER:	A. WOLF	DATE COMPLETED:	12-4-00
SITE:	SWMU 9	DRILLING METHOD:	AIR ROTARY	NORTHING:	1312804.336
GEOLOGIST:	M.G. COCHRAN	DEV. METHOD:	SURGE & WHALE PUMP	EASTING:	3025759.952



Elevation of Top of Casing: 740.63'

Stick Up of Casing Above Ground Surface: 3.07'

Elevation of Top of Riser: 740.02'

I.D. of Surface Casing: 4"

Type of Surface Casing: 4" STEEL SQUARE

Type of Surface Seal: CEMENT GROUT & ASPHALT

I.D. of Casing: 6"

Type of Casing: TEMPORARY STEEL FLUSH JOINT (REMOVED)

Casing Length: 9'

I.D. of Riser: 2"

Type of Riser: PVC SCH. 40

Borehole Diameter: 8 1/2"

Type of Backfill: CEMENT/BENTONITE GROUT QUIKCRETE + AM COLLOID WYOMING BENTONITE

Elevation / Depth Top of Seal: 730.56' / 7'

Elevation / Depth Top Bedrock: 729.56' / 8'

Type of Seal: BENTONITE PELLETS COLLOID ENVIRONMENTAL

Elevation / Depth of Top of Filter Pack: 728.56' / 9'

Elevation / Depth of Top of Screen: 726.56' / 11'

Type of Screen: PVC

Slot Size x Length: .01" X 15'

I.D. of Screen: 2"

Type of Filter Pack: GLOBAL #6 - 26-10' #7-10: 9'

Diameter of Hole in Bedrock: 5 5/8"

Elevation / Depth of Bottom of Screen: 711.56' / 26'

Elevation / Total Depth of Borehole: 711.56' / 26'

Tetra Tech NUS, Inc.

BORING LOG

Page 1 of 1

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: 7141 CTO 10
DRILLING COMPANY: Bowser Morner
DRILLING RIG: B-59 MOBILE

BORING NUMBER: 09T05
DATE: 12-4-00
GEOLOGIST: MATT COCHRAN
DRILLER: A. WOLF

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**	Drillers BZ**
							SEE BORING						
							LOGS 09SB09 AND						
							11 FOR LITHOLOGY						
							TO 9'						
	9			9.0									
S-1		30/10/6	.7/		V.DENSE	GR BRN	SHALY SILTSTONE		BEDROCK @ 9'	0	0	C	
	11		2.0			GR BRN	SHALY SANDSTONE LAMINATED. HOR. INTERBEDDING		H2O IN HOLE AT BR SURF H2O @ 7.9' IN OPEN HOLE LOST ~ 1 FOOT REC AT TOP PER DRILLER				
C-1			5.8/			BRN GREY	SHALY SILTSTONE FE STAINS @ 15.2-15.8		DRILL RATE 1 FOOT/MINUTE HOR FRACT ZONE @ 10', SATURATED				
5.6		43%	7.8	15.9									
7.8				TD 16.0		BLACK	COAL		ROCK BROKEN, V. BROKEN +	3			
	16.8					GREY	SILTSTONE NO BEDDING EVIDENT		SEVERE WEATHER @ 10', 13.2-13.8 OTHERWISE MOD. WEATHER.				
							TD 17'		CORE DAMP EXCEPT WHERE V. BROKEN				

* 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): 0

Remarks: SET 6" TEMP CASING TO 9'; POURED GRANULAR BENTONITE ALONG ANNULUS + HYDRATED. RESUMED CORING THRU ROCK, REAMED BORING W 5 7/8 ROLLER BIT

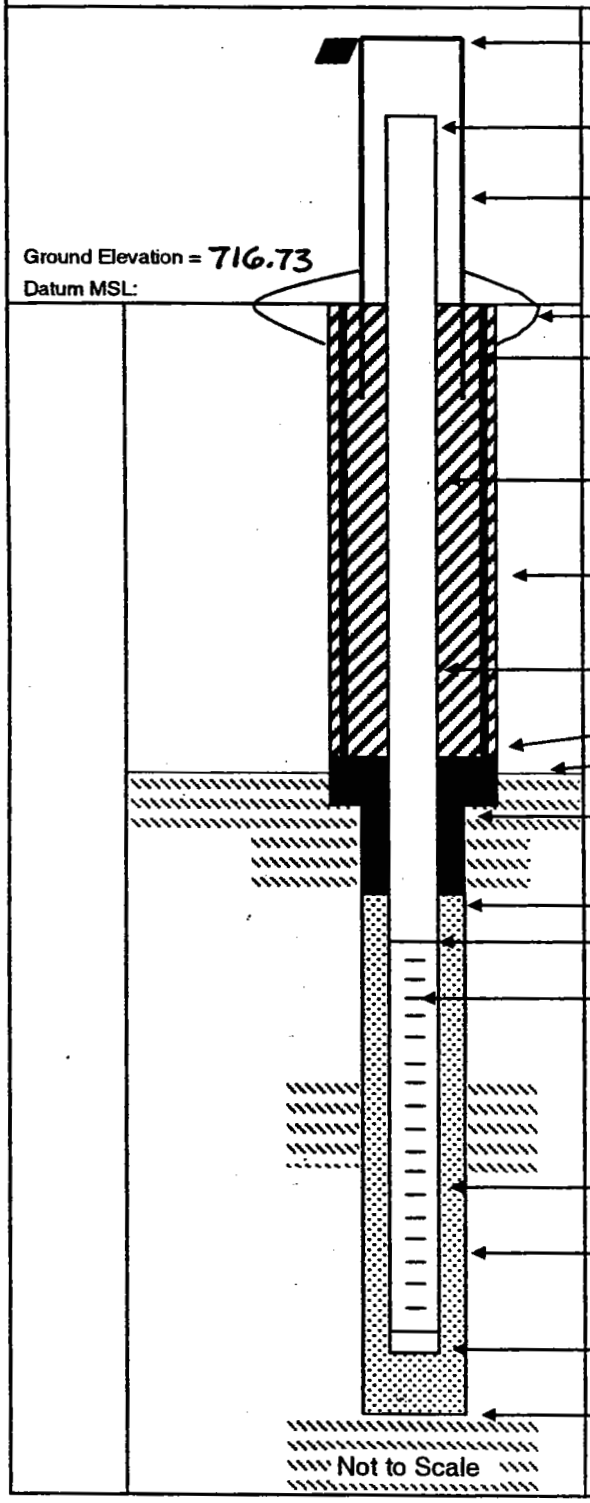
Converted to Well: Yes ✓ No _____ Well I.D. #: _____

Tetra Tech NUS, Inc.

BEDROCK MONITORING WELL SHEET

WELL No.: 09TO5

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	09TO5
PROJECT No.:	7141 CTO 010	DRILLER:	A. WOLF	DATE COMPLETED:	12-4-00
SITE:	SWMU 9	DRILLING METHOD:	AIR ROTARY	NORTHING:	1311681.497
GEOLOGIST:	M.G. COCHRAN	DEV. METHOD:	SURGE & WHALE PUMP	EASTING:	3025540.482



- Elevation of Top of Casing: 719.71
- Stick Up of Casing Above Ground Surface: 2.98
- Elevation of Top of Riser: 719.19
- I.D. of Surface Casing: 4"
- Type of Surface Casing: SQUARE STEEL
- Type of Surface Seal: CEMENT PAD
- I.D. of Casing:
- Type of Casing: TEMPORARY STEEL FLUSH JOINT (REMOVED)
- Casing Length: 9'
- I.D. of Riser: 2"
- Type of Riser: PVC SCHEDULE 40
- Borehole Diameter: 8 1/2"
- Type of Backfill: CEMENT-BENTONITE GROUT QUIKRETE + AM. COLLOID WYOMING BENTONITE
- Elevation / Depth Top of Seal: 713.73' / 3'
- Elevation / Depth Top Bedrock: 707.73' / 9'
- Type of Seal: BENTONITE PELLETS COLLOID ENVIRONMENTAL
- Elevation / Depth of Top of Filter Pack: 711.73' / 5'
- Elevation / Depth of Top of Screen: 709.73' / 7'
- Type of Screen: PVC
- Slot Size x Length: .01" X 10'
- I.D. of Screen: 2"
- Type of Filter Pack: GLOBAL #6 - 17'-6" #7 6-5'
- Diameter of Hole in Bedrock: 5 5/8"
- Elevation / Depth of Bottom of Screen: 699.73' / 17'
- Elevation / Total Depth of Borehole: 699.73' / 17'

Hole No. WES-10-52C-88

DRILLING LOG	DIVISION: US Navy	INSTALLATION: NWIRP Plane In	SHEET 1 OF 5 SHEETS
1. PROJECT: Hydrogeologic Studies Rockaway, NJ		10. SIZE AND TYPE OF BIT: 4" Q wireline	
2. LOCATION (Coordinates or Station): N505980.698 E591989.695		11. DATUM FOR ELEVATION SHOWN (TBM or MSL):	
3. DRILLING AGENCY: WES		12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500	
4. HOLE NO. (As shown on drawing title and file number): 10-52C		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED	
5. NAME OF DRILLER: Dan Taylor		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN: 7.3		16. DATE HOLE: STARTED 6/6/89 COMPLETED 6/8/89	
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE: TOC = 812.16	
9. TOTAL DEPTH OF HOLE: 83.0'		18. TOTAL CORE RECOVERY FOR BORING: %	
		19. SIGNATURE OF ~~INSPECTOR~~ Geologist: Richard W. Hunt	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0		Silty clay, yBr, soft - mod firm, moist, becomes sdy, w/grit & ss frags w/depth	Auger		0.0 - 7.3' - Augered Set 8" PVC Casing to 7.3' 7.3 - 12.0' - R.R. B.t.
	6			7.3'		Refusal
	8		Sandstone, yBr, mass f, micaceous, carb inclus, highly oxid friable, lim crust along sls.	R.R. B.t.		
	12			12.0'		Started Coring with HQ wireline @ 12.0'
				Run 1		
	16			10.1 / 10.2		
	18			~~0.1~~		
	20					

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE | PROJECT | HOLE NO.

Hole No. WES-10-52C-B3

DRILLING LOG	DIVISION	INSTALLATION	SHEET 2 OF 5 SHEETS

1. PROJECT		10. SIZE AND TYPE OF BIT	
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY		12. MANUFACTURER'S DESIGNATION OF DRILL	
4. HOLE NO. (As shown on drawing title and file number)	10-52C	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED / UNDISTURBED
5. NAME OF DRILLER		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN		16. DATE HOLE	STARTED / COMPLETED
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE	
9. TOTAL DEPTH OF HOLE		18. TOTAL CORE RECOVERY FOR BORING	%
		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	20		SS (cont.)			
	22			22.2 Run 2		22.1 Pull depth
			ripping shattered			
	24		Base of oxid. (24.3)			
			Sandstone, lGr, vf-f, occ rippled shaley pts,			
			— Gradational	10.3		
	26		Sandstone, (as above) but less w/ dGr shale in wavy rippled bd, occ burrows.	10.2 +0.1		
	28		Becomes more shaley w/depth			
	30					
	32			32.4 Run 3		Reamed hole & set 6" PVC casing to 32.0'.
			(33.1) Highly carb shaley Sandstone, Lt dGr Carb. (34.3)			6/8/84
	34		Shale, dGr Blk, carb, th bd, blocky, hd			
	36		(36.1) Coal, Blk, hd Blocky	10.1 10.2 -0.1		
	38		38.1 Shale, dGr, th bd, v hor bd abundant carb nodules, occ siderite lens - nodules, hd Blocky			
	40					

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE | PROJECT | HOLE NO.

Hole No. WES-10-52C-DH

DRILLING LOG	DIVISION	INSTALLATION	SHEET 5 OF 5 SHEETS

1. PROJECT		10. SIZE AND TYPE OF BIT	
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY		12. MANUFACTURER'S DESIGNATION OF DRILL	
4. HOLE NO. (As shown on drawing title and file number)	10-52C	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED / UNDISTURBED
5. NAME OF DRILLER		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE	STARTED / COMPLETED
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE	
8. DEPTH DRILLED INTO ROCK		18. TOTAL CORE RECOVERY FOR BORING	%
9. TOTAL DEPTH OF HOLE		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	40		Shale (cont.)			
			(Dk. gray zone along bn.)			
	42			42.6 Run 4		
	44					
	46			10.1 / 10.2		
				-0.1		
	48					
	50					
	52			52.0 Run 5		52.7 — pull depth
	54					
	56			10.3 / 10.2		
	58		Bot 4.0' has coal pts	+0.1		
	60					

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE PROJECT HOLE NO

Hole No. WES-10-52-BF

DRILLING LOG	DIVISION	INSTALLATION	SHEET 4 OF 5 SHEETS
1. PROJECT		10. SIZE AND TYPE OF BIT	
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY		12. MANUFACTURER'S DESIGNATION OF DRILL	
4. HOLE NO. (As shown on drawing title and file number)	10-52C	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED	
5. NAME OF DRILLER		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE: STARTED / COMPLETED	
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE	
8. DEPTH DRILLED INTO ROCK		18. TOTAL CORE RECOVERY FOR BORING %	
9. TOTAL DEPTH OF HOLE		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	60		Sh (cont.)			
			(61.1)			
			Coal, blk, hd, blocky			
	62		(62.3)			
			Sh (os abdt) w/coal pts			
			(62.8)	63.0		
			Sandstone, l-mGr, mass, vf-f, shaley + carb.	Run 6		
	64					
	66		GrBr calc, ss w/ small vugs.			
			(67.4)	9.7		
	68		Shale, blk, th bd, slickensides fissile, ("slick when wet"), homo	10.0		
				8/3		
	70					
	72			72.7		Full depth
				73.0		
				Run 7		
	74					
	76			10.3		
				10.0		
			alt lGr ss lens			
	78		(78.6)	+8.3		
			Highly Burr ss (78.9)			
			Shale, vdGr-blk, th bd occ lGr sdy pts, abundant			
	80					

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE PROJECT HOLE NO.

Hole No. WES-10-52C-80

DRILLING LOG	DIVISION	INSTALLATION	SHEET 5 OF 5 SHEETS

1. PROJECT		10. SIZE AND TYPE OF BIT	
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY		12. MANUFACTURER'S DESIGNATION OF DRILL	
4. HOLE NO. (As shown on drawing title and file number)	10-52C	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED / UNDISTURBED
5. NAME OF DRILLER		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE	STARTED / COMPLETED
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE	
8. DEPTH DRILLED INTO ROCK		18. TOTAL CORE RECOVERY FOR BORING	%
9. TOTAL DEPTH OF HOLE		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	80		Carb inclus, hd, blocky			
	82			83.0		
			Bot. 83.0'			
	84					

ENG FORM 1836 PREVIOUS EDITION ... PROJECT ... HOLE NO.

Hole No. WES-10-52C-88

DRILLING LOG	DIVISION	INSTALLATION	SHEET OF SHEETS
1. PROJECT		10. SIZE AND TYPE OF BIT	
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY		12. MANUFACTURER'S DESIGNATION OF DRILL	
4. HOLE NO. (As shown on drawing title and file number)	10-52C	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN / DISTURBED / UNDISTURBED	
5. NAME OF DRILLER		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE / STARTED / COMPLETED	
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE	
8. DEPTH DRILLED INTO ROCK		18. TOTAL CORE RECOVERY FOR BORING %	
9. TOTAL DEPTH OF HOLE		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
812.46			Well No: WES-10-52C-88			Date well screen was set: 6/8/89
			+2.5			
			0.0' Ground surface			
			Grout mixture			Water level just Prior to setting screen -
			33.0'			
			Bentonite Pellets			
			35.0'			
			Filter Pack			
			50.0'			
			Bentonite Plug,			
			55.0'			
			58.0			
			Well Screen			
			68.0			
			Trap			
			69.0			
			(73.0-83.0 - Bentonite plug)			
			83.0 Boring Depth			

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE-SWMU-12
PROJECT NUMBER: N6878
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: CME 550 ATV

BORING No.: 12MWT25
DATE: 9-12-04
GEOLOGIST: CONTI
DRILLER: WALSH

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	Sample BZ	Borehole	Drill BZ
S-1 @ 1040	0	8/7	.4/2		M DENSE	BRN GRAY	TOP 3" TOPSOIL SILT - SOME ROAD GRAVEL	ML	DAMP → DRY	0			
	2	7/12		2		MOTTLED			FILL ?	0			
S-2 @ 1045		6/4	1.4/2		STIFF	GRAY BRN	CLAYEY SILT - TR ROOTS TR F. SAND	ML	MOIST	0			
	4	9/10				ORANG				0			
S-3 @ 1050		6/7	2/2		V STIFF	GRAY BRN	CLAYEY SILT - SOME SAND AND SANDSTONE FRAGMENTS	ML	MOIST	0			
	6	8/12		6				SC	DAMP	0			
S-4 @ 1105	7±	36/50	1/1.1	7'	V STIFF M SOFT	GRAY BRN	SANDY SILT & WEATHERED SANDSTONE			0			
	8	50/2"		REFUSAL					REF @ 7'±	0			
										0			
9.5 1105	9.5		9.5		M SOFT	GRAY	SHALY SANDSTONE (V. THIN STREAKS OF SHALE)	VBR	SEVERAL HORIZ BREAKS ALONG BEDDING PLANES	0			
							(10.4 10.9 Fe stained Jnts)		TIGHTLY SP. NOT MUCH H2O	0			
8/55	①	15%	5.5/5.5		M HARD AT 13±	GRAY		TO BR		0			
										0			
1130	15			15						0			
1140					M SOFT			VBR	SEVERAL HORIZ	0			
					M HARD	GRAY			BEDDING PLANE JNTS W/ TR WATER THRU OUT	0			
								BR		0			
4.3/10	②	42%	10/10							0			
										0			
										0			
										0			
										0			
										0			
									24.2 → 24.6 VERT JNT TR H2O	0			
1210				25					EST WATER @ 1300	0			

* 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): 0

Remarks: 4¼" ID HSA w/ AUTO HAMMER / 2" SPOONS
SET TEMP CAS TO 9.5
NX IN ROCK - REAM TO 26 w 5½" BIT - SCREEN 15-25 SAND 10-26

Converted to Well: Yes ✓ No _____ Well I.D. #: 12MWT25

Tetra Tech NUS, Inc.

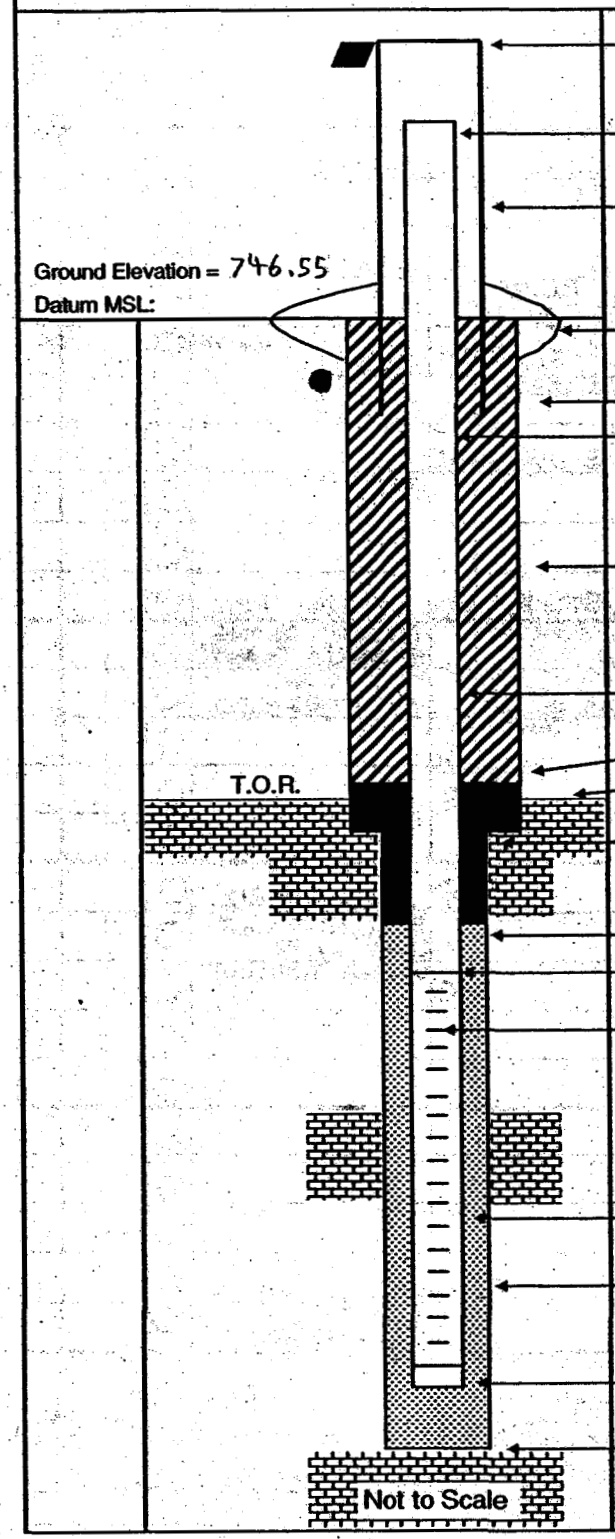
BEDROCK

MONITORING WELL SHEET

WELL No.: 12MWT25

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER-MORNER	BORING No.:	12MWT25
PROJECT No.:	N6878	DRILLER:	WALSH	DATE COMPLETED:	9-12-04
SITE:	SWMU-12	DRILLING METHOD:		NORTHING:	1313924.59
GEOLOGIST:	CONTI	DEV. METHOD:	Surge & Purge	EASTING:	302629.42



Elevation of Top of Casing:	NA
Stick Up of Casing Above Ground Surface:	NA
Elevation of Top of Riser:	748.66
I.D. of Surface Casing:	
Type of Surface Casing:	Steel
Type of Surface Seal:	
I.D. and Depth of Permanent Casing: (if applicable)	TEMP TO 9.5'
I.D. of Riser:	2"
Type of Riser:	PVC
Borehole Diameter:	8 1/2"
Type of Backfill:	BENTONITE CHIPS
Elevation / Depth Top of Seal:	743.55 / 3'
Elevation / Depth Top of Bedrock:	739.55 / 7'
Type of Seal:	BENTONITE CHIPS
Elevation / Depth of Top of Fine Sand:	NA / NA
Elevation / Depth of Top of Filter Pack:	736.55 / 10
Elevation / Depth of Top of Screen:	731.55 / 15
Type of Screen:	PVC
Slot Size x Length:	20 x 10'
I.D. of Screen:	2"
Type of Filter Pack:	GLOBAL #5
Diameter of Hole in Bedrock: Core / Ream:	5 1/2"
Elevation / Depth of Bottom of Screen:	721.55 / 25
Elevation / Total Depth of Borehole:	720.55 / 26

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE-SWMU-12
PROJECT NUMBER: N6878
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: CME 550 ATV

BORING No.: 12MWT26
DATE: 9-12-04
GEOLOGIST: CONTI
DRILLER: WALSH

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 **	Sample BZ	Borehole **	Drill. BZ
S-1 C	0	3/4	1.8/2		STIFF	BRN	TOP 3" TOP SOIL CLAYEY SILT - TR ROOTS	ML	MOIST	0			
1430	2	5/4		2		ORANGE				0			
S-2 C		2/2	2/2		M STIFF	BRN	CLAYEY SILT/SILTY CLAY	ML CL	MOIST → WET	0			
1435	4	4/3				MOTTLD	TR ROOTS			0			
S-3 C		2/2	1.5/2		M STIFF	GRAY BRN	SILTY CLAY - TR SAND	CL/ML	MOIST	0			
1440	6	5/7		6			TR ROCK FRAGS		WEATH ROCK IN SHOE	0			
S-4 C		18/24	1.5/2		M STIFF	GRAY BRN	WEATHERED SANDSTONE	VBR	DAMP	0			
1445	8	36/50		8'	M SOFT					0			
									REF @ 8'±	0			
	9.5		9.5							0			
1450					M SOFT	BRN	WEATHERED SANDSTONE - TR	VBR		0			
					M HARD		RED BRN CLAY SEAMS		SEVERAL HORIZ BEDDING PLANE	0			
							(FRIABLE)		BREAKS AND JNTS - SOME	0			
							W/ RED BRN LAMINATIONS		H2O THROUT RUN ①	0			
5/5.5	①	9%	5.5/5.5							0			
				14						0			
1515	15									0			
1525				15.5±						0			
					M HARD	TAN BRN	SANDSTONE	BR	16.8 } HORIZ 17.1 } JNTS	0			
									17.3 } TR H2O	0			
									18' VUG 18.7'	0			
7.5/10	②	76%	9.5/10							0			
						GRAY @ 21'	SANDSTONE - LAMINATED W/ SHALE STREAKS		20.3 HORIZ INT 20.8 TR H2O	0			
							22.4 COAL LENS 1/2" W/ COAL" INTERBEDS			0			
							TO 23.8			0			
				24±					24.3 M SOFT TR H2O	0			
1550	25				M SOFT	GRAY	SANDY SHALE	BR		0			

* 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): 0

Remarks: 4 1/4" HSA W/ AUTO HAMMER | 2" SPOONS
SET 6" CAS TO 9-5
NX CORE IN ROCK - REAM TO 5 1/2"

Converted to Well: Yes ✓ No _____ Well I.D. #: 12MWT26

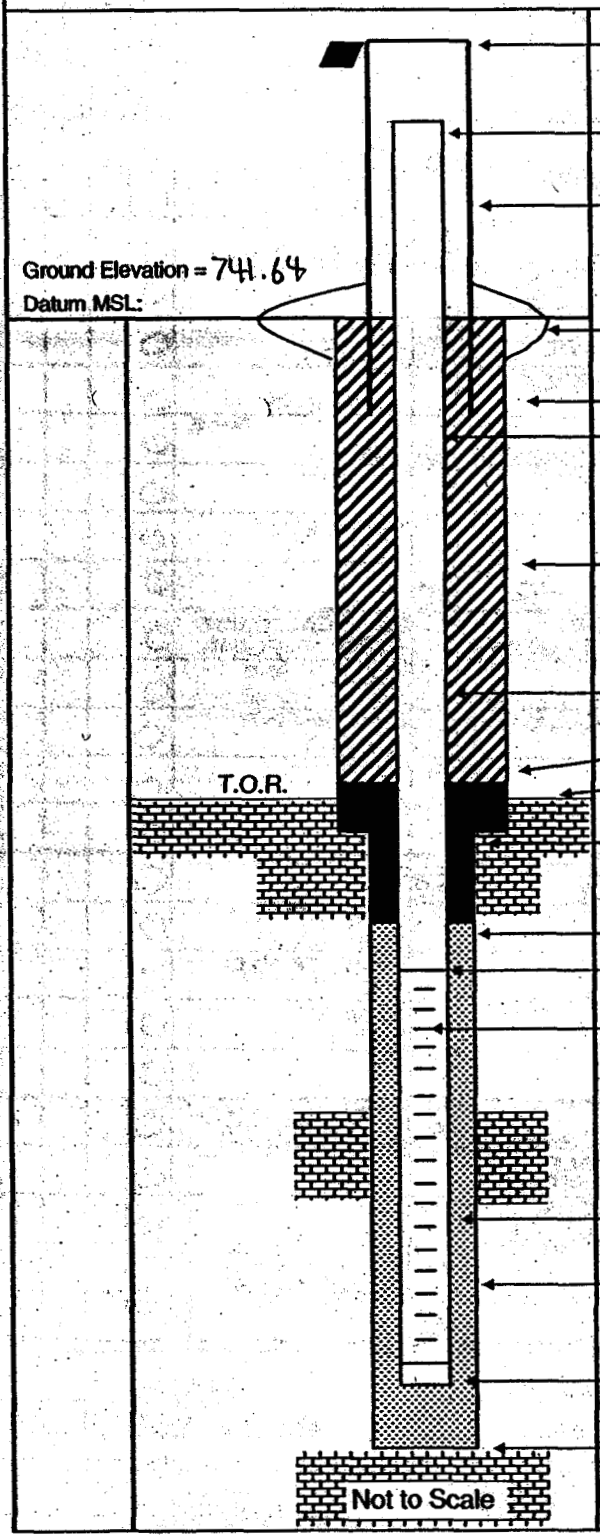
Tetra Tech NUS, Inc.

BEDROCK MONITORING WELL SHEET

WELL No.: 12MWT26

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER-MORNER	BORING No.:	12MWT26
PROJECT No.:	N6878	DRILLER:	WALSH	DATE COMPLETED:	9-12-04
SITE:	SWMU-12	DRILLING METHOD:	HSA-ROT	NORTHING:	1313638.57
GEOLOGIST:	CONTI	DEV. METHOD:	Surge & Purge	EASTING:	302598l.12



Elevation of Top of Casing:	NA
Stick Up of Casing Above Ground Surface:	NA
Elevation of Top of Riser:	743.72
I.D. of Surface Casing:	
Type of Surface Casing:	Steel
Type of Surface Seal:	
I.D. and Depth of Permanent Casing: (if applicable)	TEMP TO 9.5
I.D. of Riser:	2"
Type of Riser:	PVC
Borehole Diameter:	8½
Type of Backfill:	BENTONITE CHIPS
Elevation / Depth Top of Seal:	738.64 / 3'
Elevation / Depth Top of Bedrock:	733.68 / 8'
Type of Seal:	
Elevation / Depth of Top of Fine Sand:	NA / NA
Elevation / Depth of Top of Filter Pack:	730.68 / 11
Elevation / Depth of Top of Screen:	727.68 / 14
Type of Screen:	PVC
Slot Size x Length:	20 x10'
I.D. of Screen:	2"
Type of Filter Pack:	GLOBAL #5
Diameter of Hole in Bedrock: Core / Ream:	5½
Elevation / Depth of Bottom of Screen:	717.68 / 24
Elevation / Total Depth of Borehole:	716.68 / 25

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE-SWMU-12
PROJECT NUMBER: N6878
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: TRUCK MOUNT B-59

BORING No.: 12 MWT 27
DATE: 9/2/04
GEOLOGIST: Charles C. Laney III
DRILLER: Ken Bochmer

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**
	1						See Boring Log			Ø	Ø	Ø	Ø
	2						12MWT25 FOR						
	3						LITHOLOGY						
	4												
	5										Ø	Ø	Ø
	6						Boring was Drilled						
	7						without Sampling/coring						
	8												
	9												
	10										Ø	Ø	Ø
	11												
	12												
	13												
	14												
	15			15							Ø	Ø	Ø
	16												
	17												
	18												
	19												
	20										Ø	Ø	Ø
	21												
	22												
	23												
	24												
	25			25							Ø	Ø	Ø

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: 6" Temporary Casing set to 11' bgs.
Borehole was Reamed to 26' bgs.

Drilling Area Background (ppm): Ø

Converted to Well: Yes X No _____ Well I.D. #: 12MWT27

Tetra Tech NUS, Inc.

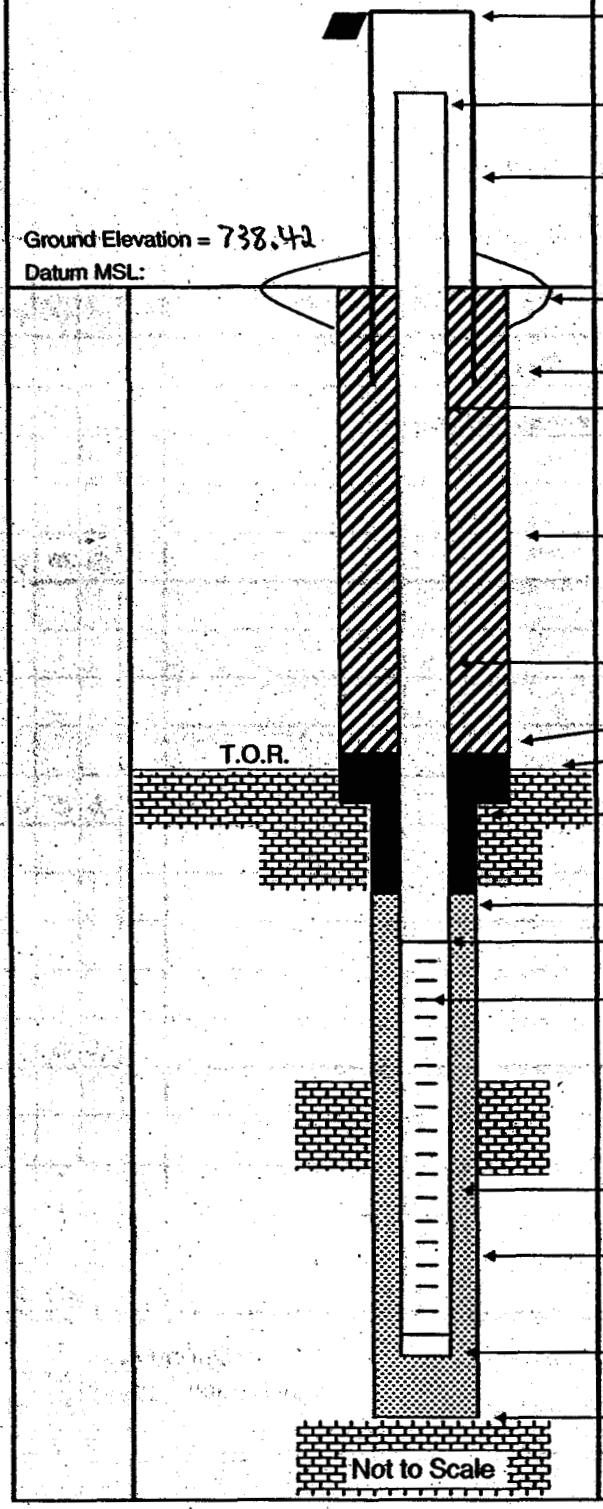
BEDROCK

MONITORING WELL SHEET

WELL No.: 12 MWT 27

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER-MORNER	BORING No.:	12 MWT 27
PROJECT No.:	N6878	DRILLER:	Ken Boehmer	DATE COMPLETED:	9/2/04
SITE:	SWMU-12	DRILLING METHOD:	HSA / Roto	NORTHING:	1313736.63
GEOLOGIST:	Charles C. Lowe III	DEV. METHOD:	Surge & Purge	EASTING:	302647.23



Elevation of Top of Casing:	NA
Stick Up of Casing Above Ground Surface:	NA
Elevation of Top of Riser:	740.52
I.D. of Surface Casing:	
Type of Surface Casing:	Steel
Type of Surface Seal:	
I.D. and Depth of Permanent Casing: (if applicable)	6" Temp To 11'
I.D. of Riser:	2"
Type of Riser:	PVC
Borehole Diameter:	8½ to 9'
Type of Backfill:	Cement Bent. Grout
Elevation / Depth Top of Seal:	735.42 / 3'
Elevation / Depth Top of Bedrock:	728.42 / 10'
Type of Seal:	Bentonite Chips
Elevation / Depth of Top of Fine Sand:	NA / N/A
Elevation / Depth of Top of Filter Pack:	726.42 / 12'
Elevation / Depth of Top of Screen:	723.42 / 15'
Type of Screen:	PVC
Slot Size x Length:	2#SL x 10'
I.D. of Screen:	2"
Type of Filter Pack:	GLOBAL #5 QUARTZ SAND
Diameter of Hole in Bedrock: Core / Ream:	5½"
Elevation / Depth of Bottom of Screen:	713.42 / 25'
Elevation / Total Depth of Borehole:	712.42 / 26'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE-SWMU-12
PROJECT NUMBER: N6878
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: Truck Mount B-59

BORING No.: 12MWT33
DATE: 8/31/04
GEOLOGIST: Charles C. Laney III
DRILLER: Tom Boehmer

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	MATERIAL DESCRIPTION: Color	MATERIAL DESCRIPTION: Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1									ϕ			
	2						See Log 12MWT25			ϕ			
	3						For Lithology From			ϕ			
	4						ϕ - 25' bgs.			ϕ			
	5									ϕ			
	6									ϕ			
	7									ϕ			
	8									ϕ			
	9									ϕ			
	10									ϕ			
	11									ϕ			
	12									ϕ			
	13									ϕ			
	14									ϕ			
	15									ϕ			
	16									ϕ			
	17									ϕ			
	18									ϕ			
	19									ϕ			
	20									ϕ			
	21									ϕ			
	22									ϕ			
	23									ϕ			
	24									ϕ			
	25									ϕ			

* 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): ϕ

Remarks: Temporary Casing Set to 10.5' bgs

Converted to Well: Yes X No _____ Well I.D. #: 12MWT33

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE-SWMU-12
PROJECT NUMBER: N6878
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: Truck Mount B-59

BORING No.: 12 MWT 33
DATE: 8/31/04
GEOLOGIST: Charles C. Lowry III
DRILLER: Tom Boehmer

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**
	26												
	27												
	28												
	29												
	30												
	31												
	32												
	33												
	34												
	35												
	36												
	37												
	38												
	39												
	40												
	41				MEDIUM HARD	GRAY	SANDSTONE		V. BR.	0			
	42				"	"	"			0			
	43				"	"	"			0			
	44				SOFT	BLACK	COAL		TRACE PYRITE	0			
C-1	45	65%	9'/9'		"	"	"			0			
39'/41'					"	"	"			0			
	46				MEDIUM HARD	GRAY	SANDSTONE			0			
	47				"	"	"			0			
	48				MEDIUM SOFT	DK GRAY	CLAYSTONE			0			
9/3/04→	49				"	"	"			0			
	50				MEDIUM HARD	"	SANDSTONE INTERBED.		BLOCKY				

* 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): 0

Remarks: Permanent Casing set to 35.5' bgs.

Converted to Well: Yes X No _____ Well I.D. #: 12MWT33

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE-SWMU-12
PROJECT NUMBER: N6878
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: Truck Mount B-59

BORING No.: 12 MWT 33
DATE: 9/2/04
GEOLOGIST: Charles C. Laney III
DRILLER: Tom Boehmer

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**
	51				Medium Hard	Dark Gray	Sandstone interbedded w/ Siltstone		Blocky A lot of Bedding	ϕ			
	52				"	"	"		"	ϕ			
	53				"	"	"		"	ϕ			
8.4/10	54	84%	9.8/10		"	"	"		"	ϕ			
	55				"	"	"		"	ϕ			
	56				"	"	"		"	ϕ			
	57				"	"	"		"	ϕ			
	58				"	"	"		"	ϕ			
ϕ/10	59				"	"	"		"	ϕ			
	60				"	"	Sandstone interbedded w/ Siltstone & Shale		V.B.R. From 61-62'	ϕ			
	61				"	"	"		← From 62.5-63'	ϕ			
	62				"	"	"		Rest - Blocky A lot of Bedding	ϕ			
	63				"	"	"		"	ϕ			
4.6/10	64	46%	9/10		"	"	"		"	ϕ			
	65				"	"	"		"	ϕ			
	66				"	"	"		"	ϕ			
	67				"	"	"		"	ϕ			
	68				"	"	"		"	ϕ			
ϕ/45	69				"	"	"		"	ϕ			
	70				"	"	"		Blocky. A lot of Bedding	ϕ			
	71				"	"	"			ϕ			
	72				Soft	Black	Coal (70.7 → 72')		V.B.R.	ϕ			
	73				"	"	" " "		"	ϕ			
4.4/10	74	41%	9/10	74	Medium Hard	Black	Siltstone		"	ϕ			
	75				"	Dark Gray	Sandstone interbedded w/ Siltstone		Blocky	ϕ			
					"	"	"		"	ϕ			

C-2 C-3 C-4

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: C-2 Core Fell into Hole once & Had to Be Retrieved

Drilling Area Background (ppm): ϕ

Converted to Well: Yes X No _____ Well I.D. #: 12 MWT 33

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE-SWMU-12
PROJECT NUMBER: N6878
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: Truck Mount B-57

BORING No.: 12MWT33
DATE: 9/2/04
GEOLOGIST: Charles C. Lever III
DRILLER: Tom Boehmer

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**
	76				medium hard	Dark Gray	SANDSTONE INTERBEDDED W/ SILTSTONE		Blocky	0			
	77				"	"	"		"	0			
	78				"	"	"		"	0			
@210	79				"	"	"		"	0			
	80				"	"	"		Blocky → Broken w/ [illegible]	0			
	81				"	"	"		Fractures appear water Bearing	0			
	82				"	"	"		"	0			
	83				"	"	"		"	0			
	84				"	"	"		"	0			
C-5 42/10	85	42%	95/10		"	"	"		"	0			
	86				"	"	"		"	0			
	87				"	"	"		"	0			
	88				"	"	"		"	0			
@234	89				"	"	"		"	0			
	90				"	"	"		"	0			
	91				"	"	"		"	0			
C-6 9.9/5	92	38%	4.9/5		"	"	"		"	0			
	93				"	"	"		"	0			
@344	94			94	"	"	"		"	0			
	95												
					BORING TERMINATED								

* 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): 0

Remarks: Hole Reamed to 95 'bgs.

Converted to Well: Yes X No _____ Well I.D. #: 12MWT33

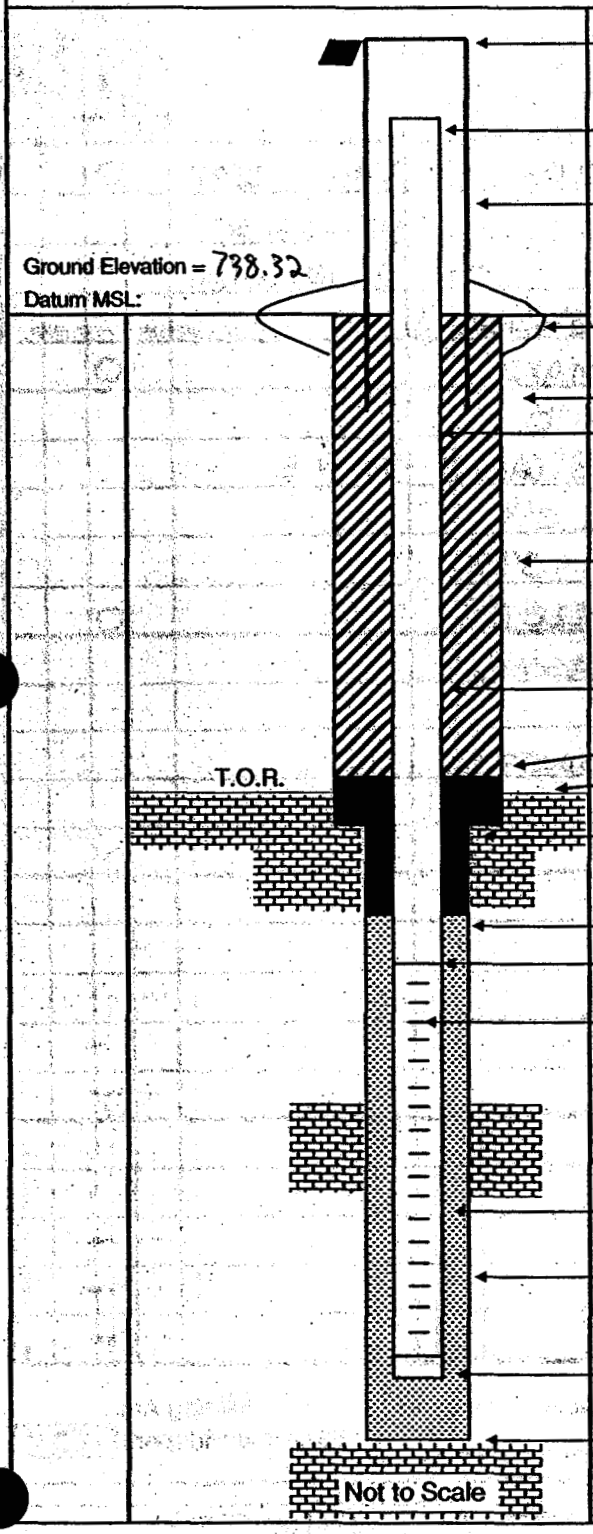
Tetra Tech NUS, Inc.

BEDROCK MONITORING WELL SHEET

WELL No.: 12MWT33

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER-MORNER	BORING No.:	12MWT33
PROJECT No.:	N6878	DRILLER:	Ken Bochmer	DATE COMPLETED:	9/2/04
SITE:	SWMU-12	DRILLING METHOD:	HSA/Rot	NORTHING:	1313728.86
GEOLOGIST:	Charles C. Lauer III	DEV. METHOD:	Surge & Purge	EASTING:	302648l.26



Elevation of Top of Casing:	NA
Stick Up of Casing Above Ground Surface:	NA
Elevation of Top of Riser:	740.49
I.D. of Surface Casing:	
Type of Surface Casing:	Steel
Type of Surface Seal:	
I.D. and Depth of Permanent Casing: (if applicable)	6" to 35.5'
I.D. of Riser:	2"
Type of Riser:	PVC
Borehole Diameter:	10"
Type of Backfill:	Cement Bentonite Grout
Elevation / Depth Top of Seal:	678.32 / 69'
Elevation / Depth Top of Bedrock:	727.82 / [illegible]
Type of Seal:	Bentonite Chips
Elevation / Depth of Top of Fine Sand:	NA / N/A
Elevation / Depth of Top of Filter Pack:	669.32 / 69'
Elevation / Depth of Top of Screen:	664.32 / 74'
Type of Screen:	PVC
Slot Size x Length:	20 SL x 10'
I.D. of Screen:	2"
Type of Filter Pack:	Global #5 Quartz Sand
Diameter of Hole in Bedrock: Core / Ream:	5½"
Elevation / Depth of Bottom of Screen:	644.32 / 94'
Elevation / Total Depth of Borehole:	641.32 / 95'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC
BORING NUMBER: 13MWT01
DATE: 3/30/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S.

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**
	1					BR	2" TOPSOIL	ML	5' 0-6'	0.0			
	2					↓	↓						
	3				DRY	YELL	2'-6' CLAYEY SILT						
	4					OR ↓							
S-1 1125	5		4.9' / 5'			LT. GRY	↓			↓		0.0	0.0
	6					YELLOW & LT. GRAY	CLAYEY SILT	↓		0.0			
	7				MOIST	BRN	6'-9.5' SILTY SAND	SM	WEATHERED S.S.	↓			
	8				↓	YELL OR	↓	↓	↓				
	9					↓	↓	↓	↓				
S-2 1145	10		4.8' / 5'		HARD DRY	↓	.5' SANDSTONE	R	ROCK @ 9.5'	↓			
↓	11					LT GRAY	WL @ 6' BGS	↓					
	12					↓	5" REAM TO 15'						
R-1	13						SANDY MATERIAL						
	14					↓	IN CUTTINGS						
↓	15					DK GRAY	SILTY MATERIAL	↓					
				T.D. 15'			WELL SET @ 15' 2" PVC						
							SCREENED 5-15'						
							SAND TO 3'						
							BENT TO 1'						

* 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): 0.0

Remarks: _____

Converted to Well: Yes X No _____ Well I.D. #: 13MWT01

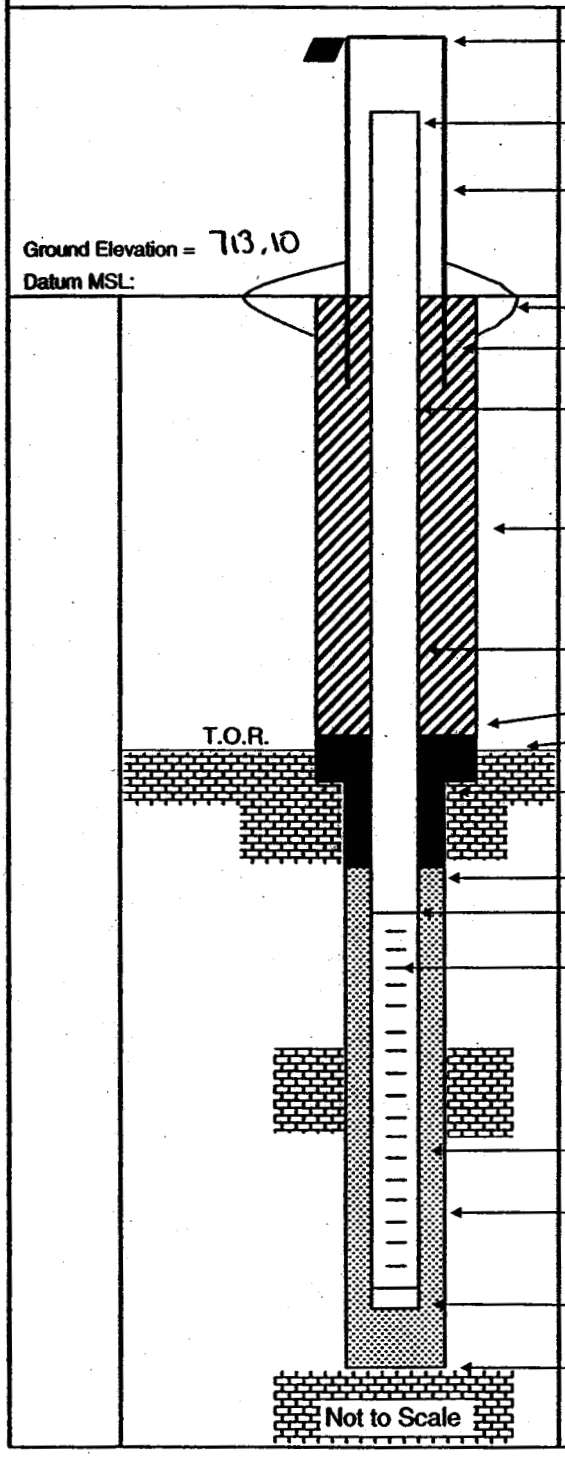
Tetra Tech NUS, Inc.

BEDROCK MONITORING WELL SHEET

WELL No.: 13MW701

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	13MW701
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVE S	DATE COMPLETED:	3/30/03
SITE:	SWMU 13	DRILLING METHOD:	ROTOSONIC	NORTHING:	1310541.574
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WATER PUMP	EASTING:	302501 5.943



Elevation of Top of Casing:	715.94
Stick Up of Casing Above Ground Surface:	2.84'
Elevation of Top of Riser:	715.34
I.D. of Surface Casing:	4" SQUARE
Type of Surface Casing:	STEEL
Type of Surface Seal:	4'x4'x6" PAD
I.D. of Permanent Casing:	NA
I.D. of Riser:	2"
Type of Riser:	PVC
Borehole Diameter:	5"
Type of Backfill:	GROUT
Elevation / Depth Top of Seal:	712.1 / 1'
Elevation / Depth Top of Bedrock:	702.6 / 9.5'
Type of Seal:	BENT CHIPS
Elevation / Depth of Top of Filter Pack:	710.1 / 3'
Elevation / Depth of Top of Screen:	709.1 / 5'
Type of Screen:	PVC
Slot Size x Length:	.20 x 10'
I.D. of Screen:	2"
Type of Filter Pack:	No. 20-40 SAND
Diameter of Hole in Bedrock: Core / Ream:	5"
Elevation / Depth of Bottom of Screen:	698.10 / 15'
Elevation / Total Depth of Borehole:	698.10 / 15'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC

BORING NUMBER: BMW703
DATE: 3/30/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S.

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	MATERIAL DESCRIPTION: Color	MATERIAL DESCRIPTION: Material Classification	USCS *	PID/FID Reading (ppm): Remarks	PID/FID Reading (ppm): Sample	PID/FID Reading (ppm): Sampler BZ	PID/FID Reading (ppm): Borehole**	PID/FID Reading (ppm): Driller BZ**
	1						SEE BMW701 FOR LITHOLOGY		5" 0-15'				
						YELL OR	SILTY MATERIAL						
						↓	↓						
1515	5					↓	↓						
							SANDY MATERIAL						
							↓						
1520	10					↓	↓		HARDER @ 10'				
							SANDY MATERIAL						
							↓						
						↓	↓						
						GRAY	COLOR CHANGE @ 13'						
1530	15					↓	SILTY MATERIAL						
				T.D. 15'			WELL SET @ 15' 2" PVC						
							SCREENED 5'-15'						
							SAND TO 3'						
							BENT TO 1'						

* 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 X No ____ Well I.D. #: BMW703

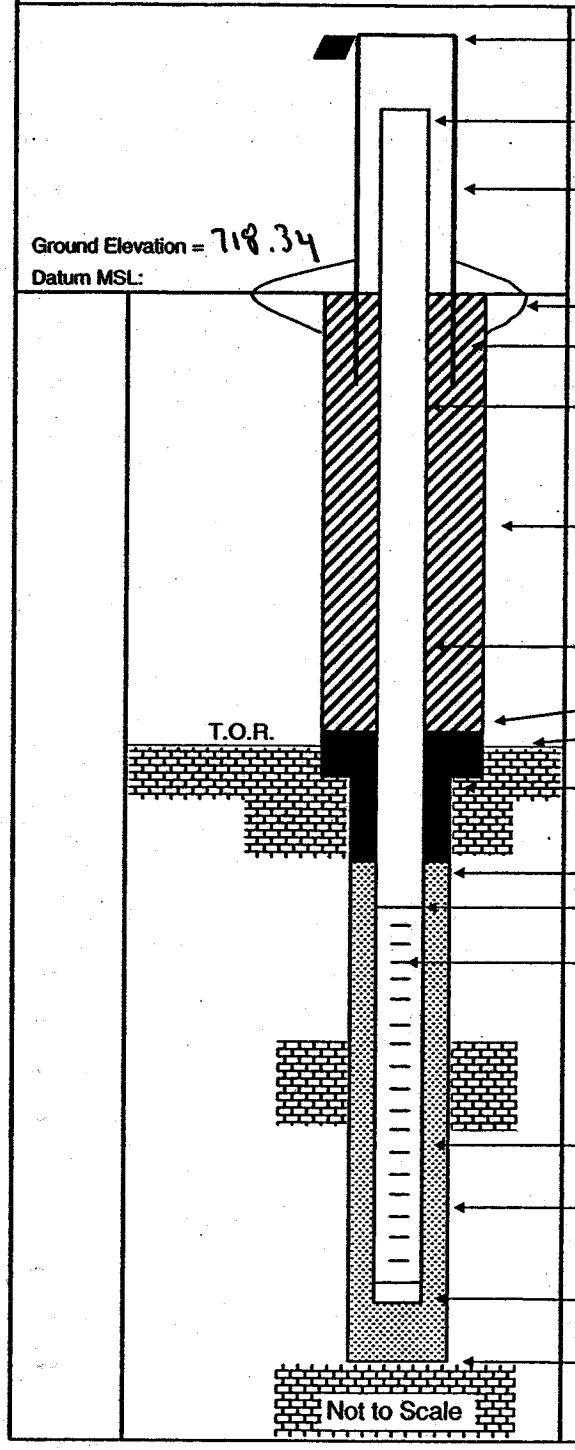
Tetra Tech NUS, Inc.

BEDROCK MONITORING WELL SHEET

WELL No.: 13MWT03

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	13MWT03
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVE S.	DATE COMPLETED:	3/30/03
SITE:	SWMU 13	DRILLING METHOD:	ROTOSONIC	NORTHING:	1310240.946
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WHALE PUMP	EASTING:	302491.661



Elevation of Top of Casing:	721.60
Stick Up of Casing Above Ground Surface:	2.86'
Elevation of Top of Riser:	721.10
I.D. of Surface Casing:	4" SQUARE
Type of Surface Casing:	STEEL
Type of Surface Seal:	4'x4'x6" PAD
I.D. of Permanent Casing:	NA
I.D. of Riser:	2"
Type of Riser:	PVC
Borehole Diameter:	5"
Type of Backfill:	GROUT
Elevation / Depth Top of Seal:	717.34 / 1'
Elevation / Depth Top of Bedrock:	709.34 / 10'
Type of Seal:	BENT. CHIPS
Elevation / Depth of Top of Filter Pack:	715.34 / 3'
Elevation / Depth of Top of Screen:	713.34 / 5'
Type of Screen:	PVC
Slot Size x Length:	10' x .20
I.D. of Screen:	2"
Type of Filter Pack:	No. 20-40 SAND
Diameter of Hole in Bedrock: Core / Ream:	5"
Elevation / Depth of Bottom of Screen:	703.34 / 15'
Elevation / Total Depth of Borehole:	703.34 / 15'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: Crane NSWC
PROJECT NUMBER: 9060
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTO-SONIC

BORING No.: 13MWT28
DATE: 11-3-03
GEOLOGIST: FRED W RAMSER
DRILLER: JON KEIFER

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	Sample-BZ	Borehole**	Driller-BZ**
	16							SM/SC	DRILLED TO				
	17								0-17.5 W/ OSPL				
	18								CUTTINGS YEL BRN SILT				
	19			TOP OF BDRK	SOFT	DK	YEL BRN MUDSTONE W/ ROCK FRAG.	VBR	+ F.G. SAND + CLAY ~10'				
	20						MOTTLED GREY		MOTTLED GREY W-20 WEATHERED				0
					SOFT	BLK	COAL, BRITTLE	VBR	BD RK COAL 18'	10			
S-1		09			MED SOFT		MED GREY SANDSTONE,	BR					
					MED		MED GREY SANDSTONE	VBR					
	25				SOFT								
			7/10				V. THIN BEDDED						
										8			
					MED								0
					HARD		MED TO LIGHT GREY SANDSTONE	BR					
	30						- IRREGULAR LAM.						
							- OCC VUGS ~1/4"						
S-2		59					HOR. FRAC.			9			
													0
	35												
			4.5/10							12			0
	40												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area

Remarks: CASING TO 38.5, 6" ID INSTALLED W/ 11" OD

Background (ppm): 0.8

Converted to Well: Yes ✓ No _____ Well I.D. #: 13MWT28

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: Crane NSWC
PROJECT NUMBER: 9060
DRILLING COMPANY: Bowser
DRILLING RIG: VERSA-SONIC

BORING No.: 13 MWT 28
DATE: 11/19/03
GEOLOGIST: S. GRIER
DRILLER: J. REIFER

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: Soft Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sample-BZ	Borehole**	Drillr-BZ
	38				~~VERY~~ HARD MED	GREY DARK	SILTY SANDSTONE		GREY W/ BLACK LAMS	0.0			0.8
							GREY SANDSTONE W/ BLACK LAMS OF SILT						
					VERY HARD	GREY	SANDSTONE ~~SOFT~~ FEW LAMS						
					HARD	GREY BLACK	SILTY SANDSTONE GREY S.S. W/ BLACK LAMS OF SILT INCREASING SILT						
C1	48	10%	9/10							10.0			0.9
C2	58	5%	10/10							11.0			0.8
					MED SOFT ~~HARD~~	BLACK	BLACK SHALE THINLY LAMINATED		FISSILE THIN LAMS				
					HARD	GREY	SILTY SANDSTONE						
					MED SOFT	BLACK	SHALE INCREASING SILT		FISSILE THIN LAMS				

* 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): 0.9

Remarks: 0950 cleaned out hole - H2O level = 77.0'
1100 H2O level = 76.45

Converted to Well: Yes ✓ No ____ Well I.D. #: 13 MWT 28

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: Crane NSWC
PROJECT NUMBER: 9060
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: VERSA-SONIC

BORING No.: 13 MWT 28
DATE: 11/19/03
GEOLOGIST: SCOTT GRIER
DRILLER: JON KEIFER

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	Sample BZ	Borehole**	Drilling BZ
	63	43			MED HARD	BLACK	~~STEEP~~ SHALE BLACK, BRITTLE	BR	FISSILE - THIN LAMS				
							SILTY SANDSTONE	SM					
C3													
	68	3%	9/10				DECREASING SILT			80			0.0
					VERY HARD	GREY	GREY SANDSTONE						
					MED SOFT FISSILE	BLACK	SHALE THIN LAMINATIONS						
C4													
	78	3%	85/10							65			0.0
					VERY HARD	GREY BROWN BLACK	SANDSTONE (VARVED)						
					MED SOFT HARD	BLACK	SHALE THIN LAMS		FISSILE - THIN LAMS				
									Screen set @ 88'→78'				
C5													
	88	5%	75/10		VERY HARD	GREY BROWN	SANDSTONE (VARIED)			02			0.8

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reporise read.

Drilling Area Background (ppm): 0.8

Remarks: 1130 hole is blown out + H2O level = 86'
1230 H2O level = 85.5'

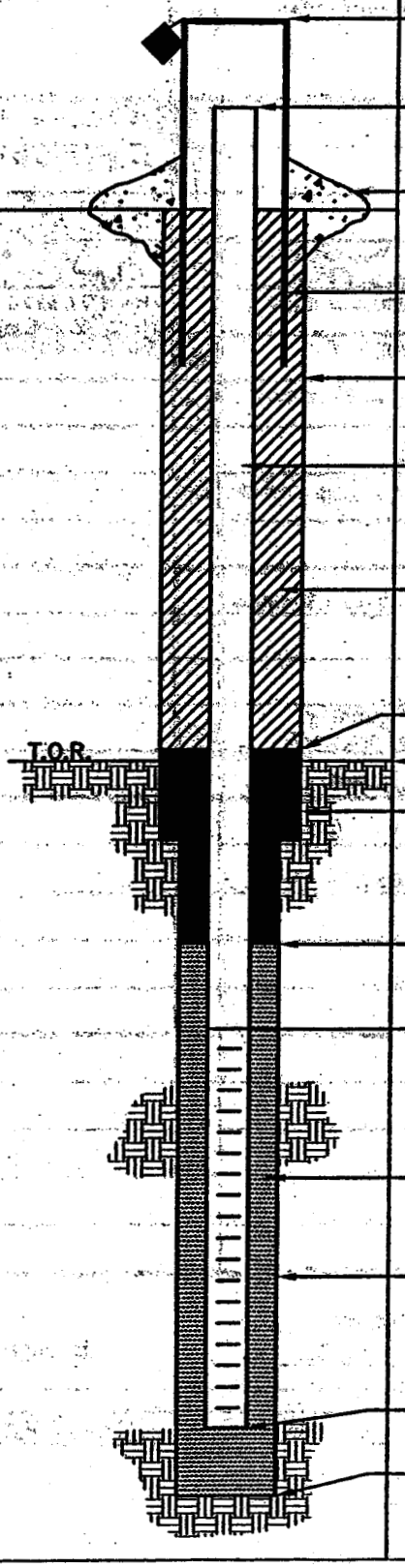
Converted to Well: Yes ✓ No _____ Well I.D. #: 13 MWT 28

WELL NO.: 13 MWT 28

Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK

PROJECT: NSWC CRANE	LOCATION: SWMU 13	DRILLER: JON KEIFER
PROJECT NO.: 9060	BORING: 13 MWT 28	DRILLING METHOD: ROTO-SONIC
DATE BEGUN: 11/19/03	DATE COMPLETED: 11/19/03	
FIELD GEOLOGIST: SCOTT GRIER		DEVELOPMENT BAILER/ METHOD: SURGE/ PUMP
GROUND ELEVATION: 703.54	DATUM: NAVD 88	



ELEVATION/HEIGHT OF TOP OF SURFACE CASING: 705.53 / 2.0

ELEVATION/HEIGHT TOP OF RISER: 705.55 / 2.0

TYPE OF SURFACE SEAL: CONCRETE

I.D. OF SURFACE CASING: 4"x4" STEEL

DIAMETER OF HOLE: 11" down to 38.5

ISOLATION CASING 6" DIA. DEPTH: 38.5

RISER PIPE I.D.: 2"

TYPE OF RISER PIPE: 2" PVC

TYPE OF BACKFILL: BENTONITE

ELEVATION/DEPTH TOP OF SEAL: 700.54 / 3'

ELEVATION/DEPTH TOP OF BEDROCK: 685.04 / 18.5

TYPE OF SEAL: BENTONITE PURE GOLD CHIPS GEL CE700

ELEVATION/DEPTH TOP OF SAND: 628.54 / 75

ELEVATION/DEPTH TOP OF SCREEN: 625.54 / 78

TYPE OF SCREEN: PVC

SLOT SIZE x LENGTH: 20 x 10'

I.D. SCREEN: 2" - 20 slot

TYPE OF SAND PACK: QTZ MED SAND

DIAMETER OF HOLE IN BEDROCK:

CORE/REAM: 4" / 5"

ELEVATION/DEPTH BOTTOM SCREEN: 615.54 / 88

ELEVATION/DEPTH BOTTOM OF SAND: 615.54 / 88

ELEVATION/DEPTH BOTTOM OF HOLE: 615.54 / 88

BACKFILL MATERIAL BELOW SAND: N/A

ACAD: FORM_MWINBR.dwg 07/20/99 INL

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: Crane NSWC
PROJECT NUMBER: 9060
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: CME 550

BORING No.: 16MWT17
DATE: 11-8-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. WALSH

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	Sample BZ	Borehole**	Driller BZ**
	0												
S1		4/10	1.2/		MDENSE	GR	SAND + GRAVEL	SP	FILL, DAMP	0	0	0	0
	2	4/4	2.0						FILL TO				
S2		3/4	1.6/		LOOSE	DK ORN	CLAYEY SILT	SM	FILL, DAMP. SS FRAG+BRICK	0	0	0	0
	4	3/5	2.0						IN SPOON. GREY MOTTLING				
S3		2/2	.4/		V LOOSE	DK BR.	SILTY CLAY	SM	GREY MOTTLING, FILL	0	0	0	0
	6	2/2	2.0										
S4		2/5	.9/		LOOSE	DK BR	SILT,		RED-BR SS FRAG IN BTM	0	0	0	0
	8	18/27	2.0	8.0									
S5		11/15	.9/	9.0	V DENSE	GR	SILT		DAMP. LOOKS NAT.	0	0	0	0
	10	50/5"	1.4										
S6		50/5"	.3/		VI	RD BRN	SANDSTONE		FE STAINED	.6	0	.6	0
	12		.4										
S7		50/1"	.1/			RD BRN	SANDSTONE			.6	.6	.6	.0
	14		.1										
S8		50/1/2"	.1/			GR BR	SANDSTONE			1.3	1.3	1.3	1.3
	16		.2										
S9		11/15	.6/			GR	SANDSTONE		WEATHERED, SAT IN 4 MA ZONE	3.8	1.3	1.3	1.3
	18	50/3"	1.3						BLACK STREAKS IN SPL				
S10		50/1.5	.3/			RD	SANDSTONE		SHALY, FE STAINED	.9	.9	.9	.9
	20		.5						SAT. ALONG SPOON				
S11		50/1.5	.2/			GR	SHALE		VF LAMS IN WHITE DAMP	0	0	0	0
	22		.3										
S12		50/.3	.3/			GR	SHALE		VF LAMS IN WHITE	0	0	0	0
	24		.3				TD 24'						

* 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: PID DRIFT IN MEAS.

Converted to Well: Yes ✓ No ____ Well I.D. #: 16MWT17

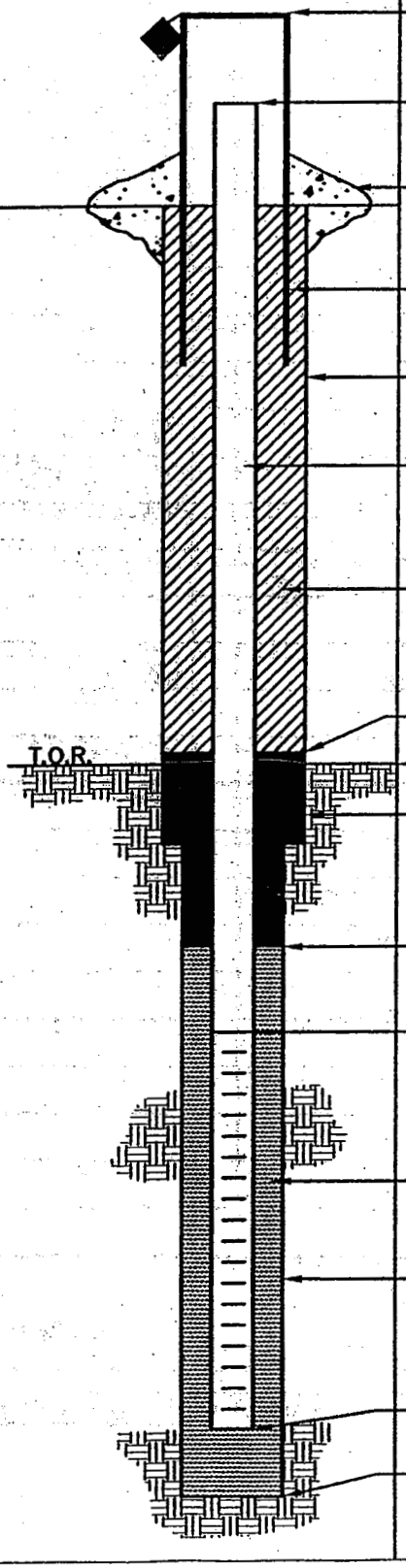
WELL NO.: 16MWT17

Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK

PROJECT: CRANE
PROJECT NO.: 9060
DATE BEGUN: 11-8-03
FIELD GEOLOGIST: M.G. COCHRAN
GROUND ELEVATION: 764.79
LOCATION: CRANE IN
BORING: 16MWT17
DATE COMPLETED: 11-8-03
DATUM: NAVD 88

DRILLER: BOWSER-MORNER
DRILLING METHOD: HSA
DEVELOPMENT METHOD: BAILER/SURGE



ELEVATION/HEIGHT OF TOP OF SURFACE CASING: 766.54/1.7

ELEVATION/HEIGHT TOP OF RISER: 766.53/1.7

TYPE OF SURFACE SEAL: CONCRETE

I.D. OF SURFACE CASING: 4" x 4" SQ. STEEL

DIAMETER OF HOLE: 8 1/2"

RISER PIPE I.D.: 2"
TYPE OF RISER PIPE: PVC SCHEDULE 40

TYPE OF BACKFILL: CETCO PURE GOLD MEDIUM PELLETS

ELEVATION/DEPTH TOP OF SEAL: 761.79/3

ELEVATION/DEPTH TOP OF BEDROCK: 755.79/9

TYPE OF SEAL: CETCO PURE GOLD MEDIUM PELLETS

ELEVATION/DEPTH TOP OF SAND: 752.79/12

ELEVATION/DEPTH TOP OF SCREEN: 750.79/14
TYPE OF SCREEN: PVC SLOTTED
SLOT SIZE x LENGTH: .020 x 10'
I.D. SCREEN: 2"

TYPE OF SAND PACK: GLOBAL MEDIUM SAND

DIAMETER OF HOLE IN BEDROCK: 8 1/2"
CORE/REAM:

ELEVATION/DEPTH BOTTOM SCREEN: 740.79/24
ELEVATION/DEPTH BOTTOM OF SAND: 740.79/24
ELEVATION/DEPTH BOTTOM OF HOLE: 740.79/24
BACKFILL MATERIAL BELOW SAND: —

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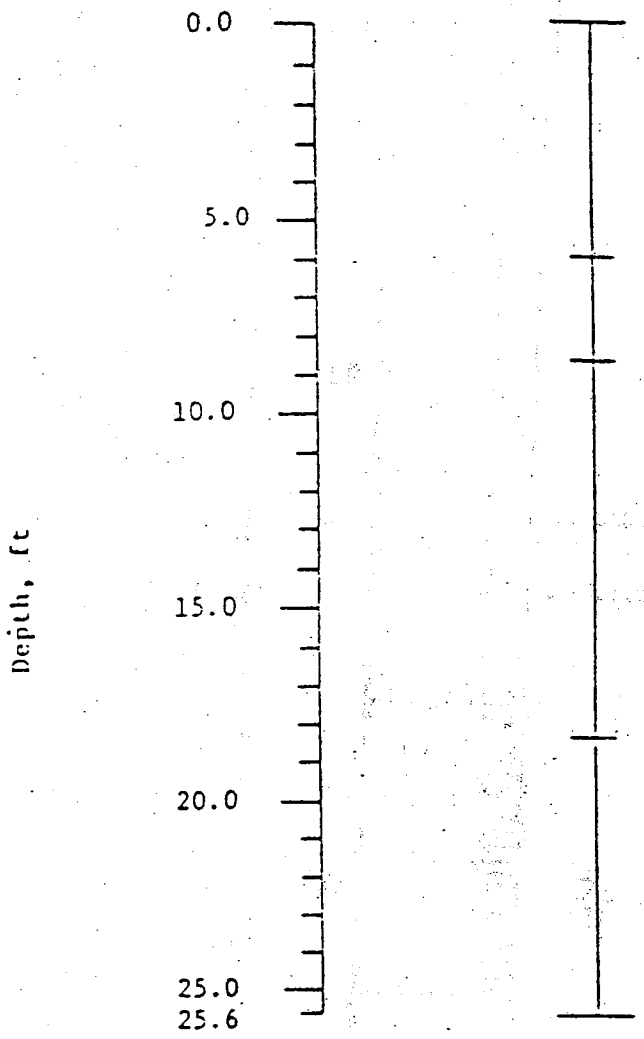
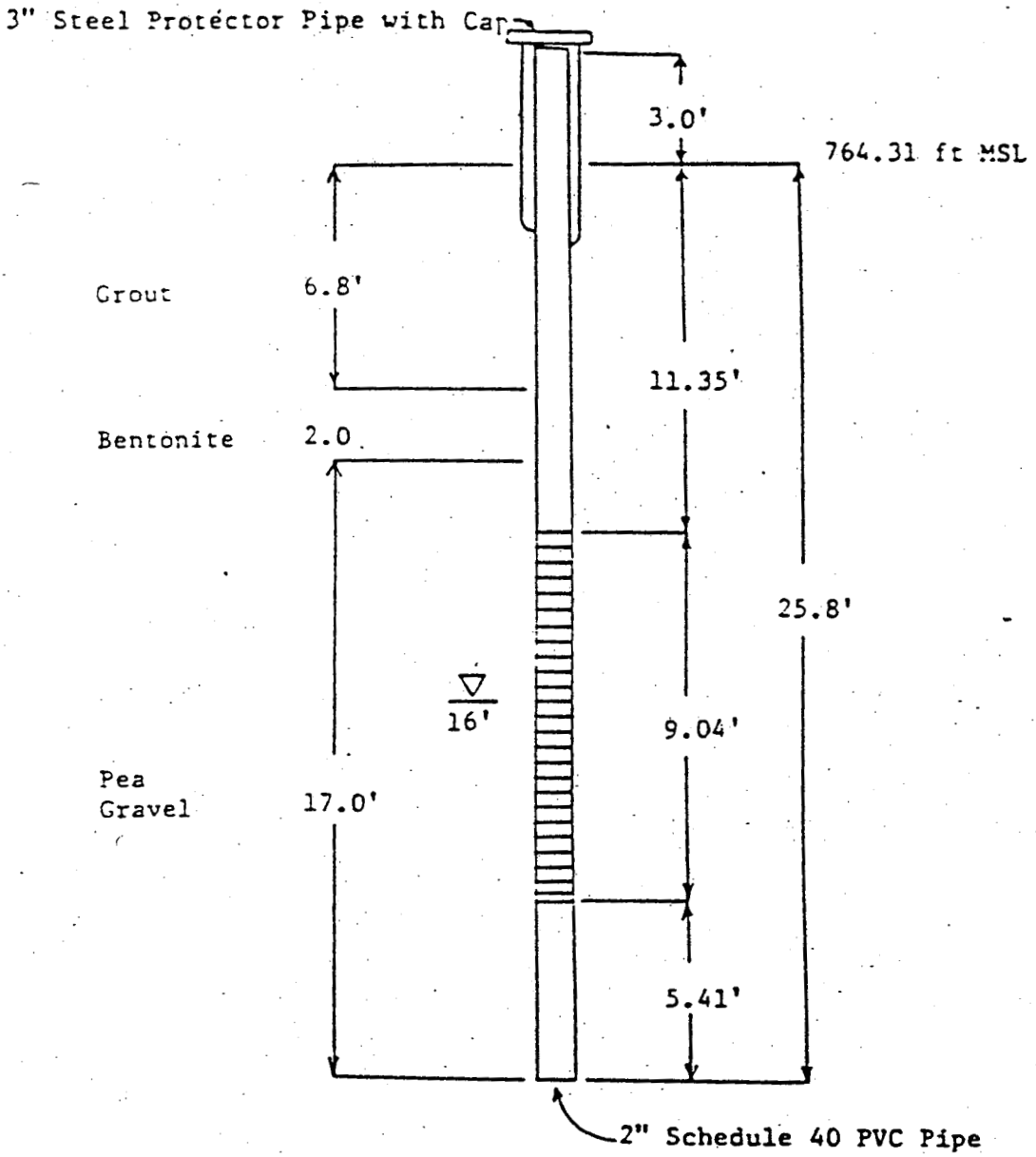


NWSC, Crane, Indiana
Building 146-Ordnance Demil Facilit
Lithology
Boring Number: WES-14-2-83



▽ Water Depth at Time of Drilling

Well Screen

NWSC, Crane, Indiana
Building 146-Ordnance
Demil Facility
Well Completion
Boring Number: WES-14-2-

TETRA TECH

BORING LOG

PROJECT NAME: NSA Crane - SWMU 18
PROJECT NUMBER: 112G01851
DRILLING COMPANY: Micah Group
DRILLING RIG: CME55

BORING No.: 18AMW1001
DATE: 11/18/11 - 12/5/11
GEOLOGIST: K. LoseKamp
DRILLER: Ben Borth / IN # 2359 WD

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	Headspace	Borehole**	BZ**
	0												
S-1		2/2	1.4/		M Stiff	DK BRN	Topsoil	OL	1515	0.1		0	0
		3/2	2.0			BRN	Clay + F Gravel	CH/CL					
S-2		2/3	.8/		M. Stiff	DK BRN	F Sand		1520				
		3/5	2.0										
S-3	5	3/4	2.0/		Stiff	BRN	Silt some clay	MH	1530	.1		0	0
		7/10	2.0				mottled moist near bottom						
S-4		8/9	1.4/		V Stiff	BRN	Same as above						
		13/14	2.0							0		0	0
S-5		21/40	1.8/		V Stiff	BRN	Same as above						
	10	30/50/4	1.9			BRN gray	Weath Sandstone		Shale inclusions	0		0	0
						BRN	Sandstone		Chatter at 10.5'				
						gray	Shale						
						BRN	Sandstone						
									Chatter at 13'				
	15												
						gray	Silty Sandstone		Chatter at 17'				
	20												
									Strong Cont.				
									Chatter at 20-21'				
									very Hard				
							Coal						
	25												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: 2" SPT 4 1/4" ID HSA 0-10, AR 10-24

Drilling Area Background (ppm): 0

Converted to Well: Yes X No _____ Well I.D. #: 18AMW1001

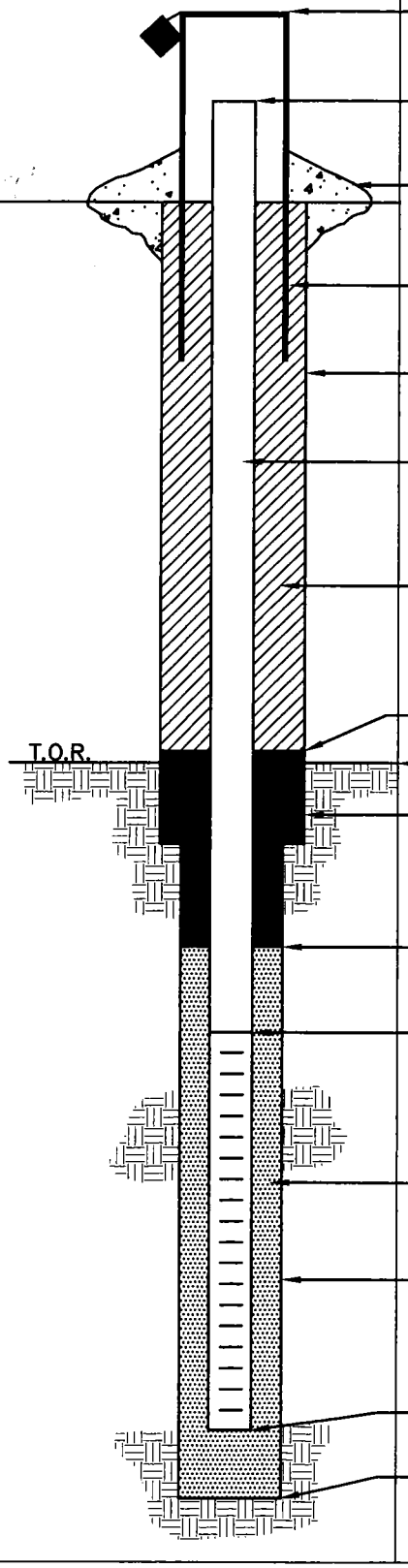
Screened 13-23
Sand 11-23
Bent. 9-11

WELL NO.: 18AMW1001

Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK

PROJECT: NSA Crane - SWMU 18	LOCATION: Subarea A	DRILLER: Micah Group / Ben Borth IN # 2359 WD
PROJECT NO.: 112G01851	BORING: 18AMW1001	DRILLING METHOD: HSA + AR
DATE BEGUN: 11-18-11	DATE COMPLETED: 12-5-11	DEVELOPMENT METHOD: [illegible]
FIELD GEOLOGIST: K. Loskamp		
GROUND ELEVATION: 634.44	DATUM: NAVD 88	



ELEVATION/HEIGHT OF TOP OF SURFACE CASING: 687.35

ELEVATION/HEIGHT TOP OF RISER: 687.09

TYPE OF SURFACE SEAL: Concrete Pad (4' x 4' x 6") w/ 4 bollards

I.D. OF SURFACE CASING: 6"

DIAMETER OF HOLE: 8"

RISER PIPE I.D.: 2"

TYPE OF RISER PIPE: Sch 40 PVC

TYPE OF BACKFILL: Cement Bentonite Grout

ELEVATION/DEPTH TOP OF SEAL: 675.59

ELEVATION/DEPTH TOP OF BEDROCK: 674.5 / 10'

TYPE OF SEAL: Bentonite

ELEVATION/DEPTH TOP OF SAND: 673.5 / 11

ELEVATION/DEPTH TOP OF SCREEN: [illegible] / 13

TYPE OF SCREEN: Sch 40 PVC

SLOT SIZE x LENGTH: 0.020" x 10'

I.D. SCREEN: 2"

TYPE OF SAND PACK: 10-20

DIAMETER OF HOLE IN BEDROCK: 5.5"

CORE/REAM: 10' - 24'

ELEVATION/DEPTH BOTTOM SCREEN: [illegible] / 23

ELEVATION/DEPTH BOTTOM OF SAND: [illegible] / 23

ELEVATION/DEPTH BOTTOM OF HOLE: [illegible] / 24

BACKFILL MATERIAL BELOW SAND: Bentonite

ACAD:FORM_MWINBR.dwg 07/20/99 INL

TETRA TECH

BORING LOG

PROJECT NAME: NSA Crane - SWMU 18
PROJECT NUMBER: 112G01851
DRILLING COMPANY: Micah Group
DRILLING RIG: CME 55 ATV/GeoProbe 100

BORING No.: 18DMWT001
DATE: 11/6/11
GEOLOGIST: T. Evans
DRILLER: Ben Borth / IN # 2359 WD

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	Headspace	Borehole**	BZ**
	0						Refer to log		1640 - 1645	-	-	Ø	Ø
							18DMWT001		HSA 0-5'				
							for lithology						
							0 - 5'						
	5												
0.6/0.8	①	21%	0.6/2.8	11.5	Tan				① Start 1650	-	-	Ø	Ø
					Brn	Fgr Sandstone		BR	End 1700				
									1710 WL=7.3'				
									② Start 1710	-	-	Ø	Ø
	10				Tan/Gray	Silty Clay			End 1720 (No Push)				
0.0/5.0	②	0%	1.2/5.0			Lost							
					Brn/Gry	Fgr Sandstone		Br					
									← 1725-1740				
								VBr	Replace Bit	-	-	O	O
0.25/5.0	15		4.7/5.0						③ Start @ 1743				
	③								End @ 1748				
							Mud Horiz Fmc @ ~16.5	Br					
									Rods drop @ 17.4 to 17.5	-	-	O	O
				18.5					11/7/11				
	20								@ 0830 WL= 6.7				
							2" PVC Screen 8.0 - 18.0 (20-Slot)		@ 0955 Ream to 8' then hydraulic problem				
							#2 Sand 7.0 - 18.5		11/8/11 @ 0855 Ream hole 8' to 18.5'				
							Bentonite 4.5 - 7.0		Grout set well				
	25												

* 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): Ø

Remarks: HSA 0-5.7
NX Core 5.7 - 17.5
5½" Ø Air rotary 5.0 - 18.5

Converted to Well: Yes ✓ No _____ Well I.D. #: 18DMWT001

TETRA TECH

BORING LOG

PROJECT NAME: NSA Crane - SWMU 18
PROJECT NUMBER: 112G01851
DRILLING COMPANY: Micah Group
DRILLING RIG: CME 55 ATV / Geoprobe 7822

BORING No.: 18DMW001-A
DATE: 11/6/11
GEOLOGIST: T. Evans
DRILLER: Ben Borth / IN # 2359 WD

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	Headspace	Borehole**	BZ**
	0								Time				
S-1		3 4	2.0		MStiff	Brn	Topsoil Silt + Tr Cla	OL ML	1455	0	-	0	0
		3 4	2.0			Tan Brn	Clay some Sand Tr F Gravel	CH	Damp				
S-2		1 2	1.0		N Dense	Orange Brn	Fgr Sandstone		1500	0	-	0	0
		3 7	2.0				Dry						
S-3	5	24 20	1.7		V Dense	Tan Brn	Fgr Sandstone Weath to		1510	0	-	0	0
		31 50/2	1.7	5.7		to White	Dry Bedded to Massive		Switch to NX core				
				111 = 111					① Start @1527				
0.4/2.8	①	14%	1.2/2.8			Tan Brn	F Sandstone	Br	End 1530 No Dust Beginning @ 8' +/-	*			
							Hit & 7.0-7.4 w/mist		② Start 1540				
	10					Tan Brn	F Sandstone	VBr	Dust Again				
1.7/4.0	②	43%	3.6/4.0					Br	& No Dust				
									End @1550				
							mud filling Horiz Frac @ 8.3'	VBr	1555 WL = 6.7'				
									Core bit broken off in hole				
	15												
									1635 Plug hole w/ bentonite & relocate approx 2 ft SW				
	20												
	25												

* 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): Ø

Remarks: 4 1/4" ID HSA 2" SM 0 to 5.7'
NX core 5.7 to 12.5

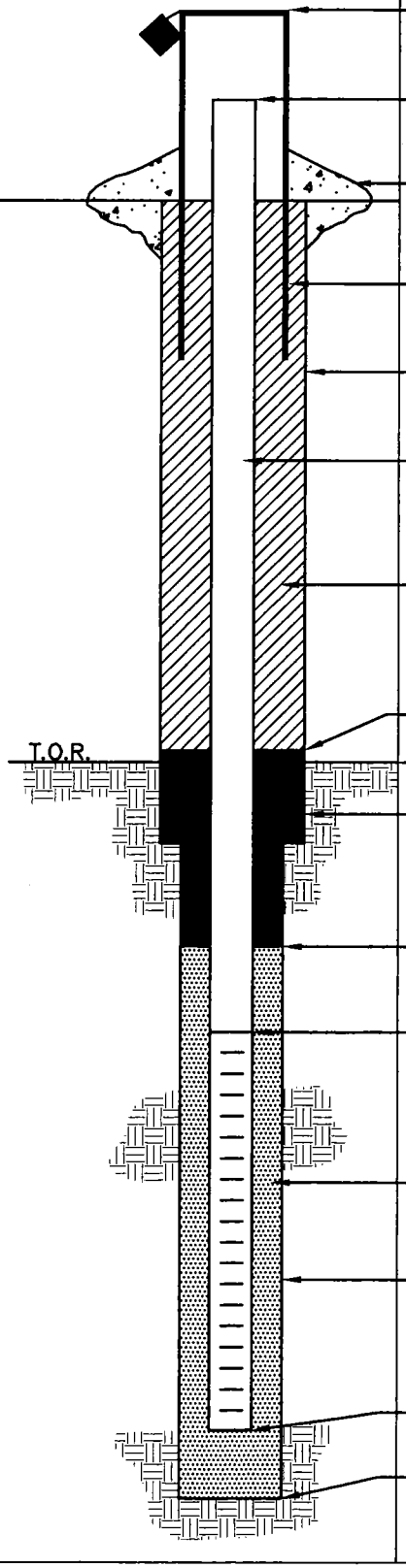
Converted to Well: Yes ____ No ✓ Well I.D. #: ____

WELL NO.: 18DMWT001

Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK

PROJECT: NSA Crane - SWMU 18	LOCATION: Subarea D	DRILLER: Micah Group / Ben Borth IN # 2359 WD
PROJECT NO.: 112G01851	BORING: 18DMWT001	DRILLING METHOD: HSA / Air Rotary
DATE BEGUN: 11-6-11	DATE COMPLETED: 11-7-11	
FIELD GEOLOGIST: T. Evans		DEVELOPMENT METHOD: [illegible]
GROUND ELEVATION: [illegible]	DATUM: MSL 88	



ELEVATION/HEIGHT OF TOP OF SURFACE CASING: [illegible] / 3.1

ELEVATION/HEIGHT TOP OF RISER: [illegible] / 2.8

TYPE OF SURFACE SEAL: Concrete Pad (4' x 4' x 6") w/ 4 Bollards

I.D. OF SURFACE CASING: 6"

DIAMETER OF HOLE: 8"

RISER PIPE I.D.: 2"

TYPE OF RISER PIPE: Sch 40 PVC

TYPE OF BACKFILL: Cement Bentonite Grout

ELEVATION/DEPTH TOP OF SEAL: [illegible] / 4.5

ELEVATION/DEPTH TOP OF BEDROCK: [illegible] / 5.7

TYPE OF SEAL: Bentonite

ELEVATION/DEPTH TOP OF SAND: [illegible] / 7.0

ELEVATION/DEPTH TOP OF SCREEN: [illegible] / 8.0

TYPE OF SCREEN: Sch 40 PVC

SLOT SIZE x LENGTH: 0.020" x 10'

I.D. SCREEN: 2"

TYPE OF SAND PACK: #2 Sand (US Sieve 10-20)

DIAMETER OF HOLE IN BEDROCK: 5.5"

CORE/REAM: NX Core 5.7 - 17.5

Ream 5.7 - 18.5

ELEVATION/DEPTH BOTTOM SCREEN: [illegible] / 18.0

ELEVATION/DEPTH BOTTOM OF SAND: [illegible] / 18.5

ELEVATION/DEPTH BOTTOM OF HOLE: [illegible] / 18.5

BACKFILL MATERIAL BELOW SAND: N/A

ACAD:FORM_MWINBR.dwg 07/20/99 INL

TETRA TECH

BORING LOG

PROJECT NAME: NSA Crane - SWMU 18
PROJECT NUMBER: 112G01851
DRILLING COMPANY: Micah Group
DRILLING RIG: CME 55 / Geoprobe 150

BORING No.: 18EMW TD01
DATE: 11-16 11
GEOLOGIST: T. Evans
DRILLER: Ben Borth / IN # 2359 WD

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	Headspace	Borehole**	BZ**
	0								Time				
S-1		1/2	1.4/2.0	11/17 @ 2		Tan	Gravelly F Silt Tr Asphalt	GM	1545 wet	0	-	0	0
		1/2				Tan Brn	Silt Tr F Sand	SM					
S-2		4/4	1.6/2.0			Tan	Silt Tr Sand	ML	1550 Damp	0	-	0	0
		5/7				Brn	Tr-Some Clay						
S-3	5	6/7	1.2/2.0			↓	↓	↓	1600	0	-	0	0
		9/11				Tan Brn	Silty Sand / Some Clay	SM					
S-4		10/19	1.4/1.4	7.4		Gray	Silty Sand	SM	1605	0	-	0	0
		50/0.4		(11E11)		Lt Brn	Weath Sandstone		(1) Start 1610				
									End 1640				
0%/20	(1)	0%	0.0/3.0				- No Recovery -			-	-	0	0
							(Dusty 10-11' Sand)		11/17/11 - water @ 1' was @ 0845				
					V Hard 11-12'	Tan Br	Silty Clay	MH/CH	(2) Start 0855	-	-	0	0
0.0/5.0	(2)	0%	4.9/5.0						End 0940				
					V Hard 13-15'	Tan Brn	F Sandstone	VBr	(Abundant water while coring)				
0.0/2.5	(3)	0%	1.7/2.5		Hard	tan	F Sandstone	VBr	(3) Start 0955	-	-	0	0
						Brn	- Horiz Frac throughout		End 1005				
							- Rust staining on core throughout						
	20			18.5					1130 Ream bore hole to +5.5'				
									1145 @ 18.5'				
							2" PVC screen (20 slot)		8.5 - 18.5				
							#2 Sand (3 bags)		8.0 - 18.5 @ 1054	0	1	#	5
							Bentonite (½ bag)		6.0 - 8.0				
	25												

* 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): 0

Remarks: 2" SPT 4/4" 0 HSA 0 - 8.0'
NX Air Core 7.4' - 18.5
5½" ⌀ Air Rotary 7.4' - 18.5

Converted to Well: Yes V No _____ Well I.D. #: 18EMWTD01

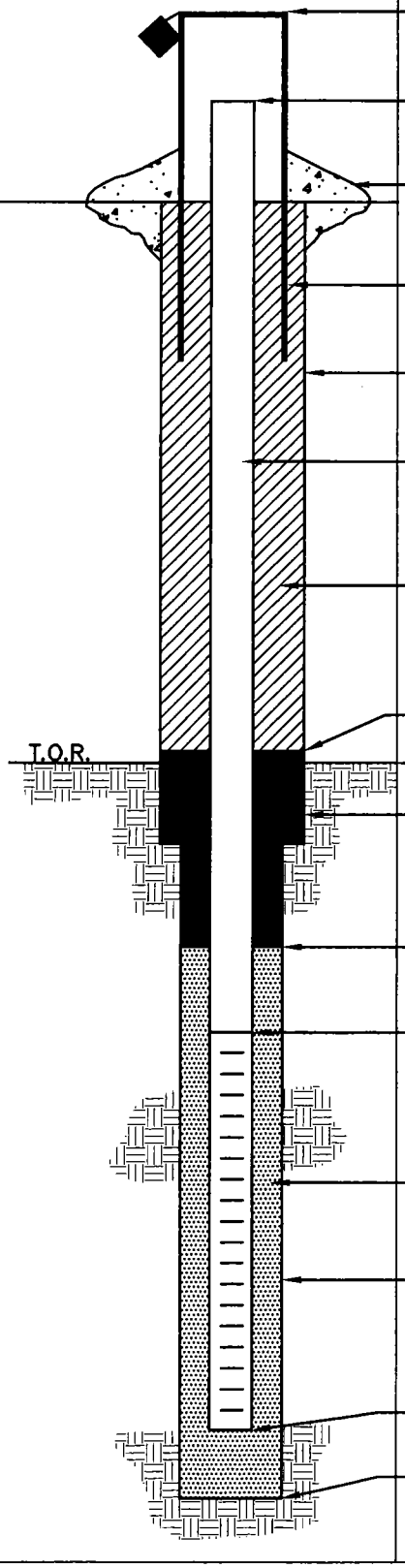
WELL NO.: 18E MW7001

Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK

PROJECT: NSA Crane - SWMU 18	LOCATION: Subarea E	DRILLER: Micah Group /	
PROJECT NO.: 112G01851	BORING: 18E MW 7001	DRILLING METHOD: Ben Borth IN # 2359 WD HSA / Air Rotary	
DATE BEGUN: 11-16-11	DATE COMPLETED: 11-17-11		
FIELD GEOLOGIST: T. Evans		DEVELOPMENT METHOD: SURGE / PUMP	
GROUND ELEVATION: 655.89	DATUM: NAVD 88		

ACAD:FORM_MWINBR.dwg 07/20/99 INL



ELEVATION/HEIGHT OF TOP OF SURFACE CASING: 659.4 / 3.5

ELEVATION/HEIGHT TOP OF RISER: 659.1 / 3.2

TYPE OF SURFACE SEAL: Concrete Pad (4' x 4' x 6") w/ 2 Bollards

I.D. OF SURFACE CASING: 6"

DIAMETER OF HOLE: 8"

RISER PIPE I.D.: 2"

TYPE OF RISER PIPE: Sch 40 PVC

TYPE OF BACKFILL: Cement-Bentonite Grout

ELEVATION/DEPTH TOP OF SEAL: 649.9 / 6.0

ELEVATION/DEPTH TOP OF BEDROCK: 648.5 / 7.4

TYPE OF SEAL: Bentonite

ELEVATION/DEPTH TOP OF SAND: 647.9 / 8.0

ELEVATION/DEPTH TOP OF SCREEN: 647.4 / 8.5

TYPE OF SCREEN: Sch 40 PVC

SLOT SIZE x LENGTH: 0.020" x 10'

I.D. SCREEN: 2"

TYPE OF SAND PACK: #2 Sand (US Sieve 10-20)

DIAMETER OF HOLE IN BEDROCK: 5.5'

CORE/REAM: NX Core 7.4 - 18.5

Ream 7.4 - 18.5

ELEVATION/DEPTH BOTTOM SCREEN: 637.4 / 18.5

ELEVATION/DEPTH BOTTOM OF SAND: 637.4 / 18.5

ELEVATION/DEPTH BOTTOM OF HOLE: 637.4 / 18.5

BACKFILL MATERIAL BELOW SAND: N/A

TETRA TECH

BORING LOG

PROJECT NAME: NSA Crane - SWMU 18
PROJECT NUMBER: 112G01851
DRILLING COMPANY: Micah Group
DRILLING RIG: CME 55 Track
BORING No.: 18GMW004
DATE: 12-15-11
GEOLOGIST: T. Evans
DRILLER: Ben Borth / IN # 2359 WD

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	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm) Sample	Headspace	Borehole**	BZ**
	0								Time				
S-1		2 / 2	1.9 /			Dk Brn	Topsoil	OL	1540	0	-	0	0
		3 / 4	/ 2.0	— —		Brn	Clay Some Silt Tr Coarse Rock Frag	CL	Damp-Dry				
S-2		2 / 3	1.5 /			Brn	Silt Tr Clay	MH	1542	0	-	0	0
		4 / 4	/ 2.0										
S-3	5	3 / 6	1.7 /			Brn	Clayey Silt Moist	ML	1545	0	-	0	0
		6 / 7	/ 2.0	←		Dk Brn / Brn	Org layer (Topsoil) / Silt Some Clay	OL / ML					
S-4		3 / 6	2.0 /			Tan Brn	Silt Tr F Sand	ML	1550	0	-	0	0
		7 / 10	/ 2.0		*	Gray							
S-5		4 / 5	1.3 /	— —		Yellow	Weath Sandstone		1600	0	-	0	0
	10	13 / 29	/ 2.0			Brn	& Mudstone		Dry				
S-6		8 / 15	1.0 / 1.2			Brn Gray	Siltstone (w/ laminae) Dry / Hard		1605	0	-	0	0
		50 / 0.2				Tan Brn	Sandstone in Shoe		12/16 - HSA to 12'				
						Tan Brn	F Sandstone Coal	BR	Install temp casing		-	0	0
1.0 / 5.0	① 15	20%	4.8 / 5.0			Gray	Siltstone w/ Blk organics	BR	① Start 0905 End 0915				
						Gray	F Sandstone Wet		② Start 0925	-	-	0	0
2.3 / 5.0	② 20	46%	2.3 / 5.0	▽			w/ laminae @ bottom		End 0935				
						Dk Gray	Shale Dry						
						Gray	Siltstone						
						Gray	Silty	WBR	③ Start 1105	-	-	0	0
3.0 / 5.0	③ 25	60%	5.0 / 5.0		*	Blk	F Sandstone w/ Blk laminae (Closer bedding)	BR	End 1110				

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: 4 1/4" ID HSA 2" SPT 0 - 11.2
NQ Core 12 - 28.5
5.5" Ø Air Rotary 12 - 28.0

Drilling Area Background (ppm): Ø

Converted to Well: Yes ✓ No ____ Well I.D. #: 18GMW004

[illegible]

TETRA TECH

BORING LOG

PROJECT NAME: NSA Crane - SWMU 18
PROJECT NUMBER: 112G01851
DRILLING COMPANY: Micah Group
DRILLING RIG: CME 55 Track

BORING No.: 18GMW7004
DATE: 12-16-11
GEOLOGIST: T Evans
DRILLER: Ben Borth / IN # 2359 WD

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	Headspace	Borehole**	BZ**
	25							BR	Time				
								BL ↓					
0.4/1.5	(4)	27%	1.1/1.5			Gray	Silty F Sandstone	BR	(4) Start 1120	-	-	0	0
						Blk	w/ Blk laminae (fissile bedding)		End 1127				
	30												
									1245 WL = 18.2'				
							Natural Caved 27 - 28.5		1300 Ream Blt				
							20-slot screen 17-27						
							#2 Sand 15-27						
							Bentonite 10-15						

* 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): 0

Remarks: _____

Converted to Well: Yes ✓ No _____ Well I.D. #: 18GMW7004

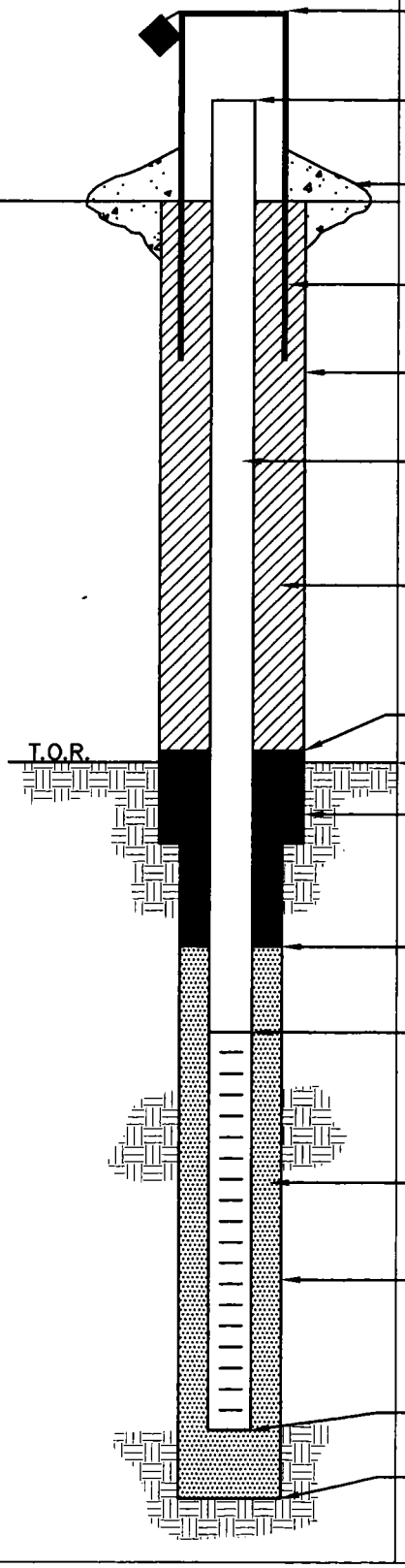
WELL NO.: 18GMW1004

Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK

PROJECT	NSA Crane - SWMU 18	LOCATION	Subarea G	DRILLER	Micah Group /
PROJECT NO.	112G01851	BORING	18GMW1004	DRILLING METHOD	Ben Borth IN # 2359 WD
DATE BEGUN	12/15/11	DATE COMPLETED	12-16-11		HSA / Air Rotary
FIELD GEOLOGIST	J Evans			DEVELOPMENT METHOD	~~PP~~ surge/pump
GROUND ELEVATION	654.09	DATUM	NAVD 88		

ACAD:FORM_MWINBR.dwg 07/20/99 INL



ELEVATION/HEIGHT OF TOP OF SURFACE CASING: 657.0/2.9

ELEVATION/HEIGHT TOP OF RISER: 656.7/2.6

TYPE OF SURFACE SEAL: Concrete Pad (4'x4'x6") w/ 4 Bollards

I.D. OF SURFACE CASING: 6" Steel

DIAMETER OF HOLE: 8"

RISER PIPE I.D.: 2"

TYPE OF RISER PIPE: Sch 40 PVC

TYPE OF BACKFILL: Cement - Bentonite Grout

ELEVATION/DEPTH TOP OF SEAL: 644.1/10.0

ELEVATION/DEPTH TOP OF BEDROCK: 642.9/11.2

TYPE OF SEAL: Bentonite

ELEVATION/DEPTH TOP OF SAND: 639.1/15.0

ELEVATION/DEPTH TOP OF SCREEN: 637.1/17.0

TYPE OF SCREEN: Sch 40 PVC

SLOT SIZE x LENGTH: 0.020" x 10'

I.D. SCREEN: 2"

TYPE OF SAND PACK: Global #5 (US Sieve 10-20)

DIAMETER OF HOLE IN BEDROCK: 5.5"

CORE/REAM: NQ 11.2 - 28.5'

5.5" Ø 11.2 - 28.0'

ELEVATION/DEPTH BOTTOM SCREEN: 627.1/27.0

ELEVATION/DEPTH BOTTOM OF SAND: 627.1/27.0

ELEVATION/DEPTH BOTTOM OF HOLE: 625.6/28.5

BACKFILL MATERIAL BELOW SAND: Natural

TETRA TECH

BORING LOG

PROJECT NAME: NSA Crane - SWMU 18
PROJECT NUMBER: 112G01851
DRILLING COMPANY: Micah Group
DRILLING RIG: CME 55 I

BORING No.: 18IMWT001
DATE: 11-22-11
GEOLOGIST: T. Evans
DRILLER: Ben Borth / IN # 2359 WD

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	Headspace	Borehole**	BZ**
S-1	0	2 3 3 5	1.4 / 2.0			DK Brn Brn	Topsoil Clay	OL CL	0935	0	-	0	0
S-2		4 5 7 10	1.4 / 2.0			Brn Lt Brn	Clay Damp Silt Tr Sand Clay	CL ML	0938	0	-	0	0
S-3	5	1 3 6 8	1.9 / 2.0			Lt Brn Gray	Silt Tr Clay	ML	0942 Dry to Damp	0	-	0	0
S-4		6 10 9 11	1.4 / 2.0			Lt Brn	Silt Tr VF Sand Clay	ML/SM CL	0947 Dry to Damp	0	-	0	0
S-5	10	3 6 7 9	1.8 / 2.0						0957	0	-	0	0
S-6		1 1 2 4	1.2 / 2.0						1000	0	-	0	0
S-7	15	8 50/4	0.4 / 0.8	15'		Tan Brn	Silty F Sand & SS Frag (Weath sandstone)	SM	1005 switch to NX Core	0	-	0	0
1.0 / 3.0	15	330/10	2.6 / 3.0		BR	Tan Brn	Silty F Sandstone		Start 1037 End 1045	-	-	0	0
2.0 / 5.0	20	40%	48 / 5.0		BR VBR BR VBR	Tan Brn Red Brn	Silty F Sandstone w/ thin laminae (1/2"-1")		Start: 1050 End: 1100	0.5	-	0	0
3.9 / 5.0	25	78%	5.0 / 5.0		BR BR	Red Brn	Silty F Sandstone (thin laminae)		Start 1105 End: 1115				
						Tan Brn			1130 WL = 24.97		-	0	0

* 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): 0

Remarks: 2" SPT, 4/4" ID HSA 0 - 12.9
NX Core 12.9 - 27.9
5.5" ID Air Rotary 27.9 - 31.0

Converted to Well: Yes ✓ No _____ Well I.D. #: 18IMWT001

TETRA TECH

BORING LOG

PROJECT NAME: NSA Crane - SWMU 18
PROJECT NUMBER: 112G01851
DRILLING COMPANY: Micah Group
DRILLING RIG: CME 55 / Geoprobe

BORING No.: 18±MW7001
DATE: 11-22-11
GEOLOGIST: A. Davis
DRILLER: Ben Borth / IN # 2359 WD

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	Headspace	Borehole**	BZ**
	25												
S7	4	38%	1.3/2.0		BR	Tan	F Sands trace		(4) Start 1315				
2.0									End 1330	-	-	0	0
									Swivel to AM Rotary				
	30								1500 - 1505 AM Rotary				
						Dk Gray	Shale						
									1530 WL = 25'				
									1555 Set well				
							2" PVC screen (10' L)		21-31				
							#2 sand (2 bags)		19-21				
							Bentonite		17-19				

* 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): 0

Remarks: _____

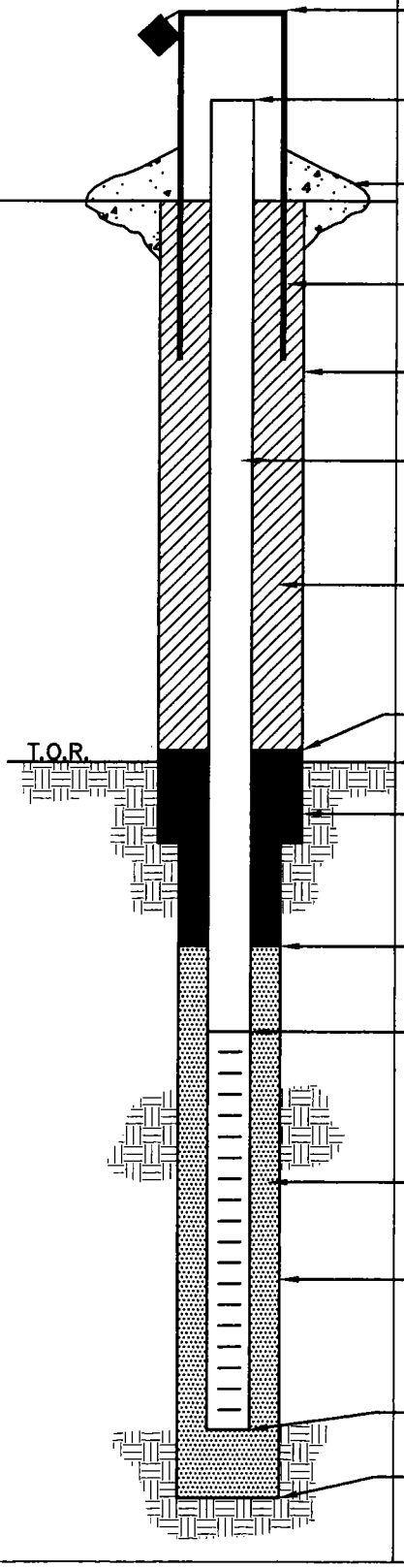
Converted to Well: Yes ✓ No _____ Well I.D. #: 18IMW7001

WELL NO.: 18IMWT001

Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK

PROJECT: NSA Crane - SWMU 18	LOCATION: Subarea I	DRILLER: Micah Group / Ben Borth IN # 2359 WD
PROJECT NO.: 112G01851	BORING: 18IMWT001	DRILLING METHOD: HSA / Air Rotary
DATE BEGUN: 11-22-11	DATE COMPLETED: 11-22-11	
FIELD GEOLOGIST: T. Evans		DEVELOPMENT METHOD: SURGE/PUMP
GROUND ELEVATION: 695.63	DATUM: NAVD 88	



ELEVATION/HEIGHT OF TOP OF SURFACE CASING: 698.42.8

ELEVATION/HEIGHT TOP OF RISER: 698.1 / 2.5

TYPE OF SURFACE SEAL: Concrete (4'x4' x 6") w/ 4 bollards

I.D. OF SURFACE CASING: 6" Steel

DIAMETER OF HOLE: 8"

RISER PIPE I.D.: 2"

TYPE OF RISER PIPE: Sch 40 PVC

TYPE OF BACKFILL: Cement-Bentonite Grout

ELEVATION/DEPTH TOP OF SEAL: 678.6 / 17.0

ELEVATION/DEPTH TOP OF BEDROCK: 682.7 / 12.9

TYPE OF SEAL: Bentonite

ELEVATION/DEPTH TOP OF SAND: 676.6 / 19.0

ELEVATION/DEPTH TOP OF SCREEN: 674.6 / 21.0

TYPE OF SCREEN: Sch 40 PVC

SLOT SIZE x LENGTH: 0.020" x 10'

I.D. SCREEN: 2"

TYPE OF SAND PACK: #2 Sand (US Sieve 10-20)

DIAMETER OF HOLE IN BEDROCK: 5.5"

CORE/REAM: NX Core 12.9 - 27.9
Ream 12.9 - 31.0

ELEVATION/DEPTH BOTTOM SCREEN: 664.6 / 31.0

ELEVATION/DEPTH BOTTOM OF SAND: 664.6 / 31.0

ELEVATION/DEPTH BOTTOM OF HOLE: 664.6 / 31.0

BACKFILL MATERIAL BELOW SAND: N/A

ACAD: FORM_MWINBR.dwg 07/20/99 INL

TETRA TECH

BORING LOG

PROJECT NAME: NSA Crane - SWMU 18
PROJECT NUMBER: 112G01851
DRILLING COMPANY: Micah Group
DRILLING RIG: CME 55 Track

BORING No.: 18J MW7001
DATE: 12/17/11
GEOLOGIST: T. Evans
DRILLER: Ben Borth / IN # 2359 WD

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	Headspace	Borehole**	BZ**
	0								Time				
S-1		2/4	1.9/			Brn	Topsoil	OL	1548	0	-	0	0
		5/6	/2.0				Silt Tr VF Sand	ML	Dry				
S-2		5/5	1.9			Tan Gry	Silt Tr VF Sand	ML	1550	0	-	0	0
		7/9	/2.0				Some VF Sand		Damp				
S-3	5	4/6	1.4			Tan	Silt & F Sand	SM	1557	0	-	0	0
		8/14	/2.0				Dry-Damp						
S-4		8/16	1.5/			Tan	Silt some Sand	SM/ML	1601	0	-	0	0
		14/13	/2.0			Brn Gray	Tr Red Brn SS frags						
S-5		6/50/.3	06/			Brn Gray	Weather sandy Siltstone		1613 Dry	0	-	0	0
	10		/0.8			Gray	laminated sandy Siltstone		Install temp casing				
							Silty Sandstone		AR				
									1632				
									Chatter @ 12.5'				
						Gray	Silty F Sandstone w/ Blk laminae						
	15					Brn	Sandy Shale						
						Brn	Silty Sandstone		1640				
						Brn Blk	Sandy Shale Coal Seam (<1" thick)						
	20					Tan Brn	F Sandstone		Chatter @ 19.5'				
									Cuttings Damp Casing @ 20'				
									1645				
									Water After Add Rod				
	25												

* 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): 0

Remarks: 4 1/4" HSA 2" SCT 0 - 8.8
5.5" ∅ Air Rotary 8.8 -

Converted to Well: Yes ✓ No _____ Well I.D. #: 18J MW7001

TETRA TECH

BORING LOG

PROJECT NAME: NSA Crane - SWMU 18
PROJECT NUMBER: 112G01851
DRILLING COMPANY: Micah Group
DRILLING RIG: CPT 51 Track

BORING No.: 18JMW7001
DATE: 12/17/11
GEOLOGIST: T. Evans
DRILLER: Ben Borth / IN # 2359 WD

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	MATERIAL DESCRIPTION: Color	MATERIAL DESCRIPTION: Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Headspace	Borehole**	BZ**
	25					Brn	f Sandstone						
									1655				
	30								1700 @ 29'				
									12/18 @ 0855 WL = 18'				
							2" PVC 20slot screen		18.5 - 28.5'				
							#2 Sand (US Silica 10-20)		16.5 - 29.0				
							Bentonite		13.8 - 16.5				

* 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): Ø

Remarks:

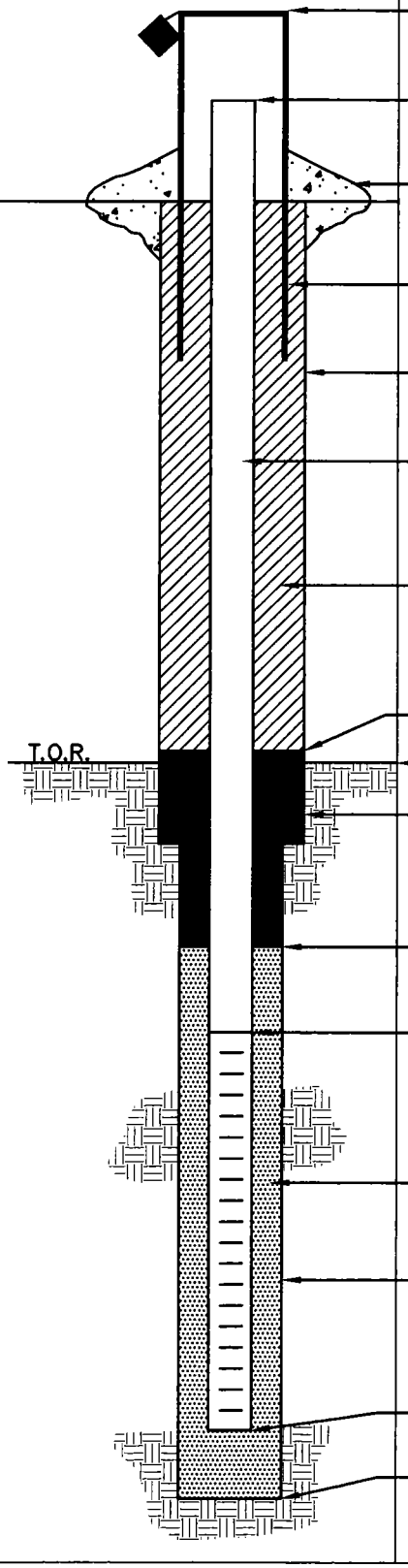
Converted to Well: Yes ✓ No _____ Well I.D. #: 18JMW7001

WELL NO.: 18JMW1001

Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK

PROJECT: NSA Crane - SWMU 18	LOCATION: Subarea J	DRILLER: Micah Group / Ben Borth IN # 2359 WD	
PROJECT NO.: 112G01851	BORING: 18JMW1001	DRILLING METHOD: HSA / Air Rotary	
DATE BEGUN: 12-17-11	DATE COMPLETED: 12-18-11	DEVELOPMENT METHOD: SURGE/PUMP	
FIELD GEOLOGIST: T.K. Vans			
GROUND ELEVATION: 650.24	DATUM: NAVD 88		



ELEVATION/HEIGHT OF TOP OF SURFACE CASING: 653.4/3.2

ELEVATION/HEIGHT TOP OF RISER: 653.1/2.9

TYPE OF SURFACE SEAL: Concrete Pad (4'x4'x6") w/ 4 Bollards

I.D. OF SURFACE CASING: 6"

DIAMETER OF HOLE: 8"

RISER PIPE I.D.: 2"

TYPE OF RISER PIPE: Sch 40 PVC

TYPE OF BACKFILL: Cement - Bentonite Grout

ELEVATION/DEPTH TOP OF SEAL: 636.4/13.8

ELEVATION/DEPTH TOP OF BEDROCK: 641.4/8.8

TYPE OF SEAL: Bentonite

ELEVATION/DEPTH TOP OF SAND: 633.7/16.5

ELEVATION/DEPTH TOP OF SCREEN: 631.7/18.5

TYPE OF SCREEN: Sch 40 PVC

SLOT SIZE x LENGTH: 0.020" x 10'

I.D. SCREEN: 2"

TYPE OF SAND PACK: Global #5 (US Sieve 10-20)

DIAMETER OF HOLE IN BEDROCK: 5.5"

CORE/REAM: N/A

ELEVATION/DEPTH BOTTOM SCREEN: 621.7/28.5

ELEVATION/DEPTH BOTTOM OF SAND: 621.2/29.0

ELEVATION/DEPTH BOTTOM OF HOLE: 621.2/29.0"

BACKFILL MATERIAL BELOW SAND: N/A

ACAD:FORM_MWINBR.dwg 07/20/99 INL

Tetra Tech

BORING LOG

PROJECT NAME: NSA Crane SWMU 22
PROJECT NUMBER: 112602362
DRILLING COMPANY: Milan Group / R. Simmons
DRILLING RIG: CME 55

BORING No.: 22MWT01
DATE: MAY 10, 2012
GEOLOGIST: J. Ferguson
DRILLER: J. Smith

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**
S-1	0-1	6 / 13			V. Dense	Gray	Silty Coarse LS gravel	GP		0	0	0	0
	1-2	23 / 25				Olive Brn	Sandy (fine) silt and silty f sand	SM/ML	13:36 weathered rock				
S-2	2-3	7 / 56			V. Dense	G. Brn-Gray	Weathered silty, f-g sandstone		weathered rock				
	3-4	50/1"					↓ ↓		13:46				
S-3	4-5	R / R			Soft	Olive Brn	micaceous sandy siltstone		13:54				
	5-6	R / R				Olive Brn				0	0	0	0
S-4	6-7	R / R			Soft	Olive Brn	weathered silty f-g sandstone		14:02				
	7-8	R / R				olive brn	and interbedded siltstone						
S-5	8-9	R / R			Soft	Tan/gray brn			14:06				
	9-10	R / R				Tan/gray brn	↓ ↓						
S-6	10-11	R / R			Soft	Olive Brn	micaceous, sandy (fine) siltstone		14:10	0	0	0	0
	11-12	R / R				Olive Brn	weathered.						
S-7	12-13	R / R			Hard	Gray	Micaceous, silty fine-grained		14:15				
	13-14	R / R				Gray	sandstone, moist						
S-8	14-15	R / R			HARD	Gray	Micaceous, interbedded shale		14:20				
	15-16	R / R				Gray	siltstone + f-g sandstone, moist			0	0	0	0
S-9	16-17	R / R			M. Hard - Hard	Gray							
	17-18	R / R				Gray	↓ ↓						
S-10	18-19	R / R			M. Hard	Gray	micaceous, sandy (F) SHALY		14:25				
	19-20	R / R				Gray	siltstone moist						
S-11	20-21	R / R			M. Hard	Gray			14:30	0	0	0	0
	21-22	R / R				Gray							
S-12	22-23	R / R			M. Hard	Gray			14:35				
	23-24	R / R				Gray							
	24-25	R / R			M. Hard	Gray	↓ ↓		wet @ base after pulling rods				

* 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): 0

Remarks: 13:20 [illegible] ∇ 24 [illegible] 365 4 1/4" [illegible] Tri-Cone Roller bit. 2" Ø SCH 40 PVC screen 0.010 slot (15'-25') [illegible] sandpack 13'-26' Bentonite [illegible] seal 10'-13'

Converted to Well: Yes X No ____ Well I.D. #: 22MWT01

Tetra Tech, Inc.

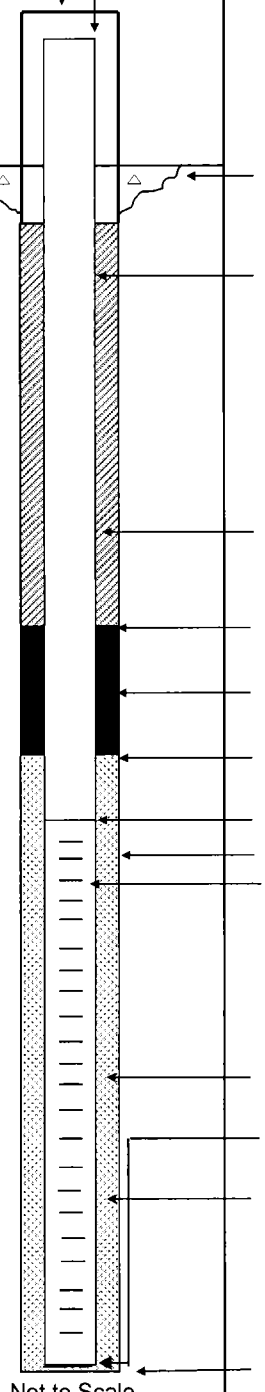
WELL No.: 22-MWT01

MONITORING WELL SHEET

PERMIT No:

PROJECT:	NSA Crane SWMU 22	DRILLING Co.:	Micah Group / R. Simmons	BORING No.:	22-MWT01
PROJECT No.:	112G02362	DRILLER:	J. Russel	DATE COMPLETED:	05/11/12
SITE:	Lead Azide Pond	DRILLING METHOD:	H.S.A. / Air Rotary	NORTHING:	1315811.32
GEOLOGIST:	J. Ferguson	DEV. METHOD:	Surge / Submersible pump	EASTING:	3027409.14

Vertical Datum NAVD 88
Horizontal Datum: NAD 83
Ground Elevation: 766.47



Not to Scale

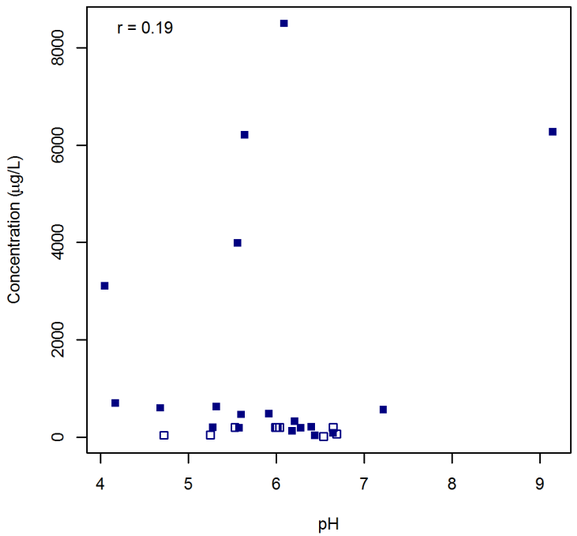
Elevation / Depth of Top of Riser:		768.94 / 2.77
Elevation / Height of Top of Surface Casing:		768.74 / 2.47
I.D. of Surface Casing:	6 - inch	
Type of Surface Casing:	Schedule 40 Steel	
Type of Surface Seal:	Concrete	
I.D. of Riser:	2" ID, flush joint	
Type of Riser:	Schedule 40 PVC	
Borehole Diameter:	8.25 inch	
Type of Backfill: mixture	Bentonite -cement	
Elevation / Depth of Seal:		756.47 / 10.0
Type of Seal:	Bentonite Pellet	
Elevation / Depth of Top of Filter Pack:		753.47 / 13.0
Elevation / Depth of Top of Screen:		751.47 / 15.0
6" ID Air Rotary Borehole		
Type of Screen:	Schedule 40 PVC	
Slot size/ screen length:	0.010 Slot - 10'	
I.D. of Screen:	2" inside daimeter PVC	
Type of Filter Pack:	DSI GP#2 Silica Sand	
Elevation / Depth of Bottom of Screen:		741.47 / 25.0
Elevation / Depth of Bottom of filter pack:		741.47 / 25.0
Type of Backfill Below Well: DSI GP#2 Silica Sand		
Elevation / Total Depth of Borehole:		741.47 / 25.0

APPENDIX C

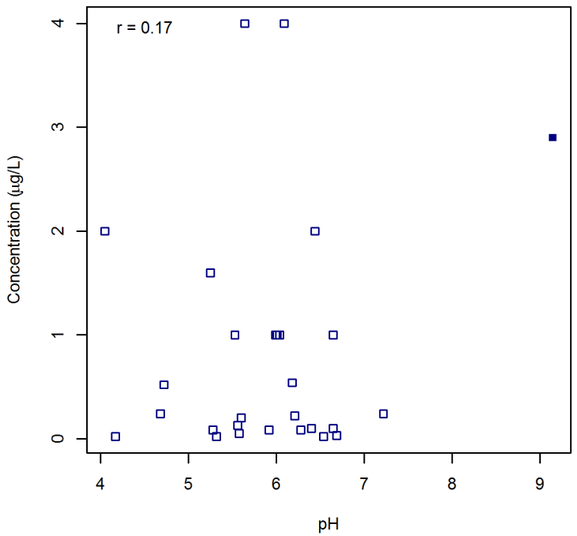
CORRELATION PLOTS OF METALS AND pH

CORRELATION OF METALS AND PH
SWMU 18 - LOAD AND FILL AREA
NSA CRANE, CRANE, INDIANA

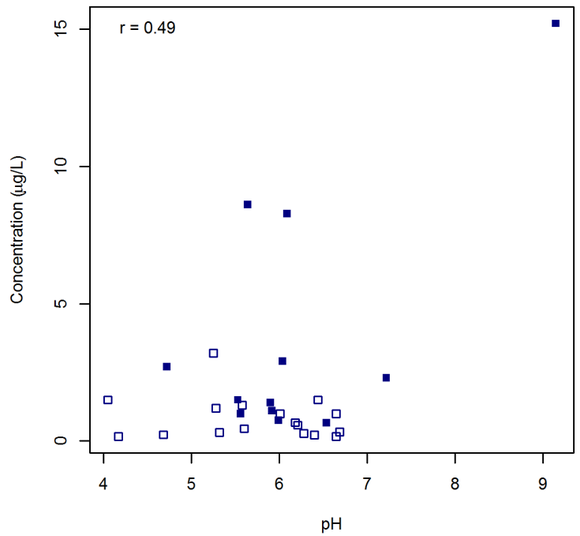
ALUMINUM VERSUS PH



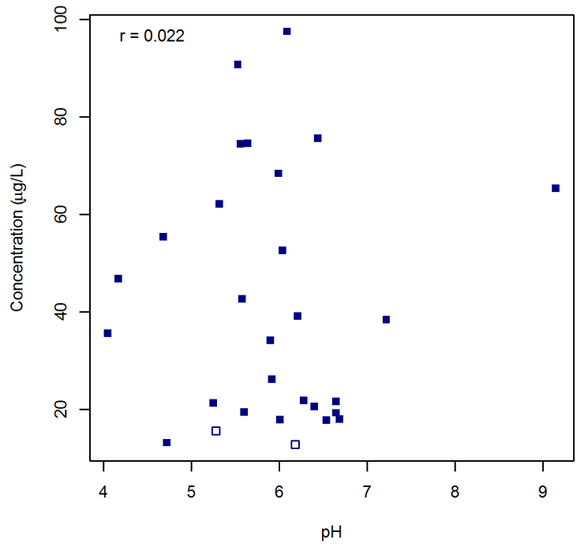
ANTIMONY VERSUS PH



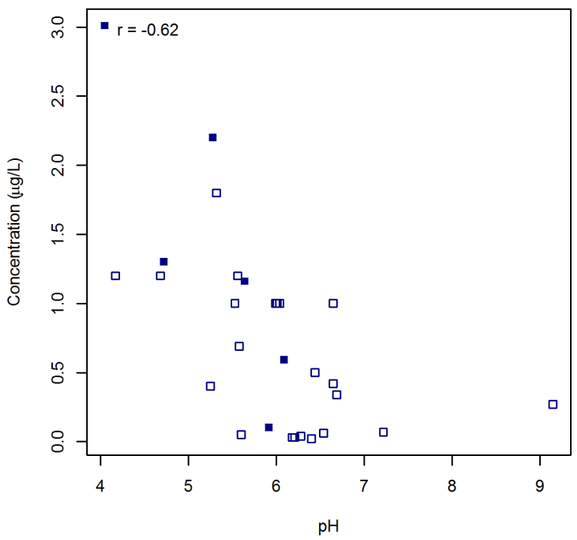
ARSENIC VERSUS PH



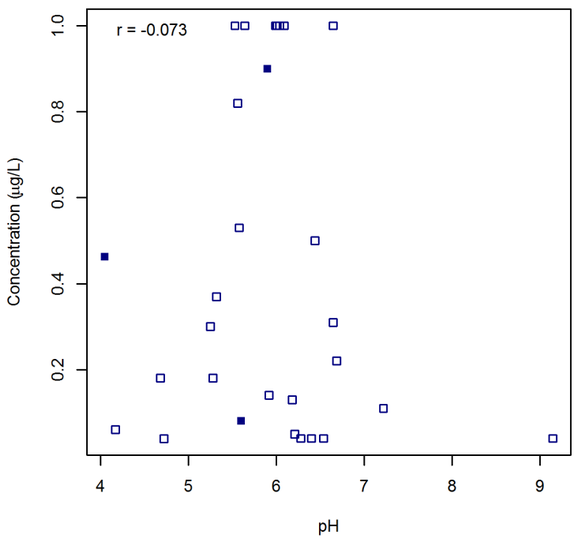
BARIUM VERSUS PH



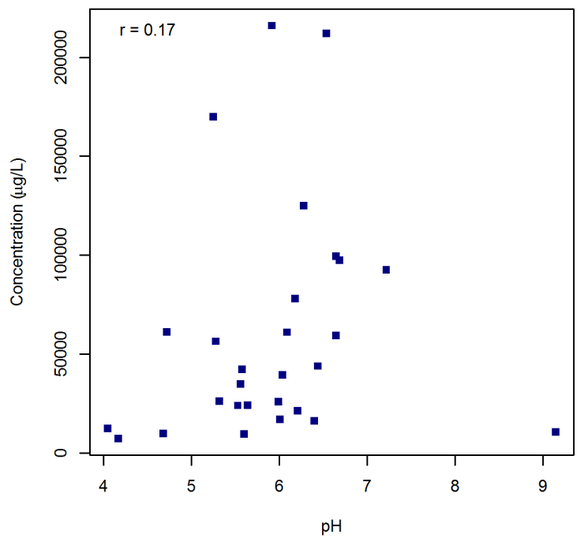
BERYLLIUM VERSUS PH



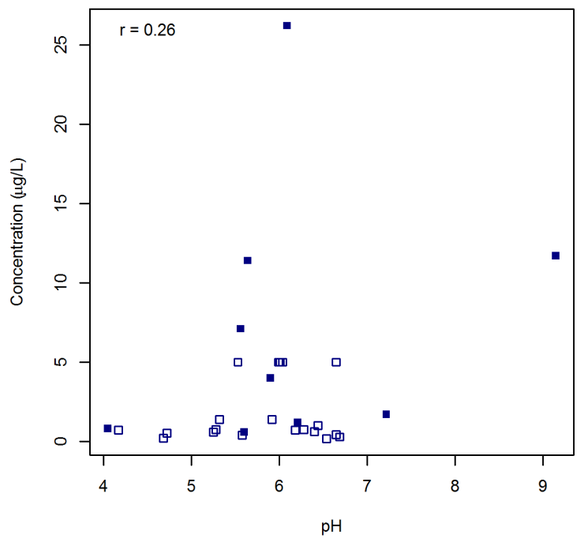
CADMIUM VERSUS PH



CALCIUM VERSUS PH



CHROMIUM VERSUS PH

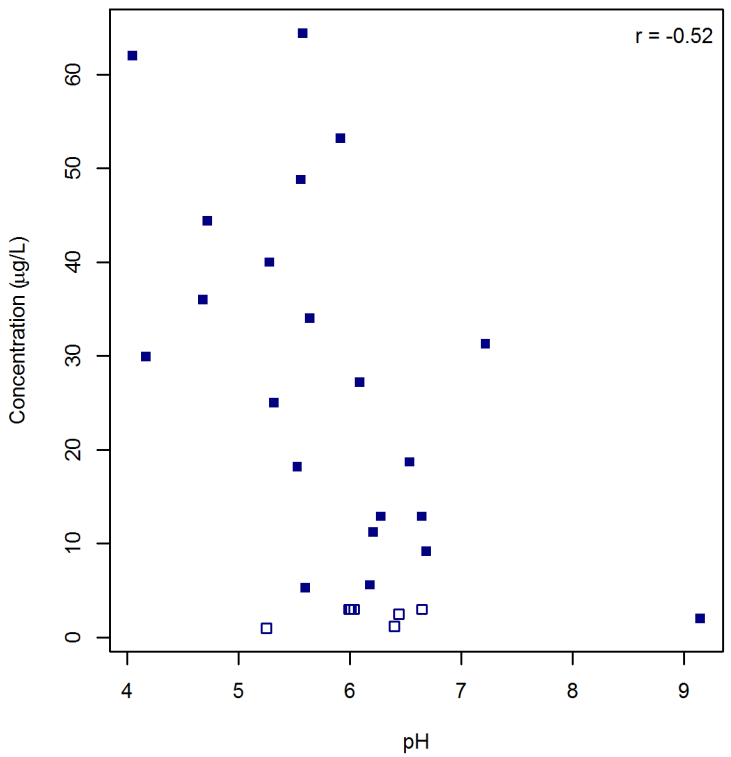


LEGEND

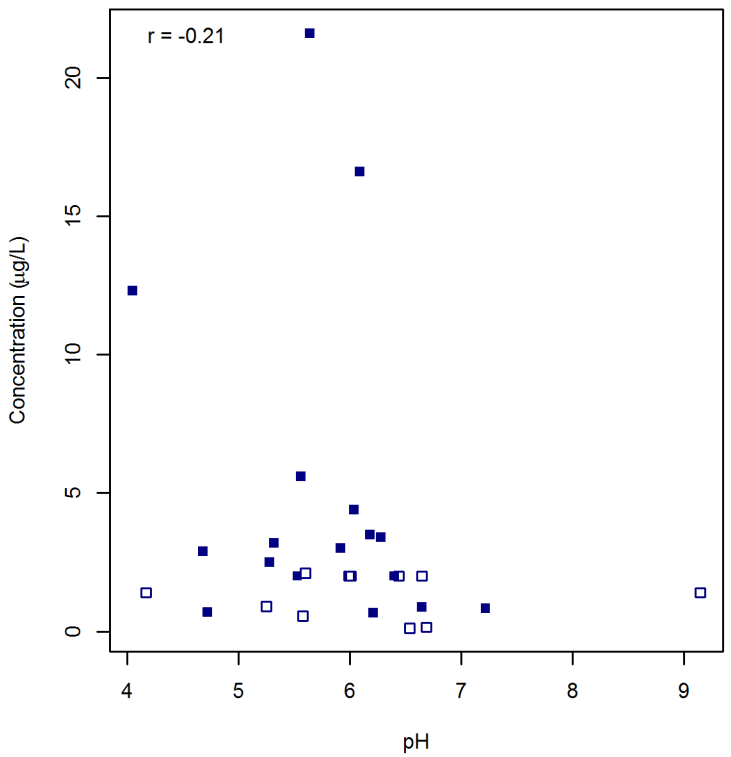
- Detect
- Non-Detect

CORRELATION OF METALS AND PH
SWMU 18 - LOAD AND FILL AREA
NSA CRANE, CRANE, INDIANA
PAGE 2 OF 3

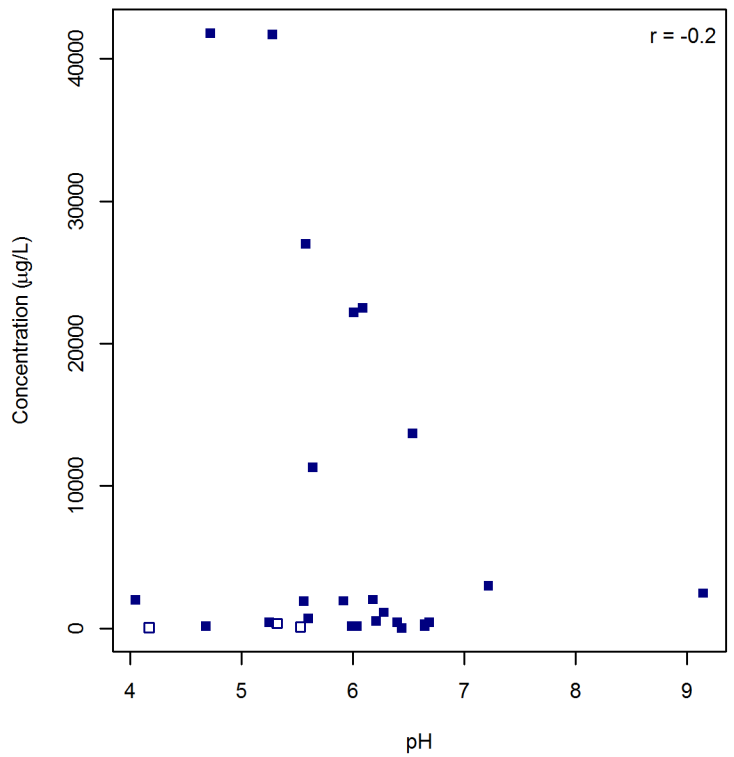
COBALT VERSUS PH



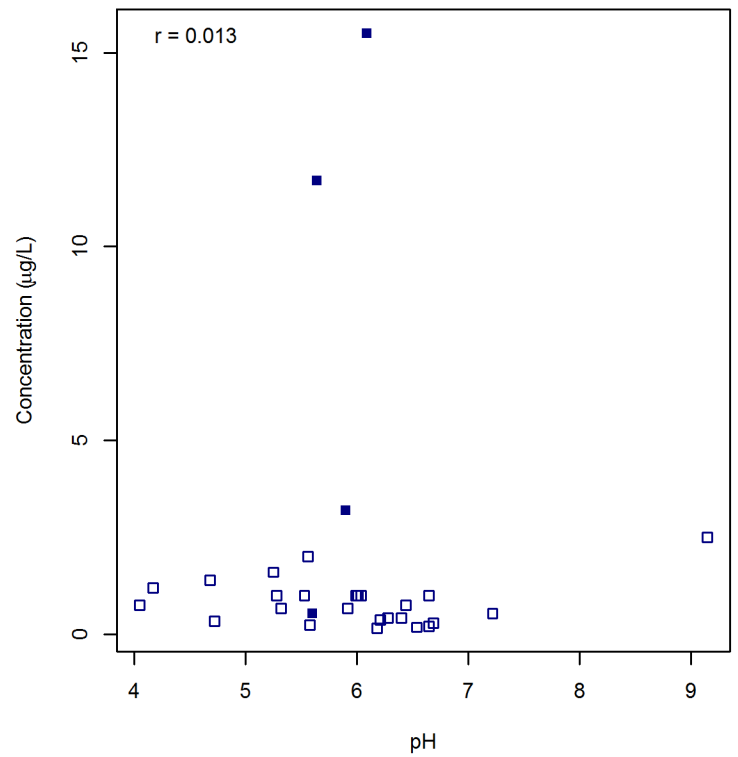
COPPER VERSUS PH



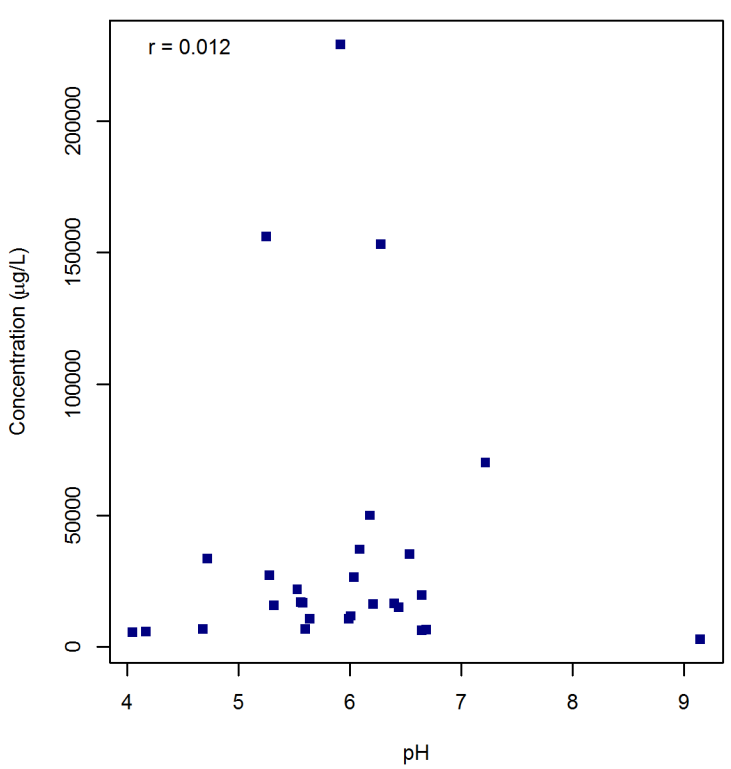
IRON VERSUS PH



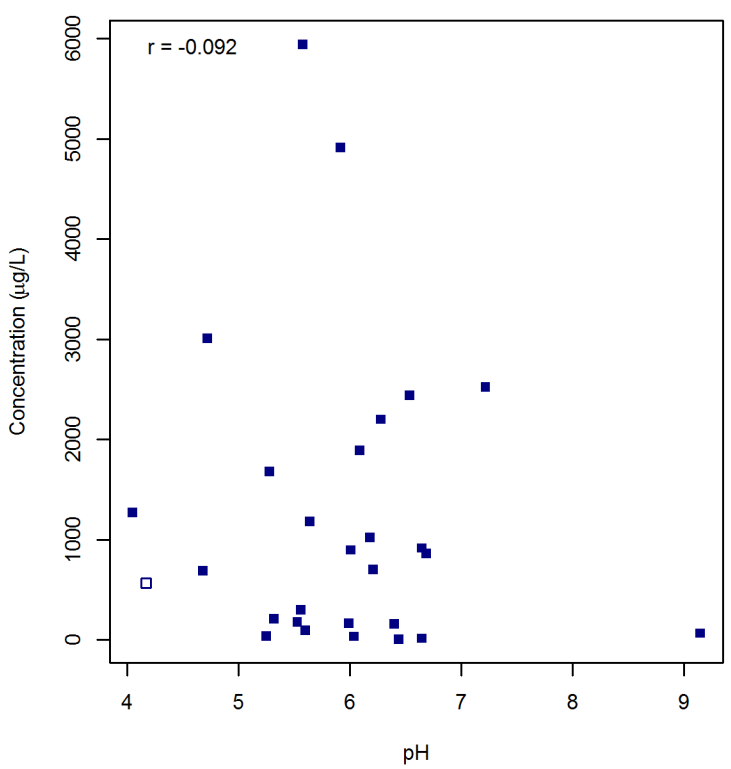
LEAD VERSUS PH



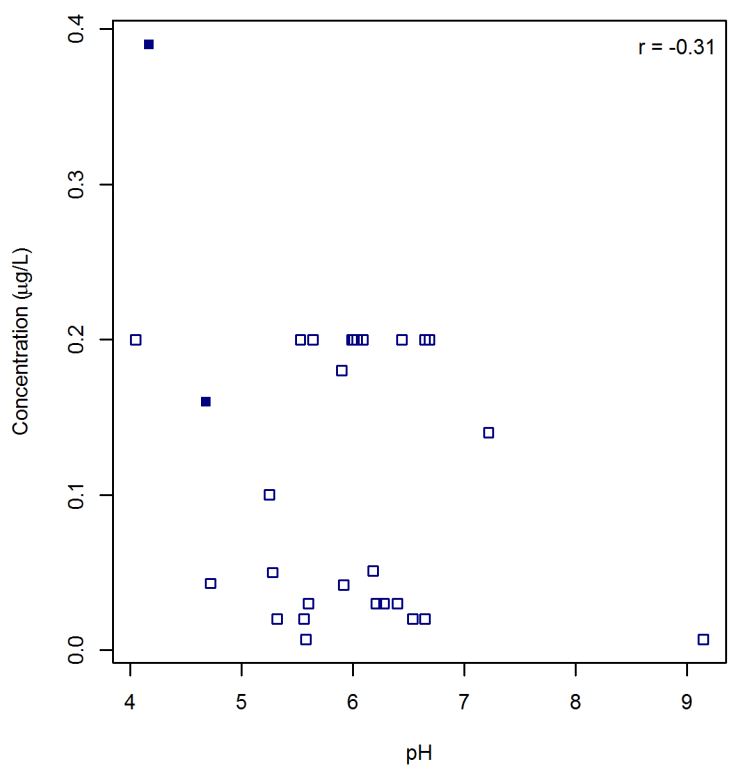
MAGNESIUM VERSUS PH



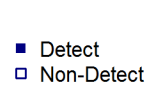
MANGANESE VERSUS PH



MERCURY VERSUS PH

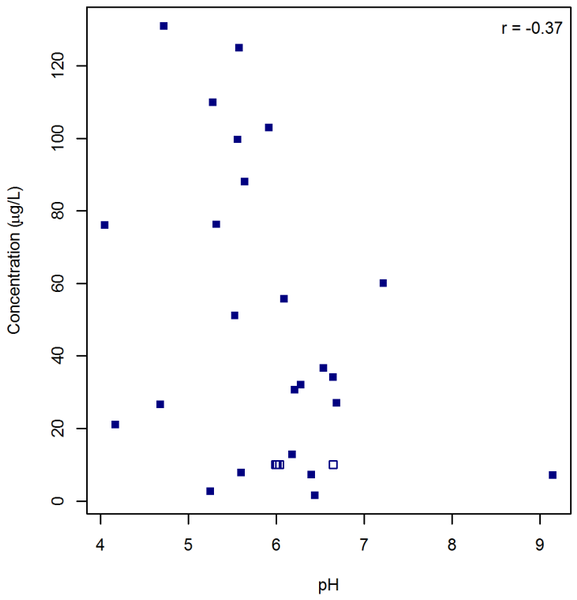


LEGEND

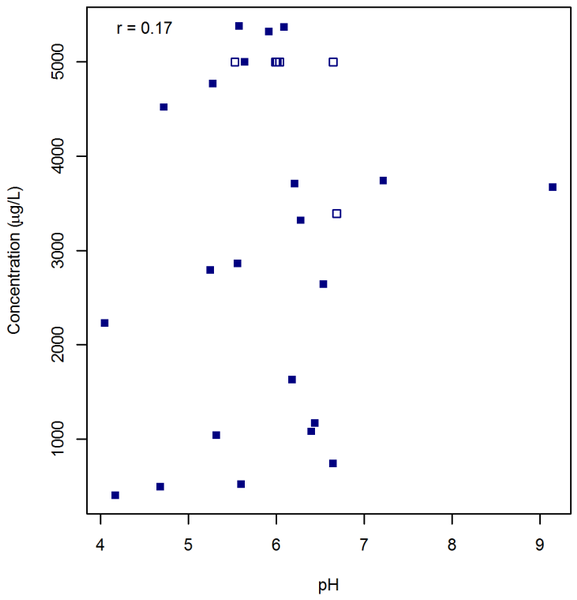


CORRELATION OF METALS AND PH
SWMU 18 - LOAD AND FILL AREA
NSA CRANE, CRANE, INDIANA

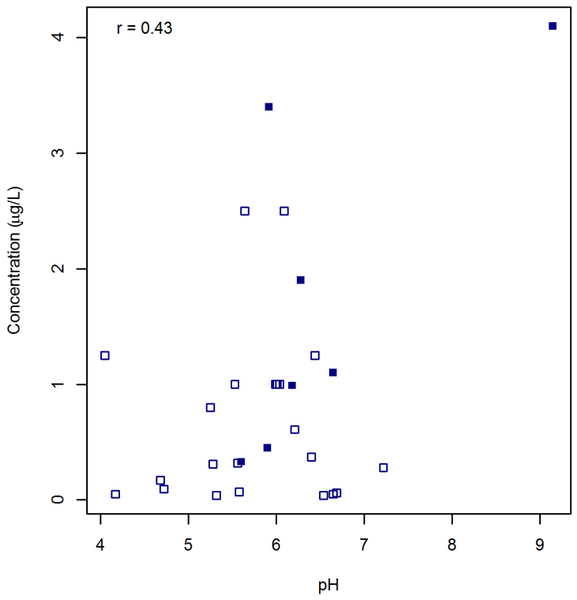
NICKEL VERSUS PH



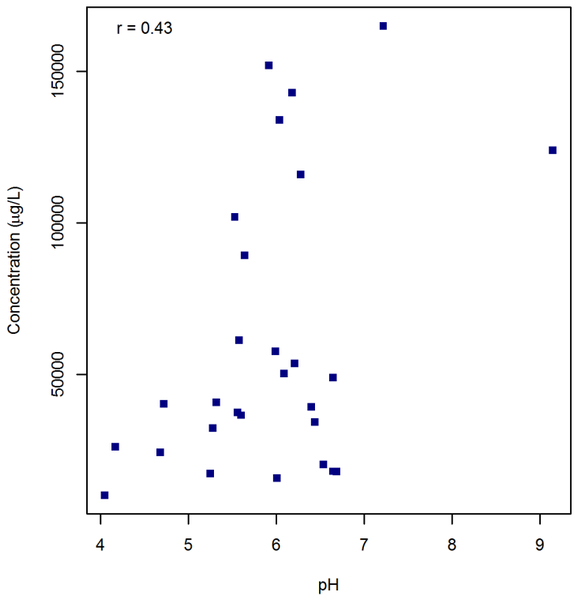
POTASSIUM VERSUS PH



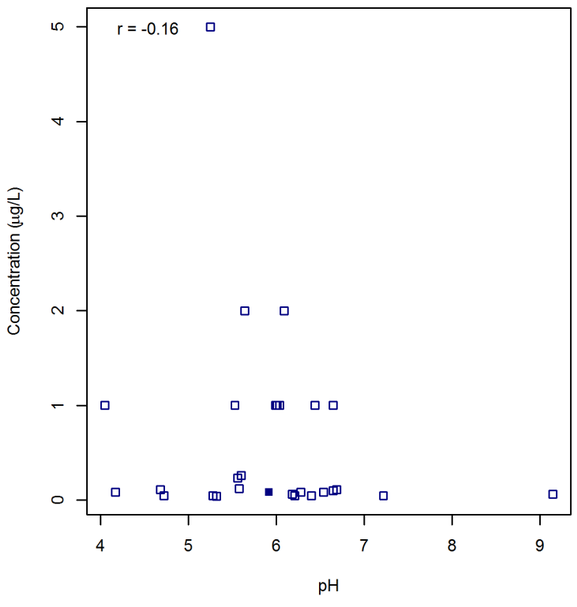
SELENIUM VERSUS PH



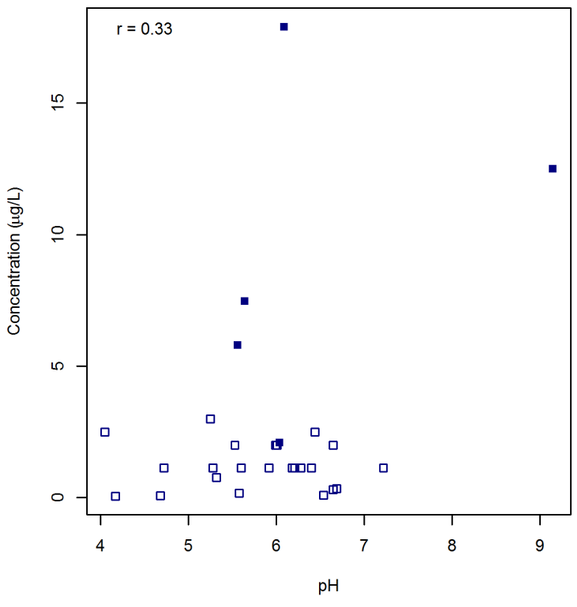
SODIUM VERSUS PH



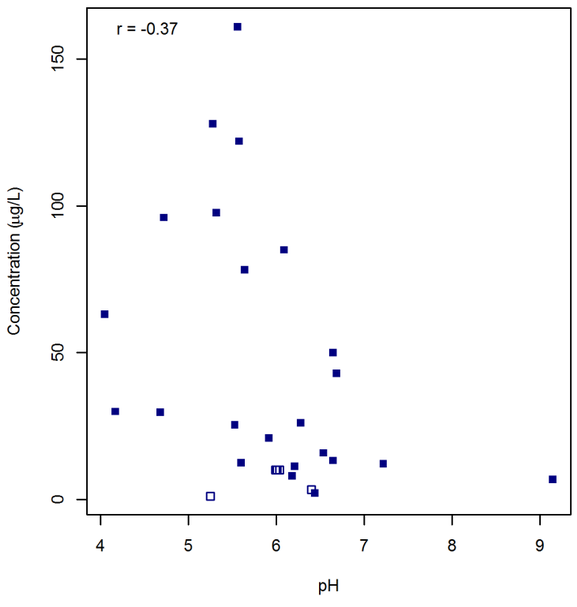
THALLIUM VERSUS PH



VANADIUM VERSUS PH



ZINC VERSUS PH



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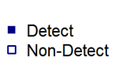
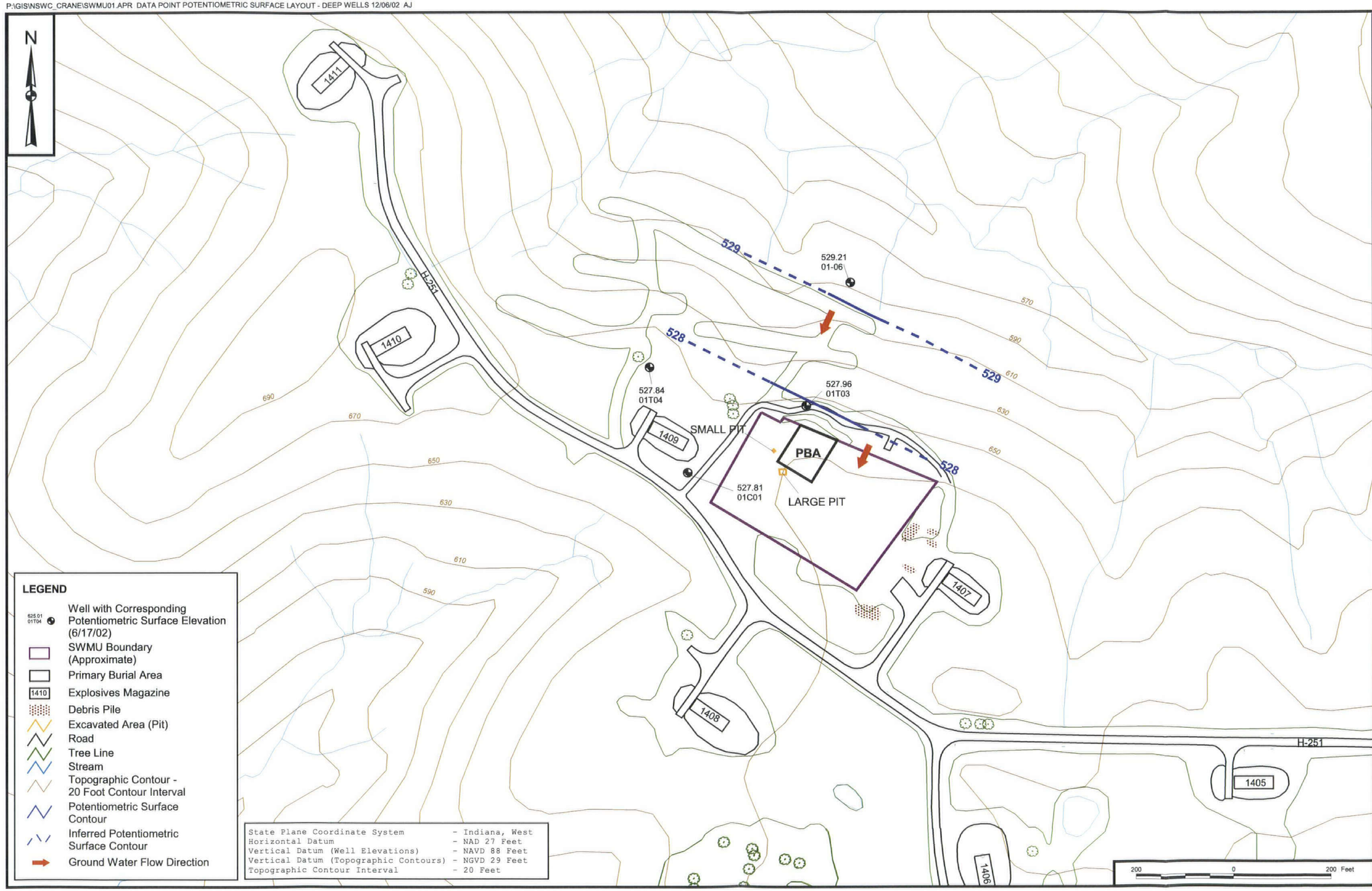


APPENDIX D

GROUNDWATER
POTENTIOMETRIC SURFACE MAPS

P:\GIS\NSWC_CRANE\SWMU01.APR DATA POINT POTENTIOMETRIC SURFACE LAYOUT - DEEP WELLS 12/06/02 AJ



LEGEND

- Well with Corresponding Potentiometric Surface Elevation (6/17/02) (625.01 / 01T04)
- SWMU Boundary (Approximate)
- Primary Burial Area
- Explosives Magazine (1410)
- Debris Pile
- Excavated Area (Pit)
- Road
- Tree Line
- Stream
- Topographic Contour - 20 Foot Contour Interval
- Potentiometric Surface Contour
- Inferred Potentiometric Surface Contour
- Ground Water Flow Direction

State Plane Coordinate System	- Indiana, West
Horizontal Datum	- NAD 27 Feet
Vertical Datum (Well Elevations)	- NAVD 88 Feet
Vertical Datum (Topographic Contours)	- NGVD 29 Feet
Topographic Contour Interval	- 20 Feet

CONTRACT NO. N3959

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

APPROVED BY ___ — DATE ___

DRAWING NO. FIGURE 1-19 — REV 0

2002 POTENTIOMETRIC SURFACE MAP - DEEP WELLS
SWMU 01 - MUSTARD GAS BURIAL GROUND
NAVAL SURFACE WARFARE CENTER CRANE
CRANE, INDIANA

DEPARTMENT OF THE NAVY * NAVFAC ENGINEERING COMMAND * SOUTHERN DIVISION

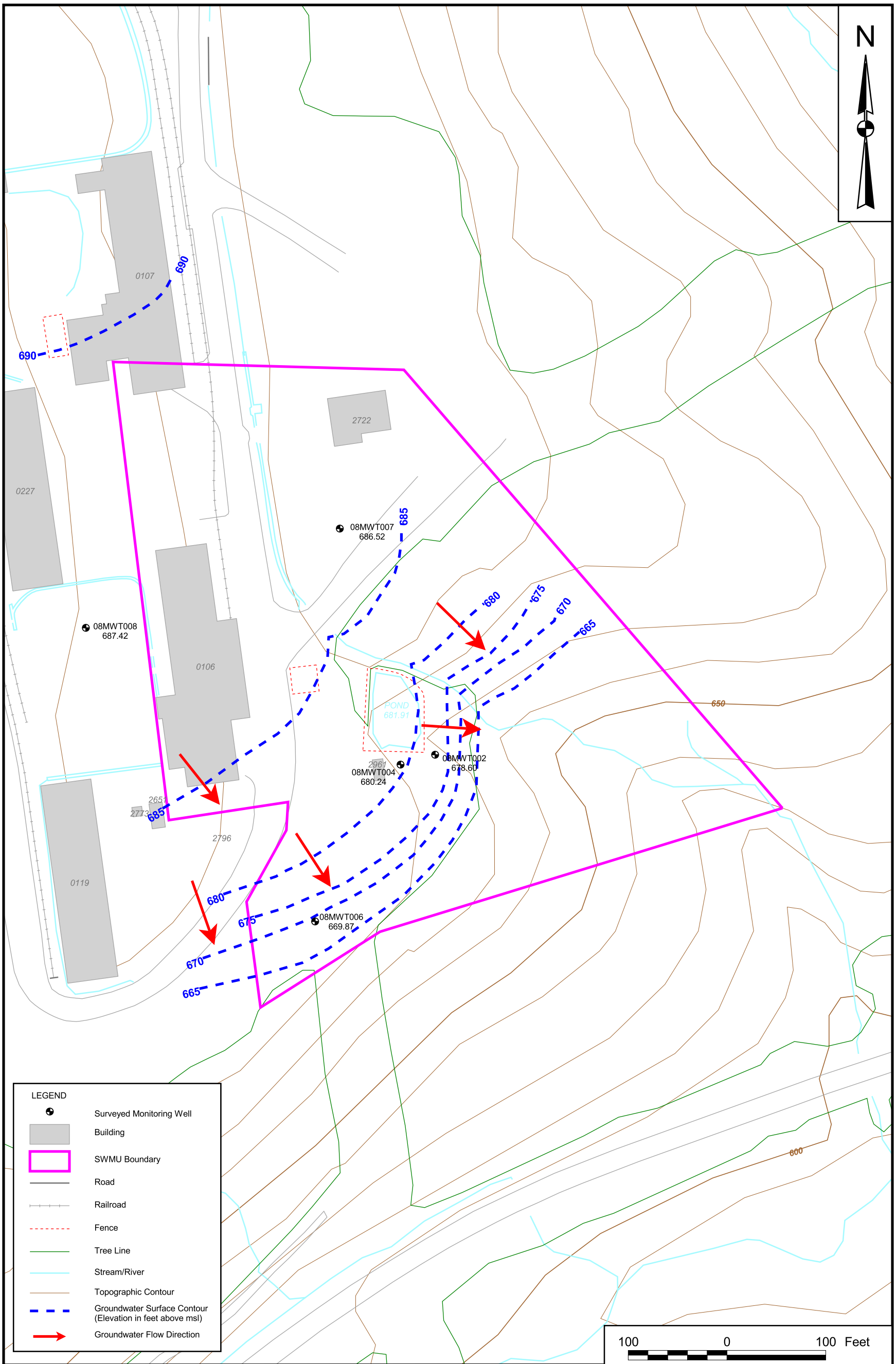
DRAWN BY A. JANOCHA — DATE 7/14/02

CHECKED BY T. JOHNSTON — DATE 9/26/02

COST/SCHED-AREA

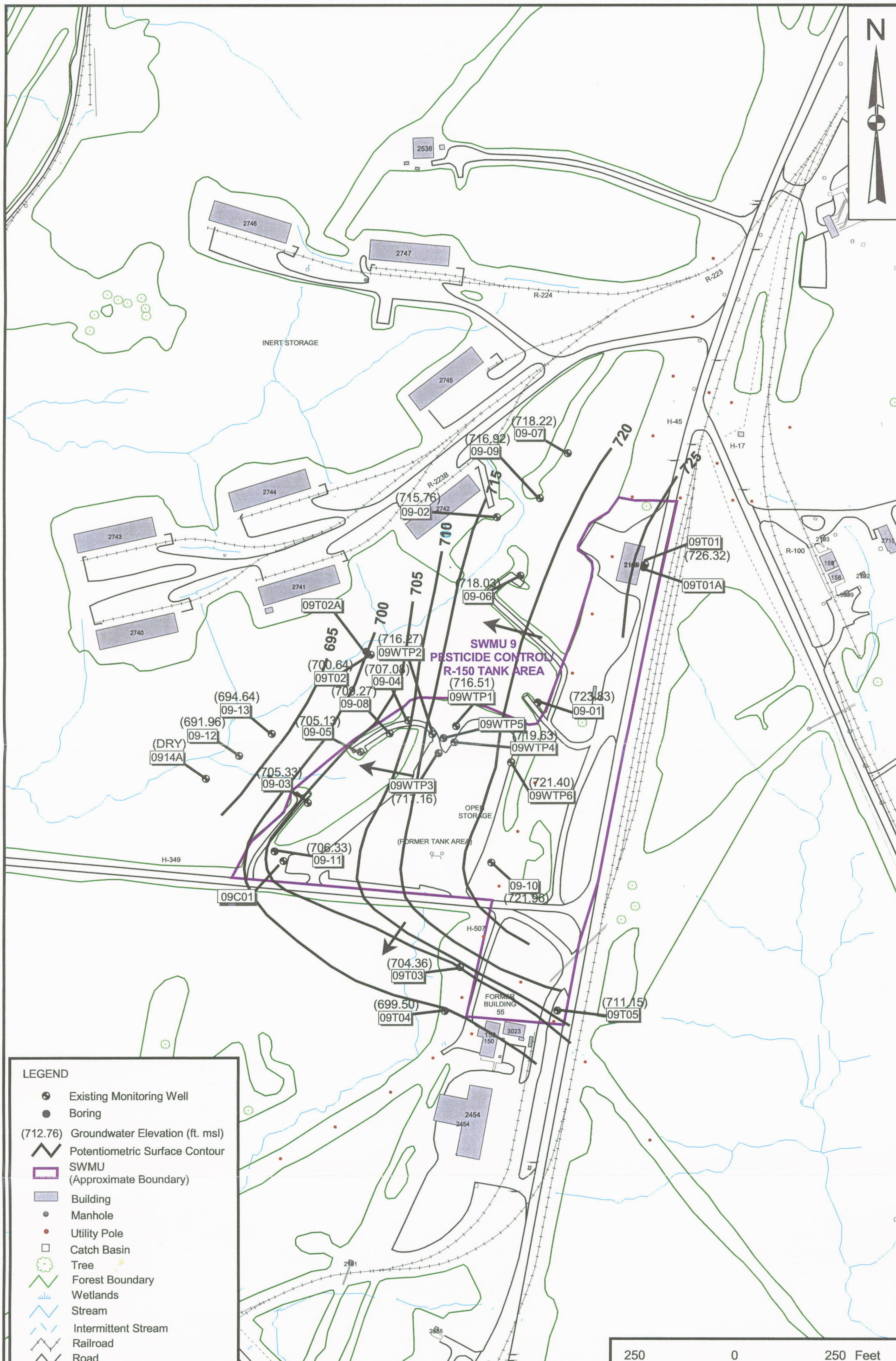
SCALE AS NOTED

P:\GIS\CRANE_NSWC\MAPDOCS\APR\SWMU08.APR SWMU08_UPPERZONE_MARCH2006 02/22/08 SS



DRAWN BY: K. PEILA	DATE: 2/23/06	POTENTIOMETRIC SURFACE MAP FOR THE OVERBURDEN/UPPER PENNSYLVANIAN WATER-BEARING ZONE - MARCH 1, 2006 SWMU 8 - BUILDING 106 POND NSWC CRANE CRANE, INDIANA	CONTRACT NUMBER: CTO 0021
CHECKED BY: K. TURNBULL	DATE: 2/22/08		APPROVED BY: — DATE: —
COST/SCHEDULE-AREA			APPROVED BY: — DATE: —
SCALE: AS NOTED			DRAWING NO.: FIGURE 1 - 5 REV: 0

P:\GIS\NSWC_Crane\CTO-10 SWMU 09_01\Potentiometric Surface Contour 5/21/02 KMP



DRAWN BY K. PEILA	DATE 5/21/02		CONTRACT NUMBER 7141
CHECKED BY	DATE	POTENTIOMETRIC SURFACE MAP (1-10-01) SWMU 9 - PESTICIDE CONTROL/R-150 TANK AREA NSWC CRANE, INDIANA	APPROVED BY — DATE —
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 6 - 6 / REV 0

P:\GIS\NSWC_CRANE\CTO-10_SWMU10_GW.APR POTENTIOMETRIC SURFACE CONTOUR MAP LOWER PENNSYLVANIAN WELLS B SIZE LAYOUT 10/3/02 KMP

N

(761.94) 10C40P2 — (762.07) 10C46 — (764.54) 10C38 — (763.18) 10C35 — (766.33) 10C36 — (762.99) 10C37 — (767.04) 10C30 — (767.33) 10C34 — (766.92) 10C33 — (767.30) 10C31 — (766.58) 10C47 — (766.15) 10C44 — (766.55) 10C52 — (766.07) 10C49 — (765.55) 10C51 — (759.70) 10C57 — (761.08) 10C56 — (766.51) 10C23 — (767.14) 10C24 — (761.23) 10C39 — (761.89) 10C41 — (763.54) 10C42 — (762.50) 10C45 — (768.81) 10C25 — (769.91) 10C26 — (769.43) 10C28 — (769.44) 10C32 — (769.86) 10C44 — (770.92) 10C43 — (770.22) 10C29 — (766.67) 10C29 — (765.93) 10C50 — (771.88) 10C54 — (771.25) 10C27 — (763.69) 10C53 — (771.08) 10C27 — (771.65) 10C-13

10SW/SD08 — 10SW/SD04 — 10SW/SD10 — 10SW/SD09 — 10SW/SD11 — 10SW/SD07 — 10SW/SD02 — 10SW/SD05 — 10SW/SD03 — 10SW/SD01

10SB01 — 10SB02 — 10SB03 — 10SB04 — 10SB05 — 10SB06 — 10SB07 — 10SB08 — 10SB09 — 10SB10

10-04 — 10-05 — 10-06 — 10-07 — 10-08 — 10-09 — 10-10 — 10-11 — 10-12 — 10-13 — 10-14 — 10-14A — 10-14B — 10-15 — 10-16 — 10-17 — 10-18 — 10-19 — 10-20 — 10-21 — 10-22

10/15-01-90 — 10/15-02-90 — 10/15-03-90 — 10/15-04-90 — 10/15-05-90 — 10/15-06A-90 — 10/15-07-90 — 10/15-08-90 — 10/15-09-90 — 10/15-10-90 — 10/15-11-90 — 10/15-12-90 — 10/15-13-90

2735 — 2737 — 2723A — 2731 — 2730 — 2739 — 2728 — 2727 — 2725 — 2726 — 3057

LEGEND

- Monitoring Well Location
- 10C45 — Well Designation - Lower Pennsylvanian
- 10C49 — Well Designation - Other
- (796.31) Groundwater Elevation (ft msl)
- Groundwater Flow Direction
- SWMU (Approximate Boundary)
- Building
- Manhole
- Utility Pole
- Catch Basin
- Fence
- Lightening Arrestor Pole
- Tree
- Forest Boundary
- Wetlands
- Stream
- Railroad
- Road
- Potentiometric Surface Contour 4 ft Interval
- Inferred Potentiometric Surface Contour
- Topographic Contour 20 ft Interval
- Contour Elevation (ft)

300 0 300 Feet

POTENTIOMETRIC SURFACE CONTOUR MAP
LOWER PENNSYLVANIAN WELLS
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA

CONTRACT NO. 7141

APPROVED BY ___ DATE ___

APPROVED BY ___ DATE ___

DRAWING NO. FIGURE 7 - 9 REV _

DEPARTMENT OF THE NAVY * NAVFACENGCOM * SOUTHERN DIV. * NAVFAC

DRAWN BY A. JANOCHA DATE 12/04/01

CHECKED BY DATE

COST/SCHED-AREA

SCALE AS NOTED

N

Legend

- Monitoring Well Location
- Building
- SWMU Boundary
- Potentiometric Contour (feet above mean seal level)
- Approximate Groundwater Flow Direction Arrow (Note: Flow arrow number refers to location of gradient and velocity calculations listed in Appendix E.2)
- Approximate Crop Line of the Upper Pennsylvanian Water-Bearing Zone
- Road
- Railroad
- Fence
- Tree Line
- Stream/River
- Topographic Contours (feet above mean sea level)

200 0 200 400 Feet

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POTENTIOMETRIC RFI 08/16/10 JEE

DRAWN BY	DATE
C. FOSTER	02/16/05
CHECKED BY	DATE
J. LUCAS	08/16/10
REVISED BY	DATE
—	—
SCALE	AS NOTED

NAVFAC

POTENTIOMETRIC SURFACE MAP FOR THE UPPER PENNSYLVANIAN WATER-BEARING ZONE - JANUARY 18, 2005
SWMU 12 - MINE FILL A
NSWC CRANE
CRANE, INDIANA

CONTRACT NO.	CTO 0357
OWNER NO.	6878
APPROVED BY	DATE
RAC	5/4/05
DRAWING NO.	REV.
FIGURE 4 - 10	0

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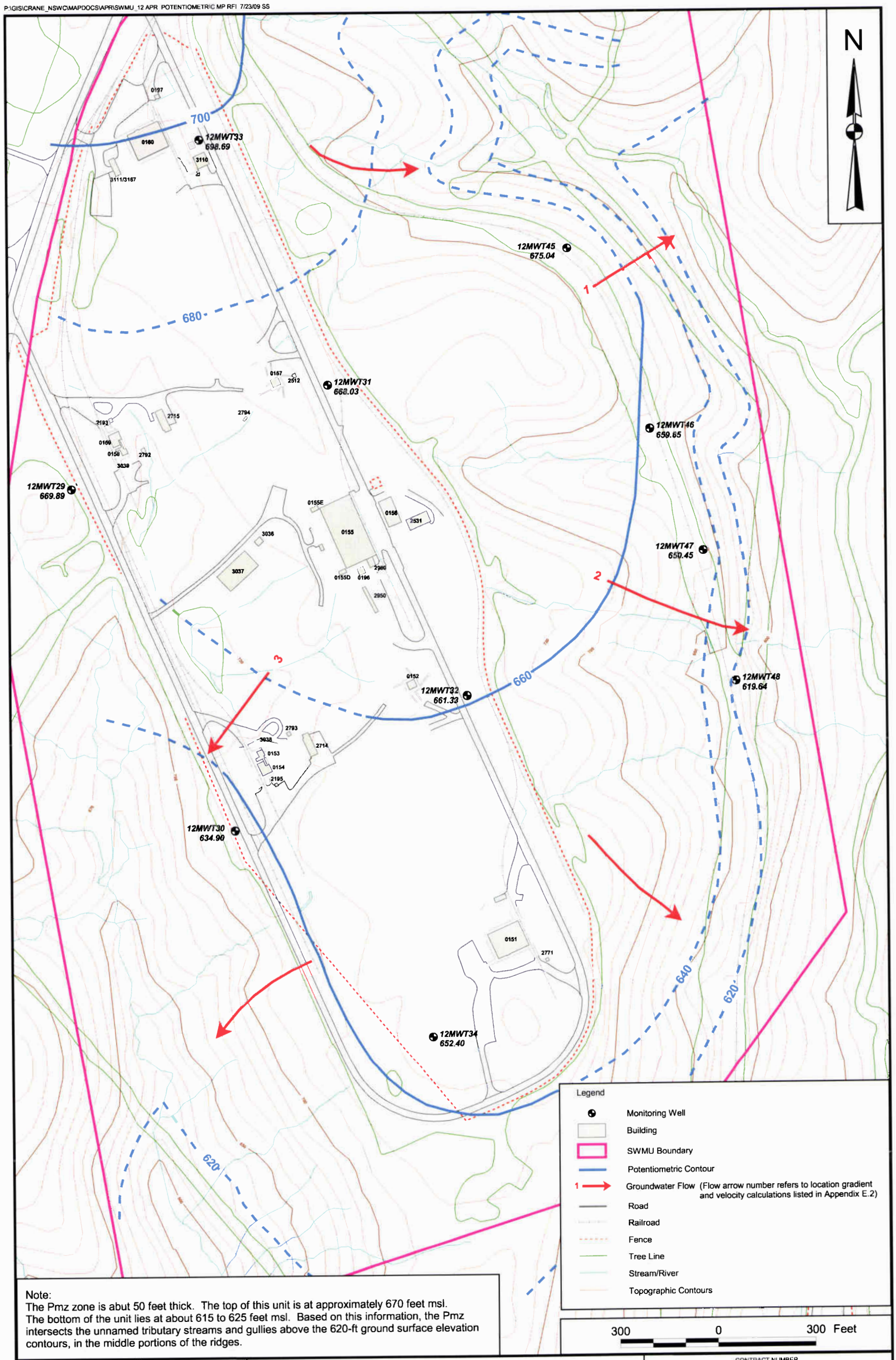


Note:
The Pmz zone is abut 50 feet thick. The top of this unit is at approximately 670 feet msl. The bottom of the unit lies at about 615 to 625 feet msl. Based on this information, the Pmz intersects the unnamed tributary streams and gullies above the 620-ft ground surface elevation contours, in the middle portions of the ridges.

DRAWN BY: C. FOSTER	DATE: 4/28/05
CHECKED BY: J. LUCAS	DATE: 7/23/09
COST/SCHEDULE-AREA	
SCALE: AS NOTED	

NAVFAC

POTENTIOMETRIC SURFACE MAP FOR THE MIDDLE PENNSYLVANIAN WATER-BEARING ZONE - JANUARY 18, 2005

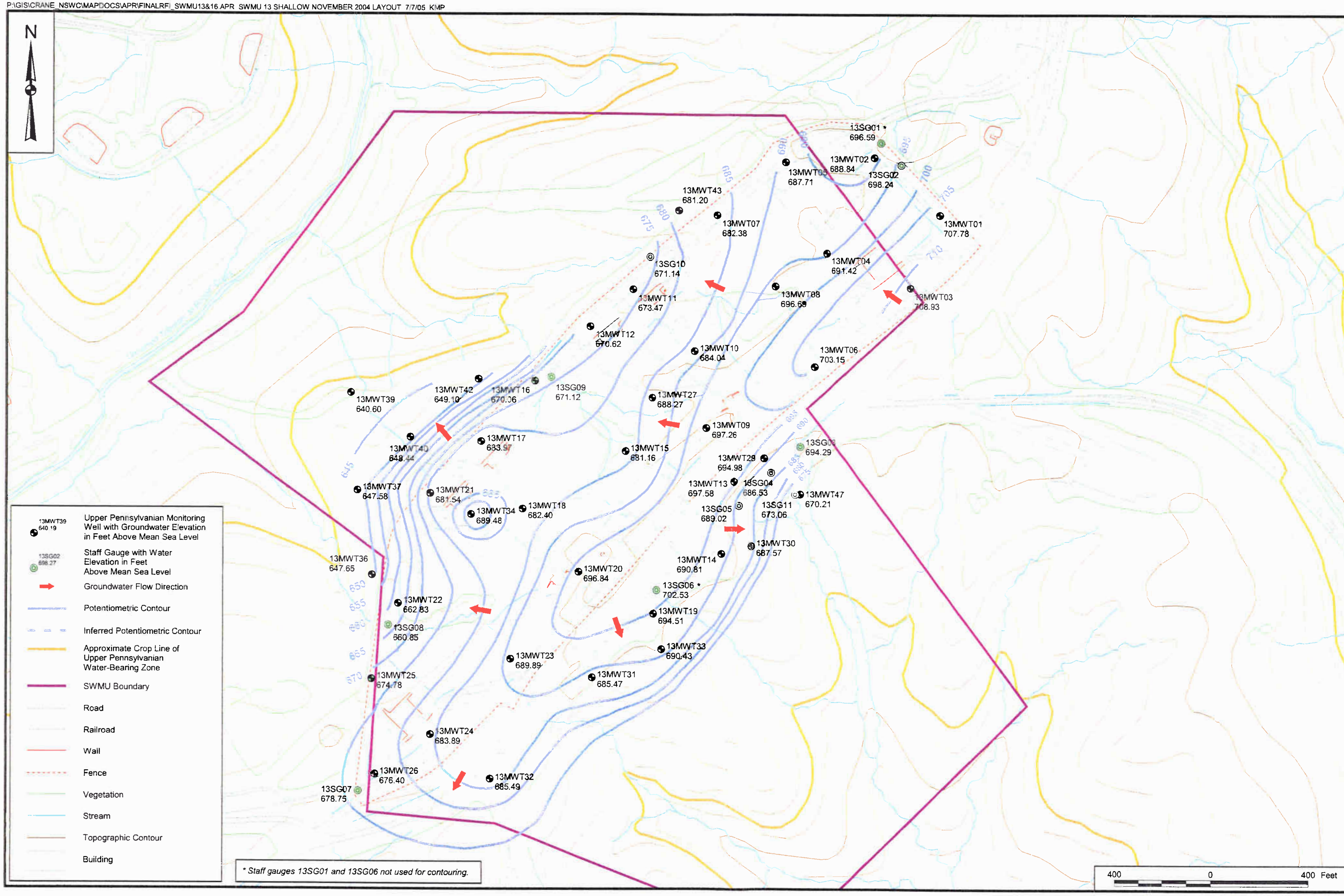
SWMU 12 MINE FILL A

NSWC CRANE

CRANE, INDIANA

CONTRACT NUMBER: 6878	
APPROVED BY: —	DATE: —
APPROVED BY: —	DATE: —
DRAWING NO.: FIGURE 4 - 11	REV: 0

P:\GIS\CRANE_NSWC\MAPDOCS\APR\FINALRFI_SWMU13&16.APR SWMU 13 SHALLOW NOVEMBER 2004 LAYOUT 7/7/05 KMP

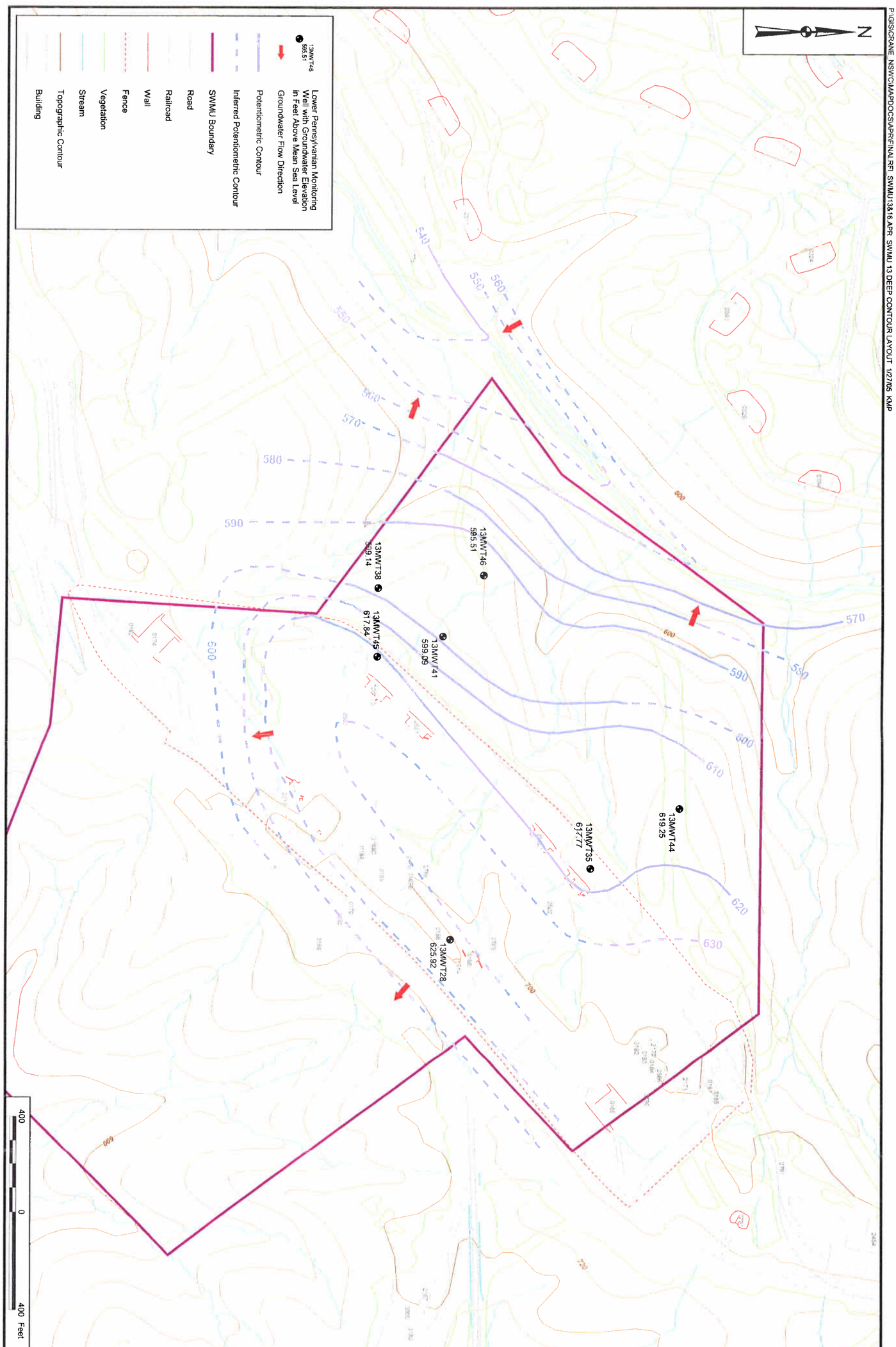


DRAWN BY	DATE
A. JANOCHA	2/23/04
CHECKED BY	DATE
J. LUCAS	5/13/04
COST/SCHED-AREA	
SCALE	AS NOTED

NAVFAC

POTENTIOMETRIC SURFACE ELEVATION MAP
FOR THE UPPER PENNSYLVANIAN
WATER-BEARING ZONE - NOVEMBER 14, 2004
SWMU 13 MINE FILL B
NSWC CRANE
CRANE, INDIANA

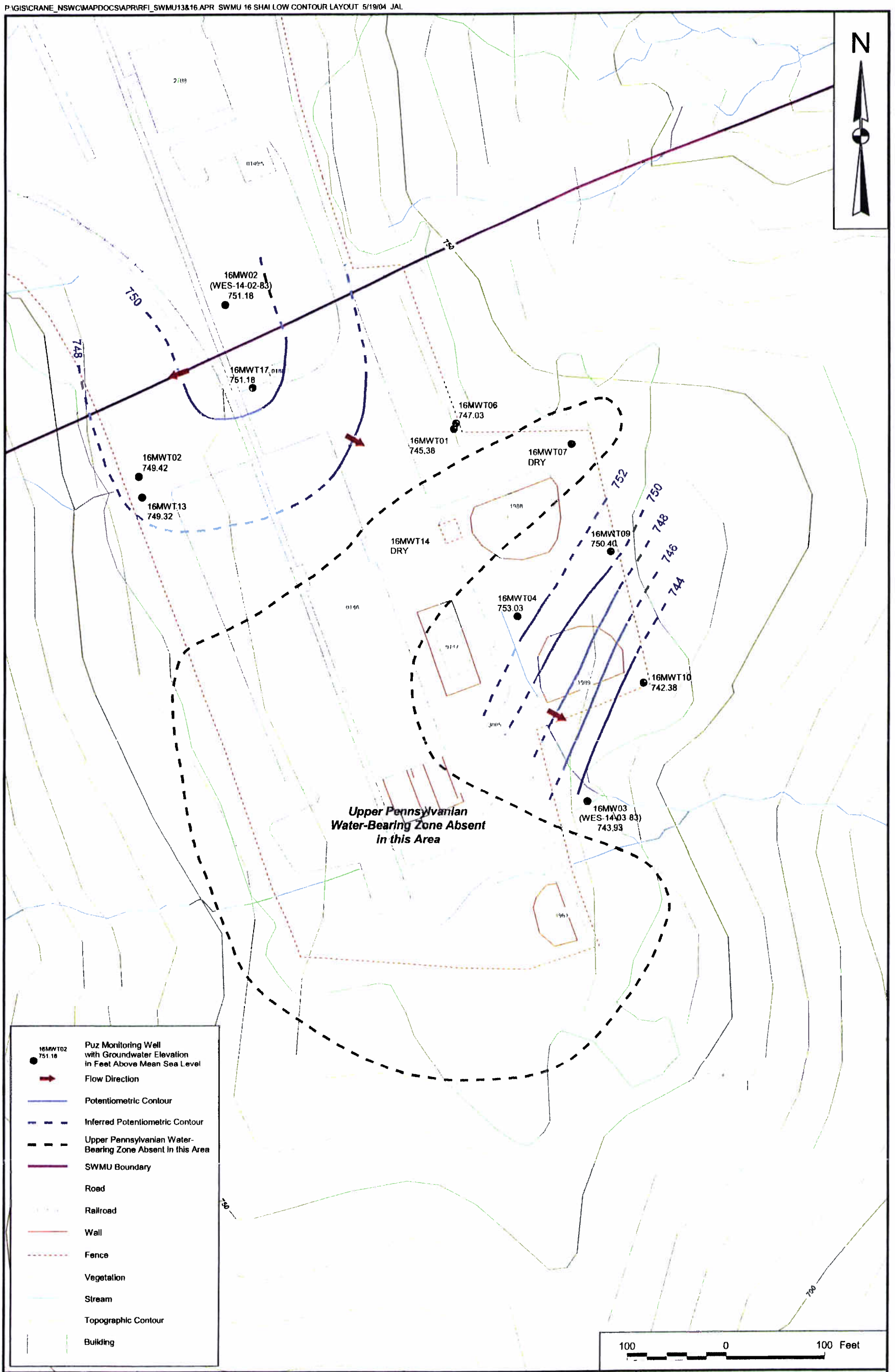
CONTRACT NO. 7448	
APPROVED BY	DATE
APPROVED BY	DATE
DRAWING NO. FIGURE 4-10	REV 0



P:\GIS\CRANE_NSWC\MAPDOCS\APR\FINALRFI_SWMU13&16.APR, SWMU 13 DEEP CONTOUR LAYOUT 1/27/05 KMP

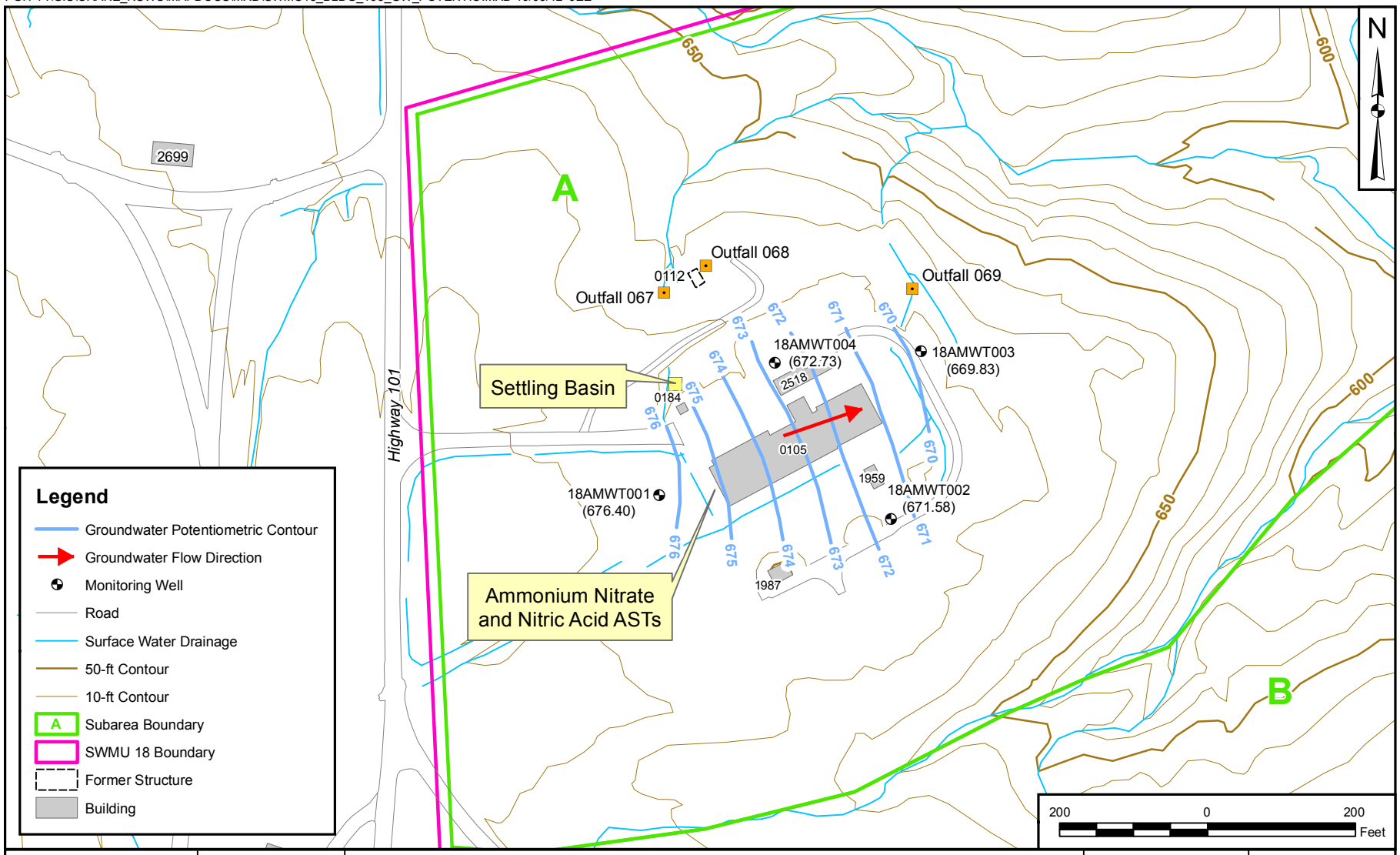
DRAWN BY A. JANOCHA	DATE 2/23/04	POTENTIOMETRIC SURFACE ELEVATION MAP FOR THE LOWER PENNSYLVANIAN WATER-BEARING ZONE - JANUARY 19 AND 20, 2004 SWMU 13 MINE FILL B NSWC CRANE CRANE, INDIANA	CONTRACT NO. 7448
CHECKED BY F. RAMSER	DATE 3/17/04		APPROVED BY / DATE
COST/SCHED-AREA			APPROVED BY / DATE
SCALE AS NOTED	NAVFAC		DRAWING NO. FIGURE 4-11 / REV 0

P:\GIS\CRANE_NSWC\MAPDOCS\APR\RFI_SWMU13&16.APR SWMU 16 SHALLOW CONTOUR LAYOUT 5/19/04 JAL



DRAWN BY A. JANOCHA	DATE 2/23/04	POTENTIOMETRIC SURFACE MAP FOR	CONTRACT NUMBER 7448
CHECKED BY J. LUCAS	DATE 5/13/04	UPPER PENNSYLVANIAN WATER-BEARING ZONE - JANUARY 24, 2004	APPROVED BY — DATE —
COST/SCHEDULE-AREA		SWMU 16 - CAST HIGH EXPLOSIVES FILL/BUILDING 146 INCINERATOR	APPROVED BY — DATE —
SCALE AS NOTED	NAVFAC	NSWC CRANE CRANE, INDIANA	DRAWING NO. FIGURE 4 - 7 / REV 0

PGH P:\GIS\CRANE_NSWC\MAPDOCS\MXD\SWMU18_BLDG_105_GW_POTENTIO.MXD 10/03/12 JEE



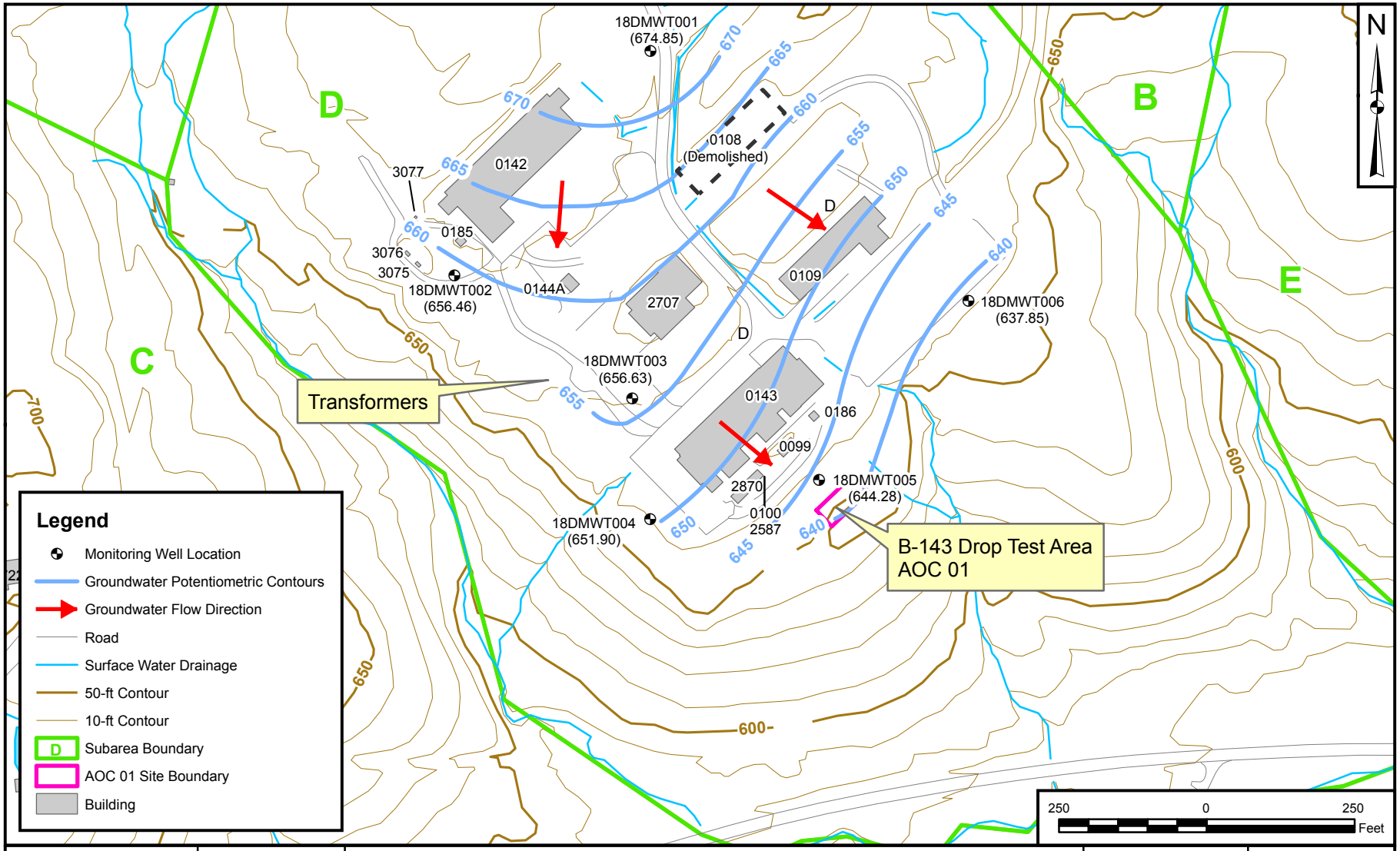
DRAWN BY	DATE
J. ENGLISH	02/15/12
CHECKED BY	DATE
T. EVANS	10/03/12
REVISED BY	DATE
J. ENGLISH	10/03/12
SCALE	
AS NOTED	

NAVFAC

SUBAREA A - BUILDING 105 AREA
GROUNDWATER POTENTIOMETRIC MAP
SWMU 18 - LOAD & FILL AREA
NSA CRANE
CRANE, INDIANA

CONTRACT NUMBER	CTO NUMBER
1851	F201
APPROVED BY	DATE
—	—
APPROVED BY	DATE
—	—
FIGURE NO.	REV
FIGURE A-4	0

PGH P:\GIS\CRANE_NSWC\MAPDOCS\MXD\SWMU18_BLDG_109_GW_POTENTIO.MXD 10/03/12 JEE



DRAWN BY	DATE
C. TULLEY	03/06/12
CHECKED BY	DATE
T. EVANS	10/03/12
REVISED BY	DATE
J. ENGLISH	10/03/12
SCALE	
AS NOTED	

NAVFAC

SUBAREA D - SPECIAL PROGRAMS AREA
GROUNDWATER POTENTIOMETRIC MAP
SWMU 18 - LOAD & FILL AREA
NSA CRANE
CRANE, INDIANA

CONTRACT NUMBER	CTO NUMBER
1851	F201
APPROVED BY	DATE
—	—
APPROVED BY	DATE
—	—
FIGURE NO.	REV
FIGURE D-4	0

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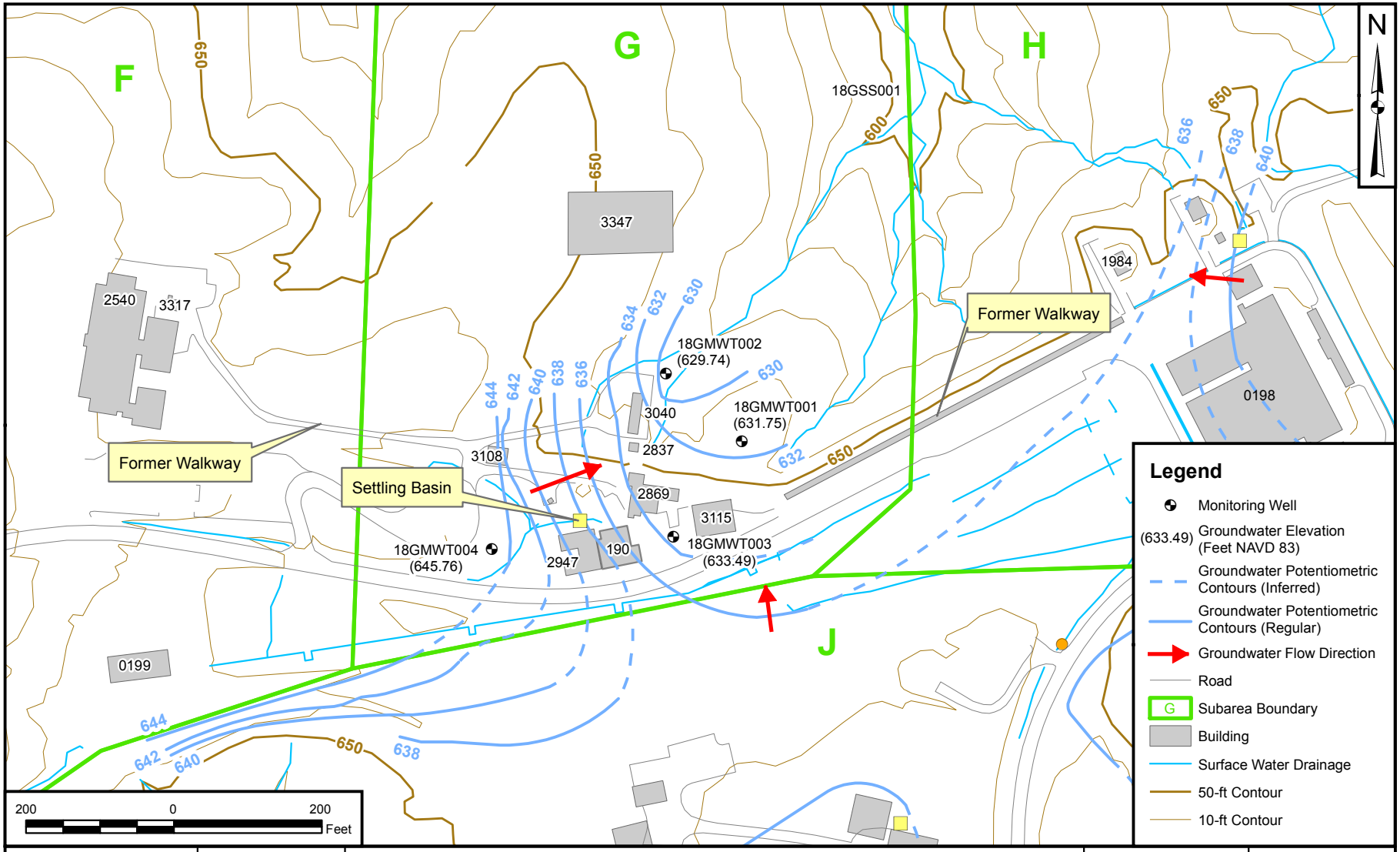


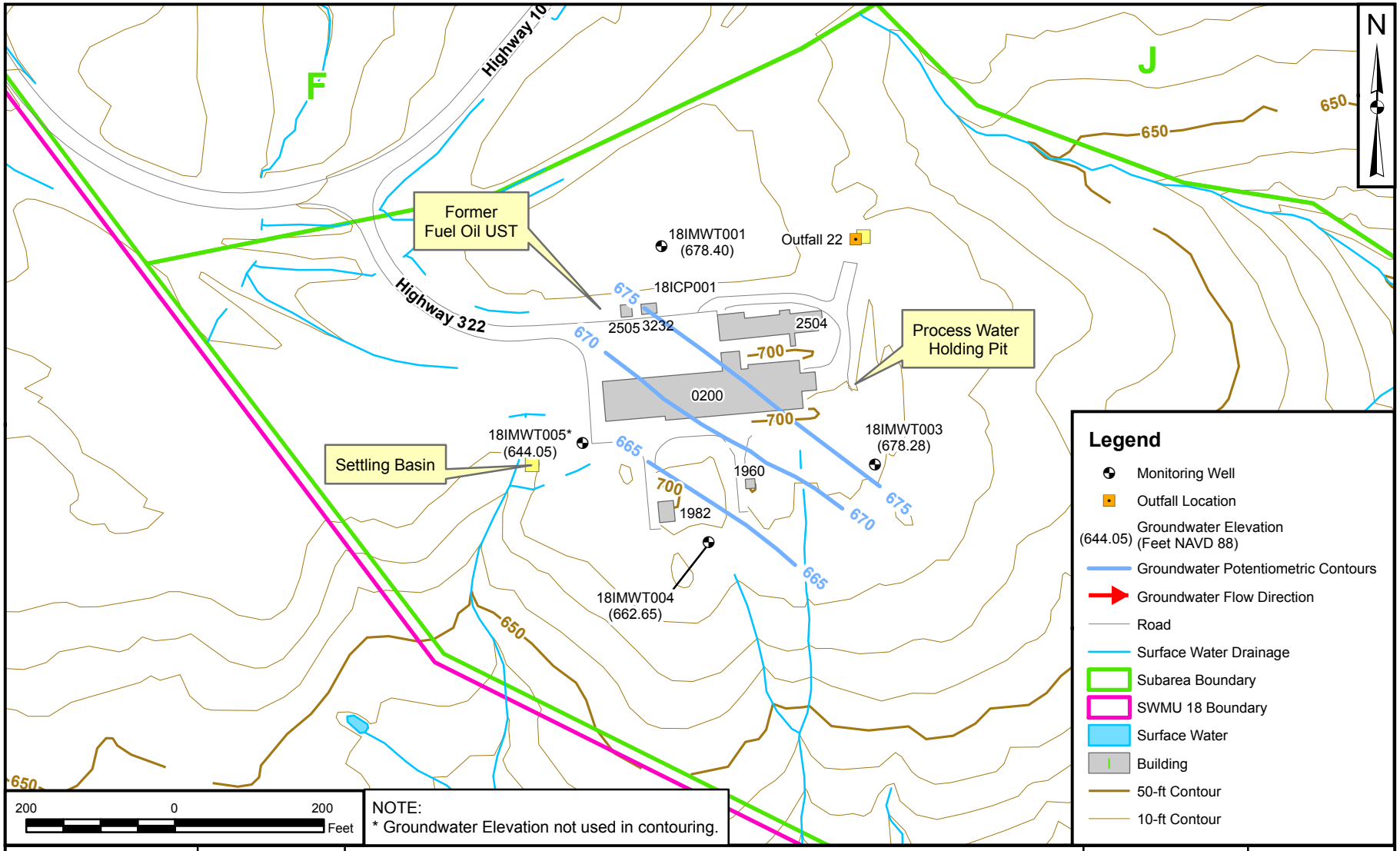
DRAWN BY	DATE
C. TULLEY	03/06/12
CHECKED BY	DATE
T. EVANS	10/03/12
REVISED BY	DATE
J. ENGLISH	10/03/12
SCALE	
AS NOTED	

NAVFAC

SUBAREA G - APPLIED SCIENCE DEPARTMENT I
GROUNDWATER POTENTIOMETRIC MAP
SWMU 18 - LOAD & FILL AREA
NSA CRANE
CRANE, INDIANA

CONTRACT NUMBER	CTO NUMBER
1851	F201
APPROVED BY	DATE
—	—
APPROVED BY	DATE
—	—
FIGURE NO.	REV
FIGURE G-4	0

PGH P:\GIS\CRANE_NSWC\MAPDOCS\MXD\SWMU18_BLDG_200_GW_POTENTIO.MXD 10/03/12 JEE



NOTE:
* Groundwater Elevation not used in contouring.

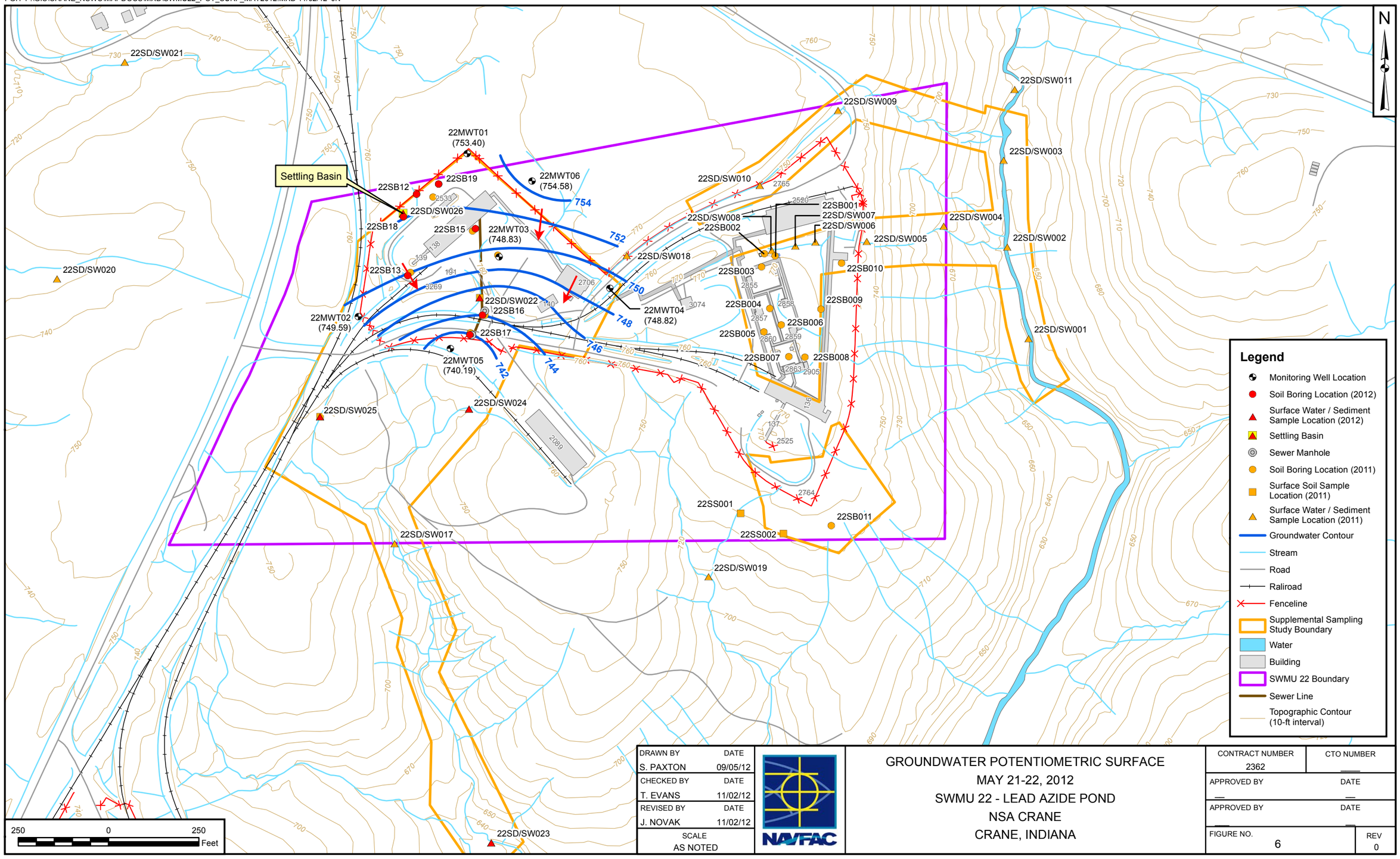
DRAWN BY	DATE
C. TULLEY	03/06/12
CHECKED BY	DATE
M. MENGEL	10/03/12
REVISED BY	DATE
J. ENGLISH	10/03/12
SCALE	
AS NOTED	

NAVFAC

SUBAREA I - BUILDING 200 AREA
GROUNDWATER POTENTIOMETRIC MAP
SWMU 18 - LOAD & FILL AREA
NSA CRANE
CRANE, INDIANA

CONTRACT NUMBER	CTO NUMBER
1851	F201
APPROVED BY	DATE
—	—
APPROVED BY	DATE
—	—
FIGURE NO.	REV
FIGURE I-4	0

PGH P:\GIS\CRANE_NSWC\MAPDOCS\MXD\SWMU22_POT_SURF_MAY2012.MXD 11/02/12 JN



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

NAVFAC

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

CONTRACT NUMBER	CTO NUMBER
2362	—
APPROVED BY	DATE
—	—
APPROVED BY	DATE
—	—
FIGURE NO.	REV
6	0

APPENDIX E

STATISTICAL ANALYSIS

STATISTICAL EVALUATION

Total inorganics data from upgradient monitoring wells in the Pennsylvanian bedrock at NSA Crane were evaluated to determine background concentrations. This section presents the data analysis and results of the statistical evaluations performed to establish the background data set for groundwater in the Pennsylvanian bedrock at NSA Crane. The statistical software package R version 2.15.0 and ProUCL version 4.1.1 were used for the statistical evaluations presented in this section.

The first step in determining the background data set is to evaluate the data for potential outliers. Potential outliers are measurements that are extremely large or small relative to the rest of the data and therefore are suspected of misrepresenting the population from which they were collected. Potential outliers may be a result of transcription errors, data-coding errors, or measurement system problems. However, outliers may represent true extreme values of a distribution and indicate more variability in the population than was expected.

Potential outliers were identified using boxplots (see Figures 1 through 22). Boxplots show the central tendency, degree of symmetry, range of variation, and potential outliers of a data set. The data set is shown as a rectangular box that represents the middle 50 percent of the data. The upper value of the box represents the 75^{th} percentile and the lower value of the box represents the 25^{th} percentile. The median is represented by the middle line in the box. Outliers on the box and whisker plots were plotted as circles.

Potential outliers were investigated using a formal outlier test (Rosner's Test, or Nonparametric Test). The following rationale was used to determine which if any outlier hypothesis tests to use to investigate the points identified on the boxplots:

- If the data were more than 90% non-detect no evaluation and the data point was retained in the data set.
- If the data were lognormal or normal, there were less than 15 % non-detects, and more than 25 samples Rosner's Test was computed.
- If the data were not normal or lognormal and all detected the non-parametric outlier test was computed.
- If the data were lognormal or normal and there were between 15 and 90 percent the nonparametric outlier test.

Details of Rosner's Test can be found in EPA's Data Quality Assessment: Statistical Methods for Practitioners and details of the nonparametric outlier test can be found in Handbook of Parametric and Nonparametric Statistical Procedures. Both hypothesis tests test the Null Hypothesis that there are outliers present versus the alternative hypothesis that outliers are not present. For the parametric tests a five percent significance level was used. For the non-parametric test outliers were considered statistically significant when the test statistic, $\frac{|x_i - meidan|}{Median\ Absolute\ Difference}$, was greater than 5.

The data distribution was determined using the following rationale:

- If the data were more than 50 percent non-detect assume nonparametric.
- If the Shapiro Wilk test on raw data concludes normal, data are normally distributed.
- If the Shapiro Wilk Test on natural log of data concludes lognormal, data are lognormally distributed.
- If the Shapiro Wilk test on raw and natural log data determined that the data are not normal or lognormally distributed then the data are nonparametric.

As noted in USEPA's Data Quality Assessment: Statistical Methods for Practitioners, "Statistical outlier test give the analyst probabilistic evidence that an extreme value does not "fit" with the distribution of the remainder of the data and is therefore a statistical outlier. These tests should only be used to identify data points that require further investigation. The tests alone cannot determine whether a statistical outlier should be discarded or corrected within a data set. This decision should be based on judgmental or scientific grounds."

Table 1 presents the frequency of detection (FOD), percent detected, number of outliers evaluated, the data distribution of the data without the suspected outlier, the outlier test computed, and the conclusion of the outlier test. Tables 2 and 3 present the results of Rosner's Test and the nonparametric test respectively.

After the statistically significant outliers were identified the wells with identified were investigated to see if there was a scientific reason (i.e., well location, turbidity) that identified outliers should not be included in the background dataset. Statistically significant outliers were identified in 7 samples (12GWT2501, 13GWT0301, 13GWT2801, 16GWT1701, 18IGWT001, 18AGWT001, 18GGWT004, and 22GWTW001).

- Data from sample 22GWTW001 was retained in the background dataset. The identified outlier was for lead, the majority of the data for lead are non-detect with low detections. However, there is no information that indicates that the outlier is not representative of actual background conditions.

- Data from sample 12GWT2501 was retained in the background dataset. The identified outlier was for selenium; the majority of the data for selenium are non-detect with low detections. However there is no information that indicates that the outlier is not representative of actual background conditions.

- Data from samples 13GWT0301 and 13GWT2801 were retained in the background dataset. There is no information that indicates that the outlier is not representative of actual background conditions.

- Data from sample 16GWT1701 were retained in the background dataset. There is no information that indicates that the outlier is not representative of actual background conditions.

- Data from samples18IGWT001, 18AGWT001, and 18GGWT004 were retained in the background dataset. There is no information that indicates that the outliers are not representative of actual background conditions.

After the data sets were evaluated for any potential outliers, basic summary statistics [FOD, range of non-detects, minimum detected concentration, maximum detected concentration, and 95% upper tolerance limit with 95 percent coverage(UTL)] were computed and are presented in Table 4. The 95% UTL is the upper value of the limit that covers 95 percent of the population with a 95%confidence. ProUCL version 4.1.1 was used to calculate the 95% UTLs. The following rationale was used to determine which UTL to use from the ProUCL output.

- If all data detected and data distribution is Normal 95% UTL with 95% coverage from normal statistics output is used.
- If all data are detected and data distribution is not Normal 95% UTL with 95% coverage from nonparametric output is used.

- If any data are non-detected 95% Kaplan Meier UTL with 95% coverage from nonparametric output is used.

REFERENCES

R Development Core Team, 2012. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org/.

Sheskin, David. 2004. Handbook of Parametric and Nonparametric Statistical Procedures, Third Edition.

USEPA, 2006. Data Quality Assessment: Statistical Methods for Practitioners EPA QA/G-9S. EPA/240/B-06/003Office of Environmental Information Washington D.C.

TABLE 1
OUTLIER TESTS AND CONCLUSIONS
PENNSYLVANIAN WELL BACKGROUND GROUNDWATER EVALUATION

PARAMETER	FOD	NUMBER OF POTENTIAL OUTLIERS	NORMAL P-VALUE	LOGNORMAL P-VALUE	DATA DISTRIBUTION	OUTLIER TEST[(1)]	CONCLUSION
TOTAL METALS							
TOTAL ALUMINUM	19/28	5	0.004944	0.02689	Nonparametric	Nonparametric Test	18IGWT001, 13GWT2801, 18GGWT004, 13GWT0301, and 18AGWT001 are statistically signficant outliers.
TOTAL ANTIMONY	1/28	3	NA	NA	Assumed Nonparametric	No Evaluation	NA
TOTAL ARSENIC	12/29	4	NA	NA	Assumed Nonparametric	Nonparametric Test	13GWT2801, 18GGWT004, and 18IGWT001 are statistically significant outliers.
TOTAL BARIUM	27/29	0	0.005937	0.05668	Log-Normal	Parametric Test	No Outliers
TOTAL BERYLLIUM	6/28	1	NA	NA	Assumed Nonparametric	Nonparametric Test	No Statistically Significant Outliers
TOTAL CADMIUM	3/29	0	NA	NA	Assumed Nonparametric	Nonparametric Test	No Outliers
TOTAL CALCIUM	28/28	2	0.002309	0.6476	Log-Normal	Parametric Test	No Statistically Significant Outliers
TOTAL CHROMIUM	9/29	2	NA	NA	Assumed Nonparametric	Nonparametric Test	18IGWT001 and 13GWT2801 are a Statistically Signifcant Outliers
TOTAL COBALT	21/28	0	0.005057	0.03454	Nonparametric	Nonparametric Test	No Outliers
TOTAL COPPER	17/28	3	0.1408	0.008892	Normal	Nonparametric Test	18GGWT004, 18IGWT001 and 18AGWT001 are statistically signifcant outliers
TOTAL IRON	25/28	5	2.12E-07	0.7755	Log-Normal	Parametric Test	No Statistically Significant Outliers
TOTAL LEAD	4/29	4	NA	NA	Assumed Nonparametric	Nonparametric Test	18IGWT001, 18GGWT004, 22GWT001, and 13GWT2801 are Statistically Signficant Outliers.
TOTAL MAGNESIUM	28/28	3	0.001005	0.8603	Log-Normal	Parametric Test	No Statistically Significant Outliers
TOTAL MANGANESE	27/28	2	0.00287	0.03736	Nonparametric	Nonparametric Test	16GWT1701 and 12GWT2501 are Statistically Signficant Outliers.
TOTAL MERCURY	2/29	0	NA	NA	Assumed Nonparametric	No Evaluation	No Outliers
TOTAL NICKEL	24/28	0	0.002705	0.1035	Log-Normal	Parametric Test	No Outliers
TOTAL POTASSIUM	22/28	0	0.005042	0.0002762	Nonparametric	Nonparametric Test	No Outliers
TOTAL SELENIUM	7/29	4	NA	NA	Assumed Nonparametric	Nonparametric Test	13TWT2801, 12GWT2501, 18IGWT001, and 18GGWT004 are Statistically Significant Outliers
TOTAL SILVER	0/29	6	NA	NA	Assumed Nonparametric	No Evaluation	NA
TOTAL SODIUM	28/28	0	0.0007477	0.3086	Log-Normal	Parametric Test	No Outliers
TOTAL THALLIUM	1/28	1	NA	NA	Assumed Nonparametric	No Evaluation	NA
TOTAL TIN	0/24	1	NA	NA	Assumed Nonparametric	No Evaluation	NA
TOTAL VANADIUM	5/28	4	NA	NA	Assumed Nonparametric	Nonparametric Test	18IGWT001, 18GGWT004,13GW2801, and 13GWT0301 are Statistically Signficant Outliers.
TOTAL ZINC	23/28	0	0.0001904	0.3981	Log-Normal	Nonparametric Test	No Outliers

Footnotes:
(1) If the data were lognormal or normal and there were less than 15% non-detects and the sample size was 25 Extreme Value Test was computed.
If the data were not lognormal or normal or if 10 to 50 percent of the data was detected the nonparametric outlier test was computed.
(2) When at least 90 percent of the data is non-detect formal hypothesis tests are not appropriate.
(3) There are additional uncertainties associated with hypothesis tests when between 50 and 90 percent of the data is non-detect.

Acronyms:
FOD = Frequency of Detection
NA = Not Applicable

TABLE 2
ROSNER'S OUTLIER TEST
PENNSYLVANIAN WELL BACKGROUND GROUNDWATER EVALUATION

PARAMETER	Outlier Sample ID	Outlier result	Test Statistic	Critical Value	Conclusion
TOTAL CALCIUM	12GWT2501	216000	1.76	2.88	No Outliers
	16GW0203	212000	1.89	2.86	No Outliers
TOTAL IRON	12GWT3301	41800	1.66	2.88	No Outliers
	12GWT3302	41700	1.79	2.86	No Outliers
	16GWT1701	27000	1.73	2.84	No Outliers
	18IGWT001	22500	1.79	2.82	No Outliers
	10GWC5201	2220	1.96	2.8	No Outliers
TOTAL MAGNESIUM	12GWT2501	229000	2.3	2.89	No Outliers
	01GW0601	156000	2.23	2.88	No Outliers
	12GWT2502	153000	2.52	2.86	No Outliers

A five percent signifcance level was used.

TABLE 3
NONPARAMETRIC OUTLIER TEST
PENNSYLVANIAN WELL BACKGROUND GROUNDWATER EVALUATION

PARAMETER	Outlier Sample ID	Outlier result	Test Statistic	Critical Value	Conclusion
TOTAL ALUMINUM	18IGWT001	8500	51.4	5	Outlier
	13GWT2801	6270	38	5	Outlier
	18GGWT004	6210	40.2	5	Outlier
	13GWT0301	3990	27.2	5	Outlier
	18AGWT001	3110	22.2	5	Outlier
TOTAL ARSENIC	13GWT2801	15.2	25.8	5	Outlier
	18GGWT004	8.61	14.5	5	Outlier
	18IGWT001	8.28	14.6	5	Outlier
	01GW0601	3.2	4.4	5	Not Outlier
TOTAL BERYLLIUM	18AGWT001	3.01	4.3	5	Not Outlier
TOTAL CHROMIUM	18IGWT001	26.2	41.3	5	Outlier
	13GWT2801	11.7	21.4	5	Outlier
TOTAL COPPER	18GGWT004	21.6	17.1	5	Outlier
	18IGWT001	16.6	12.9	5	Outlier
	18AGWT001	12.3	9.2	5	Outlier
TOTAL LEAD	18IGWT001	15.5	38.8	5	Outlier
	18GGWT004	11.7	30.8	5	Outlier
	22GWT001	3.2	7.4	5	Outlier
	13GWT2801	2.5	6.1	5	Outlier
TOTAL MANGANESE	16GWT1701	5940	7.9	5	Outlier
	12GWT2501	4910	7.4	5	Outlier
TOTAL SELENIUM	13GWT2801	4.1	7.1	5	Outlier
	12GWT2501	3.4	6.1	5	Outlier
	18IGWT001	2.5	5.1	5	Outlier
	18GGWT004	2.5	5.7	5	Outlier
TOTAL VANADIUM	18IGWT001	17.9	19.5	5	Outlier
	13GWT2801	12.5	13.2	5	Outlier
	18GGWT004	7.47	7.4	5	Outlier
	13GWT0301	5.8	5.4	5	Outlier

TABLE 4
SUMMARY STATISTICS
PENNSYLVANIAN WELL BACKGROUND GROUNDWATER EVALUATION

PARAMETER	FOD	RANGE OF DETECTION LIMITS	MINIMUM DETECTED CONCENTRATION	MAXIMUM DETECTED CONCENTRATION	LOCATION OF MAXIMUM DETECTED CONCENTRATION	DATA DISTRIBUTION(1)	UTL(2,3)
TOTAL ALUMINUM	19/28	8.3 - 200	28.5	8500	18IGWT001	Log-Normal	6183
TOTAL ANTIMONY	1/28	0.02 - 4	2.9	2.9	13GWT2801	Assumed Nonparametric	NA
TOTAL ARSENIC	12/29	0.16 - 3.2	0.66	15.2	13GWT2801	Assumed Nonparametric	9.1
TOTAL BARIUM	27/29	12.8 - 15.6	13.2	97.5	18IGWT001	Log-Normal	96.9
TOTAL BERYLLIUM	6/28	0.02 - 1.8	0.1	3.01	18AGWT001	Assumed Nonparametric	2 (4)
TOTAL CADMIUM	3/29	0.039 - 1	0.08	0.9	22GWT001	Assumed Nonparametric	0.55 (4)
TOTAL CALCIUM	28/28	NA	7190	216000	12GWT2501	Log-Normal	216000
TOTAL CHROMIUM	9/29	0.17 - 5	0.58	26.2	18IGWT001	Assumed Nonparametric	14.6 (4)
TOTAL COBALT	21/28	1 - 3	2	64.4	16GWT1701	Nonparametric	65.5
TOTAL COPPER	17/28	0.12 - 2.1	0.67	21.6	18GGWT004	Log-Normal	14.6
TOTAL IRON	25/28	61.7 - 344	12.7	41800	12GWT3301	Log-Normal	34500
TOTAL LEAD	4/29	0.157 - 2.5	0.54	15.5	18IGWT001	Assumed Nonparametric	9 (4)
TOTAL MAGNESIUM	28/28	NA	2950	229000	12GWT2501	Log-Normal	229000
TOTAL MANGANESE	27/28	566 - 566	6.89	5940	16GWT1701	Log-Normal	4470
TOTAL MERCURY	2/29	0.007 - 0.2	0.16	0.39	13GWT0102	Assumed Nonparametric	NA
TOTAL NICKEL	24/28	10 - 10	1.56	131	12GWT3301	Log-Normal	135
TOTAL POTASSIUM	22/28	3390 - 5000	403	5380	16GWT1701	Nonparametric	6450
TOTAL SELENIUM	7/29	0.04 - 2.5	0.33	4.1	13GWT2801	Assumed Nonparametric	2.7 (4)
TOTAL SILVER	0/29	0.028 - 3			All Non-Detect	Assumed Nonparametric	NA
TOTAL SODIUM	28/28	NA	10100	165000	12GWT2601	Log-Normal	165000
TOTAL THALLIUM	1/28	0.04 - 5	0.08	0.08	12GWT2501	Assumed Nonparametric	NA
TOTAL TIN	0/24	0.048 - 190			All Non-Detect	Assumed Nonparametric	NA
TOTAL VANADIUM	5/28	0.06 - 3	2.1	17.9	18IGWT001	Assumed Nonparametric	11.4 (4)
TOTAL ZINC	23/28	1.1 - 10	2.16	161	13GWT0301	Log-Normal	140

(1) Data distribution deteremined using Shaprio Wilk Test with a five percent significance level.
(2) UTLS are presented using three significant figures if the value is greater than 10 otherwise 2 significant figures were presented.
(3) UTLS were calculated using ProUCL version 4.1.1. For Assumed nonparametric the 95% KM UTL is presented.
(4) ProUCL warns that there may not be enough detected concentrations for the calculations to be reliable enough to draw conclusions.
(5) There is only one detected concentration. Computing sumary statistics is not approporiate.

UTL = Upper Tolerance Limit
NA = Not Applicable

Rationale for UTL Selected from ProUCL Output
If all data detected and data distribution is not Normal use Nonparamtric 95% UTL with 95% Coverage.
If any data are non-detect 95% Kaplain Meier UTL with 95% Coverage.

FIGURE 1
TOTAL ALUMINUM BOXPLOT
GROUNDWATER BACKGROUND EVALUATION
NSA CRANE, CRANE, INDIANA

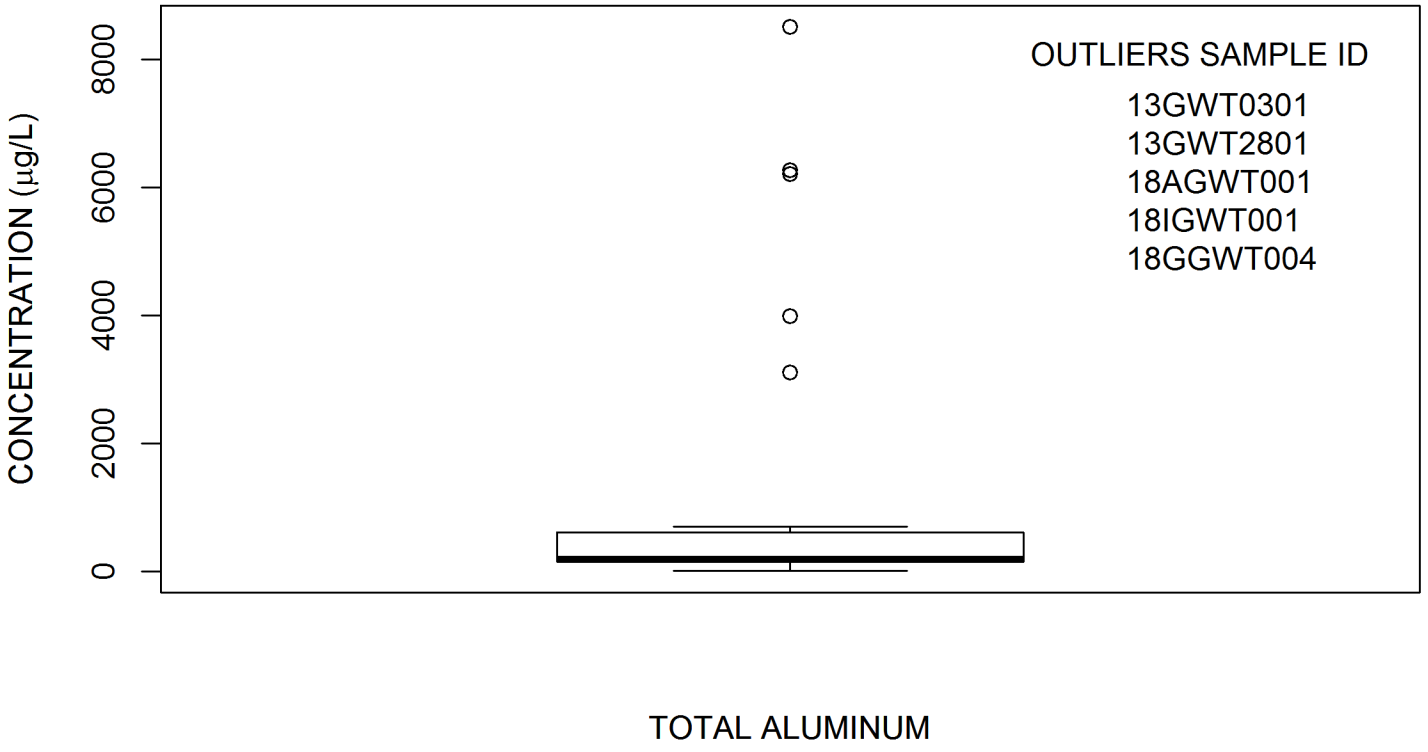


FIGURE 2
TOTAL ANTIMONY BOXPLOT
GROUNDWATER BACKGROUND EVALUATION
NSA CRANE, CRANE, INDIANA

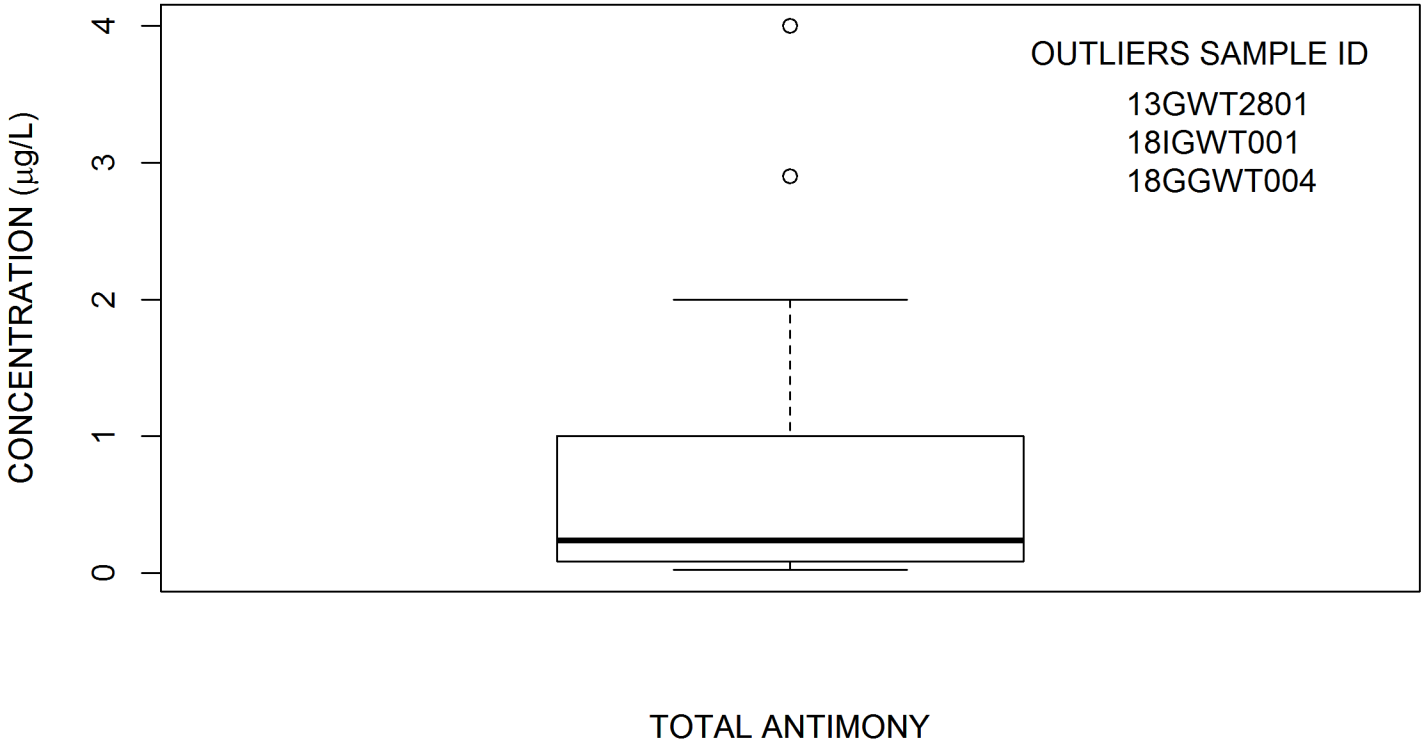


FIGURE 3
TOTAL ARSENIC BOXPLOT
GROUNDWATER BACKGROUND EVALUATION
NSA CRANE, CRANE, INDIANA

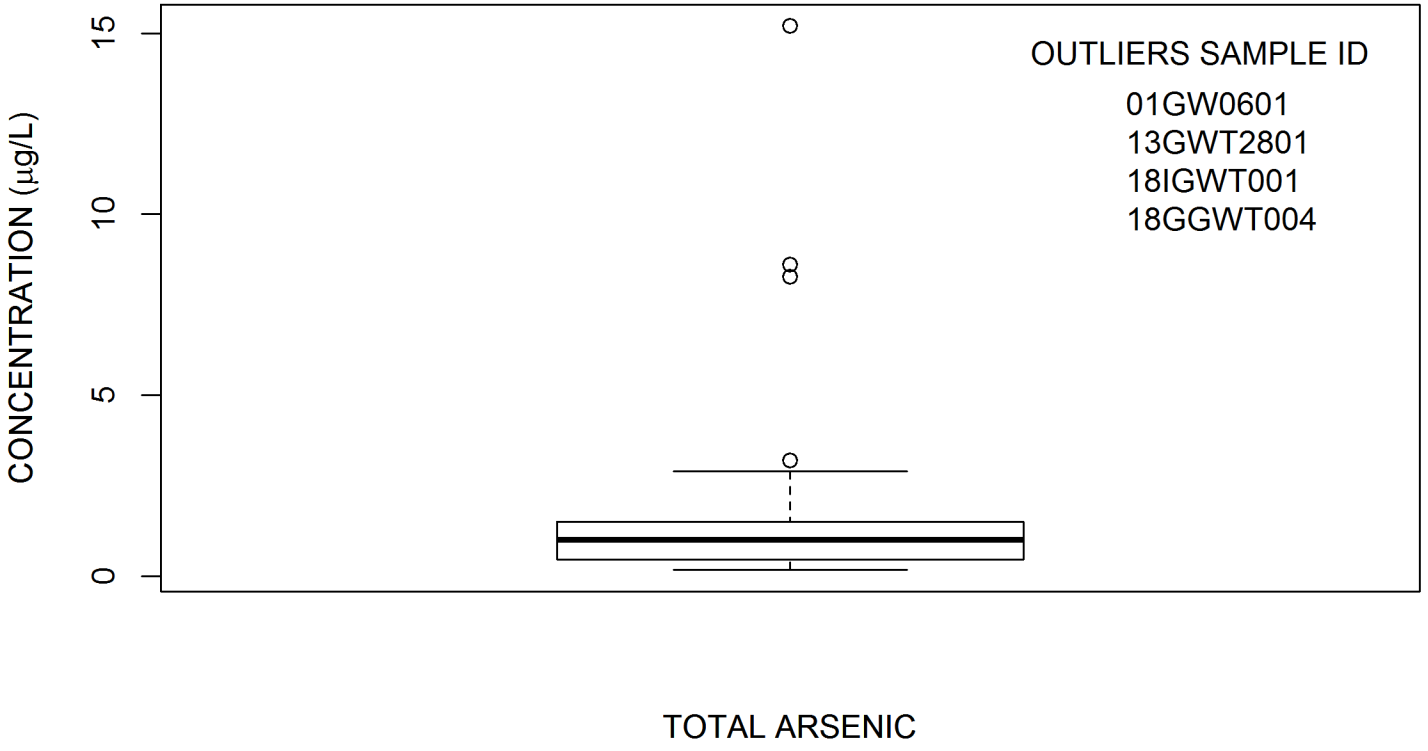


FIGURE 4
TOTAL BARIUM BOXPLOT
GROUNDWATER BACKGROUND EVALUATION
NSA CRANE, CRANE, INDIANA

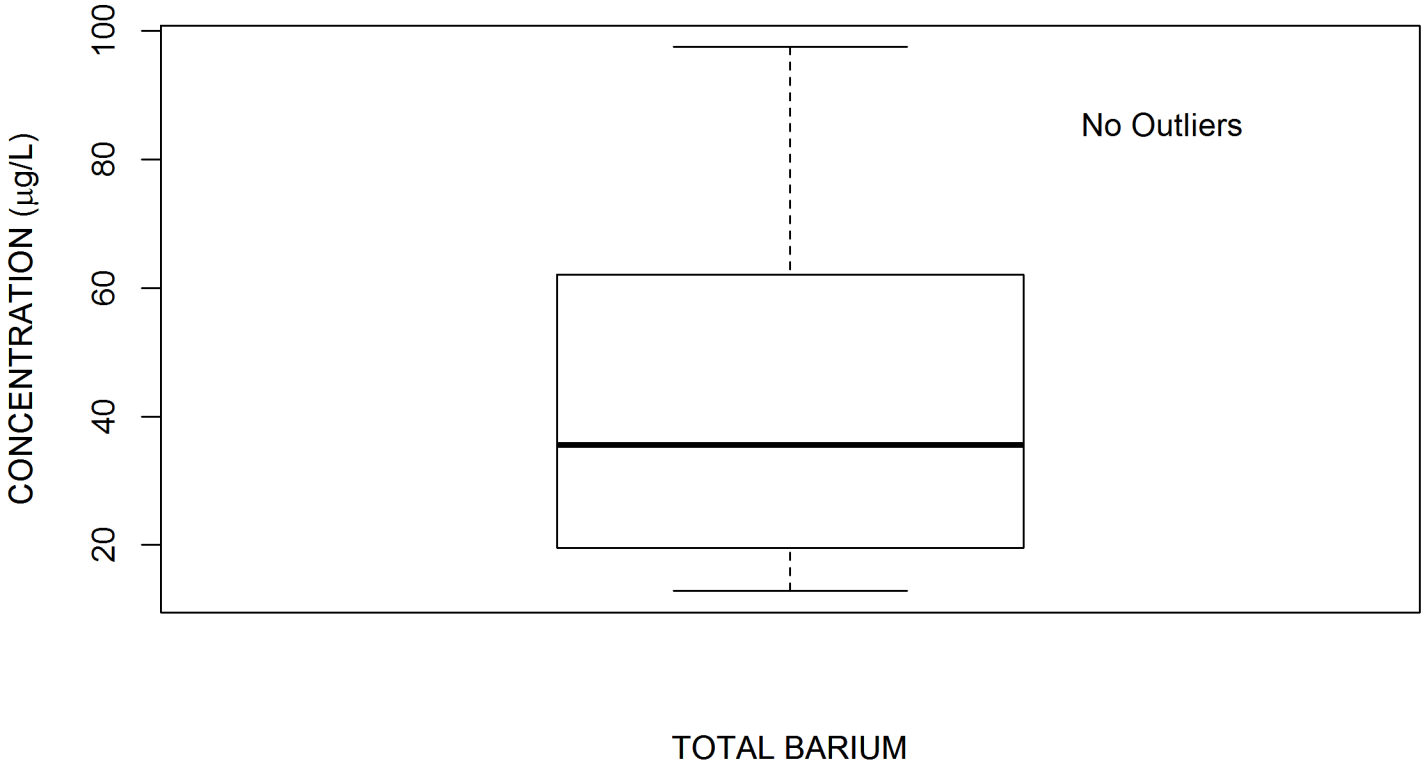


FIGURE 5
TOTAL BERYLLIUM BOXPLOT
GROUNDWATER BACKGROUND EVALUATION
NSA CRANE, CRANE, INDIANA

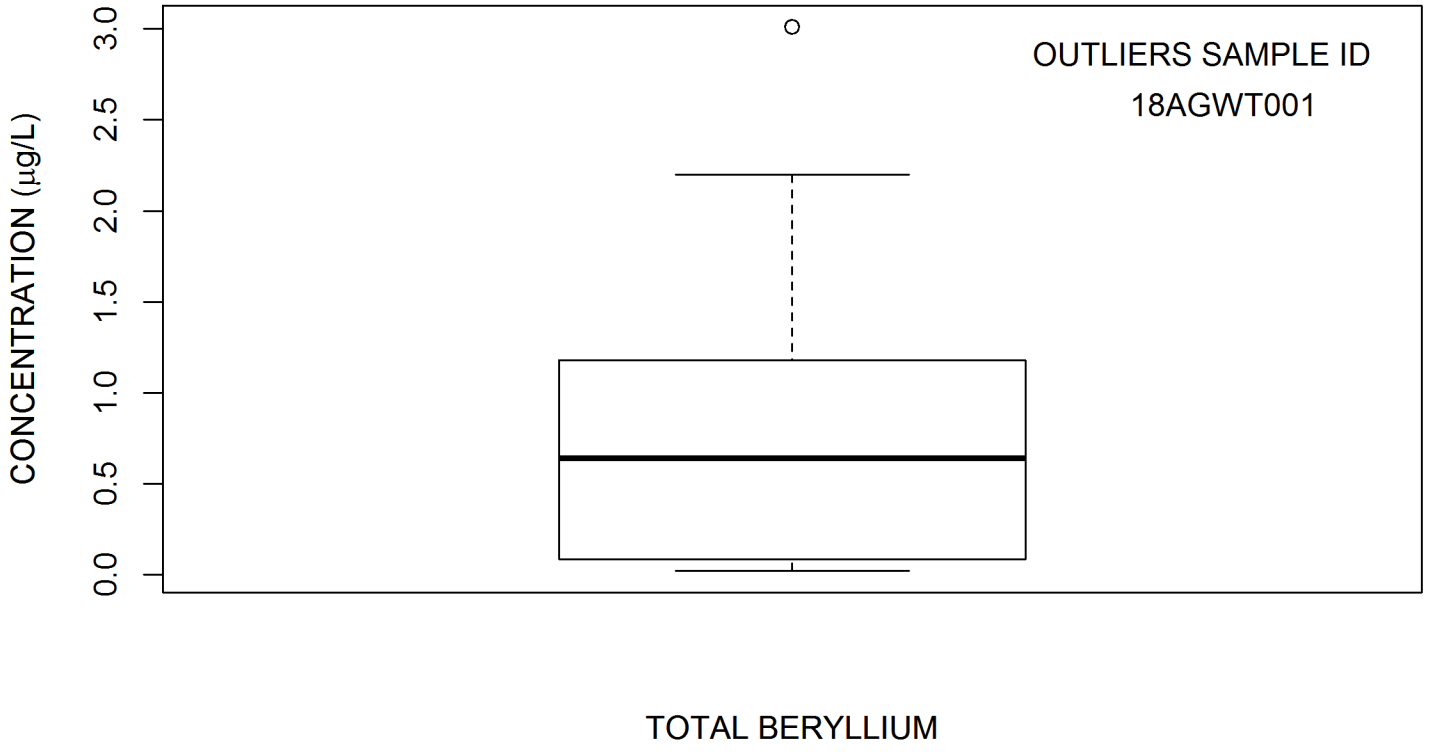


FIGURE 6
TOTAL CADMIUM BOXPLOT
GROUNDWATER BACKGROUND EVALUATION
NSA CRANE, CRANE, INDIANA

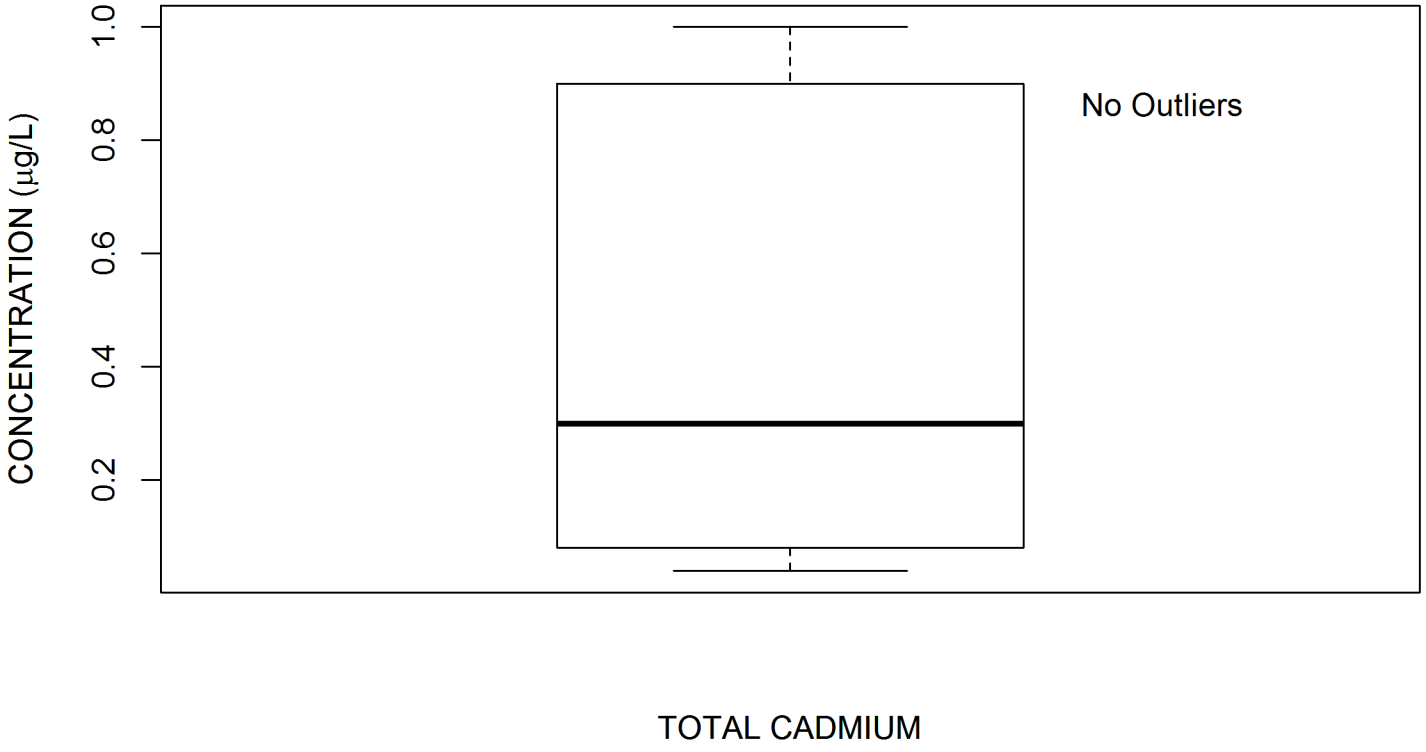


FIGURE 7
TOTAL CALCIUM BOXPLOT
GROUNDWATER BACKGROUND EVALUATION
NSA CRANE, CRANE, INDIANA

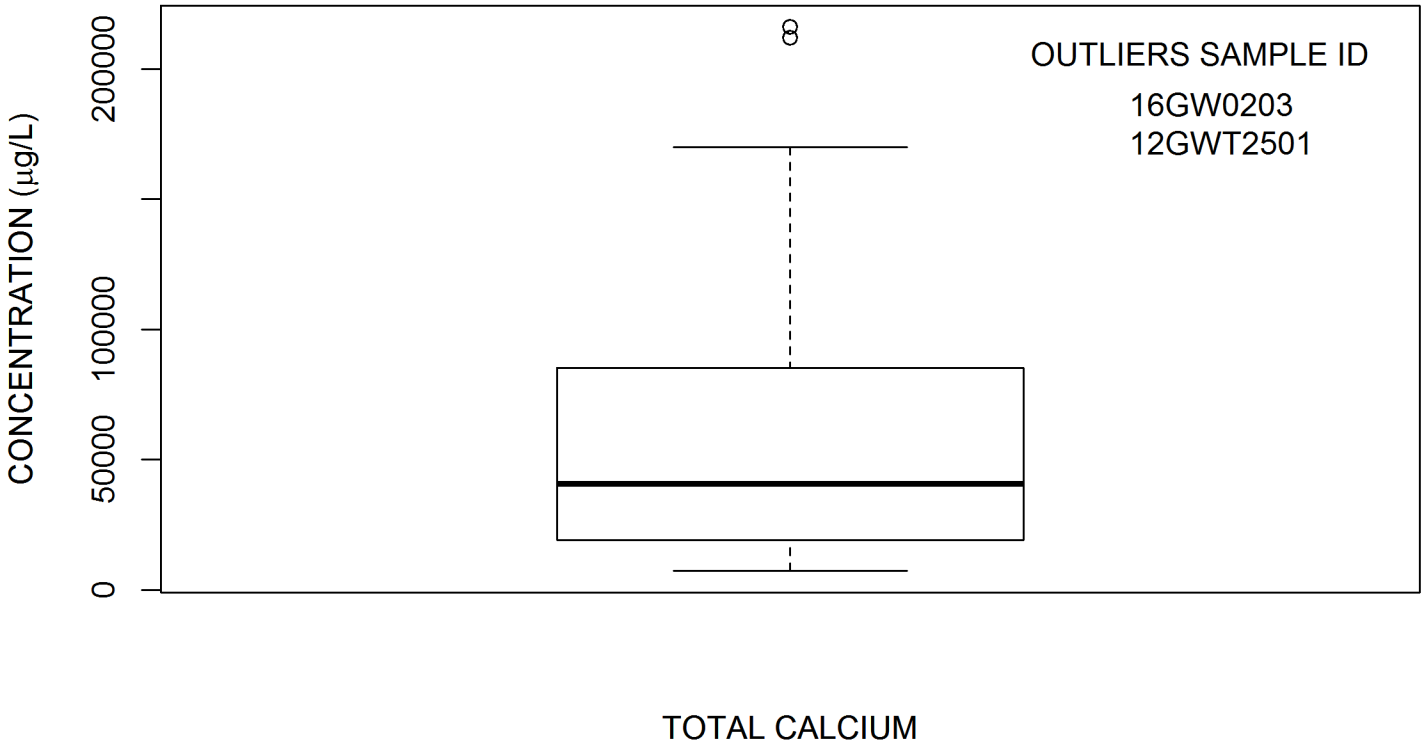


FIGURE 8
TOTAL CHROMIUM BOXPLOT
GROUNDWATER BACKGROUND EVALUATION
NSA CRANE, CRANE, INDIANA

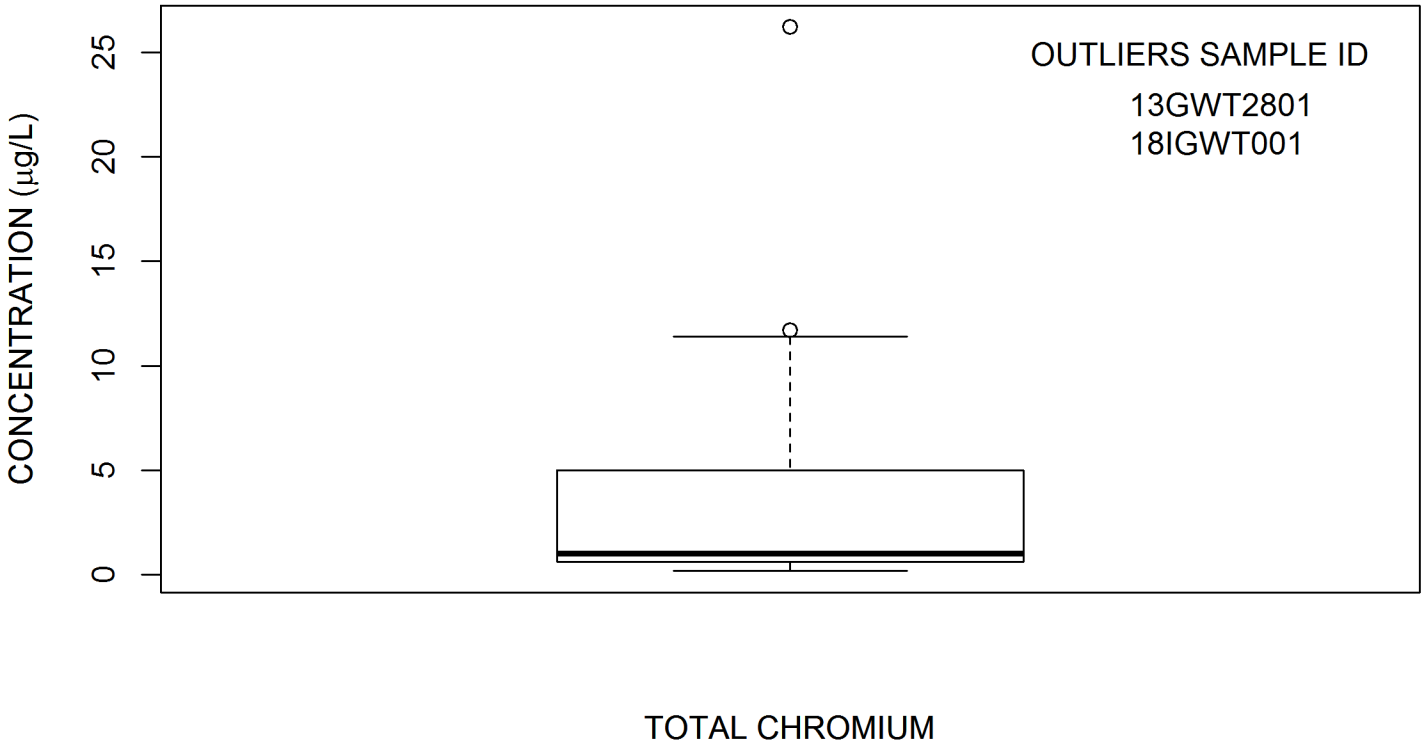


FIGURE 9
TOTAL COBALT BOXPLOT
GROUNDWATER BACKGROUND EVALUATION
NSA CRANE, CRANE, INDIANA

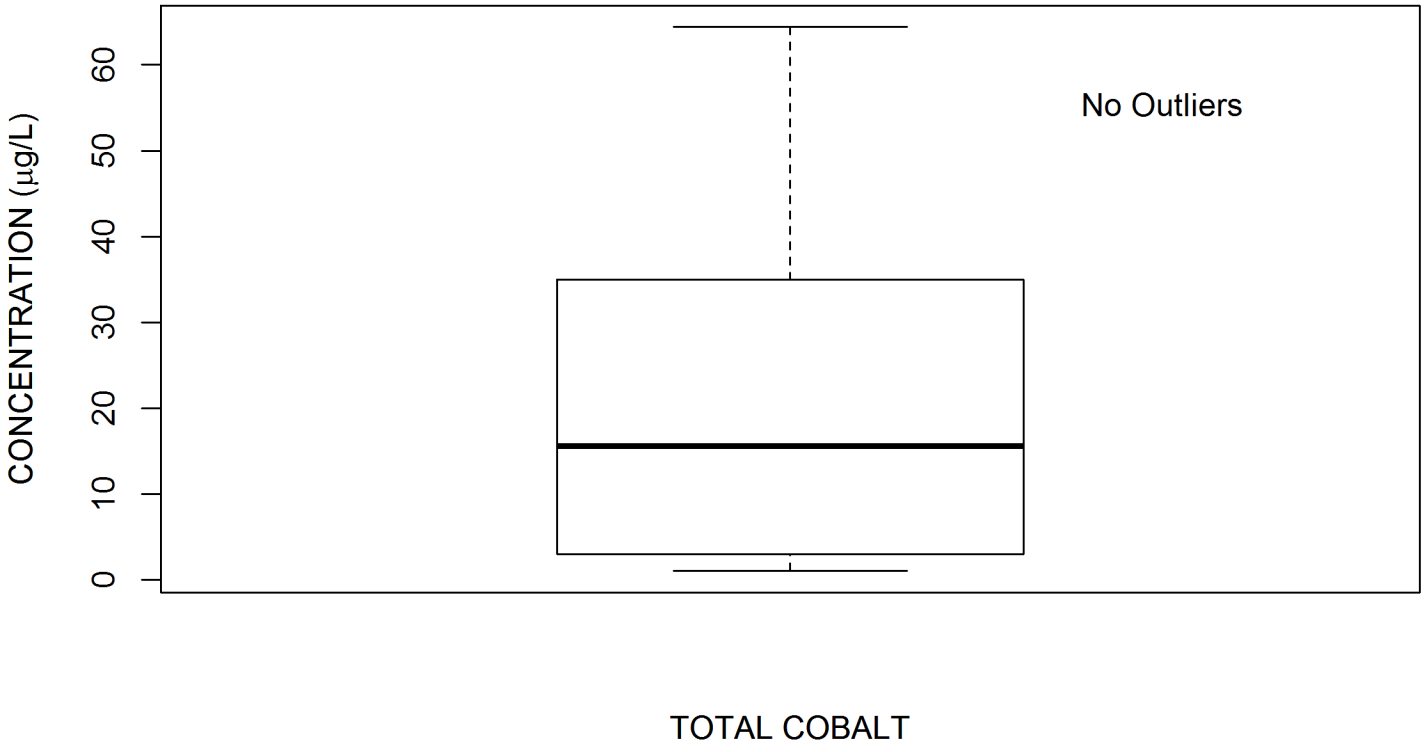


FIGURE 10
TOTAL COPPER BOXPLOT
GROUNDWATER BACKGROUND EVALUATION
NSA CRANE, CRANE, INDIANA

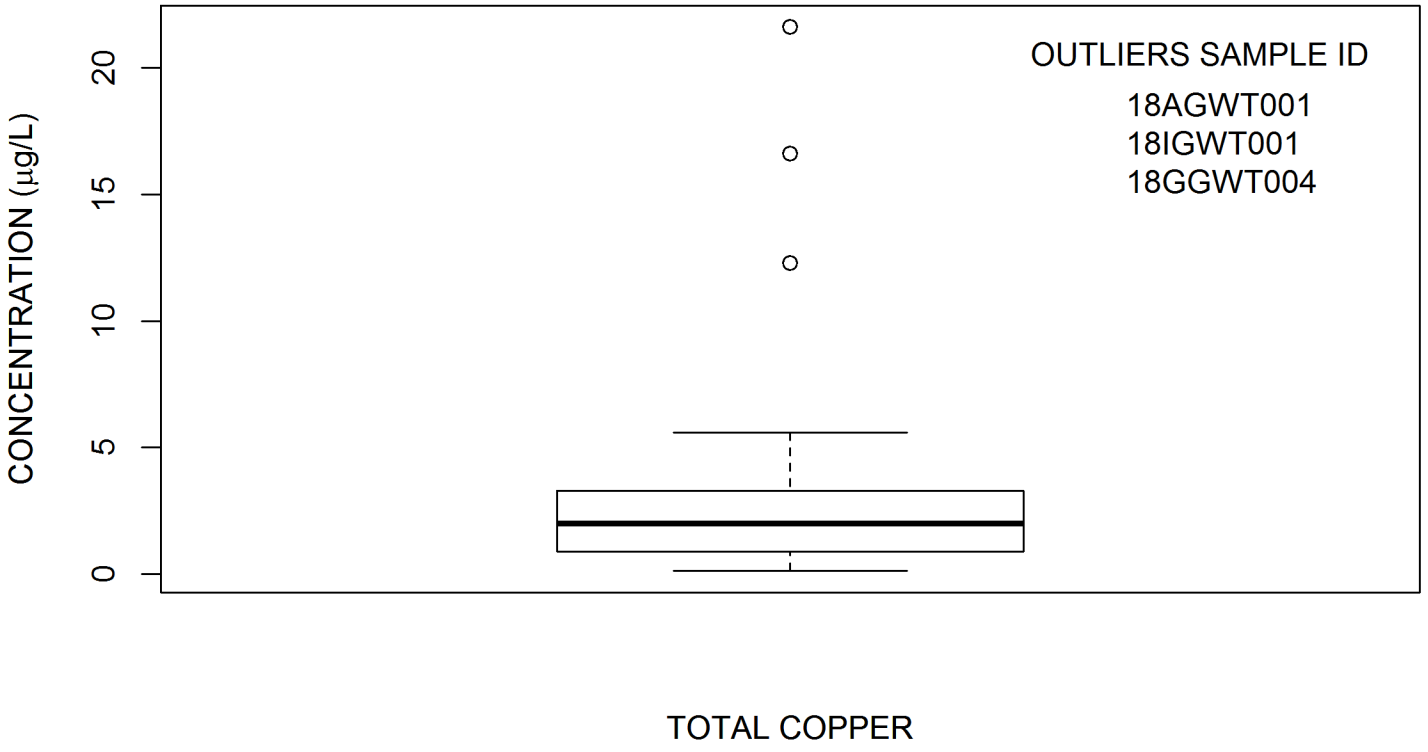


FIGURE 11
TOTAL IRON BOXPLOT
GROUNDWATER BACKGROUND EVALUATION
NSA CRANE, CRANE, INDIANA

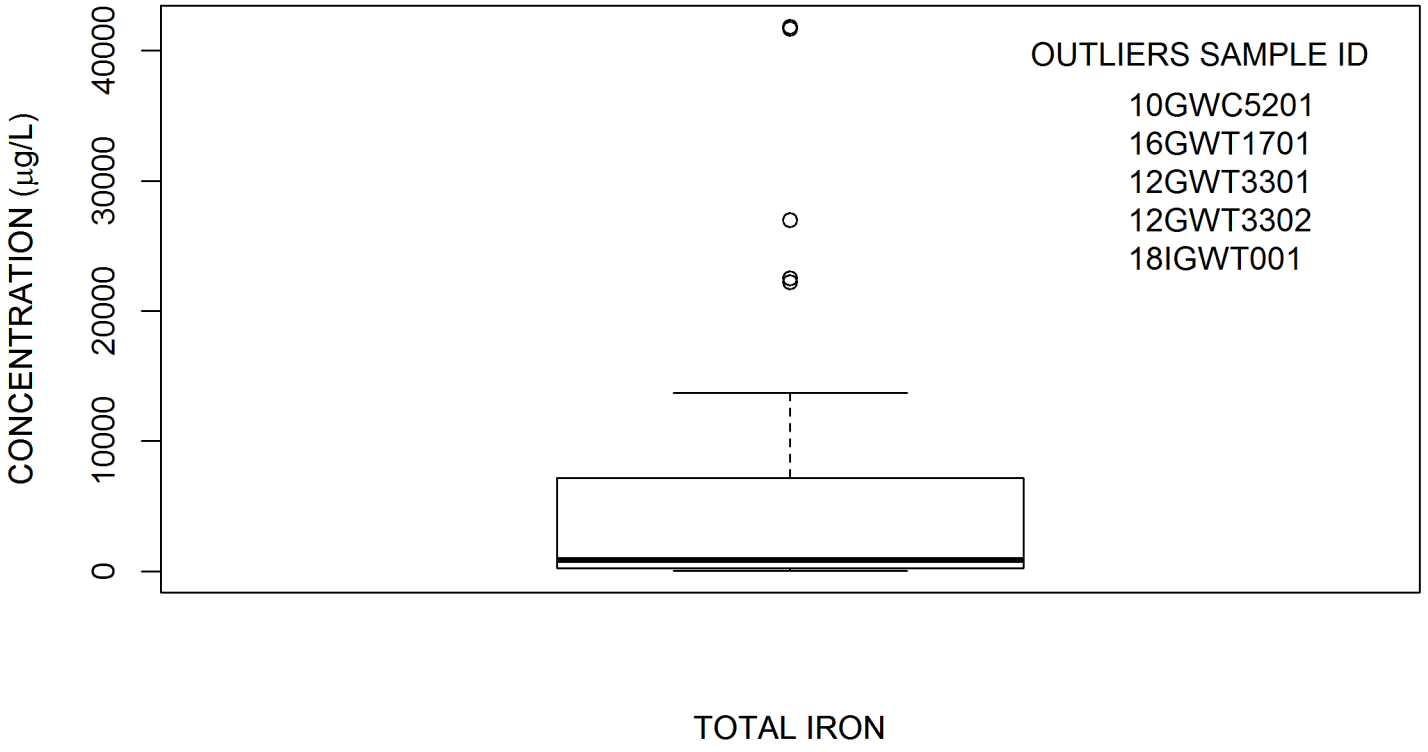


FIGURE 12
TOTAL LEAD BOXPLOT
GROUNDWATER BACKGROUND EVALUATION
NSA CRANE, CRANE, INDIANA

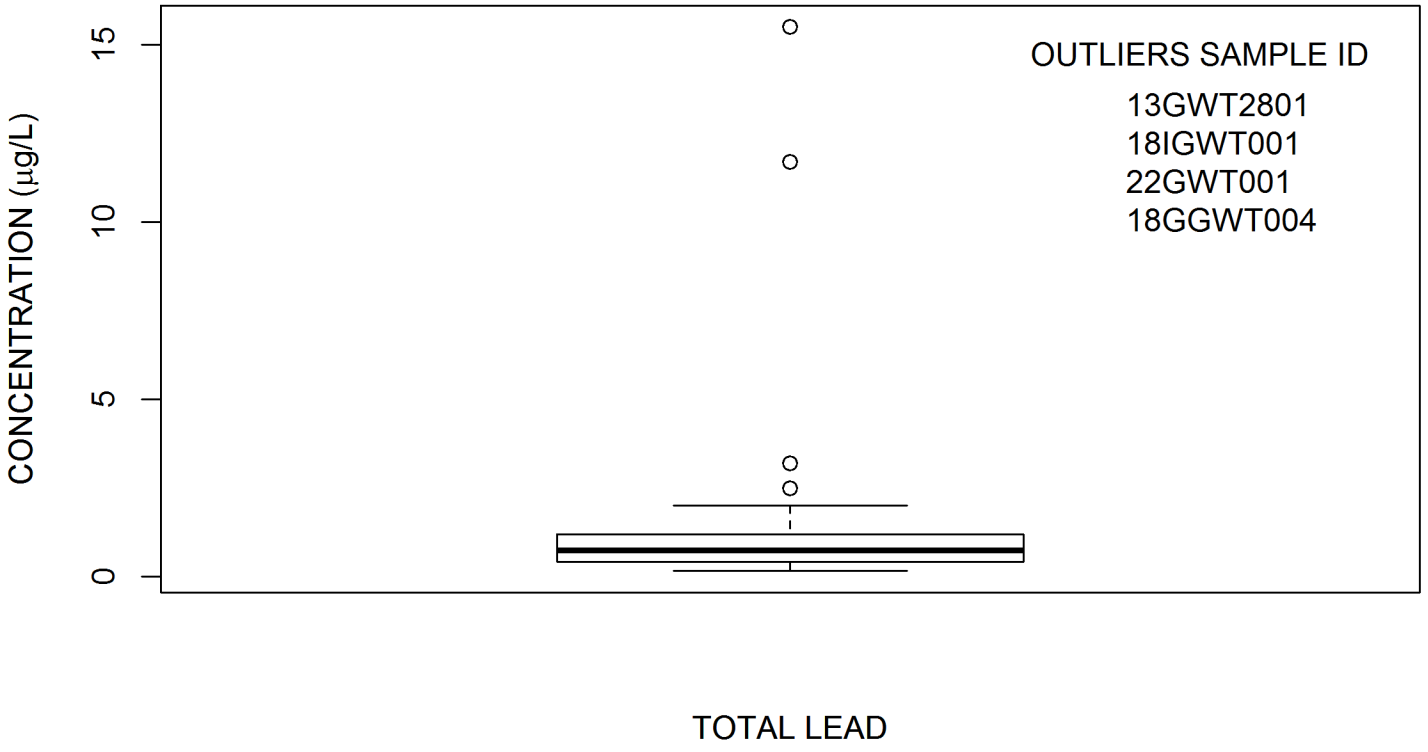


FIGURE 13
TOTAL MAGNESIUM BOXPLOT
GROUNDWATER BACKGROUND EVALUATION
NSA CRANE, CRANE, INDIANA

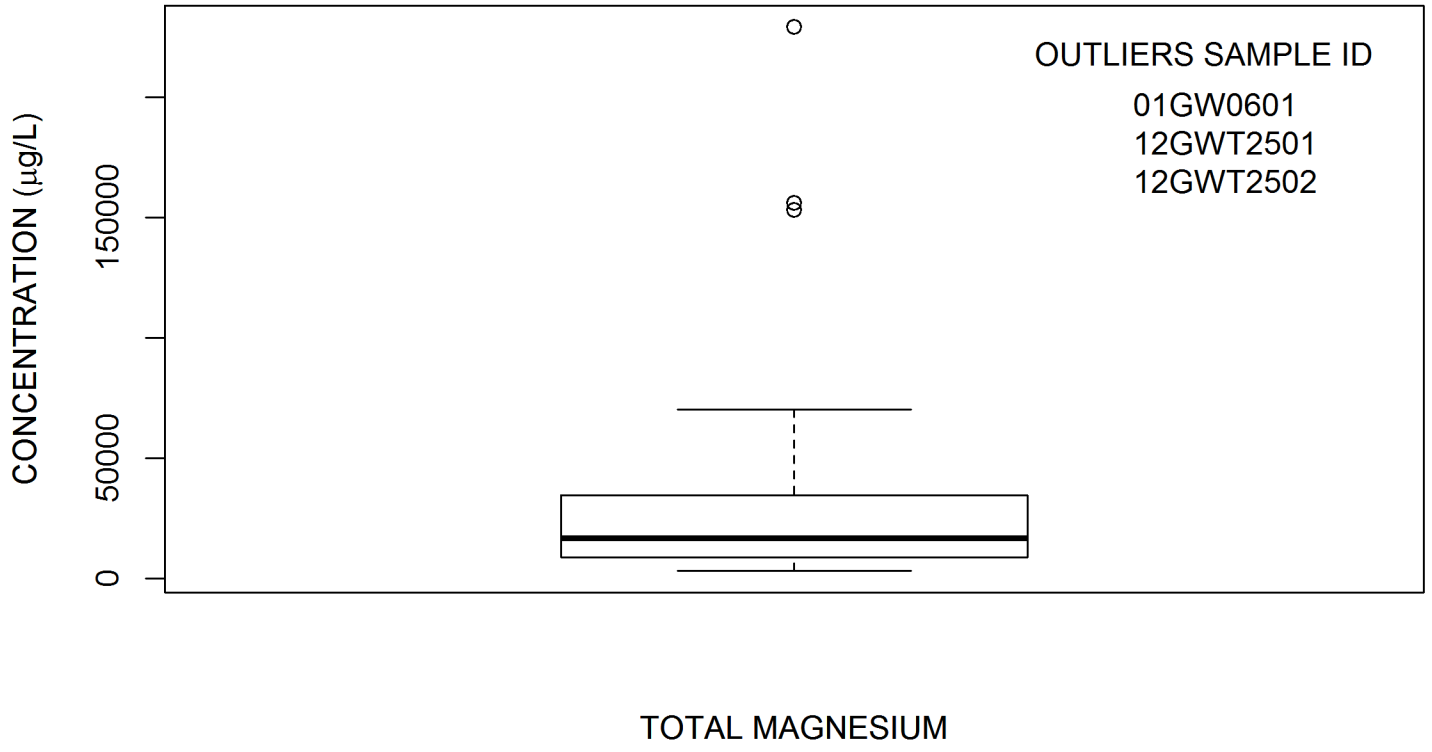


FIGURE 14
TOTAL MANGANESE BOXPLOT
GROUNDWATER BACKGROUND EVALUATION
NSA CRANE, CRANE, INDIANA

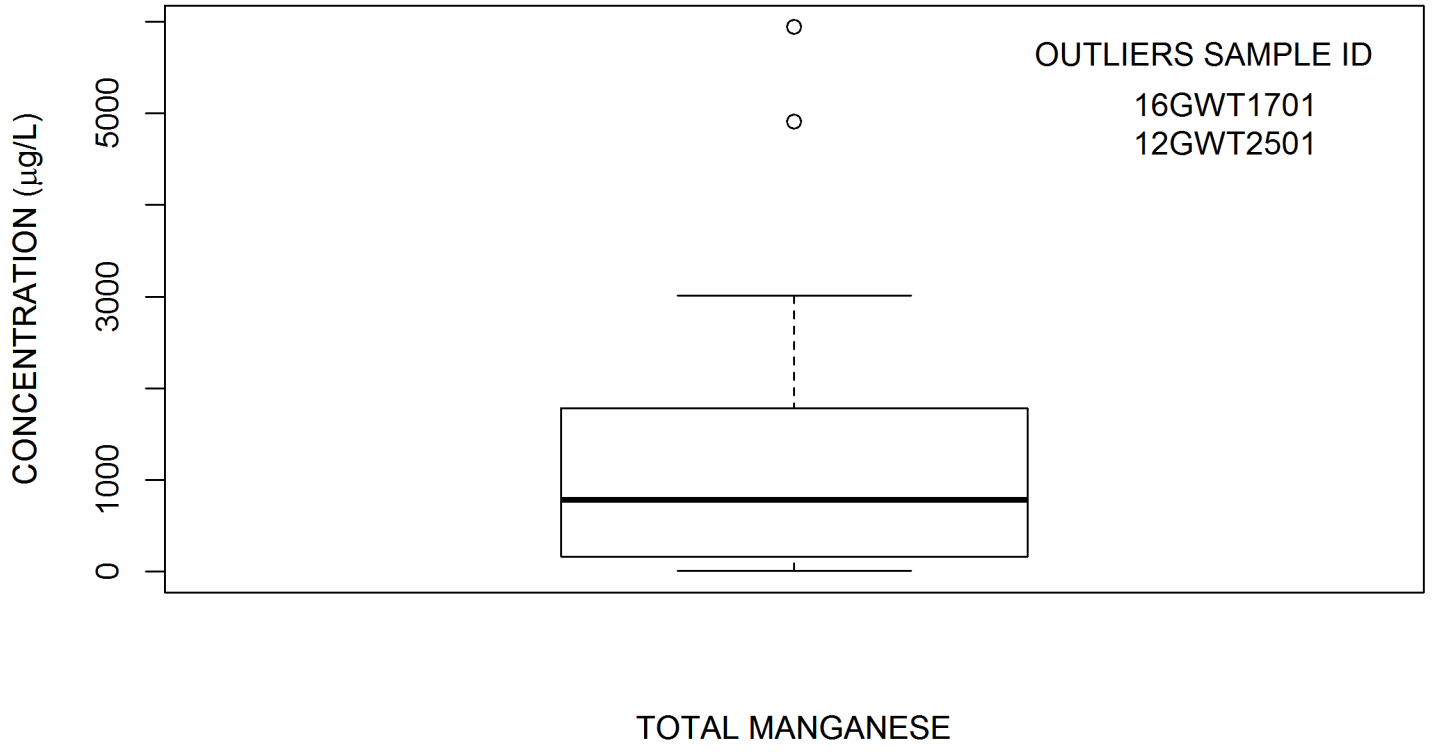


FIGURE 15
TOTAL MERCURY BOXPLOT
GROUNDWATER BACKGROUND EVALUATION
NSA CRANE, CRANE, INDIANA

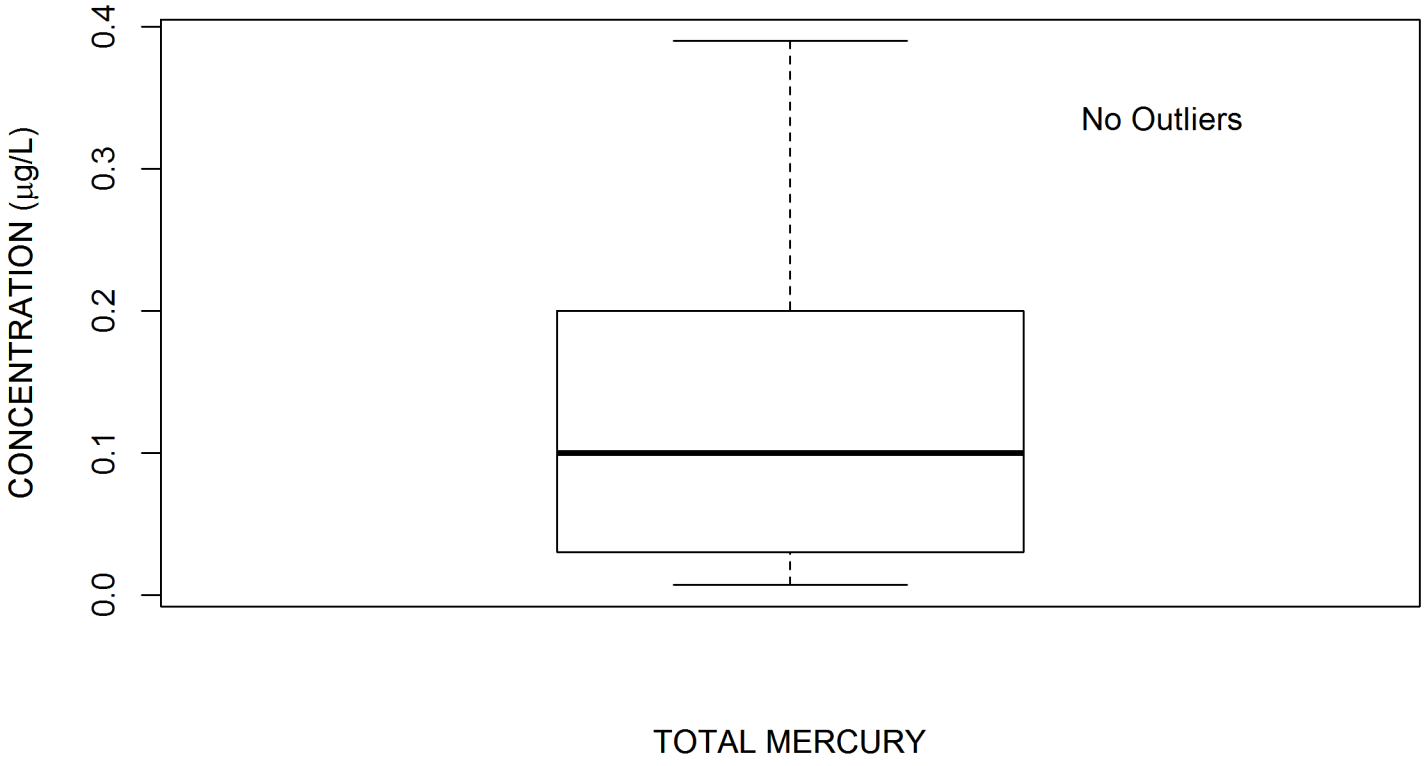


FIGURE 16
TOTAL NICKEL BOXPLOT
GROUNDWATER BACKGROUND EVALUATION
NSA CRANE, CRANE, INDIANA

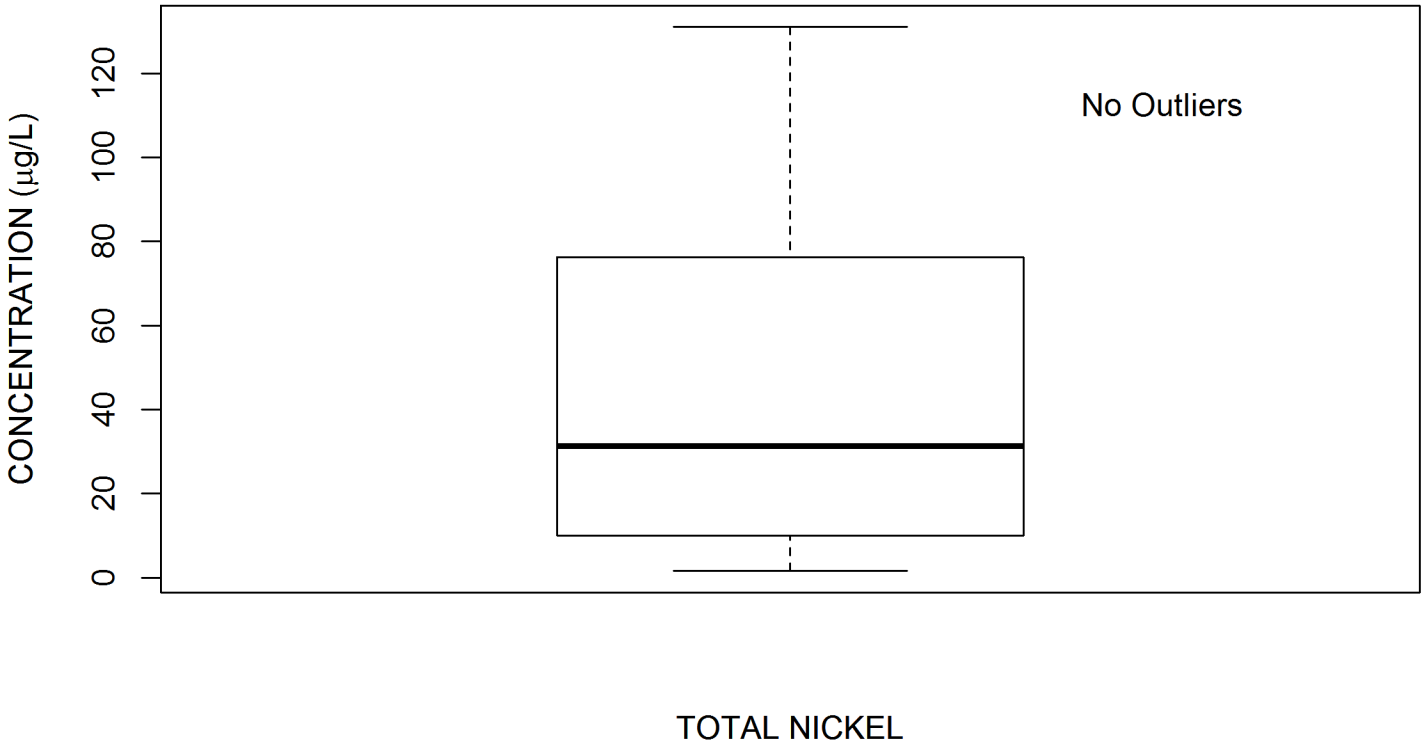


FIGURE 17
TOTAL POTASSIUM BOXPLOT
GROUNDWATER BACKGROUND EVALUATION
NSA CRANE, CRANE, INDIANA

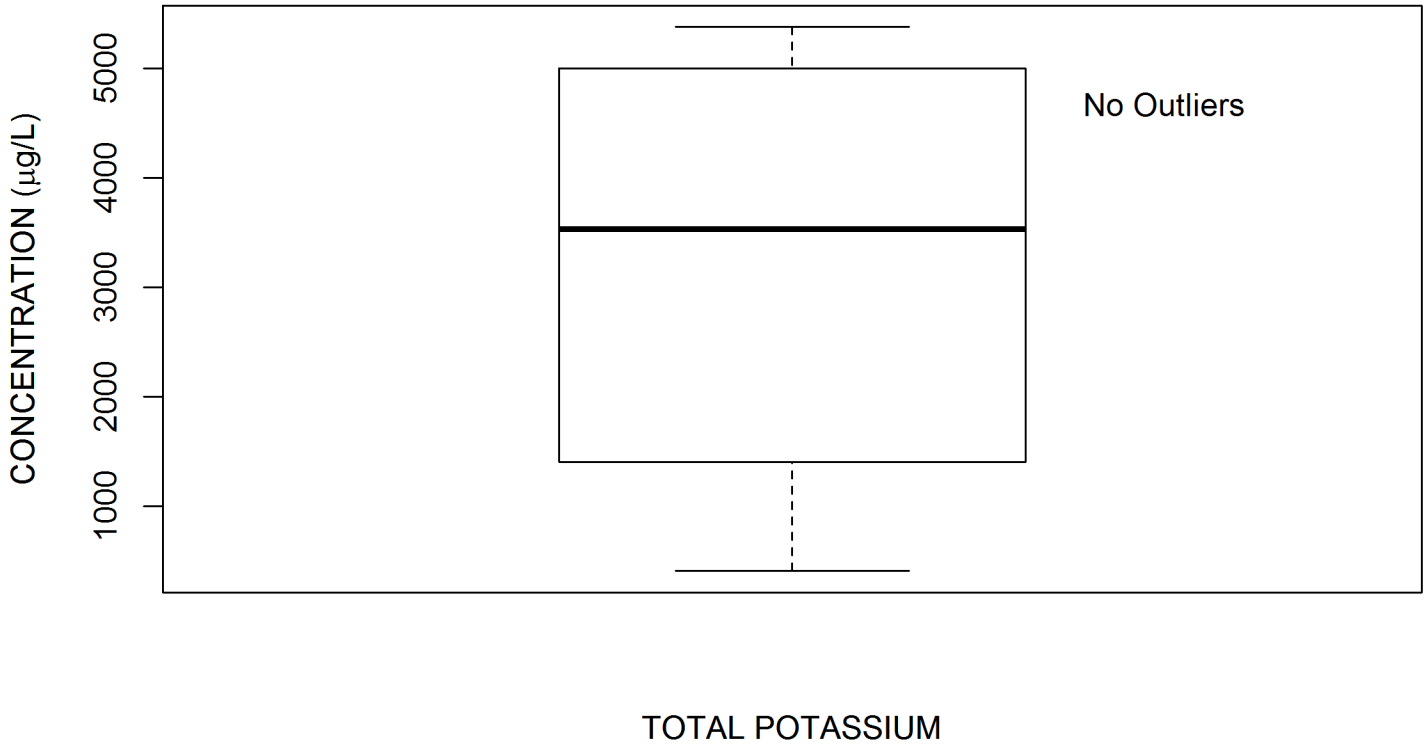


FIGURE 18
TOTAL SELENIUM BOXPLOT
GROUNDWATER BACKGROUND EVALUATION
NSA CRANE, CRANE, INDIANA

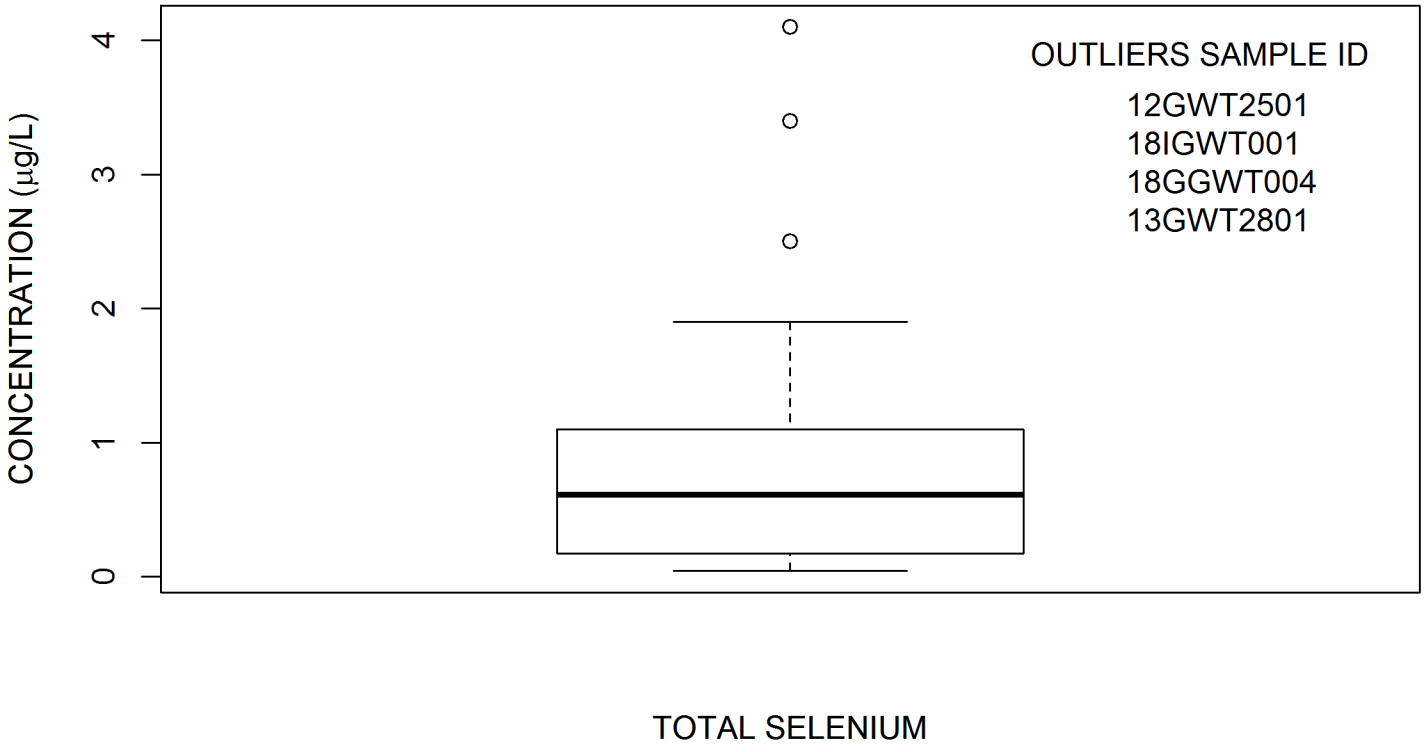


FIGURE 19
TOTAL SODIUM BOXPLOT
GROUNDWATER BACKGROUND EVALUATION
NSA CRANE, CRANE, INDIANA

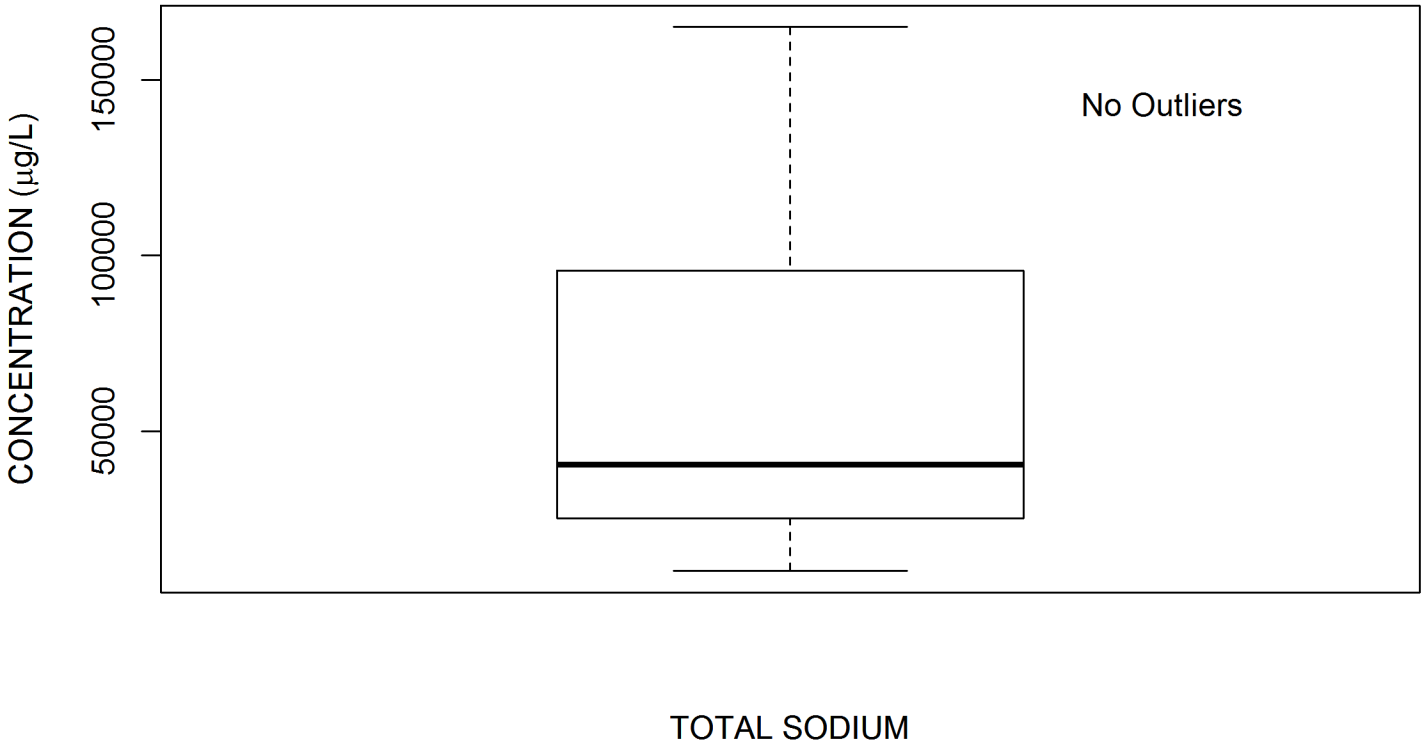


FIGURE 20
TOTAL THALLIUM BOXPLOT
GROUNDWATER BACKGROUND EVALUATION
NSA CRANE, CRANE, INDIANA

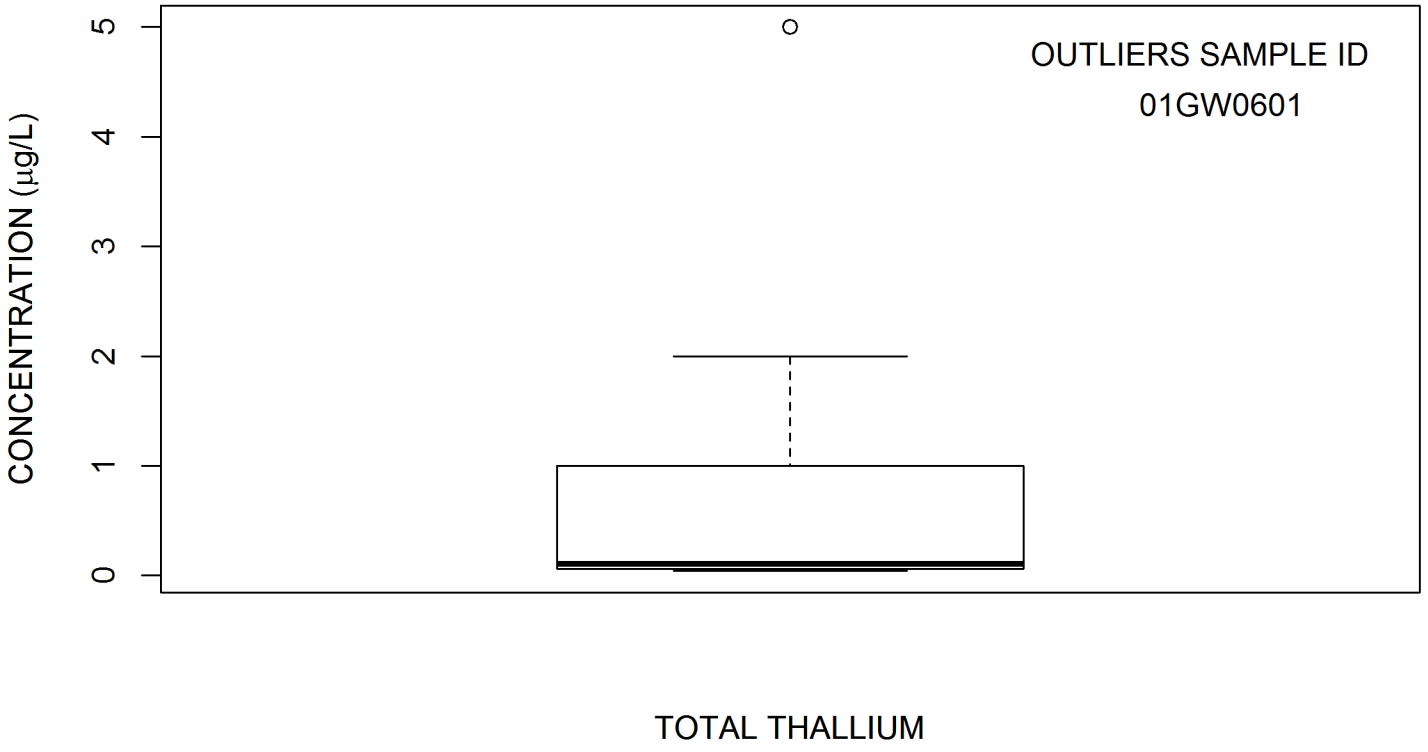


FIGURE 21
TOTAL VANADIUM BOXPLOT
GROUNDWATER BACKGROUND EVALUATION
NSA CRANE, CRANE, INDIANA

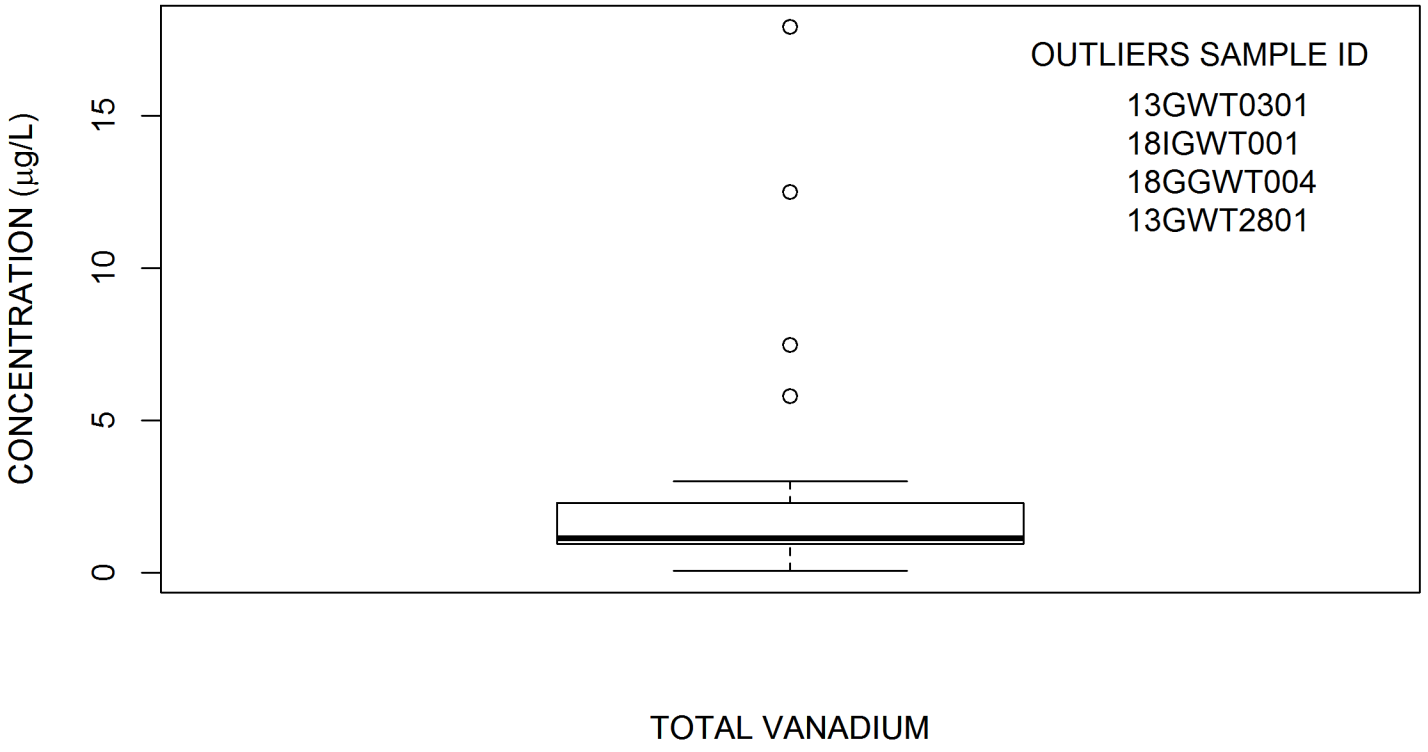
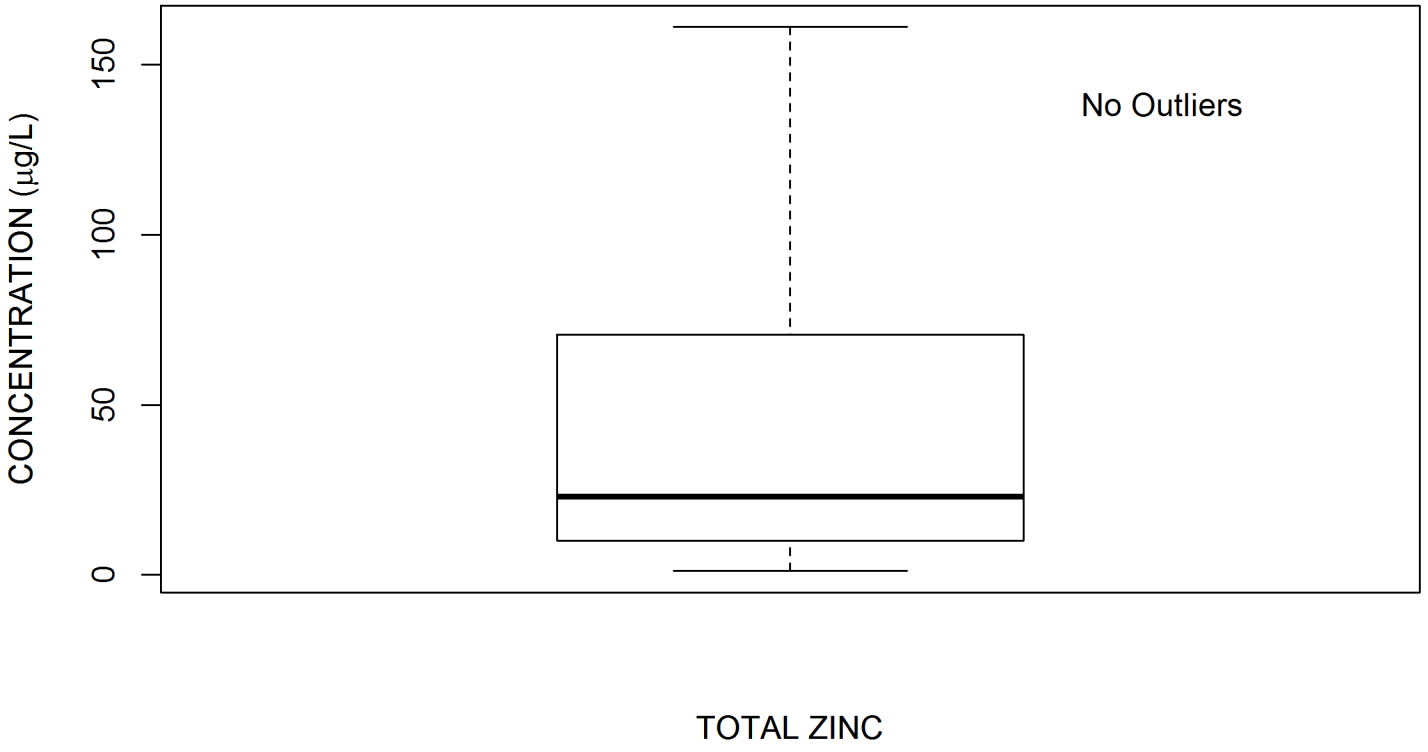


FIGURE 22
TOTAL ZINC BOXPLOT
GROUNDWATER BACKGROUND EVALUATION
NSA CRANE, CRANE, INDIANA



ProUCL INPUT

Samples	SACODE	ALUMINUM	d_ALUMINUM	ANTIMONY	d_ANTIMONY	ARSENIC	d_ARSENIC	BARIUM	d_BARIUM
01GW0601	NORMAL	40.2	0	1.6	0	3.2	0	21.3	1
08GWT00701	NORMAL	463	1	0.2	0	0.45	0	19.5	1
09GW1001	NORMAL	200	0	1	0	0.75	1	68.4	1
09GWT0101	NORMAL	200	0	1	0	2.9	1	52.6	1
09GWT0501	NORMAL	200	0	1	0	1.5	1	90.7	1
09GWTP0601	NORMAL	200	0	1	0	1	0	19.3	1
10GWC5201	NORMAL	200	0	1	0	1	0	17.9	1
12GWT2501	NORMAL	479	1	0.085	0	1.1	1	26.2	1
12GWT2502	NORMAL	192	1	0.085	0	0.27	0	21.8	1
12GWT2601	NORMAL	565	1	0.24	0	2.3	1	38.4	1
12GWT2602	NORMAL	126	1	0.54	0	0.67	0	12.8	0
12GWT2701	NORMAL	323	1	0.22	0	0.58	0	39.1	1
12GWT2702	NORMAL	205	1	0.1	0	0.22	0	20.6	1
12GWT3301	NORMAL	37.1	0	0.52	0	2.7	1	13.2	1
12GWT3302	NORMAL	200	1	0.085	0	1.2	0	15.6	0
13GWT0101	NORMAL	598	1	0.24	0	0.23	0	55.4	1
13GWT0102	NORMAL	699	1	0.02	0	0.17	0	46.8	1
13GWT0301	NORMAL	3990	1	0.13	0	1	1	74.5	1
13GWT0302	NORMAL	627	1	0.02	0	0.31	0	62.1	1
13GWT2801	NORMAL	6270	1	2.9	1	15.2	1	65.3	1
16GW0201	NORMAL	85.6	1	0.1	0	0.16	0	21.6	1
16GW0202	NORMAL	60.6	0	0.03	0	0.33	0	18	1
16GW0203	NORMAL	8.3	0	0.02	0	0.66	1	17.8	1
16GWT1701	NORMAL	187	1	0.05	0	1.3	0	42.7	1
18AGWT001	NORMAL	3110	1	2	0	1.5	0	35.6	1
18DGWT001	NORMAL	28.5	1	2	0	1.5	0	75.6	1
18GGWT004	NORMAL	6210	1	4	0	8.61	1	74.6	1
18IGWT001	NORMAL	8500	1	4	0	8.28	1	97.5	1
22GWT001	NORMAL					1.4	1	34.2	1

ProUCL INPUT

Samples	BERYLLIUM	d_BERYLLIUM	CADMIUM	d_CADMIUM	CALCIUM	d_CALCIUM	CHROMIUM	d_CHROMIUM
01GW0601	0.4	0	0.3	0	170000	1	0.6	0
08GWT00701	0.05	0	0.08	1	9640	1	0.58	1
09GW1001	1	0	1	0	25800	1	5	0
09GWT0101	1	0	1	0	39400	1	5	0
09GWT0501	1	0	1	0	24000	1	5	0
09GWTP0601	1	0	1	0	59300	1	5	0
10GWC5201	1	0	1	0	17000	1	5	0
12GWT2501	0.1	1	0.14	0	216000	1	1.4	0
12GWT2502	0.04	0	0.04	0	125000	1	0.74	0
12GWT2601	0.07	0	0.11	0	92600	1	1.7	1
12GWT2602	0.03	0	0.13	0	77900	1	0.72	0
12GWT2701	0.03	0	0.05	0	21200	1	1.2	1
12GWT2702	0.02	0	0.04	0	16300	1	0.62	0
12GWT3301	1.3	1	0.039	0	61100	1	0.52	0
12GWT3302	2.2	1	0.18	0	56400	1	0.76	0
13GWT0101	1.2	0	0.18	0	9720	1	0.2	0
13GWT0102	1.2	0	0.06	0	7190	1	0.73	0
13GWT0301	1.2	0	0.82	0	34800	1	7.1	1
13GWT0302	1.8	0	0.37	0	26100	1	1.4	0
13GWT2801	0.27	0	0.04	0	10600	1	11.7	1
16GW0201	0.42	0	0.31	0	99400	1	0.43	0
16GW0202	0.34	0	0.22	0	97300	1	0.29	0
16GW0203	0.06	0	0.04	0	212000	1	0.17	0
16GWT1701	0.69	0	0.53	0	42200	1	0.39	0
18AGWT001	3.01	1	0.462	1	12300	1	0.816	1
18DGWT001	0.5	0	0.5	0	43900	1	1	0
18GGWT004	1.16	1	1	0	24200	1	11.4	1
18IGWT001	0.591	1	1	0	61000	1	26.2	1
22GWT001			0.9	1			4	1

ProUCL INPUT

Samples	COBALT	d_COBALT	COPPER	d_COPPER	IRON	d_IRON	LEAD	d_LEAD
01GW0601	1	0	0.9	0	398	1	1.6	0
08GWT00701	5.3	1	2.1	0	681	1	0.54	1
09GW1001	3	0	2	0	136	1	1	0
09GWT0101	3	0	4.4	1	144	1	1	0
09GWT0501	18.2	1	2	1	100	0	1	0
09GWTP0601	3	0	2	0	149	1	1	0
10GWC5201	3	0	2	0	22200	1	1	0
12GWT2501	53.2	1	3	1	1920	1	0.66	0
12GWT2502	12.9	1	3.4	1	1110	1	0.425	0
12GWT2601	31.3	1	0.84	1	2990	1	0.53	0
12GWT2602	5.6	1	3.5	1	2010	1	0.157	0
12GWT2701	11.2	1	0.67	1	482	1	0.37	0
12GWT2702	1.2	0	2	1	396	1	0.42	0
12GWT3301	44.4	1	0.7	1	41800	1	0.34	0
12GWT3302	40	1	2.5	1	41700	1	1	0
13GWT0101	36	1	2.9	1	135	1	1.4	0
13GWT0102	29.9	1	1.4	0	61.7	0	1.2	0
13GWT0301	48.8	1	5.6	1	1910	1	2	0
13GWT0302	25	1	3.2	1	344	0	0.67	0
13GWT2801	2	1	1.4	0	2460	1	2.5	0
16GW0201	12.9	1	0.87	1	287	1	0.21	0
16GW0202	9.2	1	0.15	0	415	1	0.28	0
16GW0203	18.7	1	0.12	0	13700	1	0.18	0
16GWT1701	64.4	1	0.56	0	27000	1	0.24	0
18AGWT001	62	1	12.3	1	1970	1	0.75	0
18DGWT001	2.5	0	2	0	12.7	1	0.75	0
18GGWT004	34	1	21.6	1	11300	1	11.7	1
18IGWT001	27.2	1	16.6	1	22500	1	15.5	1
22GWT001							3.2	1

ProUCL INPUT

Samples	LITHIUM	d_LITHIUM	MAGNESIUM	d_MAGNESIUM	MANGANESE	d_MANGANESE	MERCURY	d_MERCURY
01GW0601			156000	1	37.9	1	0.1	0
08GWT00701			6750	1	93.9	1	0.03	0
09GW1001			10600	1	164	1	0.2	0
09GWT0101			26500	1	34.8	1	0.2	0
09GWT0501			21900	1	178	1	0.2	0
09GWTP0601			19800	1	15	1	0.2	0
10GWC5201			11800	1	897	1	0.2	0
12GWT2501			229000	1	4910	1	0.042	0
12GWT2502			153000	1	2200	1	0.03	0
12GWT2601			70000	1	2520	1	0.14	0
12GWT2602			50000	1	1020	1	0.051	0
12GWT2701			16400	1	701	1	0.03	0
12GWT2702			16500	1	160	1	0.03	0
12GWT3301			33500	1	3010	1	0.043	0
12GWT3302			27200	1	1680	1	0.05	0
13GWT0101	21.1	1	6790	1	689	1	0.16	1
13GWT0102			5850	1	566	0	0.39	1
13GWT0301	74	1	17000	1	302	1	0.02	0
13GWT0302			15800	1	211	1	0.02	0
13GWT2801			2950	1	66.7	1	0.007	0
16GW0201	32.7	1	6240	1	916	1	0.02	0
16GW0202	33.6	1	6480	1	864	1	0.2	0
16GW0203			35200	1	2440	1	0.02	0
16GWT1701			16700	1	5940	1	0.007	0
18AGWT001			5510	1	1270	1	0.2	0
18DGWT001			15100	1	6.89	1	0.2	0
18GGWT004			10800	1	1180	1	0.2	0
18IGWT001			37100	1	1890	1	0.2	0
22GWT001							0.18	0

ProUCL INPUT

Samples	NICKEL	d_NICKEL	POTASSIUM	d_POTASSIUM	SELENIUM	d_SELENIUM	SODIUM	d_SODIUM
01GW0601	2.6	1	2790	1	0.8	0	17200	1
08GWT00701	7.8	1	518	1	0.33	1	36500	1
09GW1001	10	0	5000	0	1	0	57600	1
09GWT0101	10	0	5000	0	1	0	134000	1
09GWT0501	51.2	1	5000	0	1	0	102000	1
09GWTP0601	10	0	5000	0	1.1	1	48900	1
10GWC5201	10	0	5000	0	1	0	15700	1
12GWT2501	103	1	5320	1	3.4	1	152000	1
12GWT2502	32	1	3320	1	1.9	1	116000	1
12GWT2601	60.1	1	3740	1	0.28	0	165000	1
12GWT2602	12.8	1	1630	1	0.99	1	143000	1
12GWT2701	30.7	1	3710	1	0.61	0	53600	1
12GWT2702	7.3	1	1080	1	0.37	0	39200	1
12GWT3301	131	1	4520	1	0.094	0	40300	1
12GWT3302	110	1	4770	1	0.31	0	32200	1
13GWT0101	26.6	1	494	1	0.17	0	24300	1
13GWT0102	21.1	1	403	1	0.05	0	26100	1
13GWT0301	99.7	1	2860	1	0.32	0	37400	1
13GWT0302	76.3	1	1040	1	0.04	0	40700	1
13GWT2801	7.1	1	3670	1	4.1	1	124000	1
16GW0201	34.2	1	738	1	0.05	0	18000	1
16GW0202	27	1	3390	0	0.06	0	17900	1
16GW0203	36.7	1	2640	1	0.04	0	20200	1
16GWT1701	125	1	5380	1	0.07	0	61300	1
18AGWT001	76.1	1	2230	1	1.25	0	10100	1
18DGWT001	1.56	1	1170	1	1.25	0	34300	1
18GGWT004	88.1	1	5000	1	2.5	0	89300	1
18IGWT001	55.8	1	5370	1	2.5	0	50300	1
22GWT001					0.45	1		

Samples	STRONTIUM	d_STRONTIUM	THALLIUM	d_THALLIUM	THORIUM-CALCI	_THORIUM-CAL	TITANIUM	d_TITANIUM
01GW0601	958	1	5	0	0.328864	1		
08GWT00701			0.26	0				
09GW1001			1	0				
09GWT0101			1	0				
09GWT0501			1	0				
09GWTP0601			1	0				
10GWC5201			1	0				
12GWT2501			0.08	1				
12GWT2502			0.08	0				
12GWT2601			0.043	0				
12GWT2602			0.06	0				
12GWT2701			0.043	0				
12GWT2702			0.043	0				
12GWT3301			0.043	0				
12GWT3302			0.043	0				
13GWT0101	53.3	1	0.11	0			4	1
13GWT0102			0.08	0			0.21	0
13GWT0301	97.8	1	0.23	0			32	1
13GWT0302			0.04	0			8.5	1
13GWT2801			0.06	0			99	1
16GW0201	88.4	1	0.1	0			3.8	1
16GW0202	98.4	1	0.11	0			3	1
16GW0203			0.08	0			0.17	0
16GWT1701			0.12	0			0.74	0
18AGWT001			1	0				
18DGWT001			1	0				
18GGWT004			2	0				
18IGWT001			2	0				
22GWT001								

Samples	VANADIUM	d_VANADIUM	ZINC	d_ZINC
01GW0601	3	0	1.1	0
08GWT00701	1.14	0	12.4	1
09GW1001	2	0	10	0
09GWT0101	2.1	1	10	0
09GWT0501	2	0	25.4	1
09GWTP0601	2	0	13.2	1
10GWC5201	2	0	10	0
12GWT2501	1.14	0	20.8	1
12GWT2502	1.14	0	26.1	1
12GWT2601	1.14	0	12.1	1
12GWT2602	1.14	0	8	1
12GWT2701	1.14	0	11.3	1
12GWT2702	1.14	0	3.3	0
12GWT3301	1.14	0	96	1
12GWT3302	1.14	0	128	1
13GWT0101	0.08	0	29.7	1
13GWT0102	0.06	0	29.9	1
13GWT0301	5.8	1	161	1
13GWT0302	0.76	0	97.7	1
13GWT2801	12.5	1	6.7	1
16GW0201	0.3	0	50	1
16GW0202	0.35	0	42.9	1
16GW0203	0.09	0	15.8	1
16GWT1701	0.17	0	122	1
18AGWT001	2.5	0	63.1	1
18DGWT001	2.5	0	2.16	1
18GGWT004	7.47	1	78.2	1
18IGWT001	17.9	1	85	1
22GWT001				

General Background Statistics for Data Sets with Non-Detects

User Selected Options

From File	Converted_Data.wst
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
Different or Future K Values	1
Number of Bootstrap Operations	2000

ALUMINUM

General Statistics

Number of Valid Data	28	Number of Detected Data	19
Number of Distinct Detected Data	19	Number of Non-Detect Data	9
Tolerance Factor	2.246	Percent Non-Detects	32.14%

Raw Statistics

Minimum Detected	28.5
Maximum Detected	8500
Mean of Detected	1729
SD of Detected	2595
Minimum Non-Detect	8.3
Maximum Non-Detect	200

Log-transformed Statistics

Minimum Detected	3.35
Maximum Detected	9.048
Mean of Detected	6.338
SD of Detected	1.586
Minimum Non-Detect	2.116
Maximum Non-Detect	5.298

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	14
Number treated as Detected with Single DL	14
Single DL Non-Detect Percentage	50.00%

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.671
5% Shapiro Wilk Critical Value	0.901

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.939
5% Shapiro Wilk Critical Value	0.901

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean		1194
SD		2262
95% UTL	95% Coverage	6274
95% UPL (t)		5115
90% Percentile (z)		4093
95% Percentile (z)		4914
99% Percentile (z)		6456

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)		5.507
SD (Log Scale)		1.891
95% UTL	95% Coverage	17207
95% UPL (t)		6529
90% Percentile (z)		2779
95% Percentile (z)		5522
99% Percentile (z)		20029

Maximum Likelihood Estimate(MLE) Method	
Mean	-263.6
SD	3578
95% UTL with 95% Coverage	7772
95% UPL (t)	5939
90% Percentile (z)	4322
95% Percentile (z)	5622
99% Percentile (z)	8060

Log ROS Method	
Mean in Original Scale	1186
SD in Original Scale	2266
95% UTL with 95% Coverage	19652
95% BCA UTL with 95% Coverage	8500
95% Bootstrap (%) UTL with 95% Coverage	8500
95% UPL (t)	6974
90% Percentile (z)	2798
95% Percentile (z)	5830
99% Percentile (z)	23118

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.505
Theta Star	3421
nu star	19.21
A-D Test Statistic	1.228
5% A-D Critical Value	0.797
K-S Test Statistic	0.284
5% K-S Critical Value	0.209

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data	
Mean	1174
Median	196
SD	2273
k star	0.123
Theta star	9537
Nu star	6.891
95% Percentile of Chisquare (2k)	1.4
90% Percentile	3347
95% Percentile	6674
99% Percentile	16767

Data Distribution Test with Detected Values Only

Data appear Lognormal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	1192
SD	2222
SE of Mean	431.5
95% KM UTL with 95% Coverage	6183
95% KM Chebyshev UPL	11050
95% KM UPL (t)	5044
90% Percentile (z)	4040
95% Percentile (z)	4847
99% Percentile (z)	6362

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	5123
95% Hawkins Wixley (HW) Approx. Gamma UPL	6237
95% WH Approx. Gamma UTL with 95% Coverage	8533
95% HW Approx. Gamma UTL with 95% Coverage	11951

Note: DL/2 is not a recommended method.

ANTIMONY

General Statistics

Number of Valid Data	28	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	27

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!

It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable ANTIMONY was not processed!

ARSENIC

General Statistics

Number of Valid Data	29	Number of Detected Data	12
Number of Distinct Detected Data	12	Number of Non-Detect Data	17
Tolerance Factor	2.232	Percent Non-Detects	58.62%

Raw Statistics

Minimum Detected	0.66
Maximum Detected	15.2
Mean of Detected	3.867
SD of Detected	4.5
Minimum Non-Detect	0.16
Maximum Non-Detect	3.2

Log-transformed Statistics

Minimum Detected	-0.416
Maximum Detected	2.721
Mean of Detected	0.834
SD of Detected	1.023
Minimum Non-Detect	-1.833
Maximum Non-Detect	1.163

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	26
Number treated as Detected with Single DL	3
Single DL Non-Detect Percentage	89.66%

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.726
5% Shapiro Wilk Critical Value	0.859

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.919
5% Shapiro Wilk Critical Value	0.859

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean		1.843
SD		3.322
95% UTL	95% Coverage	9.257
95% UPL (t)		7.59
90% Percentile (z)		6.1
95% Percentile (z)		7.307
99% Percentile (z)		9.571

Maximum Likelihood Estimate(MLE) Method

Mean		-14.33
SD		14.06
95% UTL with	95% Coverage	17.06

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)		-0.389
SD (Log Scale)		1.401
95% UTL	95% Coverage	15.47
95% UPL (t)		7.656
90% Percentile (z)		4.083
95% Percentile (z)		6.793
99% Percentile (z)		17.65

Log ROS Method

Mean in Original Scale		1.718
SD in Original Scale		3.367
95% UTL with	95% Coverage	13.43

95% BCA UTL with 95% Coverage	15.2
95% Bootstrap (%) UTL with 95% Coverage	15.2
95% UPL (t)	10
90% Percentile (z)	3.695
95% Percentile (z)	8.804
99% Percentile (z)	18.39

95% UPL (t)	6.472
90% Percentile (z)	3.37
95% Percentile (z)	5.717
99% Percentile (z)	15.4

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.882
Theta Star	4.383
nu star	21.17
A-D Test Statistic	0.733
5% A-D Critical Value	0.754
K-S Test Statistic	0.234
5% K-S Critical Value	0.252

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	2.009
SD	3.184
SE of Mean	0.618
95% KM UTL with 95% Coverage	9.116
95% KM Chebyshev UPL	16.13
95% KM UPL (t)	7.518
90% Percentile (z)	6.09
95% Percentile (z)	7.247
99% Percentile (z)	9.416

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data	
Mean	1.6
Median	0.000001
SD	3.422
k star	0.112
Theta star	14.33
Nu star	6.476
95% Percentile of Chisquare (2k)	1.285
90% Percentile	4.436
95% Percentile	9.206
99% Percentile	24.04

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	6.978
95% Hawkins Wixley (HW) Approx. Gamma UPL	8.027
95% WH Approx. Gamma UTL with 95% Coverage	12.1
95% HW Approx. Gamma UTL with 95% Coverage	16.43

Note: DL/2 is not a recommended method.

BARIUM

General Statistics

Number of Valid Data	29
Number of Distinct Detected Data	27
Tolerance Factor	2.232
Number of Detected Data	27
Number of Non-Detect Data	2
Percent Non-Detects	6.90%

Raw Statistics

Minimum Detected	13.2
Maximum Detected	97.5
Mean of Detected	43.36

Log-transformed Statistics

Minimum Detected	2.58
Maximum Detected	4.58
Mean of Detected	3.601

SD of Detected	25.03
Minimum Non-Detect	12.8
Maximum Non-Detect	15.6

SD of Detected	0.601
Minimum Non-Detect	2.549
Maximum Non-Detect	2.747

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	3
Number treated as Detected with Single DL	26
Single DL Non-Detect Percentage	10.34%

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.898
5% Shapiro Wilk Critical Value	0.923

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.927
5% Shapiro Wilk Critical Value	0.923

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean		40.86
SD		25.87
95% UTL	95% Coverage	98.59
95% UPL (t)		85.61
90% Percentile (z)		74.01
95% Percentile (z)		83.41
99% Percentile (z)		101

Maximum Likelihood Estimate(MLE) Method

Mean		40.02
SD		26.84
95% UTL with	95% Coverage	99.92
95% UPL (t)		86.45
90% Percentile (z)		74.41
95% Percentile (z)		84.16
99% Percentile (z)		102.5

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)		3.488
SD (Log Scale)		0.719
95% UTL	95% Coverage	162.6
95% UPL (t)		113.4
90% Percentile (z)		82.15
95% Percentile (z)		106.7
99% Percentile (z)		174

Log ROS Method

Mean in Original Scale		41.02
SD in Original Scale		25.65
95% UTL with	95% Coverage	151.4
95% BCA UTL with	95% Coverage	97.5
95% Bootstrap (%) UTL with	95% Coverage	97.5
95% UPL (t)		107.8
90% Percentile (z)		79.51
95% Percentile (z)		101.7
99% Percentile (z)		161.4

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	2.806
Theta Star	15.45
nu star	151.5
A-D Test Statistic	0.766
5% A-D Critical Value	0.751
K-S Test Statistic	0.184
5% K-S Critical Value	0.169

Data not Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Lognormal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	41.28
SD	24.9
SE of Mean	4.712

		95% KM UTL with 95% Coverage	96.86
Assuming Gamma Distribution		95% KM Chebyshev UPL	151.7
Gamma ROS Statistics with Extrapolated Data		95% KM UPL (t)	84.36
Mean	40.37	90% Percentile (z)	73.19
Median	35.6	95% Percentile (z)	82.24
SD	26.58	99% Percentile (z)	99.2
k star	0.463		
Theta star	87.19	**Gamma ROS Limits with Extrapolated Data**	
Nu star	26.85	95% Wilson Hilferty (WH) Approx. Gamma UPL	127.6
95% Percentile of Chisquare (2k)	3.656	95% Hawkins Wixley (HW) Approx. Gamma UPL	163.9
		95% WH Approx. Gamma UTL with 95% Coverage	173.8
90% Percentile	110.9	95% HW Approx. Gamma UTL with 95% Coverage	241.8
95% Percentile	159.4		
99% Percentile	279.3		

Note: DL/2 is not a recommended method.

BERYLLIUM

General Statistics

Number of Valid Data	28	Number of Detected Data	6
Number of Distinct Detected Data	6	Number of Non-Detect Data	22
Tolerance Factor	2.246	Percent Non-Detects	78.57%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.1	Minimum Detected	-2.303
Maximum Detected	3.01	Maximum Detected	1.102
Mean of Detected	1.394	Mean of Detected	-0.0879
SD of Detected	1.062	SD of Detected	1.221
Minimum Non-Detect	0.02	Minimum Non-Detect	-3.912
Maximum Non-Detect	1.8	Maximum Non-Detect	0.588

Data with Multiple Detection Limits	**Single Detection Limit Scenario**	
Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect with Single DL	26
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected with Single DL	2
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	92.86%

Warning: There are only 6 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.966
5% Shapiro Wilk Critical Value	0.788

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean		0.536
SD		0.686
95% UTL	95% Coverage	2.076
95% UPL (t)		1.725
90% Percentile (z)		1.415
95% Percentile (z)		1.664
99% Percentile (z)		2.132

Maximum Likelihood Estimate(MLE) Method N/A

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.884
5% Shapiro Wilk Critical Value	0.788

Data appear Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)		-1.518
SD (Log Scale)		1.615
95% UTL	95% Coverage	8.238
95% UPL (t)		3.601
90% Percentile (z)		1.736
95% Percentile (z)		3.121
99% Percentile (z)		9.379

Log ROS Method

Mean in Original Scale		0.329
SD in Original Scale		0.728
Mean in Log Scale		-2.838
SD in Log Scale		1.711
95% UTL	95% Coverage	2.734
95% UPL (t)		1.137
90% Percentile (z)		0.525
95% Percentile (z)		0.977
99% Percentile (z)		3.137

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.778
Theta Star	1.792
nu star	9.333
A-D Test Statistic	0.248
5% A-D Critical Value	0.71
K-S Test Statistic	0.203
5% K-S Critical Value	0.339

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.299
Median	0.000001
SD	0.74
k star	0.1
Theta star	2.978
Nu star	5.615
95% Percentile of Chisquare (2k)	1.164

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean		0.398
SD		0.698
SE of Mean		0.147
95% KM UTL with	95% Coverage	1.965
95% KM Chebyshev UPL		3.493
95% KM UPL (t)		1.608
90% Percentile (z)		1.292
95% Percentile (z)		1.546
99% Percentile (z)		2.021

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	1.04
95% Hawkins Wixley (HW) Approx. Gamma UPL	0.925

		95% WH Approx. Gamma UTL with	95% Coverage 1.93
90% Percentile	0.796	95% HW Approx. Gamma UTL with	95% Coverage 2.067
95% Percentile	1.733		
99% Percentile	4.737		

Note: DL/2 is not a recommended method.

CADMIUM

General Statistics

Number of Valid Data	29	Number of Detected Data	3
Number of Distinct Detected Data	3	Number of Non-Detect Data	26

Warning: Data set has only 3 Detected Values.

This is not enough to compute meaningful and reliable test statistics and estimates.

No statistics will be produced!

Tolerance Factor	2.232	Percent Non-Detects	89.66%

Raw Statistics

Minimum Detected	0.08
Maximum Detected	0.9
Mean of Detected	0.481
SD of Detected	0.41
Minimum Non-Detect	0.039
Maximum Non-Detect	1

Log-transformed Statistics

Minimum Detected	-2.526
Maximum Detected	-0.105
Mean of Detected	-1.134
SD of Detected	1.25
Minimum Non-Detect	-3.244
Maximum Non-Detect	0

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	29
Number treated as Detected with Single DL	0
Single DL Non-Detect Percentage	100.00%

Warning: There are only 3 Distinct Detected Values in this data set

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.

Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.

However, results obtained using 4 to 9 distinct values may not be reliable.

It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.998
5% Shapiro Wilk Critical Value	0.767

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.937
5% Shapiro Wilk Critical Value	0.767

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method		
Mean		0.241
SD		0.233
95% UTL	95% Coverage	0.761
95% UPL (t)		0.644
90% Percentile (z)		0.54
95% Percentile (z)		0.624
99% Percentile (z)		0.783
Maximum Likelihood Estimate(MLE) Method		N/A

Assuming Lognormal Distribution

DL/2 Substitution Method		
Mean (Log Scale)		-2.049
SD (Log Scale)		1.269
95% UTL	95% Coverage	2.191
95% UPL (t)		1.159
90% Percentile (z)		0.656
95% Percentile (z)		1.04
99% Percentile (z)		2.469
Log ROS Method		
Mean in Original Scale		0.0618
SD in Original Scale		0.183
Mean in Log Scale		-4.645
SD in Log Scale		1.644
95% UTL	95% Coverage	0.377
95% UPL (t)		0.165
90% Percentile (z)		0.079
95% Percentile (z)		0.144
99% Percentile (z)		0.44

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	N/A
Theta Star	N/A
nu star	N/A
A-D Test Statistic	N/A
5% A-D Critical Value	N/A
K-S Test Statistic	N/A
5% K-S Critical Value	N/A

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data	
Mean	N/A
Median	N/A
SD	N/A
k star	N/A
Theta star	N/A
Nu star	N/A
95% Percentile of Chisquare (2k)	N/A
90% Percentile	N/A
95% Percentile	N/A
99% Percentile	N/A

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method		
Mean		0.138
SD		0.187
SE of Mean		0.0497
95% KM UTL with	95% Coverage	0.555
95% KM Chebyshev UPL		0.967
95% KM UPL (t)		0.461
90% Percentile (z)		0.377
95% Percentile (z)		0.445
99% Percentile (z)		0.573

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL		N/A
95% Hawkins Wixley (HW) Approx. Gamma UPL		N/A
95% WH Approx. Gamma UTL with	95% Coverage	N/A
95% HW Approx. Gamma UTL with	95% Coverage	N/A

Note: DL/2 is not a recommended method.

CALCIUM

General Statistics

Total Number of Observations	28	Number of Distinct Observations	28
Tolerance Factor	2.246		

Raw Statistics

Minimum	7190
Maximum	216000
Second Largest	212000
First Quartile	20150
Median	40800
Third Quartile	81575
Mean	60441
Geometric Mean	39282
SD	58521
Coefficient of Variation	0.968
Skewness	1.569

Log-Transformed Statistics

Minimum	8.88
Maximum	12.28
Second Largest	12.26
First Quartile	9.907
Median	10.62
Third Quartile	11.31
Mean	10.58
SD	0.97

Background Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.799
Shapiro Wilk Critical Value	0.924

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.967
Shapiro Wilk Critical Value	0.924

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% UTL with	95% Coverage	191879
	95% UPL (t)	161883
	90% Percentile (z)	135439
	95% Percentile (z)	156699
	99% Percentile (z)	196581

Assuming Lognormal Distribution

95% UTL with	95% Coverage	346839
	95% UPL (t)	210986
	90% Percentile (z)	136124
	95% Percentile (z)	193618
	99% Percentile (z)	374946

Gamma Distribution Test

k star	1.186
Theta Star	50958
MLE of Mean	60441
MLE of Standard Deviation	55497
nu star	66.42
A-D Test Statistic	0.425
5% A-D Critical Value	0.767
K-S Test Statistic	0.131

Data Distribution Test

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics

90% Percentile	138500
95% Percentile	197300

5% K-S Critical Value	0.169	99% Percentile	214920

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

90% Percentile	133427	95% UTL with 95% Coverage	216000
95% Percentile	170560	95% Percentile Bootstrap UTL with 95% Coverage	216000
99% Percentile	255738	95% BCA Bootstrap UTL with 95% Coverage	216000
		95% UPL	214200
		95% Chebyshev UPL	320043
95% WH Approx. Gamma UPL	174449	Upper Threshold Limit Based upon IQR	173713
95% HW Approx. Gamma UPL	179903		
95% WH Approx. Gamma UTL with 95% Coverage	236352		
95% HW Approx. Gamma UTL with 95% Coverage	251864		

CHROMIUM

General Statistics

Number of Valid Data	29	Number of Detected Data	9
Number of Distinct Detected Data	9	Number of Non-Detect Data	20
Tolerance Factor	2.232	Percent Non-Detects	68.97%

Raw Statistics

Minimum Detected	0.58
Maximum Detected	26.2
Mean of Detected	7.188
SD of Detected	8.366
Minimum Non-Detect	0.17
Maximum Non-Detect	5

Log-transformed Statistics

Minimum Detected	-0.545
Maximum Detected	3.266
Mean of Detected	1.274
SD of Detected	1.343
Minimum Non-Detect	-1.772
Maximum Non-Detect	1.609

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	25
Number treated as Detected with Single DL	4
Single DL Non-Detect Percentage	86.21%

Warning: There are only 9 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.798
5% Shapiro Wilk Critical Value	0.829

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.942
5% Shapiro Wilk Critical Value	0.829

Data not Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method		
Mean		2.834
SD		5.43
95% UTL	95% Coverage	14.95
95% UPL (t)		12.23
90% Percentile (z)		9.793
95% Percentile (z)		11.77
99% Percentile (z)		15.47
Maximum Likelihood Estimate(MLE) Method		
Mean		16.23
SD		7.219
95% UTL with	95% Coverage	32.34
95% UPL (t)		28.72
90% Percentile (z)		25.48
95% Percentile (z)		28.1
99% Percentile (z)		33.02

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.637
Theta Star	11.29
nu star	11.47
A-D Test Statistic	0.321
5% A-D Critical Value	0.748
K-S Test Statistic	0.196
5% K-S Critical Value	0.288

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data		
Mean		2.253
Median		0.000001
SD		5.601
k star		0.101
Theta star		22.29
Nu star		5.862
95% Percentile of Chisquare (2k)		1.173
90% Percentile		6.022
95% Percentile		13.07

Data appear Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method		
Mean (Log Scale)		-0.101
SD (Log Scale)		1.493
95% UTL	95% Coverage	25.33
95% UPL (t)		11.97
90% Percentile (z)		6.126
95% Percentile (z)		10.54
99% Percentile (z)		29.16
Log ROS Method		
Mean in Original Scale		2.335
SD in Original Scale		5.569
95% UTL with	95% Coverage	24.86
95% BCA UTL with	95% Coverage	26.2
95% Bootstrap (%) UTL with	95% Coverage	26.2
95% UPL (t)		9.108
90% Percentile (z)		3.712
95% Percentile (z)		7.678
99% Percentile (z)		30.02

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method		
Mean		2.683
SD		5.344
SE of Mean		1.055
95% KM UTL with	95% Coverage	14.61
95% KM Chebyshev UPL		26.38
95% KM UPL (t)		11.93
90% Percentile (z)		9.531
95% Percentile (z)		11.47
99% Percentile (z)		15.11

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL		8.743
95% Hawkins Wixley (HW) Approx. Gamma UPL		9.012
95% WH Approx. Gamma UTL with	95% Coverage	15.57
95% HW Approx. Gamma UTL with	95% Coverage	19.08

99% Percentile	35.6

Note: DL/2 is not a recommended method.

COBALT

General Statistics

Number of Valid Data	28	Number of Detected Data	21
Number of Distinct Detected Data	20	Number of Non-Detect Data	7
Tolerance Factor	2.246	Percent Non-Detects	25.00%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	2	Minimum Detected	0.693
Maximum Detected	64.4	Maximum Detected	4.165
Mean of Detected	28.2	Mean of Detected	3.037
SD of Detected	18.78	SD of Detected	0.912
Minimum Non-Detect	1	Minimum Non-Detect	0
Maximum Non-Detect	3	Maximum Non-Detect	1.099

Data with Multiple Detection Limits	Single Detection Limit Scenario	
Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect with Single DL	8
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected with Single DL	20
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	28.57%

Background Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.95	Shapiro Wilk Test Statistic	0.924
5% Shapiro Wilk Critical Value	0.908	5% Shapiro Wilk Critical Value	0.908
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	21.45	Mean (Log Scale)	2.3
SD	20.08	SD (Log Scale)	1.534
95% UTL 95% Coverage	66.54	95% UTL 95% Coverage	313.2
95% UPL (t)	56.25	95% UPL (t)	142.6
90% Percentile (z)	47.18	90% Percentile (z)	71.3
95% Percentile (z)	54.47	95% Percentile (z)	124.5
99% Percentile (z)	68.15	99% Percentile (z)	354.3
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	17.45	Mean in Original Scale	21.93
SD	25.22	SD in Original Scale	19.59
95% UTL with 95% Coverage	74.1	95% UTL with 95% Coverage	178.8
		95% BCA UTL with 95% Coverage	64.4

95% Bootstrap (%) UTL with 95% Coverage	64.4
95% UPL (t)	61.18
95% UPL (t)	98
90% Percentile (z)	49.78
90% Percentile (z)	57.67
95% Percentile (z)	58.94
95% Percentile (z)	88.33
99% Percentile (z)	76.13
99% Percentile (z)	196.5

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.576
Theta Star	17.89
nu star	66.19
A-D Test Statistic	0.259
5% A-D Critical Value	0.756
K-S Test Statistic	0.109
5% K-S Critical Value	0.192

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	21.65
SD	19.51
SE of Mean	3.778
95% KM UTL with 95% Coverage	65.47
95% KM Chebyshev UPL	108.2
95% KM UPL (t)	55.47
90% Percentile (z)	46.65
95% Percentile (z)	53.74
99% Percentile (z)	67.03

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	21.15
Median	15.55
SD	20.39
k star	0.182
Theta star	116.1
Nu star	10.2
95% Percentile of Chisquare (2k)	1.922
90% Percentile	63.82
95% Percentile	111.6
99% Percentile	245.1

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	98.38
95% Hawkins Wixley (HW) Approx. Gamma UPL	138.2
95% WH Approx. Gamma UTL with 95% Coverage	152.7
95% HW Approx. Gamma UTL with 95% Coverage	244.7

Note: DL/2 is not a recommended method.

COPPER

General Statistics

Number of Valid Data	28
Number of Detected Data	17
Number of Distinct Detected Data	16
Number of Non-Detect Data	11
Tolerance Factor	2.246
Percent Non-Detects	39.29%

Raw Statistics

Minimum Detected	0.67
Maximum Detected	21.6
Mean of Detected	5.064
SD of Detected	6.002

Log-transformed Statistics

Minimum Detected	-0.4
Maximum Detected	3.073
Mean of Detected	1.096
SD of Detected	1.039

Minimum Non-Detect	0.12
Maximum Non-Detect	2.1

Minimum Non-Detect	-2.12
Maximum Non-Detect	0.742

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	17
Number treated as Detected with Single DL	11
Single DL Non-Detect Percentage	60.71%

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.698
5% Shapiro Wilk Critical Value	0.892

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.936
5% Shapiro Wilk Critical Value	0.892

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean		3.336
SD		5.117
95% UTL	95% Coverage	14.83
95% UPL (t)		12.21
90% Percentile (z)		9.894
95% Percentile (z)		11.75
99% Percentile (z)		15.24

Maximum Likelihood Estimate(MLE) Method

Mean		-1.041
SD		9.016
95% UTL with	95% Coverage	19.21
95% UPL (t)		14.59
90% Percentile (z)		10.51
95% Percentile (z)		13.79
99% Percentile (z)		19.93

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)		0.375
SD (Log Scale)		1.373
95% UTL	95% Coverage	31.77
95% UPL (t)		15.72
90% Percentile (z)		8.451
95% Percentile (z)		13.92
99% Percentile (z)		35.48

Log ROS Method

Mean in Original Scale		3.25
SD in Original Scale		5.161
95% UTL with	95% Coverage	27.39
95% BCA UTL with	95% Coverage	21.6
95% Bootstrap (%) UTL with	95% Coverage	21.6
95% UPL (t)		13.75
90% Percentile (z)		7.487
95% Percentile (z)		12.2
99% Percentile (z)		30.51

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.934
Theta Star	5.42
nu star	31.76
A-D Test Statistic	0.796
5% A-D Critical Value	0.764
K-S Test Statistic	0.218
5% K-S Critical Value	0.215

Data not Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Lognormal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean		3.36
SD		5.008
SE of Mean		0.976
95% KM UTL with	95% Coverage	14.61

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data	
Mean	3.074
Median	0.855
SD	5.262
k star	0.142
Theta star	21.58
Nu star	7.977
95% Percentile of Chisquare (2k)	1.583
90% Percentile	9.045
95% Percentile	17.09
99% Percentile	40.67

95% KM Chebyshev UPL	25.58
95% KM UPL (t)	12.04
90% Percentile (z)	9.778
95% Percentile (z)	11.6
99% Percentile (z)	15.01

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	14.48
95% Hawkins Wixley (HW) Approx. Gamma UPL	18.8
95% WH Approx. Gamma UTL with 95% Coverage	23.95
95% HW Approx. Gamma UTL with 95% Coverage	36.05

Note: DL/2 is not a recommended method.

IRON

General Statistics

Number of Valid Data	28
Number of Distinct Detected Data	25
Tolerance Factor	2.246
Number of Detected Data	25
Number of Non-Detect Data	3
Percent Non-Detects	10.71%

Raw Statistics

Minimum Detected	12.7
Maximum Detected	41800
Mean of Detected	7912
SD of Detected	12906
Minimum Non-Detect	61.7
Maximum Non-Detect	344

Log-transformed Statistics

Minimum Detected	2.542
Maximum Detected	10.64
Mean of Detected	7.288
SD of Detected	2.142
Minimum Non-Detect	4.122
Maximum Non-Detect	5.841

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	9
Number treated as Detected with Single DL	19
Single DL Non-Detect Percentage	32.14%

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.652
5% Shapiro Wilk Critical Value	0.918

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.95
5% Shapiro Wilk Critical Value	0.918

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	7074

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean (Log Scale)	6.953

SD	12415
95% UTL 95% Coverage	34957
95% UPL (t)	28594
90% Percentile (z)	22984
95% Percentile (z)	27494
99% Percentile (z)	35955

Maximum Likelihood Estimate(MLE) Method

Mean	3382
SD	15978
95% UTL with 95% Coverage	39268
95% UPL (t)	31079
90% Percentile (z)	23858
95% Percentile (z)	29663
99% Percentile (z)	40552

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.371
Theta Star	21336
nu star	18.54
A-D Test Statistic	1.122
5% A-D Critical Value	0.831
K-S Test Statistic	0.208
5% K-S Critical Value	0.187

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	7064
Median	895.5
SD	12420
k star	0.196
Theta star	36034
Nu star	10.98
95% Percentile of Chisquare (2k)	2.031
90% Percentile	21362
95% Percentile	36589
99% Percentile	78646

SD (Log Scale)	2.259
95% UTL 95% Coverage	167271
95% UPL (t)	52538
90% Percentile (z)	18926
95% Percentile (z)	43008
99% Percentile (z)	200568

Log ROS Method

Mean in Original Scale	7069
SD in Original Scale	12418
95% UTL with 95% Coverage	197181
95% BCA UTL with 95% Coverage	41800
95% Bootstrap (%) UTL with 95% Coverage	41800
95% UPL (t)	58587
90% Percentile (z)	20097
95% Percentile (z)	47502
99% Percentile (z)	238499

Data Distribution Test with Detected Values Only

Data appear Lognormal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	7069
SD	12194
SE of Mean	2352
95% KM UTL with 95% Coverage	34456
95% KM Chebyshev UPL	61161
95% KM UPL (t)	28206
90% Percentile (z)	22696
95% Percentile (z)	27126
99% Percentile (z)	35436

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	29620
95% Hawkins Wixley (HW) Approx. Gamma UPL	33579
95% WH Approx. Gamma UTL with 95% Coverage	47829
95% HW Approx. Gamma UTL with 95% Coverage	60315

Note: DL/2 is not a recommended method.

LEAD

General Statistics

Number of Valid Data	29	Number of Detected Data	4
Number of Distinct Detected Data	4	Number of Non-Detect Data	25
Tolerance Factor	2.232	Percent Non-Detects	86.21%

Raw Statistics

Minimum Detected	0.54
Maximum Detected	15.5
Mean of Detected	7.735
SD of Detected	7.032
Minimum Non-Detect	0.157
Maximum Non-Detect	2.5

Log-transformed Statistics

Minimum Detected	-0.616
Maximum Detected	2.741
Mean of Detected	1.437
SD of Detected	1.531
Minimum Non-Detect	-1.852
Maximum Non-Detect	0.916

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	26
Number treated as Detected with Single DL	3
Single DL Non-Detect Percentage	89.66%

Warning: There are only 4 Distinct Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.924
5% Shapiro Wilk Critical Value	0.748

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.906
5% Shapiro Wilk Critical Value	0.748

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean		1.423
SD		3.46
95% UTL	95% Coverage	9.147
	95% UPL (t)	7.41
	90% Percentile (z)	5.858
	95% Percentile (z)	7.115
	99% Percentile (z)	9.473

Maximum Likelihood Estimate(MLE) Method

Mean	-16.52
SD	15.16

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)		-0.78
SD (Log Scale)		1.249
95% UTL	95% Coverage	7.436
	95% UPL (t)	3.974
	90% Percentile (z)	2.27
	95% Percentile (z)	3.573
	99% Percentile (z)	8.366

Log ROS Method

Mean in Original Scale	1.079
SD in Original Scale	3.555

95% UTL with	95% Coverage	17.32
95% UPL (t)		9.711
90% Percentile (z)		2.908
95% Percentile (z)		8.417
99% Percentile (z)		18.75

95% UTL with	95% Coverage	5.368
95% BCA UTL with	95% Coverage	15.5
95% Bootstrap (%) UTL with	95% Coverage	15.5
95% UPL (t)		1.384
90% Percentile (z)		0.412
95% Percentile (z)		1.099
99% Percentile (z)		6.926

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.405
Theta Star	19.1
nu star	3.24
A-D Test Statistic	0.31
5% A-D Critical Value	0.667
K-S Test Statistic	0.279
5% K-S Critical Value	0.403

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	1.067
Median	0.000001
SD	3.559
k star	0.0873
Theta star	12.22
Nu star	5.062
95% Percentile of Chisquare (2k)	1.017
90% Percentile	2.662
95% Percentile	6.217
99% Percentile	18.12

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean		1.532
SD		3.357
SE of Mean		0.72
95% KM UTL with	95% Coverage	9.026
95% KM Chebyshev UPL		16.42
95% KM UPL (t)		7.341
90% Percentile (z)		5.835
95% Percentile (z)		7.055
99% Percentile (z)		9.343

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL		2.754
95% Hawkins Wixley (HW) Approx. Gamma UPL		1.921
95% WH Approx. Gamma UTL with	95% Coverage	5.225
95% HW Approx. Gamma UTL with	95% Coverage	4.427

Note: DL/2 is not a recommended method.

MAGNESIUM

General Statistics

Total Number of Observations		28
Tolerance Factor		2.246
Number of Distinct Observations		28

Raw Statistics

Minimum	2950
Maximum	229000
Second Largest	156000

Log-Transformed Statistics

Minimum	7.99
Maximum	12.34
Second Largest	11.96

First Quartile	9648
Median	16600
Third Quartile	33925
Mean	36803
Geometric Mean	19398
SD	53719
Coefficient of Variation	1.46
Skewness	2.593

First Quartile	9.157
Median	9.717
Third Quartile	10.43
Mean	9.873
SD	1.071

Background Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.601
Shapiro Wilk Critical Value	0.924

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.948
Shapiro Wilk Critical Value	0.924

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% UTL with	95% Coverage	157455
95% UPL (t)		129921
90% Percentile (z)		105646
95% Percentile (z)		125162
99% Percentile (z)		161771

Assuming Lognormal Distribution

95% UTL with	95% Coverage	215057
95% UPL (t)		124200
90% Percentile (z)		76544
95% Percentile (z)		112957
99% Percentile (z)		234384

Gamma Distribution Test

k star	0.838
Theta Star	43936
MLE of Mean	36803
MLE of Standard Deviation	40212
nu star	46.91
A-D Test Statistic	1.565
5% A-D Critical Value	0.778
K-S Test Statistic	0.183
5% K-S Critical Value	0.171

Data not Gamma Distributed at 5% Significance Level

Data Distribution Test

Data appear Lognormal at 5% Significance Level

Nonparametric Statistics

90% Percentile	94900
95% Percentile	154950
99% Percentile	209290

Assuming Gamma Distribution

90% Percentile		88498
95% Percentile		117432
99% Percentile		185514
95% WH Approx. Gamma UPL		115881
95% HW Approx. Gamma UPL		116015
95% WH Approx. Gamma UTL with	95% Coverage	163521
95% HW Approx. Gamma UTL with	95% Coverage	169605

95% UTL with	95% Coverage	229000
95% Percentile Bootstrap UTL with	95% Coverage	229000
95% BCA Bootstrap UTL with	95% Coverage	203450
95% UPL		196150
95% Chebyshev UPL		275102
Upper Threshold Limit Based upon IQR		70341

MANGANESE

General Statistics

Number of Valid Data	28	Number of Detected Data	27
Number of Distinct Detected Data	27	Number of Non-Detect Data	1
Tolerance Factor	2.246	Percent Non-Detects	3.57%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	6.89	Minimum Detected	1.93
Maximum Detected	5940	Maximum Detected	8.689
Mean of Detected	1237	Mean of Detected	6.115
SD of Detected	1498	SD of Detected	1.798
Minimum Non-Detect	566	Minimum Non-Detect	6.339
Maximum Non-Detect	566	Maximum Non-Detect	6.339

Background Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.781	Shapiro Wilk Test Statistic	0.937
5% Shapiro Wilk Critical Value	0.923	5% Shapiro Wilk Critical Value	0.923
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1203	Mean (Log Scale)	6.098
SD	1481	SD (Log Scale)	1.767
95% UTL 95% Coverage	4528	95% UTL 95% Coverage	23532
95% UPL (t)	3770	95% UPL (t)	9514
90% Percentile (z)	3100	90% Percentile (z)	4282
95% Percentile (z)	3638	95% Percentile (z)	8136
99% Percentile (z)	4647	99% Percentile (z)	27121
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	728.7	Mean in Original Scale	1196
SD	2006	SD in Original Scale	1485
95% UTL with 95% Coverage	5235	95% UTL with 95% Coverage	23792
		95% BCA UTL with 95% Coverage	5940
		95% Bootstrap (%) UTL with 95% Coverage	5940
95% UPL (t)	4206	95% UPL (t)	9510
90% Percentile (z)	3300	90% Percentile (z)	4237
95% Percentile (z)	4029	95% Percentile (z)	8116
99% Percentile (z)	5396	99% Percentile (z)	27470

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	0.569	Data appear Gamma Distributed at 5% Significance Level

Theta Star	2173
nu star	30.73
A-D Test Statistic	0.249
5% A-D Critical Value	0.797
K-S Test Statistic	0.103
5% K-S Critical Value	0.177

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	1193
Median	782.5
SD	1488
k star	0.374
Theta star	3186
Nu star	20.96
95% Percentile of Chisquare (2k)	3.182
90% Percentile	3408
95% Percentile	5070
99% Percentile	9280

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	1197
SD	1458
SE of Mean	280.8
95% KM UTL with 95% Coverage	4472
95% KM Chebyshev UPL	7666
95% KM UPL (t)	3725
90% Percentile (z)	3066
95% Percentile (z)	3595
99% Percentile (z)	4589

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	4664
95% Hawkins Wixley (HW) Approx. Gamma UPL	5410
95% WH Approx. Gamma UTL with 95% Coverage	6974
95% HW Approx. Gamma UTL with 95% Coverage	8768

Note: DL/2 is not a recommended method.

MERCURY

General Statistics

Number of Valid Data	29	Number of Detected Data	2
Number of Distinct Detected Data	2	Number of Non-Detect Data	27

Warning: Data set has only 2 Detected Values.

This is not enough to compute meaningful and reliable test statistics and estimates.

No statistics will be produced!

Tolerance Factor	2.232	Percent Non-Detects	93.10%

Raw Statistics

Minimum Detected	0.16
Maximum Detected	0.39
Mean of Detected	0.275
SD of Detected	0.163
Minimum Non-Detect	0.007
Maximum Non-Detect	0.2

Log-transformed Statistics

Minimum Detected	-1.833
Maximum Detected	-0.942
Mean of Detected	-1.387
SD of Detected	0.63
Minimum Non-Detect	-4.962
Maximum Non-Detect	-1.609

Data with Multiple Detection Limits

Single Detection Limit Scenario

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect with Single DL	28
Number treated as Detected with Single DL	1
Single DL Non-Detect Percentage	96.55%

Warning: Data set has only 2 Distinct Detected Values.
This may not be adequate enough to compute meaningful and reliable test statistics and estimates.
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	N/A
5% Shapiro Wilk Critical Value	N/A

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	N/A
5% Shapiro Wilk Critical Value	N/A

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean		0.0676
SD		0.0766
95% UTL	95% Coverage	0.239
	95% UPL (t)	0.2
	90% Percentile (z)	0.166
	95% Percentile (z)	0.194
	99% Percentile (z)	0.246

Maximum Likelihood Estimate(MLE) Method N/A

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)		-3.291
SD (Log Scale)		1.21
95% UTL	95% Coverage	0.554
	95% UPL (t)	0.302
	90% Percentile (z)	0.175
	95% Percentile (z)	0.272
	99% Percentile (z)	0.621

Log ROS Method

Mean in Original Scale	N/A
SD in Original Scale	N/A
Mean in Log Scale	N/A
SD in Log Scale	N/A
95% UTL 95% Coverage	N/A
95% UPL (t)	N/A
90% Percentile (z)	N/A
95% Percentile (z)	N/A
99% Percentile (z)	N/A

Gamma Distribution Test with Detected Values Only

Data Distribution Test with Detected Values Only

k star (bias corrected)	N/A
Theta Star	N/A
nu star	N/A
A-D Test Statistic	N/A
5% A-D Critical Value	N/A
K-S Test Statistic	N/A
5% K-S Critical Value	N/A

Data not Gamma Distributed at 5% Significance Level

Data do not follow a Discernable Distribution (0.05)

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data	
Mean	N/A
Median	N/A
SD	N/A
k star	N/A
Theta star	N/A
Nu star	N/A
95% Percentile of Chisquare (2k)	N/A
90% Percentile	N/A
95% Percentile	N/A
99% Percentile	N/A

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.168
SD	0.042
SE of Mean	0.011
95% KM UTL with 95% Coverage	0.262
95% KM Chebyshev UPL	0.354
95% KM UPL (t)	0.241
90% Percentile (z)	0.222
95% Percentile (z)	0.237
99% Percentile (z)	0.266

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	N/A
95% Hawkins Wixley (HW) Approx. Gamma UPL	N/A
95% WH Approx. Gamma UTL with 95% Coverage	N/A
95% HW Approx. Gamma UTL with 95% Coverage	N/A

Note: DL/2 is not a recommended method.

NICKEL

General Statistics

Number of Valid Data	28	Number of Detected Data	24
Number of Distinct Detected Data	24	Number of Non-Detect Data	4
Tolerance Factor	2.246	Percent Non-Detects	14.29%

Raw Statistics

Minimum Detected	1.56
Maximum Detected	131
Mean of Detected	50.99
SD of Detected	40.89
Minimum Non-Detect	10
Maximum Non-Detect	10

Log-transformed Statistics

Minimum Detected	0.445
Maximum Detected	4.875
Mean of Detected	3.435
SD of Detected	1.224
Minimum Non-Detect	2.303
Maximum Non-Detect	2.303

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.911

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.906

5% Shapiro Wilk Critical Value	0.916

Data not Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	44.42
SD	41.15
95% UTL 95% Coverage	136.8
95% UPL (t)	115.7
90% Percentile (z)	97.15
95% Percentile (z)	112.1
99% Percentile (z)	140.1

Maximum Likelihood Estimate(MLE) Method

Mean	34.89
SD	53.09
95% UTL with 95% Coverage	154.1
95% UPL (t)	126.9
90% Percentile (z)	102.9
95% Percentile (z)	122.2
99% Percentile (z)	158.4

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.03
Theta Star	49.53
nu star	49.42
A-D Test Statistic	0.356
5% A-D Critical Value	0.769
K-S Test Statistic	0.111
5% K-S Critical Value	0.182

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	43.99
Median	31.35
SD	41.61
k star	0.297
Theta star	148.1
Nu star	16.64
95% Percentile of Chisquare (2k)	2.727
90% Percentile	129.9

5% Shapiro Wilk Critical Value	0.916

Data not Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)	3.174
SD (Log Scale)	1.303
95% UTL 95% Coverage	446.5
95% UPL (t)	228.9
90% Percentile (z)	127
95% Percentile (z)	204
99% Percentile (z)	495.8

Log ROS Method

Mean in Original Scale	44.62
SD in Original Scale	40.96
95% UTL with 95% Coverage	441.1
95% BCA UTL with 95% Coverage	131
95% Bootstrap (%) UTL with 95% Coverage	131
95% UPL (t)	227.9
90% Percentile (z)	127.4
95% Percentile (z)	203.4
99% Percentile (z)	489.2

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	44.46
SD	40.38
SE of Mean	7.799
95% KM UTL with 95% Coverage	135.2
95% KM Chebyshev UPL	223.6
95% KM UPL (t)	114.5
90% Percentile (z)	96.21
95% Percentile (z)	110.9
99% Percentile (z)	138.4

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	174.8
95% Hawkins Wixley (HW) Approx. Gamma UPL	224.7
95% WH Approx. Gamma UTL with 95% Coverage	258.3
95% HW Approx. Gamma UTL with 95% Coverage	366.3

95% Percentile	201.9
99% Percentile	389.1

Note: DL/2 is not a recommended method.

POTASSIUM

General Statistics

Number of Valid Data	28	Number of Detected Data	22
Number of Distinct Detected Data	22	Number of Non-Detect Data	6
Tolerance Factor	2.246	Percent Non-Detects	21.43%

Raw Statistics

Minimum Detected	403
Maximum Detected	5380
Mean of Detected	2836
SD of Detected	1759
Minimum Non-Detect	3390
Maximum Non-Detect	5000

Log-transformed Statistics

Minimum Detected	5.999
Maximum Detected	8.59
Mean of Detected	7.675
SD of Detected	0.852
Minimum Non-Detect	8.129
Maximum Non-Detect	8.517

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	24
Number treated as Detected with Single DL	4
Single DL Non-Detect Percentage	85.71%

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.916
5% Shapiro Wilk Critical Value	0.911

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.883
5% Shapiro Wilk Critical Value	0.911

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean		2735
SD		1570
95% UTL	95% Coverage	6261
95% UPL (t)		5457
90% Percentile (z)		4747
95% Percentile (z)		5318
99% Percentile (z)		6387

Maximum Likelihood Estimate(MLE) Method

Mean		4493
SD		481.2
95% UTL with	95% Coverage	5574

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)		7.693
SD (Log Scale)		0.756
95% UTL	95% Coverage	11970
95% UPL (t)		8126
90% Percentile (z)		5776
95% Percentile (z)		7600
99% Percentile (z)		12719

Log ROS Method

Mean in Original Scale		2607
SD in Original Scale		1656
95% UTL with	95% Coverage	11910

95% BCA UTL with 95% Coverage	5380
95% Bootstrap (%) UTL with 95% Coverage	5380
95% UPL (t)	7946
90% Percentile (z)	5562
95% Percentile (z)	7410
99% Percentile (z)	12689

95% UPL (t)	5327
90% Percentile (z)	5110
95% Percentile (z)	5285
99% Percentile (z)	5612

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.73
Theta Star	1639
nu star	76.12
A-D Test Statistic	0.73
5% A-D Critical Value	0.756
K-S Test Statistic	0.147
5% K-S Critical Value	0.188

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	2689
SD	1673
SE of Mean	351.5
95% KM UTL with 95% Coverage	6446
95% KM Chebyshev UPL	10110
95% KM UPL (t)	5589
90% Percentile (z)	4833
95% Percentile (z)	5441
99% Percentile (z)	6581

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data	
Mean	2719
Median	2715
SD	1656
k star	1.899
Theta star	1432
Nu star	106.4
95% Percentile of Chisquare (2k)	9.159
90% Percentile	5353
95% Percentile	6557
99% Percentile	9234

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	6753
95% Hawkins Wixley (HW) Approx. Gamma UPL	7065
95% WH Approx. Gamma UTL with 95% Coverage	8709
95% HW Approx. Gamma UTL with 95% Coverage	9367

Note: DL/2 is not a recommended method.

SELENIUM

General Statistics

Number of Valid Data	29
Number of Detected Data	7
Number of Distinct Detected Data	7
Number of Non-Detect Data	22
Tolerance Factor	2.232
Percent Non-Detects	75.86%

Raw Statistics

Minimum Detected	0.33
Maximum Detected	4.1
Mean of Detected	1.753

Log-transformed Statistics

Minimum Detected	-1.109
Maximum Detected	1.411
Mean of Detected	0.208

SD of Detected	1.47
Minimum Non-Detect	0.04
Maximum Non-Detect	2.5

SD of Detected	0.955
Minimum Non-Detect	-3.219
Maximum Non-Detect	0.916

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	27
Number treated as Detected with Single DL	2
Single DL Non-Detect Percentage	93.10%

Warning: There are only 7 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.876
5% Shapiro Wilk Critical Value	0.803

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.945
5% Shapiro Wilk Critical Value	0.803

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean		0.678
SD		0.972
95% UTL	95% Coverage	2.847
95% UPL (t)		2.359
90% Percentile (z)		1.923
95% Percentile (z)		2.276
99% Percentile (z)		2.938

Maximum Likelihood Estimate(MLE) Method N/A

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)		-1.34
SD (Log Scale)		1.567
95% UTL	95% Coverage	8.658
95% UPL (t)		3.943
90% Percentile (z)		1.952
95% Percentile (z)		3.45
99% Percentile (z)		10.04

Log ROS Method

Mean in Original Scale		0.495
SD in Original Scale		0.994
Mean in Log Scale		-1.897
SD in Log Scale		1.396
95% UTL	95% Coverage	3.388
95% UPL (t)		1.681
90% Percentile (z)		0.899
95% Percentile (z)		1.492
99% Percentile (z)		3.865

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.987
Theta Star	1.776

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

nu star	13.82
A-D Test Statistic	0.268
5% A-D Critical Value	0.72
K-S Test Statistic	0.175
5% K-S Critical Value	0.317

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	0.423
Median	0.000001
SD	1.023
k star	0.1
Theta star	4.213
Nu star	5.825
95% Percentile of Chisquare (2k)	1.166
90% Percentile	1.128
95% Percentile	2.455
99% Percentile	6.706

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.696
SD	0.906
SE of Mean	0.184
95% KM UTL with 95% Coverage	2.717
95% KM Chebyshev UPL	4.71
95% KM UPL (t)	2.262
90% Percentile (z)	1.856
95% Percentile (z)	2.185
99% Percentile (z)	2.802

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	1.552
95% Hawkins Wixley (HW) Approx. Gamma UPL	1.461
95% WH Approx. Gamma UTL with 95% Coverage	2.822
95% HW Approx. Gamma UTL with 95% Coverage	3.183

Note: DL/2 is not a recommended method.

SODIUM

General Statistics

Total Number of Observations	28
Number of Distinct Observations	28
Tolerance Factor	2.246

Raw Statistics

Minimum	10100
Maximum	165000
Second Largest	152000
First Quartile	25650
Median	40500
Third Quartile	92475
Mean	60968
Geometric Mean	45803
SD	46930
Coefficient of Variation	0.77
Skewness	1.004

Log-Transformed Statistics

Minimum	9.22
Maximum	12.01
Second Largest	11.93
First Quartile	10.15
Median	10.61
Third Quartile	11.43
Mean	10.73
SD	0.783

Background Statistics

Normal Distribution Test

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.843
Shapiro Wilk Critical Value	0.924

Data not Normal at 5% Significance Level

Shapiro Wilk Test Statistic	0.955
Shapiro Wilk Critical Value	0.924

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% UTL with 95% Coverage	166373
95% UPL (t)	142318
90% Percentile (z)	121111
95% Percentile (z)	138161
99% Percentile (z)	170144

Assuming Lognormal Distribution

95% UTL with 95% Coverage	265626
95% UPL (t)	177852
90% Percentile (z)	124874
95% Percentile (z)	165940
99% Percentile (z)	282865

Gamma Distribution Test

k star	1.718
Theta Star	35479
MLE of Mean	60968
MLE of Standard Deviation	46509
nu star	96.23
A-D Test Statistic	0.686
5% A-D Critical Value	0.759
K-S Test Statistic	0.142
5% K-S Critical Value	0.168

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics

90% Percentile	136700
95% Percentile	148850
99% Percentile	161490
95% UTL with 95% Coverage	165000
95% Percentile Bootstrap UTL with 95% Coverage	165000
95% BCA Bootstrap UTL with 95% Coverage	165000
95% UPL	159150
95% Chebyshev UPL	269153
Upper Threshold Limit Based upon IQR	192713

Assuming Gamma Distribution

90% Percentile	122931
95% Percentile	151839
99% Percentile	216554
95% WH Approx. Gamma UPL	155563
95% HW Approx. Gamma UPL	159367
95% WH Approx. Gamma UTL with 95% Coverage	202800
95% HW Approx. Gamma UTL with 95% Coverage	212950

THALLIUM

General Statistics

Number of Valid Data	28
Number of Detected Data	1
Number of Distinct Detected Data	1
Number of Non-Detect Data	27

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!

It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable THALLIUM was not processed!

VANADIUM

General Statistics

Number of Valid Data	28	Number of Detected Data	5
Number of Distinct Detected Data	5	Number of Non-Detect Data	23
Tolerance Factor	2.246	Percent Non-Detects	82.14%

Raw Statistics

Minimum Detected	2.1
Maximum Detected	17.9
Mean of Detected	9.154
SD of Detected	6.155
Minimum Non-Detect	0.06
Maximum Non-Detect	3

Log-transformed Statistics

Minimum Detected	0.742
Maximum Detected	2.885
Mean of Detected	1.984
SD of Detected	0.822
Minimum Non-Detect	-2.813
Maximum Non-Detect	1.099

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	24
Number treated as Detected with Single DL	4
Single DL Non-Detect Percentage	85.71%

Warning: There are only 5 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.969
5% Shapiro Wilk Critical Value	0.762

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.96
5% Shapiro Wilk Critical Value	0.762

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean		2.136
SD		4.106
95% UTL	95% Coverage	11.36
95% UPL (t)		9.254
90% Percentile (z)		7.398
95% Percentile (z)		8.89
99% Percentile (z)		11.69

Maximum Likelihood Estimate(MLE) Method

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)		-0.399
SD (Log Scale)		1.575
95% UTL	95% Coverage	23.04
95% UPL (t)		10.28
90% Percentile (z)		5.046
95% Percentile (z)		8.941
99% Percentile (z)		26.15

Log ROS Method

Mean	N/A
SD	N/A
95% UTL with 95% Coverage	N/A
95% UPL (t)	N/A
90% Percentile (z)	N/A
95% Percentile (z)	N/A
99% Percentile (z)	N/A

Mean in Original Scale	1.867
SD in Original Scale	4.202
95% UTL with 95% Coverage	17.84
95% BCA UTL with 95% Coverage	17.9
95% Bootstrap (%) UTL with 95% Coverage	17.9
95% UPL (t)	7.26
90% Percentile (z)	3.286
95% Percentile (z)	6.215
99% Percentile (z)	20.54

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.064
Theta Star	8.601
nu star	10.64
A-D Test Statistic	0.189
5% A-D Critical Value	0.684
K-S Test Statistic	0.163
5% K-S Critical Value	0.36

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	1.635
Median	0.000001
SD	4.285
k star	0.0893
Theta star	18.31
Nu star	5
95% Percentile of Chisquare (2k)	1.041
90% Percentile	4.127
95% Percentile	9.524
99% Percentile	27.46

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	3.36
SD	3.565
SE of Mean	0.753
95% KM UTL with 95% Coverage	11.37
95% KM Chebyshev UPL	19.18
95% KM UPL (t)	9.54
90% Percentile (z)	7.929
95% Percentile (z)	9.224
99% Percentile (z)	11.65

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	5.341
95% Hawkins Wixley (HW) Approx. Gamma UPL	4.45
95% WH Approx. Gamma UTL with 95% Coverage	10.04
95% HW Approx. Gamma UTL with 95% Coverage	10.18

Note: DL/2 is not a recommended method.

ZINC

General Statistics

Number of Valid Data	28
Number of Distinct Detected Data	23
Tolerance Factor	2.246
Number of Detected Data	23
Number of Non-Detect Data	5
Percent Non-Detects	17.86%

Raw Statistics

Log-transformed Statistics

Minimum Detected	2.16
Maximum Detected	161
Mean of Detected	49.45
SD of Detected	45.66
Minimum Non-Detect	1.1
Maximum Non-Detect	10

Minimum Detected	0.77
Maximum Detected	5.081
Mean of Detected	3.406
SD of Detected	1.115
Minimum Non-Detect	0.0953
Maximum Non-Detect	2.303

Data with Multiple Detection Limits

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Single Detection Limit Scenario

Number treated as Non-Detect with Single DL	8
Number treated as Detected with Single DL	20
Single DL Non-Detect Percentage	28.57%

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.861
5% Shapiro Wilk Critical Value	0.914

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.962
5% Shapiro Wilk Critical Value	0.914

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	41.24
SD	44.96
95% UTL 95% Coverage	142.2
95% UPL (t)	119.2
90% Percentile (z)	98.86
95% Percentile (z)	115.2
99% Percentile (z)	145.8

Maximum Likelihood Estimate(MLE) Method

Mean	32.35
SD	55.23
95% UTL with 95% Coverage	156.4
95% UPL (t)	128.1
90% Percentile (z)	103.1
95% Percentile (z)	123.2
99% Percentile (z)	160.8

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)	2.967
SD (Log Scale)	1.441
95% UTL 95% Coverage	494.9
95% UPL (t)	236.4
90% Percentile (z)	123.3
95% Percentile (z)	208.1
99% Percentile (z)	555.7

Log ROS Method

Mean in Original Scale	41.26
SD in Original Scale	44.94
95% UTL with 95% Coverage	418.2
95% BCA UTL with 95% Coverage	161
95% Bootstrap (%) UTL with 95% Coverage	161
95% UPL (t)	209.4
90% Percentile (z)	113.8
95% Percentile (z)	185.8
99% Percentile (z)	466.1

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.028
Theta Star	48.1
nu star	47.29
A-D Test Statistic	0.381
5% A-D Critical Value	0.767

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

K-S Test Statistic	0.134
5% K-S Critical Value	0.186

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	40.62
Median	23.1
SD	45.5
k star	0.216
Theta star	187.8
Nu star	12.11
95% Percentile of Chisquare (2k)	2.183
90% Percentile	122.8
95% Percentile	205
99% Percentile	428.4

Mean	41.23
SD	44.16
SE of Mean	8.535
95% KM UTL with 95% Coverage	140.4
95% KM Chebyshev UPL	237.1
95% KM UPL (t)	117.8
90% Percentile (z)	97.82
95% Percentile (z)	113.9
99% Percentile (z)	144

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	175.6
95% Hawkins Wixley (HW) Approx. Gamma UPL	233.8
95% WH Approx. Gamma UTL with 95% Coverage	268.3
95% HW Approx. Gamma UTL with 95% Coverage	401

Note: DL/2 is not a recommended method.