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Quality Assurance Project Plan Addendum No. 2 for Mine Fill A (SWMU 12) Mine Fill B (SWMU 13) Cast High Explosives Fill/ B146 Incinerator (SWMU 16) and Pyrotechnic Test Area (SWMU 19)

RCRA Facility Investigation

VOLUME I OF II - TEXT

Naval Surface Warfare Center Crane

Crane, Indiana

NAVFAC
Naval Facilities Engineering Command

Southern Division
Naval Facilities Engineering Command

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QUALITY ASSURANCE PROJECT PLAN
ADDENDUM NO. 2
FOR
MINE FILL A (SWMU 12), MINE FILL B (SWMU 13), CAST HIGH EXPLOSIVES FILL/B146 INCINERATOR (SWMU 16) AND PYROTECHNIC TEST AREA (SWMU 19)

RCRA FACILITY INVESTIGATION

NAVAL SURFACE WARFARE CENTER, CRANE
CRANE, INDIANA

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

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ACRONYM LIST

amsl	Above mean sea level
bgs	Below ground surface
cm/sec	Centimeter per second
CMS	Corrective Measures Study
COC	Chain-of-Custody
CTO	Contract Task Order
DPT	Direct-Push Technology
FOD	Frequency of detection
FOL	Field Operations Leader
ft/day	Feet per day
GC	Gas chromatograph
gpm	Gallons per minute
HASP	Health and Safety Plan
HSA	Hollow-stem auger
HMX	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HPLC	High-performance liquid chromatography
IDW	Investigation-derived waste
K	Hydraulic conductivity
MFA	Mine Fill A
MFB	Mine Fill B
MS	Mass spectrometer
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NAD	North American Datum
NAVD	North American Vertical Datum
NSWC	Naval Surface Warfare Center
NTU	Nephelometric turbidity unit
ORP	Oxidation-reduction potential
OSHA	Occupational Safety and Health Administration
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
Pdz	Pennsylvanian deep water-bearing zone Bedrock
PH	Positive hits
PID	Photoionization detector

Piz	Pennsylvania intermediate water-bearing zone
PPE	Personal protective equipment
ppm	Parts per million
Psz	Pennsylvanian shallow water-bearing zone
PVC	Polyvinyl chloride
QAPP	Quality Assurance Project Plan
QA/QC	Quality assurance/quality control
RBTL	Risk-Based Target Level
RCRA	Resource Conservation and Recovery Act
RDX	Hexahydro-1,3,5-trinitro-1,3,5-triazine
RFI	RCRA Facility Investigation
RL	Reporting limit
SOP	Standard operating procedure
SSO	Site Safety Officer
SVOC	Semivolatile organic compound
SWMU	Solid Waste Management Unit
TCE	Trichloroethene
TNT	2,4,6-Trinitrotoluene
TOM	Task Order Manager
TtNUS	Tetra Tech NUS
U.S. EPA	United States Environmental Protection Agency
USACE	United States Army Corps of Engineers
USCS	Unified Soil Classification System
UXO	Unexploded ordnance
VOC	Volatile organic compound

1.0 PROJECT DESCRIPTION

The Naval Surface Warfare Center (NSWC) Crane prepared a Quality Assurance Project Plan (QAPP) [Tetra Tech NUS, Inc. (TtNUS), 2003a] for a Phase III Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) at the following Solid Waste Management Units (SWMUs):

- SWMU 12 - Mine Fill A (MFA)
- SWMU 13 - Mine Fill B (MFB)
- SWMU 16 - Cast High Explosives Fill/B146 Incinerator
- SWMU 19 - Pyrotechnic Test Area

This QAPP was approved by the United States Environmental Protection Agency (U.S. EPA) Region 5. The Round 1 field program for SWMUs 13 and 16 was conducted in May 2003. The ground water and soils data from samples collected at SWMUs 13 and 16 in Round 1 had the following data gaps:

- Explosives [primarily hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)] contamination is not bounded in ground water at SWMU 13.

- Polychlorinated biphenyl (PCB) contamination is not bounded in soils near the site of the Therminol boiler at SWMU 13.

- Explosives (primarily RDX) and volatile organics [primarily trichloroethene (TCE)] contamination is not bounded in ground water at SWMU 16.

SWMUs 12 and 13 both had similar contamination patterns for explosives in soil. The ground water data collected at SWMU 13 indicate a relationship between historical explosives contamination in soil and ground water explosives contamination. A review of these data shows that modifications are necessary to the monitoring well network at SWMU 12 to more completely delineate anticipated explosives contamination in ground water during the initial round of ground water monitoring well installation and sampling.

QAPP Addendum No. 1 (TtNUS, 2003b) was approved by U.S. EPA Region 5 in October 2003 to conduct Round 2 field investigations at SWMUs 13 and 16 to further delineate contamination. This Addendum also described the modified field program for SWMU 12. However, no investigations were conducted at SWMU 12. The Round 2 field investigations at SWMUs 13 and 16 were conducted from October 2003

through January 2004. The ground water and soils data from samples collected at SWMUs 13 and 16 in Round 2 show the following remaining data gaps:

- Explosives (primarily RDX) contamination in ground water is not bounded in the horizontal direction at SWMU 13.
- PCB contamination is not bounded in soils near the site of the Therminol boiler at SWMU 13.
- Explosives (primarily RDX) and volatile organics (primarily TCE) contamination is not bounded in the horizontal direction in ground water at SWMU 16.
- The source of TCE contamination at SWMU 16 has not been found.

This document, QAPP Addendum No. 2, addresses the following:

- SWMU 13 – Round 3 monitoring well installation and ground water and surface water sampling to complete the delineation of explosives contamination in ground water.
- SWMU 13 – Round 3, 4, 5, 6, 7, 8, and 9 ground water monitoring at select locations to determine whether explosives may be naturally degrading.
- SWMU 13 – Collection of additional soil samples in Round 3 to complete the delineation of PCB contamination in the Therminol boiler area.
- SWMU 16 – Round 3 monitoring well installation and ground water and surface water sampling to complete the delineation of explosives and TCE contamination in ground water.
- SWMU 16 – Round 3, 4, 5, 6, 7, 8, and 9 ground water monitoring at select locations to determine whether explosives and chlorinated organics may be naturally degrading.
- SWMU 16 – Soil sampling to locate the source of TCE contamination.

This QAPP Addendum No. 2 generally does not repeat information already provided in the approved QAPP. Site-specific geologic and hydrogeologic information has been updated based on the information collected at SWMUs 13 and 16 in Round 2. Ground water, soils, and surface water data collected at

SWMUs 13 and 16 in Round 2 are summarized and presented. The Rounds 3 through 9 field program is discussed in Section 3. The entire sampling and analysis plan is presented in Section 3.0, rather than incorporation of change pages to the original approved QAPP by reference, so that all field procedures would be contained in one document.

The appendices included in QAPP Addendum No. 2 contain the following information:

- Appendix A - Positive Hit Summaries for Rounds 1 and 2
- Appendix B - Frequencies of Detection for Round 2
- Appendix C - Field Standard Operating Procedures
- Appendix D - Boring Logs for Round 2
- Appendix E - Laboratory Standard Operating Procedures

1.1 RECENT ACTIVITIES

This section provides a summary of recent field investigations conducted at SWMUs 13 and 16.

1.1.1 SWMU 13 Field Investigation Activity

1.1.1.1 Round 1 Sampling

RFI Round 1 field investigation activities were conducted at SWMU 13 from February through May 2003 and included the following activities:

- Surface/subsurface soil sampling
- Monitoring well drilling, installation, development, and sampling
- Water-level measurements and aquifer testing
- Surface water/sediment sampling

A summary of positive hits data for Round 1 is presented in Appendix A.

A brief summary of the Round 1 field activities at SWMU 13 is provided below.

Surface/Subsurface Soil Sampling

A total of 15 surface soil samples were collected at SWMU 13 in Round 1. One surface soil sample was collected from each of the 15 soil borings at a depth of 0 to 2 feet below ground surface (bgs) using

Direct-Push Technology (DPT) methods, Rotosonic drilling, or hand augering. A total of 14 subsurface soil samples were collected from the 15 soil boring locations at SWMU 13. Subsurface samples were collected from a 2-foot interval from depths of 2 to 10 feet bgs using DPT methods, Rotosonic drilling, or hand augering. Refusal was encountered at soil boring 13SB14 before reaching the target depth for subsurface soil sample collection.

Monitoring Well Drilling, Installation, Development, and Sampling

Twenty-six monitoring wells (13MWT01 through 13MWT26) were installed at SWMU 13 in Round 1. One monitoring well boring (13MWT13) at SWMU 13 was drilled using the hollow-stem auger (HAS) method. Soil samples were collected continuously from the ground surface to the bottom of this well for lithologic characteristics only. The Rotosonic drilling technique was used to drill 25 borings into the bedrock. Continuous rock cores were collected from 12 borings for lithologic characteristics only. Monitoring wells at SWMU 13 ranged in total depth from 15 to 30 feet bgs. Table 1-1 provides construction details for the Round 1 monitoring wells at SWMU 13.

After each boring was completed, 2-inch diameter polyvinyl chloride (PVC) Schedule 40 well screen and riser pipe were lowered into the boring. All well screens were 10 feet in length with a slot size of 0.20 inch. All new monitoring wells at SWMU 13 were developed in accordance with Standard Operating Procedure (SOP) CTO166-12 as described in Appendix H of the approved QAPP (TtNUS, 2003a).

Twenty-eight ground water samples were collected at SWMU 13 in Round 1. The 26 new wells were sampled, and monitoring wells 13MWT09 and 13MWT20 were sampled a second time for semivolatile organic compounds (SVOCs) only due to low surrogate recoveries encountered at the laboratory.

Water-Level Measurements and Aquifer Testing

Water-level measurements were collected from the SMWU 13 monitoring wells in Round 1 on May 5 and 11, 2003 (see Table 1-1). Ten staff gauges were also installed at SWMU 13, and water levels were measured at these gauges during the May 11 round. Data from these gauges and the monitoring wells were used to determine the ground water flow direction. Slug tests were performed in eight monitoring wells at SWMU 13.

Surface Water/Sediment Sampling

Samples were collected from all 13 proposed surface water sample locations at SWMU 13. Twenty-three sediment samples were collected at SWMU 13. Originally, 22 locations were proposed. Sample location

12SW/SD23 was added based on field observations (an additional culvert located near the northern corner of the site was discovered and sampled during the field investigation).

1.1.1.2 Round 2 Sampling

RFI Round 2 field investigation activities were conducted at SWMU 13 from October 2003 through January 2004 and included the following activities:

- Surface/subsurface soil sampling
- Monitoring well drilling, installation, development, and sampling
- Water-level measurements and aquifer testing
- Surface water/sediment sampling
- Seep sampling

A summary of positive hits data for Round 2 is presented in Appendix A, and sample summary statistics (frequency of detections) are presented in Appendix B. The field SOPs for Round 2 are shown in Appendix C. The boring log sheets for Round 2 are given in Appendix D.

A brief summary of the Round 2 field activities at SWMU 13 is provided below.

Surface/Subsurface Soil Sampling

A total of 10 surface soil samples were collected in Round 2 at SWMU 13. One surface soil sample was collected from each of the 10 soil borings from the ground surface to a depth of 1 to 2 feet bgs using hand augering techniques. A total of nine subsurface soil samples were collected from the 10 soil boring locations in Round 2 at SWMU 13. Subsurface samples were collected from a 2-foot interval within the depth interval of 2 to 4 feet bgs using a hand auger. Refusal was encountered at soil boring 13SB20 before reaching the target depth for subsurface soil sample collection.

Monitoring Well Drilling, Installation, Development, and Sampling

Twenty-one monitoring wells (13MWT27 through 13MWT47) were installed at SWMU 13 in Round 2. Monitoring wells at SWMU 13 ranged in depth from 20 to 88 feet bgs (see Table 1-1). Thirteen Rotosonic borings were converted to bedrock monitoring wells. Eight monitoring well borings were drilled using the HSA drilling method. Continuous rock cores were collected from 13 bedrock borings for lithologic

characteristics only in Round 2. Select cores that were retained were placed into labeled core boxes, photographed, and turned over to the NSWC Crane Environmental Protection Department for storage.

After each boring was drilled to the desired depth, 2-inch-diameter PVC Schedule 40 well screen and riser pipe were lowered into the boring through the steel isolation casing. All well screens were 10 feet in length with a slot size of 0.20 inches. After the screen and the riser pipe were in place, the annulus of the boring was backfilled with clean silica sand from the bottom of the boring to 1 to 2 feet above the top of the well screen. A bentonite seal was then installed either in pellet (shallow wells) or slurry form (deep wells) and allowed to hydrate in accordance with the manufacturer's recommendations. The remainder of the steel isolation casing was removed while at the same time the annulus of the borehole (from the bentonite seal to the ground surface) was filled with cement/bentonite grout to approximately 1 foot bgs.

Forty-seven ground water samples were collected at SWMU 13 in Round 2. Monitoring wells 13MWT06 and 13MWT45 were slow-recovering wells, and it took several days to fill the required containers. Monitoring well 13MWT28 was dry after purging and collecting a 1-liter sample for explosives analysis. The remainder of the samples from this well were collected the following day.

Water-Level Measurements and Aquifer Testing

Water-level measurements were collected at SWMU 13 in Round 2 on January 20, 2004 (see Table 1-1). One new staff gauge was installed at SWMU 13. Water levels were measured at all gauges on January 20, 2004, and the data were used to determine the ground water flow direction. Slug tests were conducted at 19 monitoring wells in Round 2 (see Table 1-2).

Surface Water/Sediment Sampling

Twenty-two of the 23 proposed surface water samples and four of the five proposed seep samples at SWMU 13 were collected in Round 2. Nine sediment samples were collected at SWMU 13. Six of the nine new sampling locations were located in the drainage gullies southeast of SWMU 13, and three were located northeast of SWMU 13. These locations are all downgradient of the SWMU and were used to evaluate how far contaminants may have migrated from the site.

1.1.2 SWMU 16 Field Investigation

1.1.2.1 Round 1

RFI field investigation activities in Round 1 were conducted at SWMU 16 from February through May 2003 and included the following activities:

- Surface/subsurface soil sampling
- Monitoring well drilling, installation, development, repair, and sampling
- Water-level measurements and aquifer testing
- Surface water/sediment sampling

Analytical data showing the results of all media sampling conducted at SWMU 16 are presented in Appendix C. A summary of positive hits data is presented in Appendix C, and sample summary statistics are presented in Appendix D.

A brief summary of the field activities at SWMU 16 in Round 1 is provided below.

Surface/Subsurface Soil Sampling

The DPT method was used to complete 36 soil borings at SWMU 16. DPT soil borings 16SB40 and 16SB41 at SWMU 16 were advanced to the bottom of their respective sumps (7 to 8 feet bgs). All other soil borings at SWMU 16 were advanced to refusal (1.5 to 6 feet bgs). The Rotosonic method was used to drill borings for the collection of three soil samples.

A total of 39 surface soil samples were collected from the 41 soil boring locations at SWMU 16. Two soil boring locations at SWMU 16 (16SB40 and 16SB41) did not require surface samples as described in the QAPP. At these two locations, samples were collected downgradient of the sumps at middle and bottom depths of each sump. A total of 25 subsurface soil samples were collected from the 41 soil boring locations at SWMU 16. Sixteen subsurface soil samples could not be collected due to refusal. The subsurface samples were collected from a 2-foot section within the interval of 2 to 8 feet bgs using DPT or Rotosonic methods.

Monitoring Well Drilling, Installation, Development, Repair, and Sampling

Five Rotosonic borings were drilled and converted into bedrock monitoring wells at SWMU 16. Continuous rock cores were collected from five of the SWMU 16 bedrock well borings for lithologic

description purposes. Select cores that were retained were placed into labeled core boxes, photographed, and turned over to the NSWC Crane Environmental Protection Department for storage. One monitoring well boring was drilled at SWMU 16 using the HSA drilling method. This boring did not require continuous sampling for lithologic description because an adjacent well was previously installed with continuous sampling.

Six monitoring wells (16MWT01 through 16MWT06) were installed at SWMU 16 to depths ranging from 18 to 40 feet bgs (see Table 1-3 for well construction information). Monitoring well 16MWT06 was installed to replace 16MWT01 due to its low ground water yield. During initial purging activities, 16MWT01 ran dry while being pumped at 200 milliliters per minute and recovered at a rate of 0.01 foot per hour, making it difficult to collect the required sample volume for laboratory analysis.

Five existing wells at SMWU 16 were sampled, inspected, repaired as needed, and redeveloped during RFI activities. The monitoring well repairs made at SWMU 16 included replacing the rusted lock and fixing the locking latch at monitoring well WES-14-03-83 and replacing the cement pad at existing monitoring well WES-14-04-83.

Thirteen ground water samples were collected at SWMU 16. Five of the new wells were sampled once, and one new well (16MWT06) was sampled twice. Monitoring well 16MWT06 was resampled for SVOCs only due to low surrogate recoveries encountered at the laboratory. Five existing monitoring wells were sampled, and one existing monitoring well (WES-14-02-83) was sampled twice. Metals were resampled at WES-14-02-83 for statistical background comparison, and SVOCs were resampled at this well due to low surrogate recoveries encountered at the fixed-base laboratory.

Water-Level Measurements and Aquifer Testing

Water-level measurements were collected at SWMU 16 on May 5 and 30, 2003 (see Table 1-3). The May 30 water-level measurements, which were considered most representative of static conditions because the wells were allowed to equilibrate prior to development and purging, were used to determine the potentiometric surface of the water table and the ground water flow direction. Staff gauges were not installed at SWMU 16 due to the lack of surface water.

Surface Water/Sediment Sampling

Only three sump samples were collected at SWMU 16. The other four planned surface water sampling locations at SWMU 16 were dry and therefore, no samples were collected. These four locations were checked periodically, and no flow was observed at any time during the field investigation.

Nine of the proposed 11 sediment samples were collected at SWMU 16. Three sediment samples were proposed to be collected from the bottom of the three on-site sumps; however, no sediment was found inside any of these sumps. Sediment location 16SW/SD23 (formerly called 16SD02), which was intended to be sampled from inside the East Sump, was relocated to a nearby drainage ditch just east of the sump. In the past, the aforementioned ditch received discharge from the sump; however, the discharge to the ditch has since been blocked and redirected to the sewer system.

1.1.2.2 Round 2

RFI Round 2 field investigation activities were conducted at SWMU 16 from October 2003 through January 2004 and included the following activities:

- Surface/subsurface soil sampling
- Monitoring well drilling, installation, development, and sampling
- Water-level measurements and aquifer testing
- Surface water/sediment sampling

A summary of positive hits data is presented in Appendix A, and sample summary statistics are presented in Appendix B for Round 2.

A brief summary of the field activities at SWMU 16 in Round 1 is provided below.

Surface/Subsurface Soil Sampling

The surface soil samples were collected from the ground surface to a depth of 2 feet bgs or until refusal was reached using a hand auger. A total of five surface soil samples were collected from the nine soil boring locations at SWMU 16. Borings 16SB47 through 16SB50 did not require surface samples. Samples of these locations were collected only for VOC analyses at depths with the greatest PID readings. A total of four subsurface soil samples were collected from the nine soil boring locations at SWMU 16 in Round 2. The subsurface samples were collected from a 2-foot section within the interval of 1 to 5 feet bgs by hand augering.

Monitoring Well Drilling, Installation, Development, and Sampling

Eleven monitoring wells (16MWT07 through 16MWT18) were installed at SWMU 16. Well 16MWT14 was not completed and was abandoned during Round 2 field activities because the hole produced no water for sampling. The bottom of the well screen was knocked out and the hole was filled with a cement-bentonite mixture. The riser and screen were then removed from the hole and the remaining annulus was filled to the ground surface with cement-bentonite mixture. Deep monitoring wells 16MWT15 and 16MWT16 were to only be installed as contingency wells if ground water samples from corresponding shallow wells indicated that contamination was present. A decision was made to install well 16MWT15 at the same time as its corresponding shallow well (16MWT13) due to the overhead power lines needing to be shut down as a safety precaution for the digging rig.

Due to the abandonment of well 16MWT14, well 16MWT16 was drilled as a shallow replacement well. A quick turnaround on sampling results for well 16MWT16 indicated contamination was present in the well and therefore a corresponding deep well (16MWT18) was installed and sampled. Monitoring wells at SWMU 16 ranged in depth from 19 to 105 feet bgs (Table 1-3). Continuous rock cores were collected from five Round 1 and three Round 2 bedrock well borings for lithologic description purposes. Select cores that were retained were placed into labeled core boxes, photographed, and turned over to the NSWC Crane Environmental Protection Department for storage.

After each boring was drilled to the desired depth, 2-inch-diameter PVC Schedule 40 well screen and riser pipe were lowered into the boring through the steel isolation casing. All well screens were 10 feet in length with a slot size of 0.20 inch. After the screen and the riser pipe were in place, the annulus of the boring was backfilled with clean silica sand from the bottom of the boring to 1 to 2 feet above the top of the well screen. A bentonite seal was then installed either in pellet (shallow wells) or slurry form (deep wells) and allowed to hydrate in accordance with the manufacturer's recommendations. The remainder of the steel isolation casing was removed, while at the same time the annulus of the borehole (from the bentonite seal to the ground surface) was filled with cement/bentonite grout to approximately 1 foot bgs.

A total of 22 ground water samples were collected at SWMU 16 from 11 existing wells and from 11 new wells installed during the Round 2 investigation. Monitoring wells 16MWT11 and 16MWT16 were slow-recovering wells. It took several days to fill the required containers for 16MWT16.

Water-Level Measurements and Aquifer Testing

Water-level measurements were collected at SWMU 16 in Round 2 on January 24, 2004 (see Table 1-3). The data were used to determine ground water flow direction. No staff gauges were installed in Round 2. Slug tests were performed in seven monitoring wells (see Table 1-4).

Surface Water/Sediment Sampling

Three additional surface water samples (16SW0102, 16SW0202, and 16SW0702) were taken at SWMU 16 that were not proposed in the Addendum No. 1 to the approved QAPP (TtNUS, 2003b). All three were taken from sumps located within the SWMU 16 boundary. Four of the 11 proposed surface water samples (16SW1501, 16SW1601, 16SW1901, and 16SW2201) were not collected because no water was available at the time of sampling. Five seep samples were proposed for collection; however, no seeps were found at SWMU 16.

1.2 SWMU-SPECIFIC CHARACTERISTICS

The Round 2 field investigation activities conducted at SWMUs 13 and 16 from October 2003 through January 2004 provided additional information regarding SWMU-specific geology and hydrogeology as discussed in this section.

1.2.1 SWMU 13, Mine Fill B

1.2.1.1 Topography/Hydrology

The topography at MFB consists of a ridge running parallel with Highway 45 in a northeast-southwest orientation with gradual slopes to the northwest across MFB and steeper slopes to the southeast into adjacent stream valleys (Figure 1-1). The ground surface elevations at the SWMU range from 661 feet in the southwest to a maximum of approximately 718 feet above mean sea level (amsl) in the northeastern corner.

Several man-made ditch systems located in the southern, eastern, and northern portions of the site, labeled 1, 2, and 3, respectively, on Figure 1-1, convey surface water runoff toward larger tributaries. Ditch systems 1 and 2 ultimately discharge into Turkey Creek east of SWMU 13, and ditch system 3 conveys runoff water towards Boggs Creek to the west. Intermittent streams originating in the central portion of the site flow westward towards stream systems 1, 2, 3, and 4, which ultimately drain into Boggs Creek. Intermittent stream systems 5 and 6, east of Highway 45, flow southeastward and convey water

towards Turkey Creek. Ditch systems are defined as man-made controls to divert surface water runoff, whereas stream systems are naturally occurring.

Surface water flow estimates were made in the Round 1 field investigation based on visual observations during surface water sample collection. It was estimated that stream systems flowed at rates ranging from 1 to 50 gallons per minute (gpm), and ditch systems flowed at rates of less than 1 to 5 gpm.

1.2.1.2 Geology

MFB is located on a flattened ridgetop that has relatively steep slopes that lead down to stream channels located on the northwestern and southeastern sides of the ridge. The geology and hydrogeology of SWMU 13 have been investigated during two different field efforts. In March through May 2003 (Round 1 field effort), 26 monitoring wells were installed. In October and November 2003 (Round 2 field effort), 21 additional monitoring wells were installed. Thus, a total of 47 monitoring wells were installed on the top of the ridge or high on the sideslopes of the ridge. During these drilling activities, lithologic characteristics of the geology underlying the SWMU were examined. To date, no drilling or installation of monitoring wells has occurred in the valleys near the bottom of the ridge.

The geologic materials that underlie the MFB ridge include fill, natural unconsolidated soil materials, and bedrock (Lower Pennsylvanian- and Mississippian-age units). A description of each geologic material is included in the remainder of this subsection. The maximum depth of investigation to date for this SWMU was approximately 88 feet bgs (13MWT45). Figure 1-2 illustrates the locations of the hydrogeologic cross sections, including select borings, through SWMU 13. Figures 1-3, 1-4, and 1-5 show hydrogeologic cross sections A - A', B – B', and C – C', respectively.

Fill was encountered in various borings and extended to a maximum depth of 6 feet bgs in soil boring 13MWT20 (Figure 1-4). In some cases, the fill extended to the bedrock surface. Fill material was found in several borings installed near the railroad tracks in the western portion of the SWMU (e.g., 13MWT12 and 13MWT17), in borings located near buildings (e.g., 13MWT02), and in areas of past excavation (e.g., 13MWT19 and 13MWT20). The fill material included cinders, gravel, sand, and sandstone fragments.

Natural unconsolidated materials, referred to as residual soils of the Raccoon Creek Group (Figure 1-6), underlie the fill and exist at the ground surface where the fill is not present. The maximum thickness of residual soil (17.5 feet) was found in soil boring 13MWT28 (Figure 1-5). The residual soils on the ridgetop and sideslopes consist predominantly of fine materials, including varying amounts of clay, silt, and sand.

Pennsylvanian bedrock was encountered beneath natural unconsolidated materials and fill and consisted of discontinuous layers of siltstones, sandstones, shales, and coal seams. Most fractures found in the bedrock were horizontal bedding plane fractures. The top of the ridge is capped with sandstone and siltstone that is weathered and stained brown because of iron oxidation. These rock units extend to about 635 to 645 feet amsl (Figures 1-2 through 1-4). When grouped together, the ridge-capping sandstone and siltstone units form what is termed the Pennsylvanian shallow water-bearing zone (Psz); this zone will be discussed in greater detail in the following subsection. Of the 47 monitoring wells that have been installed at this site to date, 40 of the wells are screened in this upper bedrock zone (Table 1-1).

Beneath the upper sandstone and siltstone units lies a shale unit that extends throughout the SWMU area and is interlayered with discontinuous siltstone and sandstone lenses. The sandstone lenses are most prevalent in the northeastern portion of SWMU 13. The top of this shale and siltstone unit was encountered at approximately 635 to 645 feet amsl (Figures 1-2 through 1-4). The bottom of the shale/siltstone unit lies at about 605 to 615 feet amsl. The total thickness of the shale/siltstone unit is about 30 feet. This shale/siltstone unit is considered to be an aquitard for reasons presented in the next subsection.

A sandstone layer was the next lithologic unit encountered beneath the interlayered shale and siltstone unit. The top of this sandstone unit was encountered at approximately 605 to 615 feet amsl. Seven of 27 monitoring wells were drilled to this interface and penetrated as much as 10 feet into the underlying sandstone. None of the wells penetrated deeper into the sandstone. As a result, the thickness of the sandstone unit is unknown.

The elevation of the Pennsylvanian/Mississippian unconformity is estimated to be between 500 to 550 feet amsl near SWMU 13 (Barnhill, 1993), or roughly 168 to 218 feet bgs. This would place the base of the Pennsylvanian rock at or below the elevation of the tributary stream on the northwestern side of SWMU 13. No boring has reportedly penetrated the Pennsylvanian/Mississippian unconformity, so the lithologic characteristics of this contact and the underlying rocks are unknown at SWMU 13.

1.2.1.3 Hydrogeology

Round 1

The field investigation conducted in Round 1 focused on shallow ground water beneath SWMU 13, which exists in the bedrock and was not found in either fill or the native soils. Shallow ground water is believed

to be confined to semi-confined at the MFB site. During drilling activities, ground water was encountered at depths ranging from approximately 7 to 22 feet bgs. Ground water elevations in completed wells rose above the depth at which ground water was encountered in 19 of 26 wells installed (73 percent). The static depth to ground water during Round 1 (see Figure 1-1) ranged from 0.5 foot bgs in low-lying areas at 13MWT07 to 17 feet bgs in the higher elevations to the north at 13MWT02.

Shallow ground water flow directions were established in Round 1 based on water-level and staff gauge measurements collected on May 11, 2003 (Table 1-1 and Figure 1-1). Water elevations from staff gauges located in ditches that were not hydraulically connected to the bedrock ground water flow system were not considered during preparation of the potentiometric surface map.

In general, ground water flows from two high points at the site. Ground water in the northeastern corner of the site flows primarily to the northwest across the site, ultimately discharging into stream systems 1 and 2, which convey water further to the northwest towards Boggs Creek. A smaller component of ground water flows to the south and southeast towards stream system 6, which conveys water southeast beneath Highway 45.

Shallow ground water also flows radially in all directions from a high point in the southern portion of the site in the vicinity of 13MWT20 (see Figure 1-1). Southern and eastern ground water flow components flow toward southeastern ditch system 2 and stream system 5, which convey surface water beneath Highway 45. Northern and western ground water flow across the site discharges into stream systems 2, 3, and 4, which convey surface water to the northwest.

Based on slug test results, the geometric mean hydraulic conductivity (K) for bedrock aquifer wells tested at SWMU 13 in Round 1 was approximately 0.28 foot per day (ft/day) [1×10^{-4} centimeter per second (cm/sec)] (see Table 1-2). Hydraulic gradients across the site were calculated from ground water elevations as shown on Figure 1-1. The average hydraulic gradients across the western and eastern parts of the site were estimated to be 0.063 and 0.037, respectively. Assuming a fracture-related porosity of about 0.005 for the bedrock, average ground water velocities were then calculated to be approximately 3.53 ft/day and 2.10 ft/day for the western and eastern parts of the site.

Round 2

Additional monitoring wells were installed in Round 2. The maximum thickness of overburden encountered on the ridgetop at MFB in Round 2 was 17.5 feet in soil boring 13MWT28 (Figure 1-5). Elsewhere, the overburden was generally 10 feet thick or less. While drilling through the overburden, no

saturated conditions or flowing water was observed. Therefore, it is concluded that very little if any ground water is perching on the interface between bedrock and overburden. Water elevations from staff gauges 13SG01, 13SG02, 13SG06 and 13SG07 located in ditches that are not hydraulically connected to the bedrock ground water were not considered during preparation of the potentiometric surface maps. The surface water at these locations is believed to be perched on top of the clayey residual soils.

In general, the shallow bedrock aquifer is recharged by downward infiltration through the residual soil, and recharge occurs more readily where this soil is thin or disturbed and supplanted with fill material.

During Round 2 drilling activities, ground water was generally encountered in the shallow bedrock at approximately 7 to 22 feet bgs. Ground water elevations in completed wells then rose above the depth at which ground water was first encountered. In Round 2, a comprehensive round of water levels was measured from both shallow and deep wells. The static depth to the shallow ground water ranged from 1.4 feet bgs at 13MWT07 to 18.9 feet bgs at 13MWT42. The shallow ground water elevations ranged from 640.19 feet amsl at well 13MWT39 to 711.12 feet amsl at well 13MWT03, with an average ground water elevation of 682.24 feet amsl. The potentiometric surface for the shallow water-bearing zone in the Pennsylvanian-age rock, measured in Round 2, is presented in Figure 1-7. The highest ground water elevations form a ridge that lies along the main road and the railroad tracks that lie along the southeastern SWMU 13 boundary. Shallow ground water on the northwestern side of this ridge is flowing to the northwest and west. Shallow ground water on the southeastern side of the ridge is flowing southeast. All shallow ground water flow is presumably discharging in the gullies that are incised on the northwestern and southeastern sides of the ridge. The hydraulic gradients in the Psz are steep as the sideslopes of the ridge are approached. A local mounding of shallow ground water is seen at well 13MWT34 and is possibly a result of recent excavation of the residual soils at the well location as part of a soil remediation project.

Ground water elevations measured in Round 2 at the seven monitoring wells completed in the deep water-bearing zone in the Pennsylvanian bedrock ranged from 595.51 in monitoring well 13MWT46 to 625.92 feet amsl in monitoring well 13MWT28 (Table 1-1), with an average elevation of 610.64 feet amsl. These water levels were much lower (about 72 feet) than the water levels measured in the Psz, thus indicating that a significant downward vertical gradient exists between the two water-bearing zones. Based on the average head difference between the two portions of the aquifer, the deeper ground water is believed to be hydrostatically separate from the overlying shallow ground water. The shale unit, encountered between about 610 to 640 feet amsl, appears to be an effective aquitard between the Psz and the Pdz.

A Round 2 potentiometric surface map for ground water in the Pdz is presented in Figure 1-8. The deep ground water flows toward the west and most likely discharges to the deeply incised gullies on the side of the ridge and into an unnamed tributary to Boggs Creek.

The results of slug tests performed on select monitoring wells at SWMU 13 in Round 2 are presented in Table 1-2. The average hydraulic conductivities for the shallow monitoring wells ranged from 0.00345 to 13.95 ft/day (1.2E-6 to 4.9E-3 cm/sec). The geometric mean K for shallow bedrock was approximately 0.212 ft/day (7.5E-5 cm/sec). Horizontal hydraulic gradients for the Psz across the site were calculated graphically from ground water elevations presented in Figure 1-7. The average hydraulic gradients across the southwestern and eastern parts of the site were estimated to be 0.094 and 0.0478, respectively. Assuming a fracture-related porosity of about 0.005 for the bedrock, average ground water velocities were calculated to be approximately 3.99 ft/day and 2.0 ft/day for the western and eastern parts of the site, respectively.

The hydraulic conductivities for the deep monitoring wells ranged from 0.000137 to 7.76 ft/day (4.8E-8 to 2.7E-3 cm/sec). The geometric mean K for deep bedrock was approximately 0.00896 ft/day (3.2E-6 cm/sec). The horizontal hydraulic gradient across the site was calculated graphically from ground water elevations presented in Figure 1-8. The average hydraulic gradient across the site for the deep ground water was calculated to be 0.0387. Assuming a fracture-related porosity of about 0.005 for the bedrock, the average ground water velocity was calculated to be approximately 0.069 ft/day.

1.2.2 SWMU 16 – Cast High Explosives Fill/B146 Incinerator

1.2.2.1 Topography/Hydrology

The Cast High Explosives Fill/B146 Incinerator area (SWMU 16) is located on a flattened ridgetop that has relatively steep slopes that lead down to stream channels located on the western, southern, and eastern sides of the ridge. The elevation of the ground surface ranges from 715 feet in the southeastern portion of the SWMU to a maximum of approximately 766 feet amsl in the south near WES-14-05-83 (see Figure 1-9). In Round 1, ditch systems 1 and 2 (see Figure 1-9), located in the northern portion of the site, and systems 3 and 4 located in the southern portion of the site were dry and showed only minor pooling during storm events. Surface runoff encountered during storm events flows across the site to the south, east, and west and into these ditch systems, which ultimately discharge surface water into Turkey Creek.

1.2.2.2 Geology

The geology and hydrogeology of SWMU 16 was first investigated in the early 1980s when the United States Army Corps of Engineers (USACE) installed five monitoring wells in the area (WES-14-01-83 through WES-14-05-83). The area has been investigated more recently for the RFI during two field efforts. In March through May 2003 (Round 1 field effort), six new monitoring wells were installed. In October and November 2003 (Round 2 field effort), 12 additional monitoring wells were installed; one of these wells has subsequently been abandoned. Thus, a total of 22 monitoring wells were installed on the top of the ridge or high on the sideslopes of the ridge. To date, no drilling or installation of monitoring wells has occurred in the valleys near the bottom of the ridge.

The geologic materials that underlie the SWMU 16 ridge include natural unconsolidated soil materials and bedrock (Lower Pennsylvanian- and Mississippian-age rocks). A description of each geologic material is included in the remainder of this subsection. The maximum depth of investigation to date for this SWMU was approximately 105 feet bgs (16MWT18). Figure 1-10 illustrates the locations of the hydrogeologic cross sections, including select borings, through SWMU 16. Figures 1-11 and 1-12 show hydrogeologic cross sections A – A' and B – B' and C – C', respectively.

Natural unconsolidated materials on the ridgetop and sides of the ridge are residual soils that formed as a result of weathering of the underlying Raccoon Creek Group. The residual soils consist predominantly of fine materials, including varying amounts of clay, silt, and sand. The maximum thickness of soils was 13 feet.

The bedrock found at the site consists of siltstones, sandstones, shales, and coal seams. The layers of siltstone, sandstone, and coal seams encountered are somewhat discontinuous. A number of shallow, discontinuous, and weathered sandstone layers (5 to 10 feet thick) were encountered near the top of the ridge at elevations of about 742 to 755 feet amsl (Figures 1-11 and 1-12). The sandstones are presumably capping the ridge and are resistant to erosion. Ground water was first encountered in these sandstones so they have been grouped together and are referred to as the shallow water-bearing zone within the Pennsylvanian bedrock, which is discussed in Section 1.2.2.3.

Shale layers are somewhat continuous and are interlayered with the shallow sandstones and lie beneath the shallow sandstone lenses down to about 735 to 740 feet amsl (Figure 1-11 and 1-12). These shale layers are irregular in thickness but appear to be an effective aquitard between the shallow sandstones (Psz) and the intermediate depth sandstones, as will be discussed in Section 1.2.2.3.

Slightly deeper, intermediate depth sandstone lenses are classified as the intermediate water-bearing zone of the Pennsylvanian bedrock, as discussed below, and were encountered at approximately 735 to 740 feet amsl and extend to about 720 feet amsl. The thickest intermediate-depth sandstone unit was encountered in well 16MW01 (Figure 1-11), which is located on the southwestern side of SWMU 16. This sandstone unit extends east to west across the northern end of SWMU 16 (cross section A-A', Figure 1-11) and is interpreted to extend south to well 16MW01 (cross section B-B', Figure 1-12).

Beneath the intermediate-depth sandstone lenses is about 35 to 50 feet of shale, which is continuous across the site. The elevation of the shale ranges from about 675 to 725 feet amsl (Figures 1-11 and 1-12). Because of its thickness, this shale acts as an aquitard beneath the intermediate-depth sandstone lenses described above (the Piz) and the underlying interlayered sandstone and siltstone described below.

Below the thick shale unit is an interlayered sandstone and siltstone unit, which also contains a coal seam near the top (Figures 1-11 and 1-12). Four monitoring wells have penetrated this unit; however, none of them extend more than about 12 feet into it. Therefore, it is not possible to determine how thick this sandstone is and how its lithologic properties might change at greater depth. This interlayered sandstone and siltstone is considered to be the deep water-bearing zone in the Pennsylvanian bedrock (Pdz), which is discussed in greater detail in Section 1.2.2.3.

The Pennsylvanian bedrock beneath SWMU 16 is estimated to be 122 to 134 feet in thickness. The Pennsylvanian/Mississippian Unconformity at SWMU 16 is estimated to be at 640 to 650 feet amsl, roughly 126 to 136 feet bgs (Barnhill, 1993).

1.2.2.3 Hydrogeology

Round 1

In Round 1, ground water was present beneath SWMU 16 in bedrock but was not found in the unconsolidated overburden. Ground water was encountered at depths as shallow as 9 feet bgs in low-lying areas (16MWT02) and to depths greater than 30 feet in wells located at higher elevations to the south (16MWT05, WES-14-01-83, WES-14-05-83, and WES-14-04-83).

The shallow ground water flow direction was determined based on water levels collected in Round 1 on May 30, 2003 (Table 1-3). The Round 1 potentiometric surface map for SWMU 16 is provided as Figure

1-9. Ground water elevations indicate that shallow ground water flows predominantly in a southwestward direction, ultimately discharging into Turkey Creek southwest of the site.

Monitoring well 16MWT01 was not used in developing the SWMU 16 Round 1 potentiometric surface map. The potentiometric surface elevation for 16MWT01 was approximately 6.78 feet lower than adjacent well 16MWT06. An evaluation of fracturing encountered during drilling activities showed that less frequent fracturing exists in 16MWT01 compared to 16MWT06 and other wells at the site. A very low ground water yield was noted during purging and development of 16MWT01, which may explain the lower water level elevations in this well.

Based on Round 1 slug test results, the geometric mean K for bedrock aquifer wells tested at SWMU 16 is approximately 1.40 ft/day (4.95×10^{-4} cm/sec). The hydraulic gradient across the site was calculated from ground water elevations as shown on Figure 1-9, with the average hydraulic gradient estimated to be 0.05. Assuming a fracture-related porosity of about 0.005 for the bedrock, the ground water velocity was then approximated to be 14 ft/day.

Round 2

The maximum thickness of overburden (i.e., residual soils) encountered on the ridgetop at SWMU 16 was 13 feet. Elsewhere, the residual soils were generally 10 feet thick or less. While drilling through the overburden, no saturated conditions or flowing water was observed. Therefore, it is concluded that very little if any ground water is perching on the interface between bedrock and overburden. Water elevations measured at staff gauges located in drainage gullies that are not hydraulically connected to the bedrock ground water were not considered during preparation of the potentiometric surface maps. The surface water at these locations is believed to be perched on top of the clayey residual soils.

The Pennsylvanian bedrock encountered during the field investigations was divided into three water-bearing zones (Psz, Piz, and Pdz) based on stratigraphic sequences, differences in water-yielding properties, and differences in hydraulic potential encountered in each of the three zones. Shale units and occasional siltstone lenses separate the three water-bearing zones and appear to act as aquitards. The shallow, intermediate, and deep ground water potentiometric surfaces and flow patterns were determined based on water levels measured in Round 2 on January 24, 2004 (Table 1-3).

Shallow-Depth Ground Water

There are 12 monitoring wells installed across the site screened in the shallow water-bearing zone (Table 1-3 and Figure 1-13). The static depth to ground water ranged from 10.94 feet bgs at 16MWT02 to 22.05 feet bgs at 16MWT10. The shallow ground water elevation ranged from 742.38 feet amsl at well 16MWT10 to 753.03 feet amsl at well 16MWT04, with an average ground water elevation of 748.33 feet amsl. Monitoring wells 16MWT07 and 16MWT14 were installed in the same shallow depth interval as the other 10 wells. However, these two wells failed to produce water, demonstrating the discontinuous nature of the Psz.

In general, the shallow potentiometric surface (Figure 1-13) mimics the surface topography. The highest ground water elevations in the northern portion of the site were measured in monitoring wells 16MW02 and 16MWT17, which are located in a northwestern and southeastern orientation near the centerline of the ridge. Ground water to the west of the divide flows to the west and southwest across the site, ultimately discharging into gullies that drain surface water and ground water westward toward a tributary of Boggs Creek. Shallow ground water east of the divide flows to the northeast towards gullies on the eastern side of the site. Shallow ground water is also present in the east-central portion of the site and flows in a southeasterly direction towards gullies on the southeastern side of the site that convey water eastward and southeastward towards Turkey Creek (Figure 1-13).

Note that the shallow water-bearing zone is absent or dry throughout most of the west-central and southern portions, and a small northeastern area, of this SWMU (Figure 1-13).

Monitoring well 16MWT01 was not used in developing the SWMU 16 shallow potentiometric surface map. The potentiometric surface elevation for 16MWT01 was approximately 6.78 feet lower than 16MWT06 during the Round 1 May 30, 2003 measurements, and the water level difference was 1.71 feet during the Round 2 January 24, 2004 measurements. The ground water in this well does not appear to be hydraulically connected to the shallow ground water flow system at the site. An evaluation of fractures during drilling activities showed that fewer fractures exist in 16MWT01 compared to 16MWT06 and other wells at the site. A lower ground water yield was noted during purging and development of 16MWT01, which may explain the lower water level elevations in this well.

Intermediate-Depth Ground Water

There are seven monitoring wells screened in the intermediate water-bearing zone (Table 1-3 and Figure 1-14). The static depth to ground water ranged from 17.91 feet bgs at 16MWT12 to 33.17 feet bgs at

16MWT16 (Table 1-3). The intermediate ground water elevation ranges from 731.81 feet amsl at well 16MWT16 to 736.07 feet amsl at well 16MWT03, with an average ground water elevation of 734.74 feet amsl (see Figure 1-14).

Monitoring well 16MWT16 was not used in developing the SWMU 16 potentiometric surface map for the Piz because the ground water in this well may not be hydraulically connected to the remainder of the intermediate ground water flow system at the site. The potentiometric surface elevation for 16MWT16 was approximately 3 feet lower than the average water level for other monitoring wells screened in the intermediate water-bearing zone.

Ground water elevations are highest near the central portion of this SWMU (near B146), and ground water flows toward the southwestern, southern, and southeastern hillsides. When it reaches the hillsides, the ground water is most likely discharging to the ground surface, primarily where gullies have deeply incised the ground surface. These gullies convey water to tributaries of Turkey Creek.

Deep Ground Water

There are four monitoring wells screened in the deep water-bearing zone (Table 1-3 and Figure 1-15). Monitoring well 16MWT15 was not used in developing the potentiometric surface map for the deep water-bearing zone. The potentiometric elevation for 16MWT15 was approximately 40 feet higher than the average water level measured in the three other wells screened in the deep water-bearing zone, which cannot be explained at this time.

The static depth to deep ground water ranged from 51.27 feet bgs at 16MWT15 to 97.03 feet bgs at 16MWT08. The deep ground water elevation ranged from 664.53 at well 16MWT08 to 706.46 feet amsl at well 16MWT15 in Round 2 on January 24, 2004, with an average elevation of 676.93 feet amsl (Figure 1-15). Without the data for monitoring well 16MWT15, the deep ground water elevations ranged from 664.53 to 668.94 feet amsl, and averaged about 667 feet amsl. This ground water elevation is about 68 feet and 81 feet deeper, respectively, than the average Piz and Psz water levels. Thus, a very significant vertical gradient exists between the three water-bearing zones.

The potentiometric surface measured for the Pdz in Round 2 on January 24, 2004 is presented in Figure 1-15. Ground water flow direction on the eastern side of the site is towards the northeast. The ground water is likely discharging to the ground surface on the northeastern side. Most of this discharge is likely going into the deep gullies that have incised the hillsides. These gullies in turn are conveying water to tributaries of Turkey Creek.

Aquifer Characteristics

The results of slug tests performed on select monitoring wells at SWMU 16 are presented in Table 1-4.

Shallow-Depth Ground Water

The hydraulic conductivities for the shallow monitoring wells in Round 2 ranged from 0.034 to 26.7 ft/day (1.2E-4 to 9.4E-3 cm/sec) (Table 1-4). The geometric mean K for the shallow water-bearing zone was approximately 1.83 ft/day (5.9 x 10-4 cm/s). The horizontal hydraulic gradient for the shallow zone was calculated graphically from ground water elevations measured in the northern area on Figure 1-13. The calculated hydraulic gradient was calculated to be 0.0198. Assuming a fracture-related porosity of about 0.005 for the bedrock, the ground water velocity was estimated to be 7.3 ft/day.

For the east-central area of SWMU 16, the average hydraulic gradient for the site was estimated to be 0.0727. The same horizontal hydraulic conductivity (1.83 ft/day) and porosity (0.005) were used to estimate a seepage velocity to be 26.61 ft/day.

Intermediate-Depth Ground

A single horizontal hydraulic conductivity (0.611 ft/day, 2.2E-4 cm/sec) was measured for the intermediate monitoring wells (Table 1-4). The horizontal hydraulic gradient for the site was calculated graphically from ground water elevations measured in the southern area, as shown on Figure 1-14. The hydraulic gradient for the site was calculated to be 0.0048. Assuming a fracture-related porosity of about 0.005 for the bedrock, the ground water velocity was approximated to be 0.59 ft/day.

Deep Ground Water

A single horizontal hydraulic conductivity (0.004 ft/day, 1.4E-6 cm/sec) was measured for the deep monitoring wells (Table 1-4). The hydraulic gradient for the site was calculated graphically from ground water elevations measured in the northeastern part of the site, as shown on Figure 1-15. The average hydraulic gradient for this area was estimated to be 0.02. Assuming a fracture-related porosity of about 0.005 for the bedrock, the ground water velocity was approximated to be 0.016 ft/day.

1.3 ANALYTICAL RESULTS

The Round 1 and Round 2 analytical results for SWMUs 13 and 16 are briefly described below. Because this QAPP Addendum No. 2 is focused on a Round 3 sampling effort that may be followed by additional sampling and analyses, the level of effort expended on descriptions of field activities and analytical results is sufficient only to identify data gaps and to prepare for the third round of work. More detailed descriptions of field activities and analytical results will be provided in the RFI report that will be prepared upon completion of the field work described in this QAPP Addendum No. 2.

1.3.1 SWMU 13, Mine Fill B

Concentrations for a few of the more prominent contaminants in soil and ground water are used in the following discussions to show the spatial contamination patterns in those environmental media. The contamination in these media was the main driving force for the Round 2 sampling effort at SMWU 13. Contamination in surface water and sediment was less significant, although it was evaluated during planning for the Round 2 sampling. Round 1 and Round 2 positive hits (PH) data sets and frequencies of detection (FODs) are provided in Appendices A and B, respectively, for all media sampled at SWMU 13. In the PH table (Appendix A), all data for any chemicals detected at least once are presented. Chemicals that were not detected in any sample are not included in the table.

1.3.1.1 Surface Soil

Round 1

A total of 15 surface soil samples were collected at SWMU 13 in Round 1. Analyses for volatile organic compounds (VOCs), SVOCs, dioxins, PCBs, and miscellaneous parameters were conducted on all or some of those samples. Only Aroclor-1248 was detected. The Aroclor-1248 concentration exceeds 10 parts per million (ppm) at 5 of the 15 sampling locations, and the greatest concentrations are associated with the southwestern boiler area. The concentrations of other chemicals in surface soil appear to represent little to no risk to human or ecological receptors based on a comparison to risk-based criteria.

Round 2

A total of 10 surface soil samples were collected at SWMU 13 in Round 2. All samples were analyzed only for PCBs. Figure 1-16 presents the results of Round 1 and Round 2 surface soil sampling for PCBs. Aroclor-1248 was the only PCB detected. The Aroclor-1248 concentrations exceed 10 ppm at one

(13SB20) of the 10 sample locations in Round 2, with the greatest concentrations in the southwestern Therminol boiler area. Based on the results from Round 2, PCB contamination in surface soil has not been completely delineated at SWMU 13.

1.3.1.2 Subsurface Soil

Round 1

A total of 14 subsurface soil samples were collected in Round 1 from 15 soil borings at SWMU 13. Analyses for VOCs, SVOCs, dioxins, PCBs, and miscellaneous parameters were conducted on all or some of those samples. Refusal was encountered at soil boring 13SB14 before reaching the target depth for subsurface soil sample collection. PCB (Aroclor 1248) contamination generally decreases with depth in the soil, although at least one subsurface sample still had a total PCB concentration of over 210,000 µg/kg. Several samples on the perimeter of the sampling pattern had PCB concentrations in excess of risk-based screening levels. The concentrations of other chemicals in subsurface soil appear to represent little to no risk to human or ecological receptors based on a comparison to risk-based criteria.

The lateral and vertical extent of PCB contamination near the Therminol boilers was not adequately delineated during Round 1. Based on PCB concentration profiles at the other locations and an operational history of likely surface releases from spilled oil containing PCBs, PCB concentrations in the Therminol boiler area are expected to decrease with depth.

Round 2

A total of nine subsurface samples were collected from 10 soil boring locations in Round 2. Refusal was encountered at soil boring 13SB20 before reaching the target depth for subsurface soil sample collection. All samples were analyzed only for PCBs. Aroclor-1248 was the only PCB detected. Figure 1-17 presents the results of Round 1 and Round 2 surface soil sampling for Aroclor-1248. A comparison of Figures 1-16 and 1-17 shows that the PCB contamination generally decreases with depth in the soil. One subsurface sample (13SB19) had an Aroclor-1248 concentration of 28,000 µg/kg.

Sampling results from Round 2 have provided further information in delineating PCB contamination in certain areas. However, the lateral and vertical extent of PCB contamination in soil near the Therminol boilers was not completely delineated in Round 2.

1.3.1.3 Surface Water

Round 1

Thirteen surface water samples were collected at SWMU 13 in Round 1. Figure 1-18 shows the location of these samples. Analyses for SVOCs, explosives, and metals were conducted on these samples. Except for explosives, chemical concentrations were generally low compared to risk-based criteria, and the chemicals were detected infrequently. Figure 1-18 also includes results for the explosives octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX) and RDX. HMX and/or RDX appeared at concentrations exceeding 10 µg/L at locations 13SW/SD02, 13SW/SD10, 13SW/SD11, 13SW/SD12, and 13SW/SD13. Otherwise the concentrations of these chemicals were approximately 5 µg/L or less, and HMX and RDX were not detected in the remaining eight samples. The greatest HMX and RDX concentrations were observed at location 13SW/SD11 (RDX = 610 µg/L; HMX = 93 µg/L). The concentrations of these chemicals appear to correlate spatially.

HMX and RDX appear to be the most widespread surface water contaminants, and they exhibit the greatest levels of contamination relative to their risk-based evaluation criteria. These contaminant patterns indicate that explosives contamination in surface water at SWMU 13 was not adequately delineated in the Round 1 field effort.

Round 2

Samples were collected at 22 of the 23 proposed surface water sample locations, and four of the five proposed seep sample locations were collected. Figure 1-18 shows the location of these samples. Seep sample 13SP0501 was not collected. Analyses for explosives, metals, nitrite/nitrate, and ammonia were conducted on all Round 2 surface water samples. Two surface water samples (13SW2501 and 13SW3201) were also chosen for selected ion monitoring analysis. All seep samples were analyzed for explosives, metals, nitrite/nitrate, and ammonia. The four seep samples were also filtered and analyzed only for metals. The only explosive detected in Round 2 was RDX. Figure 1-18 includes the RDX concentrations for Round 2. RDX concentrations exceeded 10 µg/L at locations 13SW/SD11, 13SW/SD12, 13SW/SD13, 13SW/SD14, 13SW/SD15, 13SW/SD16, and 13SW/SD27, otherwise RDX concentrations were less than 7 µg/L. The maximum RDX concentration was 5,500 µg/L at 13SW11. Concentrations of metals (iron and manganese) were elevated above Risk-Based Target Levels (RBTLs) at locations 13SW/SD08, 13SW/SD10, 13SW/SD11, and 13SW/SD16. These metals are generally not attributable to site operations, however, metal concentrations will be monitored at select locations, to gain a better understanding of the relationship among surface water, sediment, and other media with regards to metal concentrations.

1.3.1.4 Sediment

Round 1

Twenty-three sediment samples were collected in Round 1 at SWMU 13. Figure 1-19 shows the location of these samples. Originally, 22 locations were proposed, and sample location 13SW/SD23 was added based on field observations (an additional culvert located near the northern corner of the site was discovered and a sampled during the field investigation).

Analyses for explosives and metals were conducted on all sediment samples, and SVOC analyses were conducted on samples 13SD0401, 13SD0501, and 13SD0601. Unlike surface water samples, the sediment samples did not contain significant levels of explosives contamination. The highest explosives concentration detected was RDX (2.2 mg/kg) at location 13SW/SD11. Concentrations of three metals (e.g., cadmium, copper, lead) appeared to be elevated at one or more locations (e.g., 13SW/SD01, 13SW/SD13, 13SW/SD19, 13SW/SD20 and 13SW/SD22) when compared to typical NSWC Crane background concentrations (TtNUS, 2001). Metals contamination was not completely delineated in sediments during Round 1.

Round 2

Nine sediment samples were collected at SWMU 13 in Round 2. Figure 1-19 shows the location of these samples. Six samples were located in drainage gullies, and the remaining three were located northeast of SWMU 13. Analyses for explosives and metals were conducted on eight of these samples. Sample 13SD2501 was also analyzed by selected ion monitoring to measure PAH concentrations. No explosives were detected in Round 2. Concentrations of metals were generally within the ranges of NSWC Crane background concentration levels with the exception of the metals chromium, iron, and manganese. Concentrations of chromium, iron, and manganese were elevated above background levels at one or more sampling locations (13SW/SD24, 13SW/SD25, 13SW/SD26, 13SW/SD27, 13SW/SD28, and 13SW/SD30). Metals have not been identified as site operation-related contaminants. The higher concentrations were at locations farthest from the locations where operations took place.

1.3.1.5 Ground Water

Round 1

Twenty-eight ground water samples were collected at SWMU 13 during Round 1. All 26 new wells were sampled, and monitoring wells 13MWT09 and 13MWT20 were sampled again for SVOCs only due to low surrogate recoveries encountered at the laboratory during the original analyses. Analyses for SVOCs, VOCs, explosives, and metals were conducted on these ground water samples. Results of the Round 1 ground water sampling at SWMU 13 are presented in Figures 1-20 through 1-23 for arsenic, lead, RDX, and 2,4,6-trinitrotoluene (TNT), respectively.

As shown on Figures 1-20 and 1-21, total arsenic and lead concentrations are greatest in the southwestern perimeter well 13MWT25. RDX concentrations (Figure 1-22) are greatest in areas that are generally downgradient of where mine filling operations occurred. The greatest RDX concentrations are associated with interior well 13MWT08, and the northwestern perimeter wells 13MWT11 and 13MWT21. These concentrations are substantially higher than the 0.61 µg/L risk-based screening value for RDX. The concentrations of TNT are elevated in the same general areas as RDX, although the TNT concentrations are much lower (Figure 1-23). These contamination patterns are consistent with the site history and known or expected contaminant release mechanisms. The observed contaminant concentrations indicate that the extent of ground water contamination was not adequately delineated in Round 1 for explosives and metals.

Round 2

Twenty-one groundwater monitoring wells were installed in Round 2. Seven of these new wells (13MWT28, 13MWT35, 13MWT38, 13MWT41, 13MWT44, 13MWT45, and 13MWT46) were deep wells ranging in depth from 66 to 89 feet bgs. Forty-seven ground water samples were collected in Round 2. Analyses for explosives, VOCs, SVOCs, dioxins, PCBs, and miscellaneous parameters were conducted on all or some of those samples. As indicated by Figures 1-20 and 1-21, total arsenic and lead concentrations in Round 2 are highest in the southwestern wells (13MWT25 and 13MWT38). RDX concentrations (see Figure 1-22) are greatest in the areas that are generally downgradient of mine filling operations. The maximum RDX concentration is associated with a southwestern well (13MWT21). The RDX concentration for this well (7,700 µg/L) was significantly higher than the 0.61 µg/L risk-based screening value. The maximum concentration of TNT (see Figure 1-23) was also located at the same well (13MWT21) that reported the maximum RDX. However, the TNT concentration (69 µg/L) at this well location was much lower than the RDX maximum concentration. The contaminant concentrations in Round 2 indicate that explosives contamination in ground water is confined to the shallow aquifer and

appears to be delineated in the vertical direction in the southwestern portion of the SWMU. However, contaminant concentrations for lead and arsenic were not delineated in Round 2.

1.3.2 SWMU 16, Cast High Explosives Fill

Concentrations of a few of the more prominent contaminants in soil and ground water are used in the following discussions to represent the spatial contamination patterns in those environmental media. The contamination in these media was the main driving force for the Round 3 sampling effort at SMWU 16. Contamination in surface water and sediment was less significant, although it was evaluated during planning for the Round 2 sampling. A Round 2 PH data set and FODs are provided in Appendices A and B, respectively, for all media sampled at SWMU 16. In the PH table, all data for any chemicals detected at least once are presented. Chemicals that were not detected in any sample are not included in Appendix A.

1.3.2.1 Surface Soil

Round 1

A total of 39 surface soil samples were collected in Round 1 from the 41 soil boring locations at SWMU 16. Figure 1-24 shows the location of these samples. Some or all of these samples were analyzed for VOCs, SVOCs, explosives, dioxins and furans, metals, PCBs and miscellaneous parameters. Surface soil samples were not collected from two soil boring locations at SWMU 16 (16SB40 and 16SB41). Surface and subsurface dioxin and furan concentrations were similar, with relatively few detections overall. Other organic chemicals were also infrequently detected, with the exception of PAHs in surface soil at location 16SS09 and TCE at location 16SB39 (see Appendices A and B). Some metal concentrations, e.g., lead at locations 16SB14 (1,240 mg/kg) and 16SB20 (765 mg/kg) and zinc at locations 16SB13 through 17 (438 to 1,560 mg/kg) and 16SB21 (2,510 mg/kg) were high in comparison to typical background concentrations (TtNUS, 2001). Based on these data, surface soil contamination has not been completely delineated for select metals.

Round 2

A total of five surface soil samples were collected by hand augering from the nine soil boring locations at SWMU 16. (Borings 16SB47 through 16SB50 did not require surface samples.) Figure 1-24 shows the location of these soil borings. The five surface soil samples were analyzed only for metals; the four subsurface samples collected from borings 16SB47 through 16SB50 were analyzed only for VOCs. Metal concentrations for copper, lead and zinc were much higher than typical background concentrations

(TtNUS, 2001). Copper concentrations were high at 16SB42 (115.0 mg/kg) and 16SB44 (72.9 mg/kg). Lead concentrations were high at 16SB42 (373.0 mg/kg), 16SB44 (240 mg/kg), 16SB45 (127 mg/kg) and 16SB46 (115 mg/kg). Zinc concentrations were high at 16SB42 (1,840 mg/kg), 16SB44 (967 mg/kg), 16SB45 (455 mg/kg), 16SB46 (260 mg/kg). Based on the results of Round 2, metals have not been delineated in surface soil at SWMU 16 and this medium warrants further investigation for metals.

1.3.2.2 Subsurface Soil

Round 1

A total of 27 subsurface soil samples were collected from the 41 soil boring locations at SWMU 16. Some or all of these samples were analyzed for VOCs, SVOCs, explosives, dioxins and furans, metals, PCBs and miscellaneous parameters. Sixteen subsurface soil samples could not be collected due to the limited soil thicknesses at these locations. The subsurface samples generally exhibited organic chemical concentrations similar to surface soils, although cis-1,2-dichloroethene and TCE concentrations at location 16SB39 were relatively high (200 µg/kg and 280 µg/kg, respectively). Metals concentrations appear to be consistent with subsurface soil background metals concentrations.

Round 2

A total of four subsurface soil samples were collected from the nine soil boring locations at SWMU 16. The subsurface samples were collected from 2-foot sections within the interval of 1 to 5 feet bgs by hand augering. These subsurface samples were analyzed only for VOCs. VOC concentrations of dichlorodifluoromethane were elevated above the RBTL at all four sampling locations. Most other VOCs were reported at the detection limit. The maximum concentration of dichlorodifluoromethane was 170 µg/kg at location 16SB47. Similar to Round 1, cis-1,2-dichloroethene and trichloroethene were detected. These soil borings are in the same general location of soil boring 16SB39 where the elevated cis-1,2-dichloroethene was observed.

1.3.2.3 Surface Water

Round 1

Three samples of surface water from sumps were collected at SWMU 16 in Round 1. Figure 1-25 shows the location of these samples. The other four proposed surface water locations at SWMU 16 were dry and therefore, no samples were collected. These four locations were checked periodically, and no flow was observed at any time during the field investigation.

The explosives HMX and RDX exhibited the greatest levels of contamination relative to their risk-based evaluation criteria. The greatest RDX and HMX concentrations were observed in sump sample 16SW01 (RDX = 88,000 µg/L and HMX = 29,000 µg/L). Most other RDX and HMX concentrations were less than detectable levels. The observed contamination concentrations indicate that surface water contamination should be investigated further in drainage channels for potential migration.

Round 2

During Round 2, 21 of the proposed 22 surface water samples were collected. Figure 1-25 shows the location of these samples. 13SW2901 was not collected due to absence of water at the time of sampling. Four of the five proposed seeps were sampled during Round 2. During Round 2 at SWMU 16, all three proposed sump locations were sampled, four surface water samples were not collected due to absence of water, and none of the five proposed seeps were located for sampling. Three additional surface water samples (16SW0102, 16SW0202, 16SW0702) were taken at SWMU 16 that were not proposed in the Addendum No. 1 to the approved QAPP (TtNUS, 2003b). All three were taken from sumps located within the SWMU 16 boundary.

Some or all of the samples were analyzed for VOCs, explosives, and inorganics. The highest VOC concentrations (cis-1,2-dichloroethene and TCE) were at locations 16SW02, 16SW07, and 16SW12. Concentrations of cis-1,2-dichloroethene and TCE were one to two orders of magnitude greater than the RBTLs. The explosives concentrations of RDX and HMX for all samples were at or less than detectable levels. Concentrations for inorganics (aluminum, iron, and manganese) were significantly greater than RBTLs primarily in samples 16SW1301, 16SW1501, and 16SW2101.

1.3.2.4 Sediment

Round 1

Nine of the proposed 11 sediment samples were collected at SWMU 16. Figure 1-25 shows the location of these samples. Three sediment samples were proposed to be collected from the bottoms of the three on-site sumps; however, no sediment was found inside any of these sumps. Sediment location 16SW/SD23 (formerly called 16SD02), which was intended to be inside the East Sump, was relocated to a nearby drainage ditch just east of the sump. In the past, the aforementioned ditch received discharge from the sump; however, the discharge to the ditch has since been blocked and redirected to the sewer system. Proposed sediment sampling locations 16SW/SD01 and 16SW/SD07 were associated with the North Sump and West Sump, respectively.

The sediment samples were analyzed for SVOCs, explosives, metals, and miscellaneous parameters. Select industrial metal concentrations (e.g., antimony and lead) were significantly greater than background concentrations and risk-based screening levels. These detections, along with the sampling locations, indicate that metals contamination was not adequately delineated in Round 1. The same is true of semivolatile organic contamination, especially PAHs, which were present at concentrations greater than 50 µg/kg at two locations (16SW/SD05 and 16SW/SD11).

Round 2

Eleven sediment samples were collected at SWMU 16. Figure 1-25 shows the location of these samples. The sample locations are all located outside of the SWMU 16 boundary and are downgradient of the samples collected during the Round 1 investigation. One or more samples were analyzed for VOCs, SVOCs, explosives, and inorganics. VOC and SVOC concentrations were at or slightly greater than detection limits. Concentrations of iron and lead were significantly greater than typical soil background levels at locations 16SW/SD12, 16SW/SD13, 16SW/SD18, 16SW/SD19, and 16SW/SD20. Zinc concentrations were also greater than background concentrations at location 16SW/SD13. Based on the results of Round 2, metals contamination in sediment has not been delineated at SWMU 16. Further investigation of metals in sediments is warranted.

1.3.2.5 Ground Water

Round 1

Thirteen ground water samples were collected at SWMU 16 in Round 1. All six new wells were sampled, and one new well (16MWT06) was sampled twice. Five existing monitoring wells were sampled, and one existing monitoring well (WES-14-02-83) was sampled twice. Metals were resampled at WES-14-02-83 for statistical background comparison, and SVOCs were resampled at this well due to low surrogate recoveries encountered at the laboratory. Monitoring well 16MWT06 was resampled for SVOCs only due to low surrogate recoveries encountered at the laboratory.

The ground water samples were analyzed for VOCs, SVOCs, explosives, metals, and miscellaneous parameters. Most organic and many inorganic chemicals were not detectable or exhibited low concentrations (see Appendices C and D). RDX and TCE are the primary site contaminants.

Ground water results for RDX and TCE contamination from Round 1 sampling at SWMU 16 are presented in Figures 1-26 and 1-27, respectively. RDX concentrations were highest in the eastern and

southern portions of this SMWU. The maximum TCE concentration was observed near the East Sump in the northern portion of the SWMU. Well 16MWT06, which is within 20 feet of the sump, had a TCE concentration of 35,000 µg/L. All other ground water TCE concentrations were orders of magnitude less. Well 16MWT02, located 10 feet away from well 16MWT06, had TCE at only 16 µg/L, but that well did not produce water very well and may not be representative of the associated water-bearing geologic unit. Overall, the contaminant distribution patterns are consistent with site operations (sumps containing TCE in the north and explosives storage and use in the central and eastern areas of the SWMU). Based on chemical concentrations that are much greater than risk-based criteria, this ground water contamination was not adequately bounded in Round 1.

Round 2

A total of 22 ground water samples were collected at SWMU 16 from 11 existing wells and from 11 new wells installed during the Round 2 investigation. Monitoring wells 16MWT11 and 16MWT16 were slow-recovering wells. Samples were analyzed for VOCs, explosives, metals, and miscellaneous parameters. Ground water results for RDX and TCE in Round 2 are shown in Figures 1-26 and 1-27. Once again, RDX concentrations were highest in the eastern and southeastern portions of the SWMU. The maximum RDX concentration was detected at 16MWT04 at 200 µg/L. Well 16MWT09, located just east of 16MWT04, had a RDX concentration of 110 µg/L. Monitoring wells 16MW09, 16MWT10, and 16MW03, located east and south of 16MWT04, had RDX concentrations of 110, 55 and 71 µg/L, respectively, in Round 2. All other RDX concentrations in Round 2 were less than 6.7 µg/L. Based on the results of Round 2, RDX contamination has not been delineated.

TCE concentrations were highest in the northern portion of the SWMU adjacent to the East Sump. The maximum TCE concentration in Round 2 was 250,000 µg/L at 16MWT06. The second and third highest TCE concentrations observed in Round 2 were 110,000 and 62,000 µg/L at wells 16MWT17 and 16MWT13, respectively. All other TCE concentrations were equal to or less than 230 µg/L. Based on the TCE monitoring well results for Round 2, TCE contamination has not been completely delineated.

1.4 PROJECT TARGET PARAMETERS AND RATIONALE FOR SELECTION

1.4.1 Round 3

Key target parameters for SWMUs 13 and 16 were selected based on historical activities and results from sampling Rounds 1 and 2. This section presents the target parameters and the rationales used to select these parameters for further characterization and delineation.

A list of parameters to be measured in the field and the associated analytical requirements are listed in Table 1-5. Chemicals included in each analytical fraction scheduled for laboratory analysis are presented in Table 1-6. Data used to determine the nature and extent of contamination will also be used to evaluate human health and ecological risks.

1.4.1.1 SWMU 13

The following were chosen as target parameters for SWMU 13:

- Energetics (nitroaromatics and nitramines in ground water, surface water, and vegetation) - To better understand the extent of ground water contamination in the lateral directions, new wells will be installed outside of the previously established ground water sampling pattern. New and existing wells will be sampled and analyzed for energetic compounds. To supplement current information concerning the extent of energetics contamination and transport in streams, surface water samples will also be collected and analyzed for energetics. To supplement information regarding fate and transport vegetation samples will be collected to determine whether contaminated ground water is being taken up by plants.

- Natural Attenuation Parameters (chloride, nitrate plus nitrite as nitrogen, and sulfate in ground water only) - These chemical concentrations will be measured to assess the efficacy of natural attenuation of VOCs and energetic compounds in ground water.

- PCBs (aroclors in soil only - Contamination in soil has not been completely delineated in the lateral and vertical directions near the two former Therminol boiler locations. Therefore, additional soil samples will be collected from these areas and analyzed for PCBs with the intent of sufficiently bounding the contamination to support risk assessments and a Corrective Measures Study (CMS).

- RDX Degradation Products (ground water only) - These chemical concentrations will be measured to assess the efficacy of natural attenuation for energetic compounds.

- Metals (ground water, sediment, and surface water) - Some metal concentrations are elevated in these media. Additional sampling in Round 3 will help to bound this contamination.

- Well Stabilization Parameters (dissolved oxygen, oxidation-reduction potential, pH, specific conductance, temperature, and turbidity in ground water and surface water) - These parameters will be measured in the field to ensure that ground water sampling conditions are stabilized prior to

sample collection. They will also be used to understand ground water chemical fate and transport mechanisms.

1.4.1.2 SWMU 16

The following were chosen as target parameters for SWMU 16:

- Energetics (nitroaromatics and nitramines in ground water and surface water) - To better understand the extent of ground water contamination in the lateral directions, new wells will be installed outside of the previously established ground water sampling pattern. New and existing wells will be sampled and analyzed for these energetic compounds. To supplement current information concerning the extent of energetics contamination and transport in streams, surface water samples will also be collected and analyzed for energetics.

- Natural Attenuation Parameters (chloride, nitrate plus nitrite as nitrogen, and sulfate, ethane, ethane, and methane in ground water only) - These parameters will be used to assess the efficacy of VOC natural attenuation.

- RDX Degradation Products (ground water only) - These chemical concentrations will be measured to assess the efficacy of natural attenuation for energetic compounds.

- Metals (ground water, sediment, and surface water) - Some metal concentrations are elevated in these media. Additional sampling in Round 3 will help to bound this contamination.

- VOCs (ground water, surface water, and soil) - Three potential VOC contaminant sources have not been sufficiently explored. These are the drain lines that are believed to lead from Building 146 to the eastern, northern, and western sumps, respectively, at the northern end of SWMU 16. Surface and subsurface soil samples will be collected near the expected drain line locations to delineate VOC contamination in these areas. Ground water will be collected and analyzed to obtain information related to the extent of ground water contamination and the effectiveness of VOC natural attenuation. To refine the understanding of contaminant transport potential in surface water, surface water samples will be collected from locations that represent potential transport pathways.

- Well Stabilization Parameters (dissolved oxygen, oxidation-reduction potential, pH, specific conductance, temperature, and turbidity in ground water and surface water) - These parameters will

be measured in the field to ensure that ground water sampling conditions are stabilized prior to sample collection. They will also be used to understand ground water chemical fate and transport.

1.4.2 Rounds 4-9

1.4.2.1 SWMU 13

The source of explosive contamination in ground water at SWMU 13 was explosives deposited onto surface soils. These explosives migrated into subsurface soils and into ground water and from ground water into surface water. The Navy had conducted a remedial action in which explosive-contaminated soils have been remediated by composting procedures. Therefore, the source of explosives contamination has been largely removed. In the absence of a source, residual explosives may be naturally degrading. In order to determine whether residual explosives are naturally degrading, long-term ground water monitoring for explosives and explosives degradation products will be conducted.

For SWMU 13, a total of 17 monitoring wells will be sampled every 3 months during sampling Rounds 4 through 9 (i.e. six quarters). The locations of these wells are shown on Figure 3-4. These wells were selected as monitoring points, such that they represent a wide variety of hydrogeological and contaminant conditions upgradient, within, and downgradient of the RDX plumes, as specified in the U.S. EPA "Region 5 Framework for Monitored Natural Attenuation Decisions for Ground Water" (dated September 27, 2000) and stated in the Proposed Round 3 Monitoring Strategy for this site (TtNUS, January 26, 2004). These 17 wells are distributed as follows:

- Two clean, laterally upgradient wells (13MWT01, 13MWT15)
- Four source area wells (13MWT09, 13MWT11, 13MWT17, 13 MWT21)
- Four wells within the RDX plumes (13 MWT13, 13 MWT34, 13MWT37, 13MWT40)
- Three wells at the leading edge of the plumes (13MWT14, 13MWT31, 13MWT51)
- One laterally downgradient well that is clean (13MWT47)
- Three clean, deep wells below the RDX plumes (13MWT28, 13MWT45, and 13MWT46)

Samples will be collected from each monitoring well and evaluated for explosives in each round. In Rounds 4, 6, and 8, samples will also be collected and analyzed for explosive degradation products and nitrate and nitrite. Monitoring these wells at SWMU 13 over nine rounds will provide adequate information concerning contaminant concentrations over time, plume dynamics, and geochemical and hydraulic conditions over time which affect biodegradation rates and natural attenuation.

1.4.2.2 SWMU 16

The source of explosives (RDX) and volatiles (TCE) contamination is believed to be releases from sewers leading to sumps and from the sumps themselves. These releases would have gone into the soils and migrated from soils into ground water. Releases are no longer occurring. A remedial action was conducted for TCE-contaminated sump water, and process lines have been rerouted to the sanitary system. Additional investigations are being conducted during Round 3 to determine whether soils still contain TCE in concentrations which are a source of continuing releases to ground water. RDX releases may also have occurred from ash residue (from the B-146 incinerators), which was stored on the ground surface. This ash pile has been removed in the past. The absence of continuing releases and assuming that soils are not a significant source of TCE releases to ground water, concentrations of RDX and TCE should decrease in ground water in the future.

For SWMU 16, a total of 12 monitoring wells will be sampled approximately 3 months during sampling Rounds 4 through 9 (i.e., six quarters). The location of these wells is shown on Figure 3-4. These wells were selected as monitoring points, such that they represent a wide variety of hydrogeological and contaminant conditions upgradient, within, and downgradient of the RDX and TCE plumes. These 12 wells are distributed as follows:

- One clean, laterally upgradient well (16MW02)
- Three source area wells (16MWT06, 16MWT13, 16MWT17)
- Four wells within the RDX and TCE plumes (16MW03, 16MWT04, 16MWT09, 16MWT10)
- One well at the leading edge of the plume (16MW04)
- One laterally downgradient well that is clean (16MWT12)
- Two clean, deep wells below the plumes (16MWT11, 16MWT15)

Samples will be collected from each monitoring well and evaluated for explosives in each round. In Rounds 4, 6, and 8 samples will also be collected and analyzed for explosive degradation products, nitrate and nitrite, sulfate, chloride, methane, ethane, and ethene. Monitoring these wells at SWMU 16 over nine rounds should provide adequate information concerning temporal trends contaminant concentrations, plume dynamics, and geochemical and hydraulic conditions over time which affect biodegradation rates and natural attenuation.

1.4.3 Overall Analysis Summary

Table 1-7 presents a summary of scheduled analyses and rationales for Round 3 sampling.

TABLE 1-1

MONITORING WELL CONSTRUCTION INFORMATION AND WATER-LEVEL MEASUREMENTS
SWMU 13 - MINE FILL B
NSWC CRANE
CRANE, INDIANA

Well Number	Installation Date	Northing (feet)	Easting (feet)	Ground Elevation (feet amsl)	Top of Riser Elevation (feet amsl)	Total Depth (feet bgs)(1)	Screened Interval				Water-Bearing Zone	May 5, 2003		May 11, 2003		January 20, 2004	
							Top (feet bgs)	Bottom (feet bgs)	Top (feet amsl)	Bottom (feet amsl)		Depth to Water (feet btor)	Ground Water Elevation (feet amsl)	Depth to Water (feet btor)	Ground Water Elevation (feet amsl)	Depth to Water (feet btor)	Ground Water Elevation (feet amsl)
13MWT01	3/30/2003	1310541.574	3025015.943	713.10	715.34	15.00	5.00	15.00	708.10	698.10	Psz	6.21	709.13	5.82	709.52	7.55	707.79
13MWT02	3/29/2003	1310776.555	3024743.547	702.10	704.72	27.00	17.00	27.00	685.10	675.10	Psz	17.15	687.57	17.10	687.62	16.24	688.48
13MWT03	3/30/2003	1310240.946	3024891.661	718.34	721.10	15.00	5.00	15.00	713.34	703.34	Psz	8.79	712.31	8.88	712.22	9.98	711.12
13MWT04	3/30/2003	1310383.396	3024546.113	704.37	706.84	15.00	5.00	15.00	699.37	689.37	Psz	12.98	693.86	12.75	694.09	14.09	692.75
13MWT05	3/29/2003	1310758.927	3024380.025	693.61	696.44	16.00	6.00	16.00	687.61	677.61	Psz	5.42	691.02	4.13	692.31	5.78	690.66
13MWT06	4/7/2003	1309916.177	3024495.270	715.30	717.93	15.00	5.00	15.00	710.30	700.30	Psz	15.11	702.82	15.62	702.31	11.91	706.02
13MWT07	3/29/2003	1310539.322	3024094.128	684.38	687.22	15.00	5.00	15.00	679.38	669.38	Psz	3.12	684.10	3.10	684.12	4.21	683.01
13MWT08	3/30/2003	1310247.860	3024337.560	698.42	700.56	15.00	5.00	15.00	693.42	683.42	Psz	3.17	697.39	2.92	697.64	3.88	696.68
13MWT09	4/1/2003	1309662.066	3024049.030	703.29	705.90	20.00	10.00	20.00	693.29	683.29	Psz	7.74	698.16	7.40	698.50	8.77	697.13
13MWT10	3/27/2003	1309979.693	3024001.262	697.77	700.15	25.00	15.00	25.00	682.77	672.77	Psz	13.65	686.50	13.11	687.04	14.96	685.19
13MWT11	3/28/2003	1310233.721	3023750.087	679.76	682.29	15.00	5.00	15.00	674.76	664.76	Psz	7.87	674.42	7.00	675.29	8.76	673.53
13MWT12	3/27/2003	1310080.207	3023574.945	679.96	682.12	20.00	10.00	20.00	669.96	659.96	Psz	7.88	674.24	7.78	674.34	10.75	671.37
13MWT13	4/23/2003	1309441.270	3024163.605	699.28	701.98	19.00	8.00	18.00	691.28	681.28	Psz	3.62	698.36	3.18	698.80	4.93	697.05
13MWT14	3/31/2003	1309142.232	3024110.167	703.15	705.50	23.00	13.00	23.00	690.15	680.15	Psz	13.25	692.25	13.08	692.42	14.17	691.33
13MWT15	3/25/2003	1309565.518	3023717.803	694.27	696.65	25.00	15.00	25.00	679.27	669.27	Psz	12.88	683.77	12.63	684.02	14.59	682.06
13MWT16	3/27/2003	1309854.276	3023341.916	682.13	684.35	15.00	5.00	15.00	677.13	667.13	Psz	8.49	675.86	8.61	675.74	11.01	673.34
13MWT17	3/26/2003	1309605.272	3023123.966	690.68	693.01	18.00	8.00	18.00	682.68	672.68	Psz	8.70	684.31	8.09	684.92	8.89	684.12
13MWT18	3/26/2003	1309326.980	3023293.416	700.05	702.92	30.00	20.00	30.00	680.05	670.05	Psz	19.06	683.86	19.04	683.88	20.21	682.71
13MWT19	3/31/2003	1308893.971	3023834.565	703.10	705.82	19.00	9.00	19.00	694.10	684.10	Psz	8.31	697.51	6.80	699.02	10.96	694.86
13MWT20	4/1/2003	1309066.757	3023527.233	699.33	702.07	20.00	10.00	20.00	689.33	679.33	Psz	4.22	697.85	4.00	698.07	5.00	697.07
13MWT21	3/28/2003	1309391.009	3022916.218	688.37	690.74	15.00	5.00	15.00	683.37	673.37	Psz	7.69	683.05	7.34	683.40	9.09	681.65
13MWT22	3/28/2003	1308936.338	3022785.672	669.53	671.96	15.00	5.00	15.00	664.53	654.53	Psz	7.44	664.52	7.25	664.71	8.18	663.78
13MWT23	4/1/2003	1308708.016	3023245.117	696.66	699.14	22.00	11.50	21.50	685.16	675.16	Psz	7.45	691.69	7.17	691.97	8.50	690.64
13MWT24	4/1/2003	1308397.230	3022916.484	691.33	693.93	22.00	12.00	22.00	679.33	669.33	Psz	8.45	685.48	8.23	685.70	9.25	684.68
13MWT25	3/28/2003	1308625.618	3022677.444	678.87	681.57	15.00	5.00	15.00	673.87	663.87	Psz	16.00	665.57	16.61	664.96	7.05	674.52
13MWT26	3/28/2003	1308232.686	3022690.142	684.86	687.49	20.00	10.00	20.00	674.86	664.86	Psz	9.10	678.39	8.93	678.56	10.05	677.44
13MWT27	11/5/2003	1309786.548	3023829.075	696.09	698.13	21.00	10.00	20.00	686.09	676.09	Psz	na	na	na	na	9.31	688.82

TABLE 1-1

MONITORING WELL CONSTRUCTION INFORMATION AND WATER-LEVEL MEASUREMENTS
SWMU 13 - MINE FILL B
NSWC CRANE
CRANE, INDIANA

Well Number	Installation Date	Northing (feet)	Easting (feet)	Ground Elevation (feet amsl)	Top of Riser Elevation (feet amsl)	Total Depth (feet bgs)[1]	Screened Interval				Water-Bearing Zone	May 5, 2003		May 11, 2003		January 20, 2004	
							Top (feet bgs)	Bottom (feet bgs)	Top (feet amsl)	Bottom (feet amsl)		Depth to Water (feet btor)	Ground Water Elevation (feet amsl)	Depth to Water (feet btor)	Ground Water Elevation (feet amsl)	Depth to Water (feet btor)	Ground Water Elevation (feet amsl)
13MWT28	11/19/2003	1309678.623	3024066.666	703.54	705.55	88.00	78.00	88.00	625.54	615.54	Pdz	na	na	na	na	79.63	625.92
13MWT29	11/4/2003	1309538.755	3024290.715	698.10	700.44	20.00	9.00	19.00	689.10	679.10	Psz	na	na	na	na	5.82	694.62
13MWT30	11/6/2003	1309174.842	3024237.447	696.57	698.94	25.00	14.00	24.00	682.57	672.57	Psz	na	na	na	na	11.72	687.22
13MWT31	11/5/2003	1308631.827	3023583.849	693.56	696.21	20.00	10.00	20.00	683.56	673.56	Psz	na	na	na	na	10.65	685.56
13MWT32	10/29/2003	1308214.113	3023162.004	693.62	696.04	25.00	8.00	18.00	685.62	675.62	Psz	na	na	na	na	9.52	686.52
13MWT33	11/6/2003	1308749.271	3023868.766	700.14	701.97	20.00	10.00	20.00	690.14	680.14	Psz	na	na	na	na	10.63	691.34
13MWT34	11/11/2003	1309304.310	3023084.250	693.35	695.93	20.50	10.00	20.00	683.35	673.35	Psz	na	na	na	na	5.42	690.51
13MWT35	11/19/2003	1310254.914	3023773.290	679.51	681.73	69.00	57.00	67.00	622.51	612.51	Pdz	na	na	na	na	63.96	617.77
13MWT36	11/5/2003	1309053.391	3022677.863	664.91	667.21	26.00	15.00	25.00	649.91	639.91	Psz	na	na	na	na	19.26	647.95
13MWT37	10/24/2003	1309402.928	3022617.274	659.96	662.29	25.00	14.50	24.50	645.46	635.46	Psz	na	na	na	na	14.37	647.92
13MWT38	11/4/2003	1309376.761	3022619.525	659.03	661.04	80.00	55.00	65.00	604.03	594.03	Pdz	na	na	na	na	61.90	599.14
13MWT39	11/4/2003	1309804.482	3022589.032	652.42	654.44	25.00	14.00	24.00	638.42	628.42	Psz	na	na	na	na	14.25	640.19
13MWT40	10/23/2003	1309622.333	3022833.330	664.93	667.18	25.50	15.00	25.00	649.93	639.93	Psz	na	na	na	na	18.55	648.63
13MWT41	11/10/2003	1309645.205	3022818.998	663.65	665.67	66.00	55.00	65.00	608.65	598.65	Pdz	na	na	na	na	66.58	599.09
13MWT42	10/22/2003	1309862.275	3023113.220	668.05	670.31	25.00	11.00	21.00	657.05	647.05	Psz	na	na	na	na	21.14	649.17
13MWT43	11/6/2003	1310558.559	3023939.448	688.88	690.90	21.00	10.00	20.00	678.88	668.88	Psz	na	na	na	na	8.50	682.40
13MWT44	11/10/2003	1310621.143	3023530.333	682.11	683.82	88.00	73.00	83.00	609.11	599.11	Pdz	na	na	na	na	64.57	619.25
13MWT45	11/10/2003	1309373.683	3022901.377	688.76	690.59	84.00	70.00	80.00	618.76	608.76	Pdz	na	na	na	na	72.75	617.84
13MWT46	11/22/2003	1309812.022	3022565.944	651.64	653.61	68.00	55.00	65.00	596.64	586.64	Pdz	na	na	na	na	58.10	595.51
13MWT47	11/20/2003	1309389.470	3024437.454	675.41	677.23	21.00	8.00	18.00	667.41	657.41	Psz	na	na	na	na	7.32	669.91
STAFF GAUGES																	
13SG01[2]	3/29/2003	1310836.894	3024771.436	698.35	na	na	na	na	na	na	na	na	na	1.73	696.62	1.77	696.58
13SG02	3/29/2003	1310746.566	3024854.367	701.95	na	na	na	na	na	na	Psz	na	na	3.64	698.31	3.68	698.27
13SG03	3/29/2003	1309585.700	3024436.891	696.24	na	na	na	na	na	na	Psz	na	na	1.96	694.28	1.87	694.37
13SG04	3/29/2003	1309478.258	3024317.864	688.99	na	na	na	na	na	na	Psz	na	na	2.38	686.61	2.45	686.54
13SG05	3/29/2003	1309341.458	3024185.404	692.94	na	na	na	na	na	na	Psz	na	na	3.89	689.05	3.90	689.04
13SG06[2]	3/29/2003	1308991.982	3023849.675	704.88	na	na	na	na	na	na	na	na	na	2.37	702.51	2.35	702.53

TABLE 1-1

MONITORING WELL CONSTRUCTION INFORMATION AND WATER-LEVEL MEASUREMENTS
SWMU 13 - MINE FILL B
NSWC CRANE
CRANE, INDIANA

Well Number	Installation Date	Northing (feet)	Easting (feet)	Ground Elevation (feet amsl)	Top of Riser Elevation (feet amsl)	Total Depth (feet bgs)[1]	Screened Interval				Water-Bearing Zone	May 5, 2003		May 11, 2003		January 20, 2004	
							Top (feet bgs)	Bottom (feet bgs)	Top (feet amsl)	Bottom (feet amsl)		Depth to Water (feet btor)	Ground Water Elevation (feet amsl)	Depth to Water (feet btor)	Ground Water Elevation (feet amsl)	Depth to Water (feet btor)	Ground Water Elevation (feet amsl)
13SG07	3/29/2003	1308164.248	3022622.065	680.30	na	na	na	na	na	na	Psz	na	na	1.50	678.80	1.47	678.83
13SG08	3/29/2003	1308846.735	3022744.778	665.95	na	na	na	na	na	na	Psz	na	na	5.05	660.90	5.08	660.87
13SG09	3/29/2003	1309868.608	3023412.150	675.30	na	na	na	na	na	na	Psz	na	na	4.15	671.15	4.15	671.15
13SG10	3/29/2003	1310366.976	3023821.247	676.10	na	na	na	na	na	na	Psz	na	na	4.78	671.32	4.82	671.28
13SG11	1/19/2004	1309388.009	3024416.837	675.36	na	na	na	na	na	na	Psz	na	na	na	na	2.74	672.62

Notes:

1 = Total depth of boring, total depth of well may be less.
2 = Contained perched water not hydraulically connected to the Pennsylvanian.
bgs = Below ground surface.
btor = Below top of riser/reference point.
amsl = Above mean sea level (NAVD88).
na = Not applicable.
Psz = Pennsylvanian shallow water-bearing zone.
Pdz = Pennsylvanian deep water-bearing zone.

TABLE 1-2

SLUG TEST HYDRAULIC CONDUCTIVITY RESULTS
SWMU 13 - MINE FILL B
NSWC CRANE
CRANE, INDIANA

Water-Bearing Zone	Well Identification	Screened Interval Lithologic Type[1]	Falling Head Test (feet/day)	Rising Head Test (feet/day)	Average[2] (feet/day)	Average[2] (cm/sec)
Shallow	13MWT02	Sandstone	0.00388	0.00302	0.00345	1.2E-06
	13MWT08	Overburden/Siltstone	10.9	2.16	6.53	2.3E-03
	13MWT11	Overburden/Siltstone	0.389	0.159	0.274	9.7E-05
	13MWT14	Mudstone/Sandstone	1.67	1.26	1.465	5.2E-04
	13MWT15	Siltstone	0.195	0.128	0.1615	5.7E-05
	13MWT17	Overburden/Siltstone	10.6	17.3	13.95	4.9E-03
	13MWT20	Mudstone	0.135	0.131	0.133	4.7E-05
	13MWT26	Overburden/Siltstone	0.0186	0.0132	0.0159	5.6E-06
	13MWT30	Siltstone	0.0873	0.0607	0.074	2.6E-05
	13MWT32	Sandstone	0.303	0.231	0.267	9.4E-05
	13MWT33	Mudstone	na	0.0147	0.0147	5.2E-06
	13MWT34	Siltstone	0.199	0.163	0.181	6.4E-05
	13MWT37	Sandstone	1.37	1.03	1.2	4.2E-04
	13MWT42	Sandstone	na	0.0794	0.0794	2.8E-05
	13MWT47	Sandstone	0.375	0.349[3]	0.362	1.3E-04
				Geometric Mean =	**0.212**	**7.5E-05**
Deep	13MWT35	Mudstone/Sandstone	na	0.000895	0.000895	3.2E-07
	13MWT38	Sandstone	na	0.00678	0.00678	2.4E-06
	13MWT45	Siltstone	na	0.000137	0.000137	4.8E-08
	13MWT46	Sandstone	6.12	9.4	7.76	2.7E-03
				Geometric Mean =	**0.00896**	**3.2E-06**

1 The overburden primarily consists of decomposed bedrock (clay, silt, and sand).
2 Average of the rising and falling head tests.
3 Two rising head tests were averaged for this value.
na = Not available.

TABLE 1-3

MONITORING WELL CONSTRUCTION INFORMATION AND WATER-LEVEL MEASUREMENTS
SWMU 16 - CAST HIGH EXPLOSIVES FILL/B146 INCINERATOR
NSWC CRANE
CRANE, INDIANA

Well Number	Installation Date	Northing (feet)	Easting (feet)	Ground Elevation (feet amsl)	Top of Riser Elevation (feet amsl)	Total Depth (feet bgs)(1)	Screened Interval				Water-Bearing Zone	May 5, 2003		May 30, 2003		January 24, 2004	
							Top (feet bgs)	Bottom (feet bgs)	Top (feet amsl)	Bottom (feet amsl)		Depth to Water (feet btor)	Ground Water Elevaton (feet amsl)	Dept to Water (feet btor)	Ground Water Elevaton (feet amsl)	Dept to Water (feet btor)	Ground Water Elevaton (feet amsl)
16MWT01	4/8/2003	1321193.488	3032881.285	762.02	764.50	24.00	14.00	24.00	748.02	738.02	Psz	25.19	739.31	22.7	741.80	19.12	745.38
16MWT02	4/11/2003	1321146.42	3032559.16	757.60	760.36	18.00	8.00	18.00	749.60	739.60	Psz	6.55	753.81	12.18	748.18	10.94	749.42
16MWT03	4/10/2003	1320946.968	3032644.291	761.95	764.41	35.00	25.00	35.00	736.95	726.95	Piz	27.20	737.21	28.07	736.34	28.34	736.07
16MWT04	4/9/2003	1321003.281	3032946.466	763.88	766.14	25.00	15.00	25.00	748.88	738.88	Psz	8.05	758.09	13.14	753.00	13.11	753.03
16MWT05	4/9/2003	1320741.793	3032812.772	764.50	766.88	40.00	29.00	39.00	735.50	725.50	Piz	29.77	737.11	30.39	736.49	31.44	735.44
16MWT06	4/24/2003	1321199.519	3032883.373	761.77	764.44	25.00	15.00	25.00	746.77	736.77	Psz	22.33	742.11	15.92	748.52	17.41	747.03
16MWT07	11/11/2003	1321176.931	3033001.574	760.54	762.87	25.50	15.00	25.00	745.54	735.54	Psz	na	na	na	na	dry	dry
16MWT08	11/9/2003	1321179.449	3033009.24	759.57	761.56	99.00	85.00	95.00	674.57	664.57	Pdz	na	na	na	na	97.03	664.53
16MWT09	11/8/2003	1321068.489	3033041.444	762.43	764.28	25.00	15.00	25.00	747.43	737.43	Psz	na	na	na	na	13.88	750.40
16MWT10	11/9/2003	1320936.048	3033074.741	761.93	764.43	25.00	14.00	24.00	747.93	737.93	Psz	na	na	na	na	22.05	742.38
16MWT11	11/11/2003	1320934.642	3033062.786	763.23	765.24	98.00	86.00	96.00	677.23	667.23	Pdz	na	na	na	na	96.3	668.94
16MWT12	11/7/2003	1320729.139	3033074.921	753.23	755.45	26.50	16.00	26.00	737.23	727.23	Piz	na	na	na	na	20.13	735.32
16MWT13	11/11/2003	1321125.775	3032562.405	757.62	759.57	19.00	8.00	18.00	749.62	739.62	Psz	na	na	na	na	10.25	749.32
16MWT14	11/7/2003	na	na	764.98	Abn	25.00	15.00	25.00	749.98	739.98	Psz	na	na	na	na	na	dry
16MWT15	11/9/2003	1321120.81	3032563.53	757.73	759.69	92.00	81.00	91.00	676.73	666.73	Pdz	na	na	na	na	53.23	706.46
16MWT16	11/9/2003	1321059.41	3032814.52	764.98	764.74	40.00	26.00	36.00	738.98	728.98	Piz	na	na	na	na	32.93	731.81
16MWT17	11/8/2003	1321235.88	3032675.07	764.79	766.53	24.00	14.00	24.00	750.79	740.79	Psz	na	na	na	na	15.35	751.18
16MWT18	1/18/2004	1321068.96	3032807.84	764.99	764.44	105.00	94.00	104.00	670.99	660.99	Pdz	na	na	na	na	96.65	667.79
WES-14-01-83	1983	1320638.353	3032713.383	763.87	766.67	50.70	35.80	45.30	728.07	718.57	Piz	31.00	735.67	31.00	735.67	31.94	734.73
WES-14-02-83	1983	1321319.899	3032647.27	763.69	766.54	25.80	11.35	20.39	752.34	743.30	Psz	14.23	752.31	14.56	751.98	15.36	751.18
WES-14-03-83	1983	1320816.004	3033018.495	761.51	763.93	35.40	20.88	29.99	740.63	731.52	Psz	18.80	745.13	19.83	744.10	20	743.93
WES-14-04-83	1983	1320572.345	3032960.959	760.42	762.99	46.00	31.38	40.47	729.04	719.95	Piz	26.80	736.19	27.27	735.72	28.39	734.6
WES-14-05-83	1983	1320584.051	3032850.321	766.60	769.40	50.70	35.80	45.25	730.80	721.35	Piz	32.59	736.81	33.05	736.35	34.18	735.22

Notes:
1 = Total depth of boring, total depth of well may be less.
bgs = Below ground surface.
btor = Below top of riser.
amsl = Above mean sea level (NAVD88).
Psz = Pennsylvanian shallow water-bearing zone.
Piz = Pennsylvanian intermediate water-bearing zone.
Pdz = Pennsylvanian deep water-bearing zone.
na = Not available.

TABLE 1-4

SLUG TEST HYDRAULIC CONDUCTIVITY RESULTS
SWMU 16
CRANE NSWC
CRANE, INDIANA

Water-Bearing Zone	Well Identification	Screen Interval Lithologic Type	Falling Head Test (feet/day)	Rising Head Test (feet/day)	Average[1] (feet/day)	Average[1] (cm/sec)
Shallow	16MWT02	Sandstone	5.090	3.370	4.230	1.49E-03
	16MWT04	Sandstone/Mudstone	1.090	1.050	1.070	3.77E-04
	16MWT09	Mudstone	0.267	0.413	0.340	1.20E-04
	16MWT10	Sandstone/Siltstone	na	26.7[2]	26.700	9.42E-03
	16MWT17	Sandstone/Mudstone	0.501	0.509	0.505	1.78E-04
				Geometric Mean =	**1.83**	**5.9E-04**
Intermediate	16MWT05	Mudstone	0.638	0.584	0.611	2.16E-04
				Geometric Mean =	**0.611**	**2.16E-04**
Deep	16MWT15	Siltstone	0.004	na	0.004	1.4E-06
				Geometric Mean =	**0.004**	**1.4E-06**

1 Average of the rising and falling head tests.
2 Two rising head tests were averaged for this value.

TABLE 1-5

AQUEOUS FIELD TARGET PARAMETERS
AND METHOD DETECTION LIMITS
SWMU 13 (Round 2) AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Parameter	Estimated Detection Limit
Dissolved Oxygen (meter)	0.1 mg/L
Oxidation-Reduction Potential (ORP)	NA
pH	NA
Specific Conductance	0.02 µS/cm
Temperature	0.1°C*
Turbidity	1 NTU
Water Level	0.01 foot*

NA – Not applicable.
mg/L = milligrams per liter.
µS/cm = microSiemens per centimeter.
NTU = Nephelometric turbidity unit.
°C = degrees Celsius.
*Stated value is required limit of resolution rather than a detection limit.

TABLE 1-6

SPECIFIC FIXED-BASED
LABORATORY ANALYTICAL METHODOLOGIES AND
CORRESPONDING TARGET ANALYTE LISTS[1]
SWMU 13 (Round 3) AND SWMU 16 (Round 3)
NSWC CRANE
CRANE, INDIANA

Parameter	CAS#	Aqueous Matrix				Solid Matrix				
		Units	Lab RL	Lab TV	Risk-Based Target Level	Units	Lab RL	Lab TV	Risk-Based Soil Target Level	Risk-Based Sediment Target Level
EXPLOSIVES (NITROAROMATICS AND NITRAMINES) (SW-846 8330)[3]										
1,3,5-Trinitrobenzene	99-35-4	µg/L	0.5	0.25	1100	mg/kg	0.5	0.25	0.25	0.000121
1,3-Dinitrobenzene	99-65-0	µg/L	0.5	0.25	2.36	mg/kg	0.5	0.25	0.00096	0.000924
2,4,6-Trinitrotoluene	118-96-7	µg/L	0.5	0.25	2.2	mg/kg	0.5	0.25	0.00057	NA
2,4-Dinitrotoluene	121-14-2	µg/L	0.5	0.25	73	mg/kg	0.5	0.25	0.000049	0.07513
2,6-Dinitrotoluene	606-20-2	µg/L	0.5	0.25	36	mg/kg	0.5	0.25	0.000042	0.02062
2-Amino-4,6-dinitrotoluene	35572-78-2	µg/L	0.5	0.25	NA	mg/kg	0.5	0.25	NA	NA
2-Nitrotoluene	88-72-2	µg/L	0.5	0.25	61	mg/kg	0.5	0.25	0.15	NA
3-Nitrotoluene	99-08-1	µg/L	0.5	0.25	61	mg/kg	0.5	0.25	0.3	NA
4-Amino-2,6-dinitrotoluene	19406-51-0	µg/L	0.5	0.25	NA	mg/kg	0.5	0.25	NA	NA
4-Nitrotoluene	99-99-0	µg/L	0.5	0.25	61	mg/kg	0.5	0.25	0.15	NA
HMX	2691-41-0	µg/L	0.5	0.25	1800	mg/kg	0.5	0.25	3100	NA
Nitrobenzene	98-95-3	µg/L	0.5	0.25	3.4	mg/kg	0.5	0.25	0.006	0.4876
RDX	121-82-4	µg/L	0.5	0.25	0.61	mg/kg	0.5	0.25	4.4	NA
Tetryl	479-45-8	µg/L	0.5	0.25	360	mg/kg	0.5	0.25	610	NA
RDX DEGRADATION PRODCTS (SW-846 8330, Modified)[2,3]										
2,4-DA-6-NT	6629-29-4	µg/L	0.5	0.25	2.2	mg/kg	NA	NA	4700	4700
2,6-DA-4-NT	59229-75-3	µg/L	0.5	0.25	2.2	mg/kg	NA	NA	4700	4700
3,5-DNA	618-87-1	µg/L	0.5	0.25	NA	mg/kg	NA	NA	NA	NA
DNX	NA	µg/L	0.5	0.25	NA	mg/kg	NA	NA	NA	NA
MNX	NA	µg/L	0.5	0.25	NA	mg/kg	NA	NA	NA	NA
TNX	NA	µg/L	0.5	0.25	NA	mg/kg	NA	NA	NA	NA
4,4'-TN-AZOXY	NA	µg/L	1.0	0.65	NA	mg/kg	0.5	0.25	NA	NA
MISCELLANEOUS PARAMETERS										
Chloride (SW-846 9056)	16887-00-6	mg/L	1	0.5	NA	NA	NA	NA	NA	NA
Sulfate (SW-846 9056)	14808-79-8	µg/L	1	0.5	NA	NA	NA	NA	NA	NA
Nitrate + Nitrite, as N (EPA 353.2)	NA	mg/L	0.05	0.025	NA	NA	NA	NA	NA	NA

TABLE 1-6

SPECIFIC FIXED-BASED
LABORATORY ANALYTICAL METHODOLOGIES AND
CORRESPONDING TARGET ANALYTE LISTS[1]
SWMU 13 (Round 3) AND SWMU 16 (Round 3)
NSWC CRANE
CRANE, INDIANA

Parameter	CAS#	Aqueous Matrix				Solid Matrix				
		Units	Lab RL	Lab TV	Risk-Based Target Level	Units	Lab RL	Lab TV	Risk-Based Soil Target Level	Risk-Based Sediment Target Level
METALS (SW-846 6020)										
Aluminum	7429-90-5	µg/L	50	2.6	36000	mg/kg	25	1.3	76000	76000
Antimony	7440-36-0	µg/L	1	0.1	15	mg/kg	0.5	0.05	0.142	31
Arsenic	7440-38-2	µg/L	1	0.2	0.045	mg/kg	0.5	0.1	0.39	0.39
Barium	7440-39-3	µg/L	1	0.1	220	mg/kg	0.5	0.05	1.04	5400
Beryllium	7440-41-7	µg/L	1	0.1	3.6	mg/kg	0.5	0.05	1.06	150
Cadmium	7440-43-9	µg/L	1	0.7	0.15	mg/kg	0.5	0.35	0.00222	0.99
Calcium	7440-70-2	µg/L	100	2.7		mg/kg	50	1.35		
Chromium	7440-47-3	µg/L	1	0.1	42	mg/kg	0.5	0.05	0.4	43.4
Cobalt	7440-48-4	µg/L	1	0.1	24	mg/kg	0.5	0.05	0.14	50
Copper	7440-50-8	µg/L	2	0.1	1.58	mg/kg	1	0.05	5.4	31.6
Iron	7439-89-6	µg/L	50	3.9	11000	mg/kg	25	1.95	23000	23000
Lead	7439-92-1	µg/L	1	0.1	1.17	mg/kg	0.5	0.05	0.0537	35.8
Magnesium	7439-95-4	µg/L	100	3.7		mg/kg	50	1.85		
Manganese	7439-96-5	µg/L	5	0.1	880	mg/kg	2.5	0.05	1800	1800
Mercury	7439-97-6	µg/L	1	0.02	0.0013	mg/kg	0.1	0.05		
Nickel	7440-02-0	µg/L	1	0.1	730	mg/kg	0.5	25	1600	1600
Potassium	7440-09-7	µg/L	100	50		mg/kg	50	0.2		
Selenium	7782-49-2	µg/L	1	0.4	5	mg/kg	0.5	0.05	0.0276	390
Silver	7440-22-4	µg/L	1	0.1	0.12	mg/kg	0.5	0.8	4.04	0.5
Sodium	7440-23-5	µg/L	500	1.6		mg/kg	50	0.05		
Thallium	7440-28-0	µg/L	1	0.1	2.4	mg/kg	0.5	0.05	0.0569	5.2
Tin	7440-31-5	µg/L	10	0.1	180	mg/kg	5	0.045	7.62	
Vanadium	7440-62-2	µg/L	2	0.1	12	mg/kg	1	0.05	1.59	550
Zinc	7440-66-6	µg/L	10	0.5	65.7	mg/kg	5	0.25	6.62	121
SW-846 7470A/7471A										
Mercury	7439-97-6	µg/L	0.2	0.1	0.0013	mg/kg	0.1	0.02	0.1	0.174

TABLE 1-6

SPECIFIC FIXED-BASED
LABORATORY ANALYTICAL METHODOLOGIES AND
CORRESPONDING TARGET ANALYTE LISTS[1]
SWMU 13 (Round 3) AND SWMU 16 (Round 3)
NSWC CRANE
CRANE, INDIANA

Parameter	CAS#	Aqueous Matrix				Solid Matrix				
		Units	Lab RL	Lab TV	Risk-Based Target Level	Units	Lab RL	Lab TV	Risk-Based Soil Target Level	Risk-Based Sediment Target Level
VOLATILES [SW-846 5030B (water) or 5035 (Soil) Preparation, with 8260B Analysis Except Where Noted] (Continued)										
2-Hexanone	591-78-6	µg/L	5	0.5	1710	µg/kg	10	1	NA	1010
3-Chloro-1-propene	107-05-1	µg/L	5	0.5	1800	µg/kg	10	1	1800	0.266
4-Methyl-2-pentanone	108-10-1	µg/L	5	0.5	160	µg/kg	10	1	620	544.37
Acetone	67-64-1	µg/L	5	0.5	610	µg/kg	10	1	730	453.37
Acetonitrile (SW-846 8015B)	75-05-8	µg/L	40	20	100	µg/kg	80	40	420000	139.05
Acrolein	107-02-8	µg/L	5	0.5	0.042	µg/kg	10	1	0.23	0.0144
Acrylonitrile	107-13-1	µg/L	5	0.5	0.039	µg/kg	10	1	0.032	0.0157
Benzene	71-43-2	µg/L	1	0.3	0.34	µg/kg	3	1	1.7	141.57
Bromodichloromethane	75-27-4	µg/L	1	0.3	0.18	µg/kg	3	1	32	1.13
Bromoform	75-25-2	µg/L	1	0.3	8.5	µg/kg	3	1	38	996.27
Bromomethane	74-83-9	µg/L	1	0.3	8.7	µg/kg	3	1	12	235.16
Carbon disulfide	75-15-0	µg/L	1	0.3	84.1	µg/kg	3	1	1500	94.12
Carbon tetrachloride	56-23-5	µg/L	1	0.3	0.17	µg/kg	3	1	3.3	35.73
Chlorobenzene	108-90-7	µg/L	1	0.3	10	µg/kg	3	1	65	61.94
Chloroethane	75-00-3	µg/L	1	0.5	4.6	µg/kg	3	1	330	58600
Chloroform	67-66-3	µg/L	1	0.3	6.2	µg/kg	3	1	29	27
Chloromethane	74-87-3	µg/L	1	0.3	1.5	µg/kg	3	1	2	0.0785
Chloroprene	126-99-8	µg/L	5	0.5	14	µg/kg	10	1	560	1.06
cis-1,2-Dichloroethene	156-59-2	µg/L	1	0.3	61	µg/kg	3	1	20	208.94
cis-1,3-Dichloropropene	10061-01-5	µg/L	1	0.3	0.4	µg/kg	3	1	0.3	2.96
Dibromochloromethane	124-48-1	µg/L	1	0.3	0.13	µg/kg	3	1	20	267.61
Dibromomethane	74-95-3	µg/L	1	0.3	61	µg/kg	3	1	77	0.0859
Dichlorodifluoromethane	75-71-8	µg/L	1	0.3	390	µg/kg	3	1	28000	1.33
Ethyl methacrylate	97-63-2	µg/L	5	0.5	550	µg/kg	10	1	810	0.602
Ethylbenzene	100-41-4	µg/L	1	0.3	2.9	µg/kg	3	1	670	0.1
Iodomethane	74-88-4	µg/L	5	0.5	NA	µg/kg	10	1	NA	0.305

TABLE 1-6

SPECIFIC FIXED-BASED
LABORATORY ANALYTICAL METHODOLOGIES AND
CORRESPONDING TARGET ANALYTE LISTS[1]
SWMU 13 (Round 3) AND SWMU 16 (Round 3)
NSWC CRANE
CRANE, INDIANA

Parameter	CAS#	Aqueous Matrix				Solid Matrix				
		Units	Lab RL	Lab TV	Risk-Based Target Level	Units	Lab RL	Lab TV	Risk-Based Soil Target Level	Risk-Based Sediment Target Level
VOLATILES [SW-846 5030B (water) or 5035 (Soil) Preparation, with 8260B Analysis Except Where Noted] (Continued)										
Isobutyl alcohol (SW-846 8015B)	78-83-1	µg/L	40	20	1800	µg/kg	80	40	2300	3350
Methacrylonitrile	126-98-7	µg/L	5	0.3	1	µg/kg	10	1	1	0.0297
Methyl methacrylate	80-62-6	µg/L	5	0.5	1400	µg/kg	10	1	12000	167.56
Methylene chloride	75-09-2	µg/L	1	0.3	4.3	µg/kg	3	1	1.2	1260
Propionitrile (SW-846 8015B)	107-12-0	µg/L	40	20	6080	µg/kg	80	40	NA	49.83
Styrene	100-42-5	µg/L	1	0.3	56	µg/kg	3	1	180	444.96
Tetrachloroethene	127-18-4	µg/L	1	0.3	0.66	µg/kg	3	1	2.9	195.83
Toluene	108-88-3	µg/L	1	0.3	253	µg/kg	3	1	590	5450
trans-1,2-Dichloroethene	156-60-5	µg/L	1	0.3	100	µg/kg	3	1	34	208.94
trans-1,3-Dichloropropene	10061-02-6	µg/L	1	0.3	0.4	µg/kg	3	1	0.3	2.96
trans-1,4-Dichloro-2-butene	110-57-6	µg/L	5	0.5	NA	µg/kg	10	1	NA	1.82
Trichloroethene	79-01-6	µg/L	1	0.3	0.028	µg/kg	3	1	2.8	179.56
Trichlorofluoromethane	75-69-4	µg/L	1	0.3	1300	µg/kg	3	1	8000	3.07
Vinyl acetate	108-05-4	µg/L	5	0.5	248.03	µg/kg	10	1	2300	12.95
Vinyl chloride	75-01-4	µg/L	1	0.3	0.02	µg/kg	3	1	0.67	2
Xylenes, Total	1330-20-7	µg/L	1	0.3	117	µg/kg	3	1	71000	1880
POLYCHLORINATED BIPHENYLS (SW-846 METHOD 8082)										
Aroclor-1016	12674-11-2	µg/L	0.25	0.5	0.00012	µg/kg	0.25	0.0166	0.000332	0.0598
Aroclor-1221	11104-28-2	µg/L	0.25	0.5	0.00012	µg/kg	0.25	0.0166	0.000332	0.0598
Aroclor-1232	11141-16-5	µg/L	0.25	0.5	0.00012	µg/kg	0.25	0.0166	0.000332	0.0598
Aroclor-1242	53469-21-9	µg/L	0.25	0.5	0.00012	µg/kg	0.25	0.0166	0.000332	0.0598
Aroclor-1248	12672-29-6	µg/L	0.25	0.5	0.00012	µg/kg	0.25	0.0166	0.000332	0.0598
Aroclor-1254	11097-69-1	µg/L	0.25	0.5	0.00012	µg/kg	0.25	0.0166	0.000332	0.0598
Aroclor-1260	11096-82-5	µg/L	0.25	0.5	0.00012	µg/kg	0.25	0.0166	0.000332	0.0598
DISSOLVED GASES										
Ethane (Microseeps)	74-84-0	ng/L	1	5	NA	ng/g	ANR	ANR	ANR	ANR
Ethene (Microseeps)	74-85-1	ng/L	3	5	NA	ng/g	ANR	ANR	ANR	ANR
Methane (Microseeps)	74-82-8	µg/L	0.002	0.015	NA	ng/g	ANR	ANR	ANR	ANR

TABLE 1-6

SPECIFIC FIXED-BASED
LABORATORY ANALYTICAL METHODOLOGIES AND
CORRESPONDING TARGET ANALYTE LISTS(1)
SWMU 13 (Round 3) AND SWMU 16 (Round 3)
NSWC CRANE
CRANE, INDIANA

1 - This table was excerpted from the original QAPP (TtNUS, 2003a). Risk-based target levels (RBTLs) for solid and aqueous matrices are the lowest of the criteria presented in Appendix Tables B-1, B-2, and B-5 (solid matrix), and Appendix Tables B-3 and B-4 (aqueous matrices) of the original QAPP.
2 - These chemicals form the "RDX Degradation Products" group .
3 - Vegetation analysis for explosives and degradation products will be performed by SW-846 Method 8330. RL's and TV's have yet to be determined.
The shaded value exceeds at least one of the associated RBTLs.
CAS # = Chemical abstracts registry service number.
NA = Not applicable.
ANR = Analysis not required.
RL = Reporting limit.
TV = Threshold Value (realistic estimate of method detection limit after accounting for matrix variability).

TABLE 1-7

PROJECT TARGET PARAMETERS AND RATIONALES
ROUND 3 AT MINE FILL B (SWMU 13) AND CAST HIGH FILL (ROUND 3)
NSWC CRANE
CRANE, INDIANA

Parameter	MINE FILL B SWMU 13					CAST HIGH FILL SWMU 16				Rationale/Intended Data Use
	ENVIRONMENTAL MEDIUM					ENVIRONMENTAL MEDIUM				
	SS/SB	SW	SD	GW	VG	SS/SB	SW	SD	GW	
LABORATORY PARAMETERS										
Explosives (Nitroaromatics and Nitramines), SW-846 Method 8330		X		X	X		X		X	To refine understanding of extent of contamination. To evaluate risks to potential receptors (human health and ecological) from potentially site-related contaminants. To determine whether explosives are naturally degrading over time.
RDX Degradation Products, Method 8330, Modified				X	X				X	To determine whether explosives, present in ground water and surface water, are naturally degrading.
Metals		X	X	X			X	X	X	To refine understanding of the extent of contamination.
VOCs, SW-846 5035B preparation with 8260B or 8015B[1] analysis.						X	X		X	To refine understanding of extent of contamination. To evaluate risks to potential receptors (human health and ecological) from potentially site-related contaminants. To determine whether volatiles (TCE) are naturally degrading over time.
PCBs, SW-846 8082	X									To complete the delineation of PCB contamination at the Therminol boilers. To evaluate risks to potential receptors (human health and ecological) from potentially site-related contaminants.
Nitrate + Nitrite as Nitrogen, EPA 353.2				X					X	To evaluate fate and transport of potential contaminants and natural attenuation.
Chloride and Sulfate, SW-846 9056				X					X	To evaluate natural attenuation and fate and transport of potential contaminants. To establish the reducing/oxidizing tendency of the sample matrix.

TABLE 1-7

PROJECT TARGET PARAMETERS AND RATIONALES
ROUND 3 AT MINE FILL B (SWMU 13) AND CAST HIGH FILL (ROUND 3)
NSWC CRANE
CRANE, INDIANA

Parameter	MINE FILL B SWMU 13					CAST HIGH FILL SWMU 16				Rationale/Intended Data Use
	ENVIRONMENTAL MEDIUM					ENVIRONMENTAL MEDIUM				
	SS/SB	SW	SD	GW	VG	SS/SB	SW	SD	GW	
Organic Gases (Ethane, Ethene, Methane), Microseeps Method AM1									X	To evaluate natural attenuation and fate and transport of chlorinated organic compounds. To establish the reducing/oxidizing tendency of the sample matrix.
Grain Size	X									To characterize soil samples according to grain size for fate and transport information.
Dissolved Oxygen				X					X	To evaluate water quality, natural attenuation, and fate and transport.
Flow Rate									X	To establish transient rate and absence or presence of potential contaminants for interpretation of surface water chemical concentrations. Semi-quantitative parameter only.
Oxidation-Reduction Potential				X					X	To evaluate natural attenuation, fate and transport of potential contaminants, and water quality. To establish the reducing/oxidizing tendency of the sample matrix.
pH				X					X	To establish well stabilization prior to collecting ground water samples. Generally useful for data interpretation and potential future uses.
Sample Depth/ Location	X	X		X					X	To identify sample locations in the vertical and horizontal direction.
Specific Conductance				X					X	To establish well stabilization prior to collecting ground water samples.

TABLE 1-7

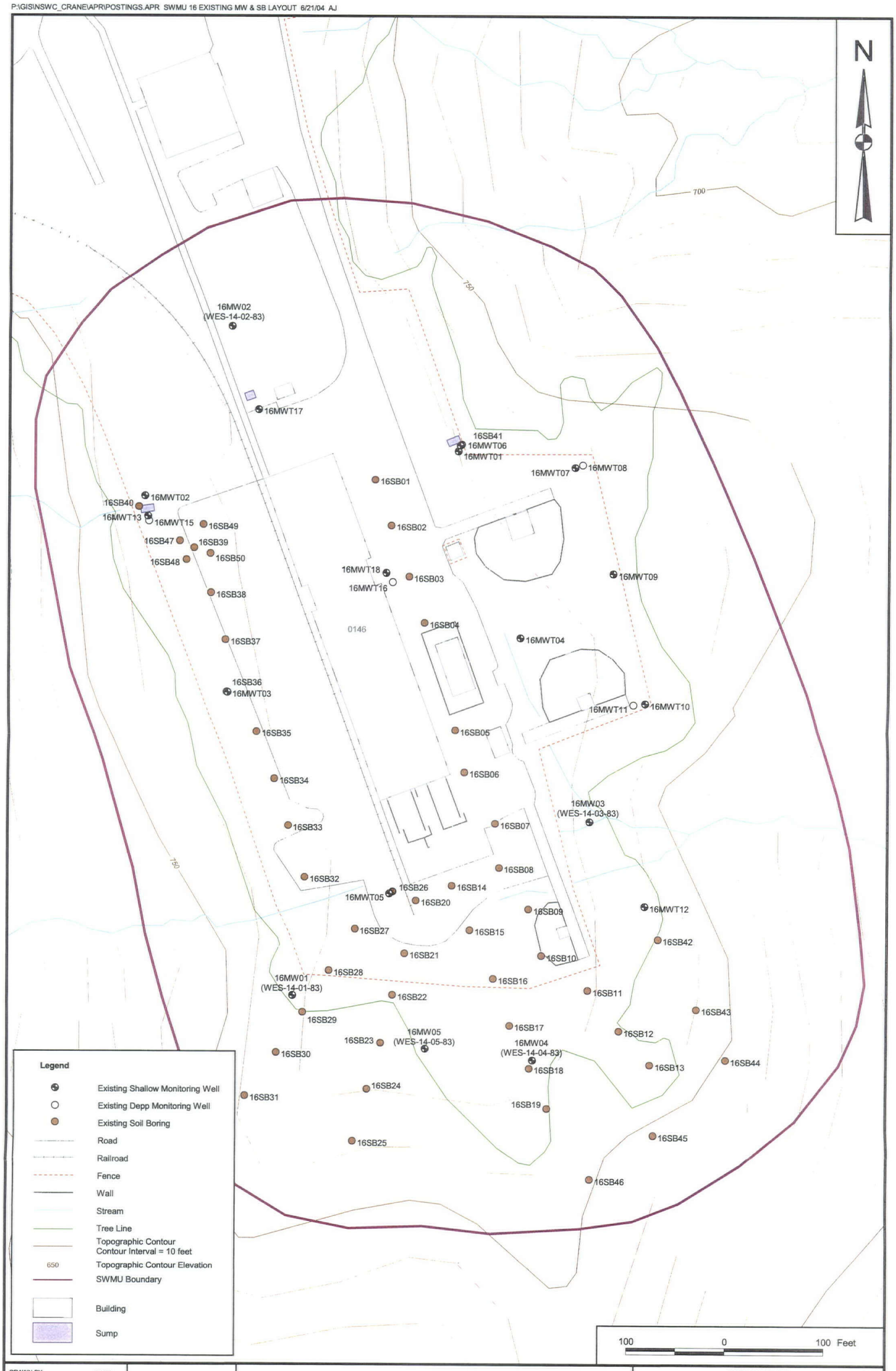
PROJECT TARGET PARAMETERS AND RATIONALES
ROUND 3 AT MINE FILL B (SWMU 13) AND CAST HIGH FILL (ROUND 3)
NSWC CRANE
CRANE, INDIANA

Parameter	MINE FILL B SWMU 13					CAST HIGH FILL SWMU 16				Rationale/Intended Data Use
	ENVIRONMENTAL MEDIUM					ENVIRONMENTAL MEDIUM				
	SS/SB	SW	SD	GW	VG	SS/SB	SW	SD	GW	
Temperature				X					X	To establish well stabilization prior to collecting ground water samples. Also because pH and specific conductivity are temperature dependent.
Turbidity				X					X	To establish well stabilization prior to collecting ground water samples. To determine if detected concentrations of contaminants are caused by suspended solids.
Water Level				X					X	To calculate potentiometric surface, ground water velocity, and hydraulic gradient.

1. Surface soil samples for VOC analysis will be collected from 1 to 2 feet bgs. Acetonitrile, 1,4-dioxane, propionitrile, and isobutanol will be analyzed by Method 8015B; all others will be analyzed by Method 8260B. No sediment samples will be analyzed in Round 3.

GW - Ground water.
SW - Surface water.
SS - Surface soil.
SB - Subsurface soil.
bgs - Below ground surface.
VOC - Volatile organic compound.
PCB - Polychlorinated biphenyl.
TCE - Trichloroethene.

P:\GIS\NSWC_CRANE\APR\POSTINGS.APR SWMU 16 EXISTING MW & SB LAYOUT 6/21/04 AJ



DRAWN BY A. JANOCHA	DATE 5/13/04	EXISTING SOIL AND GROUND WATER SAMPLING LOCATIONS SWMU 16 - CAST HIGH EXPLOSIVES FILL/B146 INCINERATOR NSWC CRANE CRANE, INDIANA	CONTRACT NUMBER 7448
CHECKED BY J. SCHUBERT	DATE 6/21/04		APPROVED BY J. SCHUBERT — DATE 6/21/04
COST/SCHEDULE-AREA			APPROVED BY — — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 1 - 24 — REV 0

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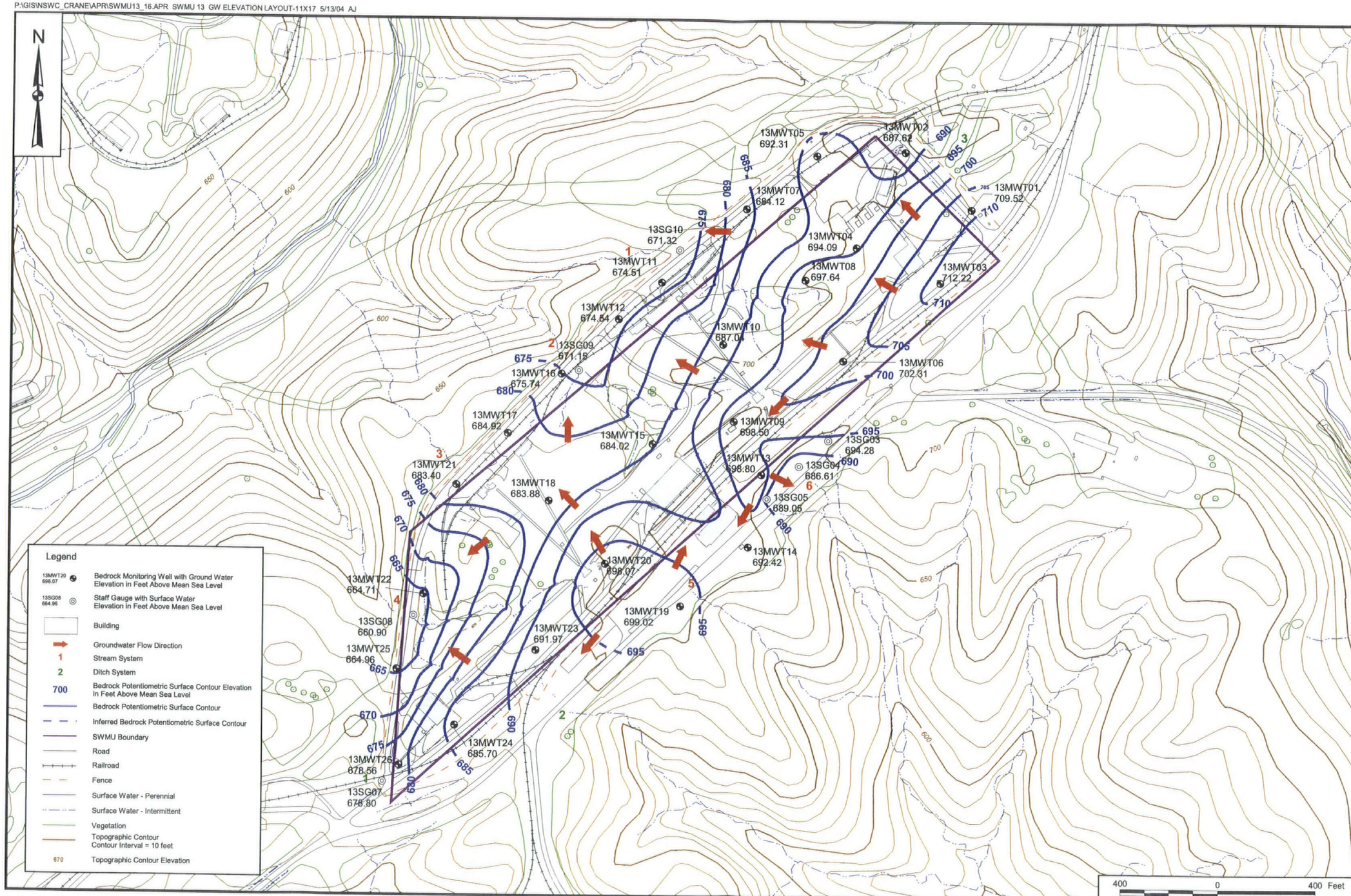


CONTRACT NO. 7448

APPROVED BY ____ DATE ____

APPROVED BY ____ DATE ____

DRAWING NO. FIGURE 1 - 1

REV 0

BEDROCK POTENTIOMETRIC SURFACE MAP ROUND 1
(MAY 11, 2003)
BEDROCK WELLS AND STAFF GAUGES
SWMU 13 - MINE FILL B
NSWC CRANE
CRANE, INDIANA

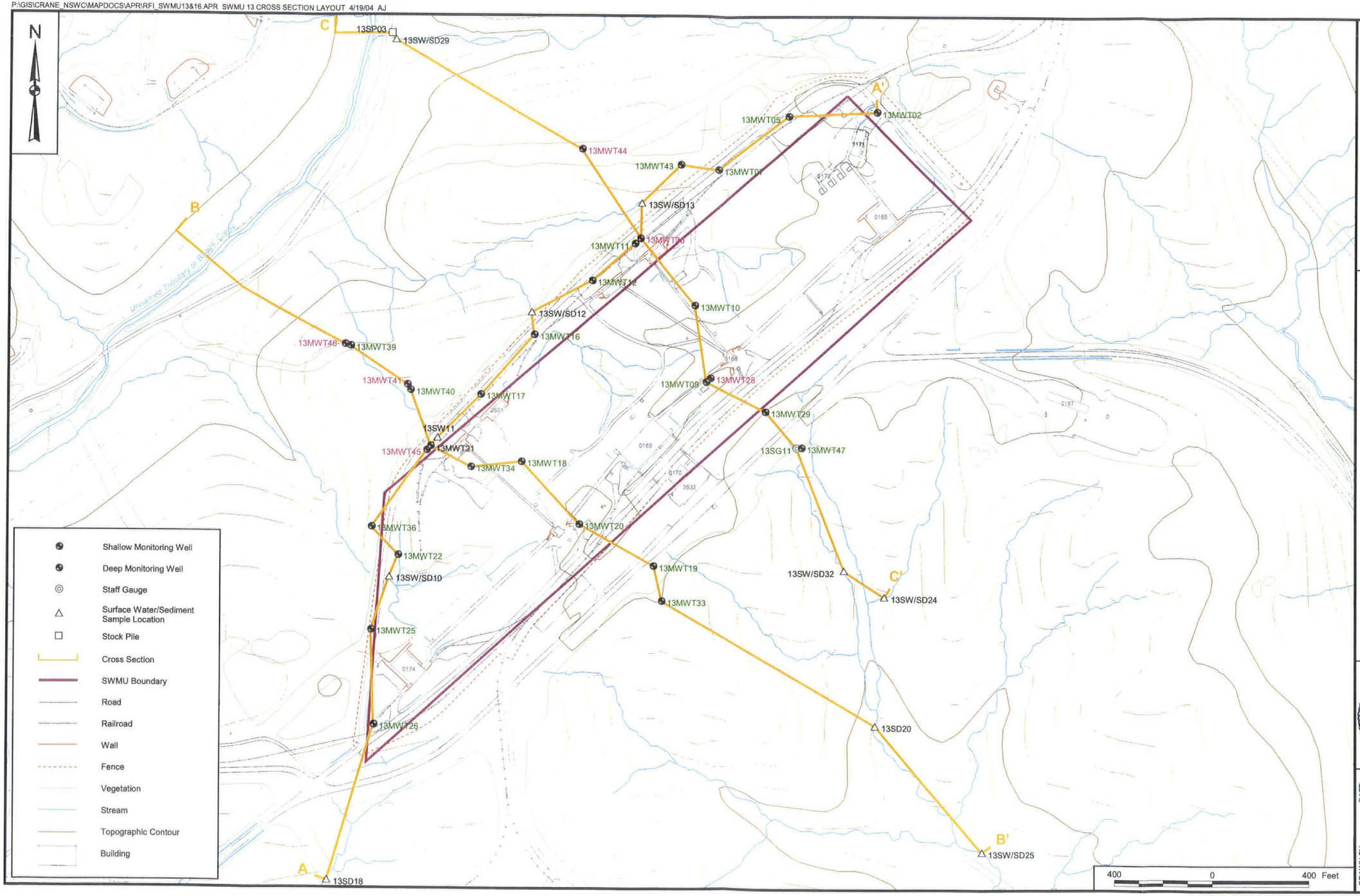
DRAWN BY A. JANOCHA DATE 7/09/03

CHECKED BY J. LUCAS DATE 5/13/04

COST/SCHED-AREA

SCALE AS NOTED

P:\GIS\CRANE_NSWC\MAPDOCS\APR\RFI_SWMU13&16.APR SWMU 13 CROSS SECTION LAYOUT 4/19/04 AJ



CONTRACT NO. N7448

APPROVED BY ___ DATE ___

APPROVED BY ___ DATE ___

DRAWING NO. FIGURE 1 - 2

REV 0

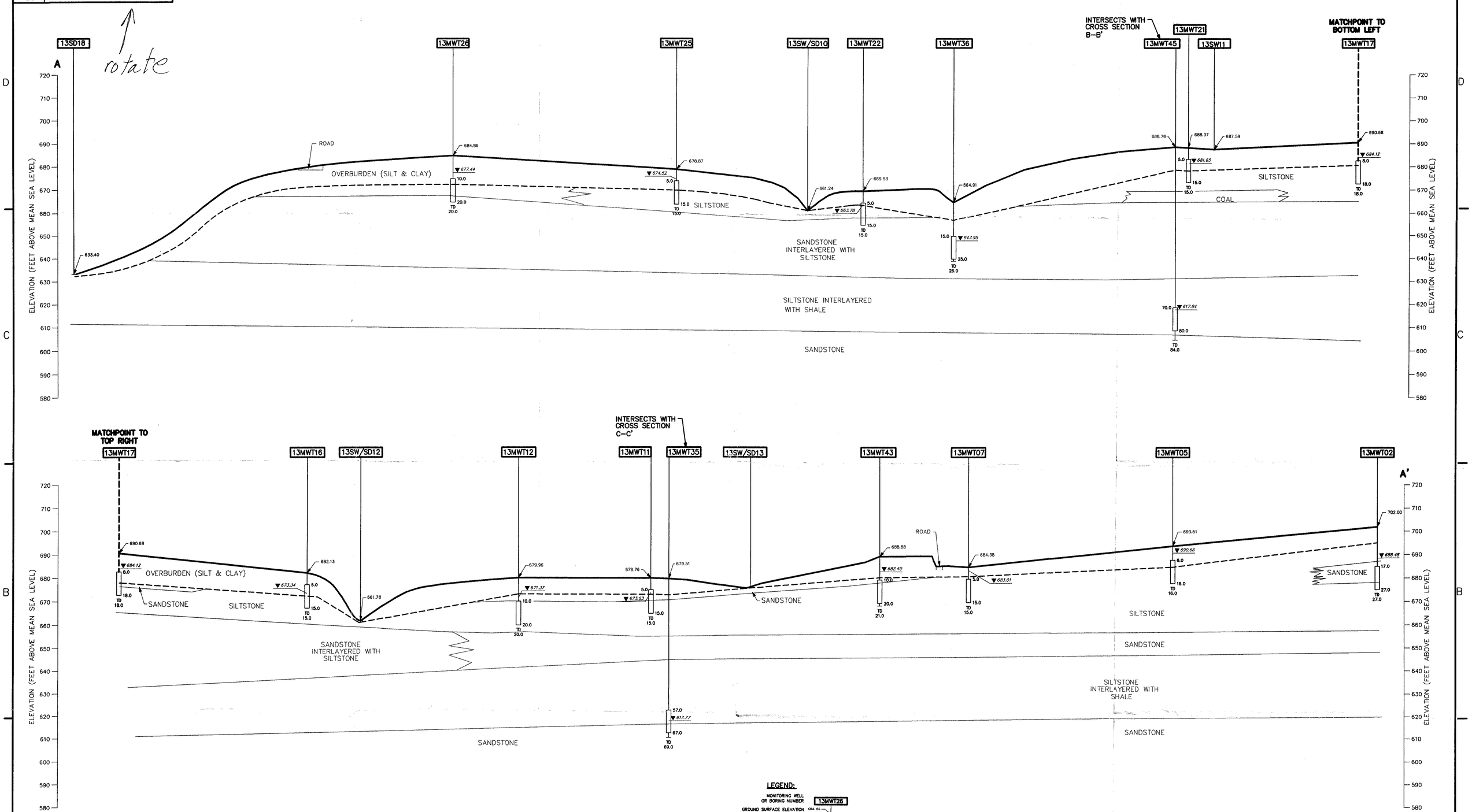
CROSS SECTION MAP
SWMU 13 - MINE FILL B
NSWC CRANE
CRANE, INDIANA

DRAWN BY A. JANOCHA DATE 3/10/04

CHECKED BY F. RAMSER DATE 3/17/04

COST/SCHED-AREA

SCALE AS NOTED



C00872RB01X

DRAWN BY HJB	DATE 2/17/04	SWMU 13 GEOLOGICAL CROSS SECTION A-A' NSWC CRANE CRANE, INDIANA	CONTRACT NO. 7448
CHECKED BY ----	DATE ----		OWNER NO. ----
REVISED BY ----	DATE ----		APPROVED BY / DATE
SCALE AS NOTED			DRAWING NO. FIGURE 1-3 / REV. 0

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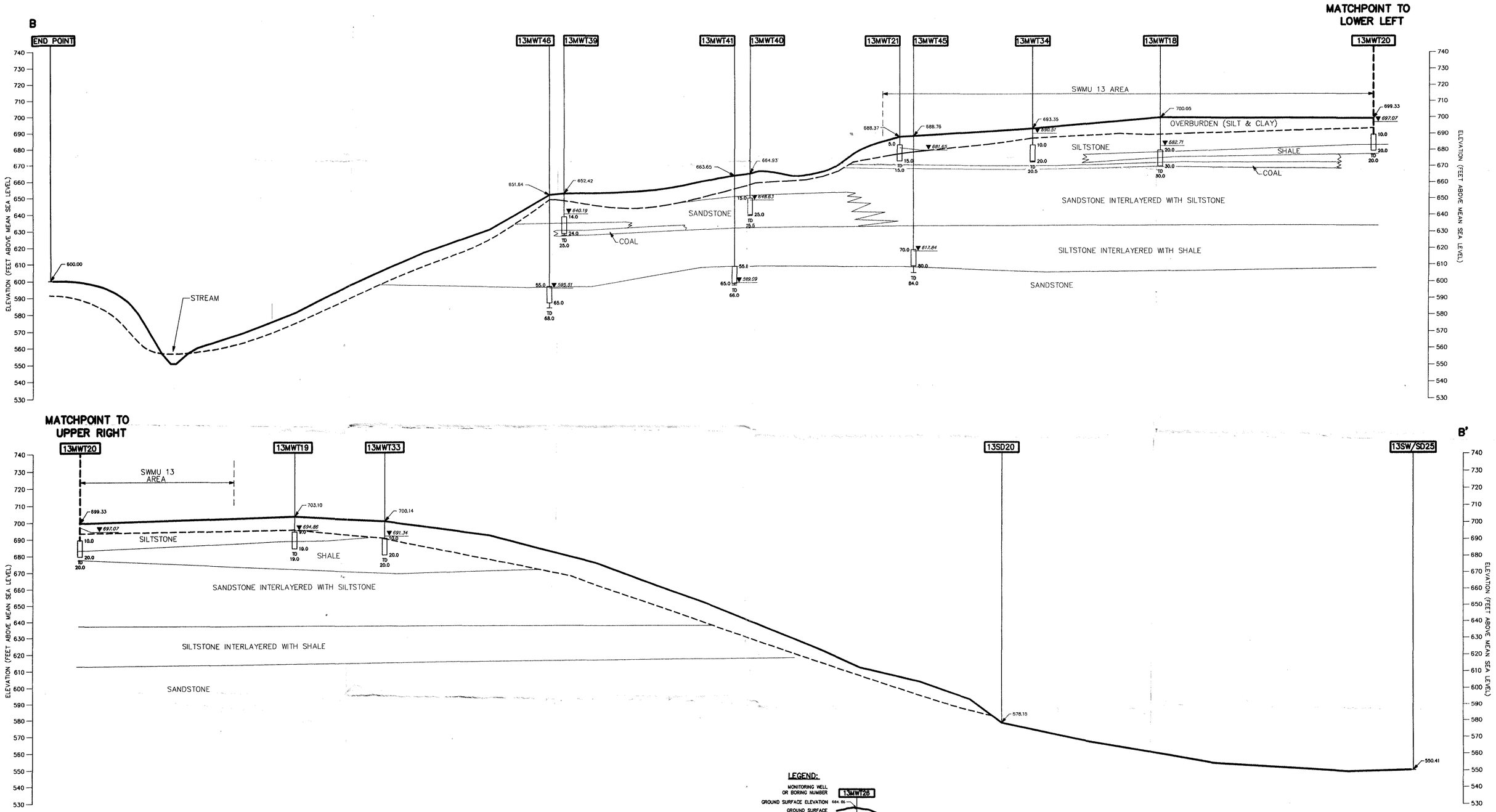


DRAWN BY HJB	DATE 4/14/04
CHECKED BY ----	DATE ----
REVISED BY ----	DATE ----
SCALE AS NOTED	

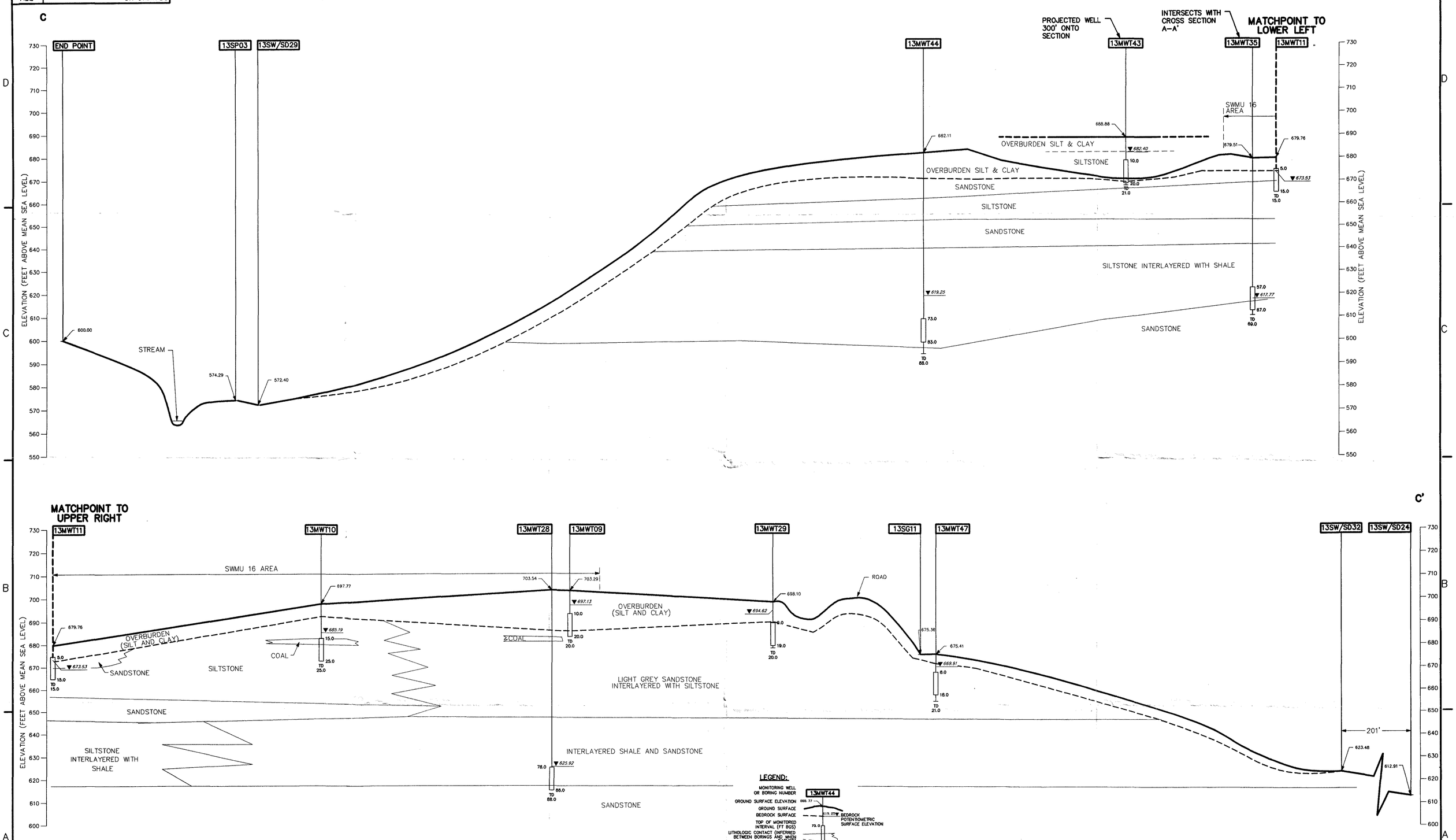
DEPARTMENT OF THE NAVY · SOUTHERN DIV. FACILITIES ENGINEERING COMMAND

SWMU 13
GEOLOGICAL CROSS SECTION B–B'
NSWC CRANE
CRANE, INDIANA

CONTRACT NO.	7448
OWNER NO.	----
APPROVED BY	DATE
DRAWING NO.	FIGURE 1–4
REV.	0

ACAD: 7448.GX03.dwg 04/15/04 HJB PIT

DRAWING NO. FIGURE 1–4 REV. 0



DRAWN BY HJB	DATE 3/17/04
CHECKED BY ----	DATE ----
REVISED BY ----	DATE ----
SCALE AS NOTED	

SWMU 13
GEOLOGICAL CROSS SECTION C–C'
NSWC CRANE
CRANE, INDIANA

CONTRACT NO.	7448
OWNER NO.	----
APPROVED BY	DATE
DRAWING NO.	FIGURE 1–5
REV.	0

ACAD: 7448GX02.dwg 04/15/04 HJB PIT

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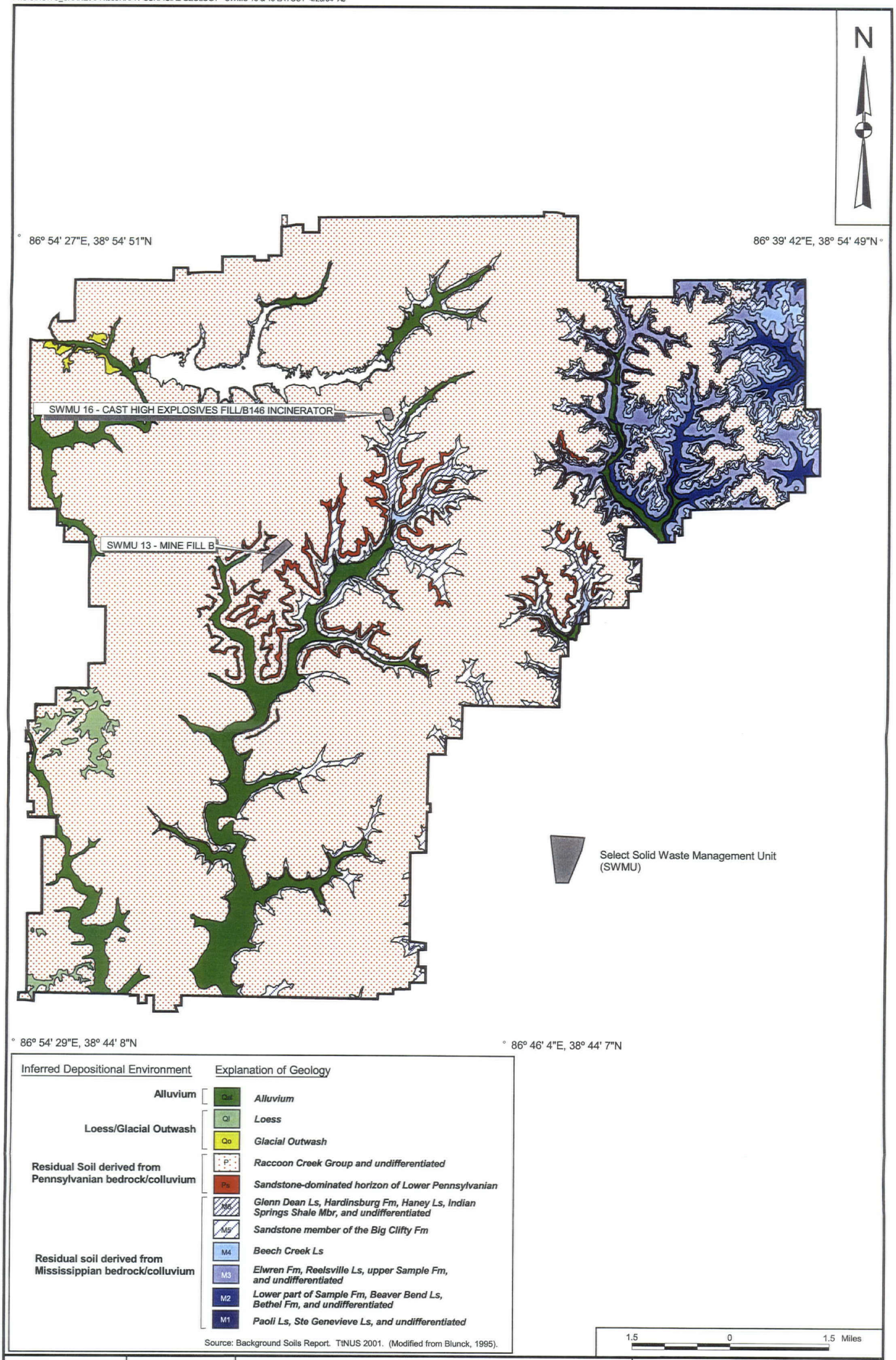

DRAWN BY	DATE
A. JANOCHA	7/09/03
CHECKED BY	DATE
J. LUCAS	4/20/04
COST/SCHEDULE-AREA	
SCALE	
AS NOTED	

SURFICIAL GEOLOGY AND DEPOSITIONAL ENVIRONMENTS

NSWC CRANE

CRANE, INDIANA

CONTRACT NUMBER	
N7448	
APPROVED BY	DATE
—	—
APPROVED BY	DATE
—	—
DRAWING NO.	REV
FIGURE 1 - 6	0

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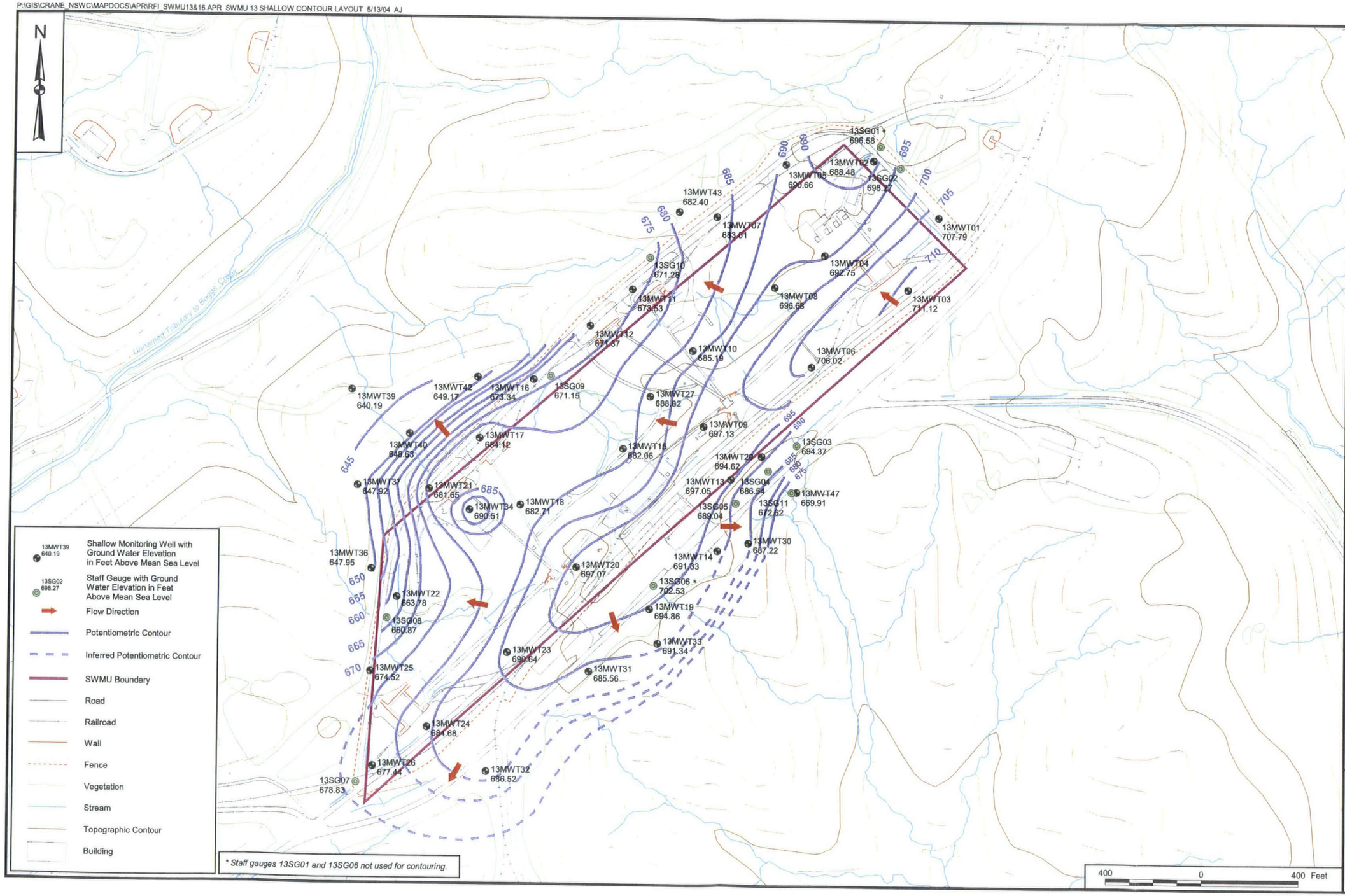

CONTRACT NO. 7448

APPROVED BY ____ DATE ____

APPROVED BY ____ DATE ____

DRAWING NO. FIGURE 1 - 7

REV 0

POTENTIOMETRIC SURFACE ELEVATION MAP
FOR SHALLOW WELLS - JANUARY 24, 2004
SWMU 13 - MINE FILL B
NSWC CRANE
CRANE, INDIANA

DEPARTMENT OF THE NAVY * SOUTHERN DIV NAVAL FACILITIES ENGINEERING COMD *

DRAWN BY A. JANOCHA DATE 2/23/04

CHECKED BY J. LUCAS DATE 5/13/04

COST/SCHED-AREA

SCALE AS NOTED

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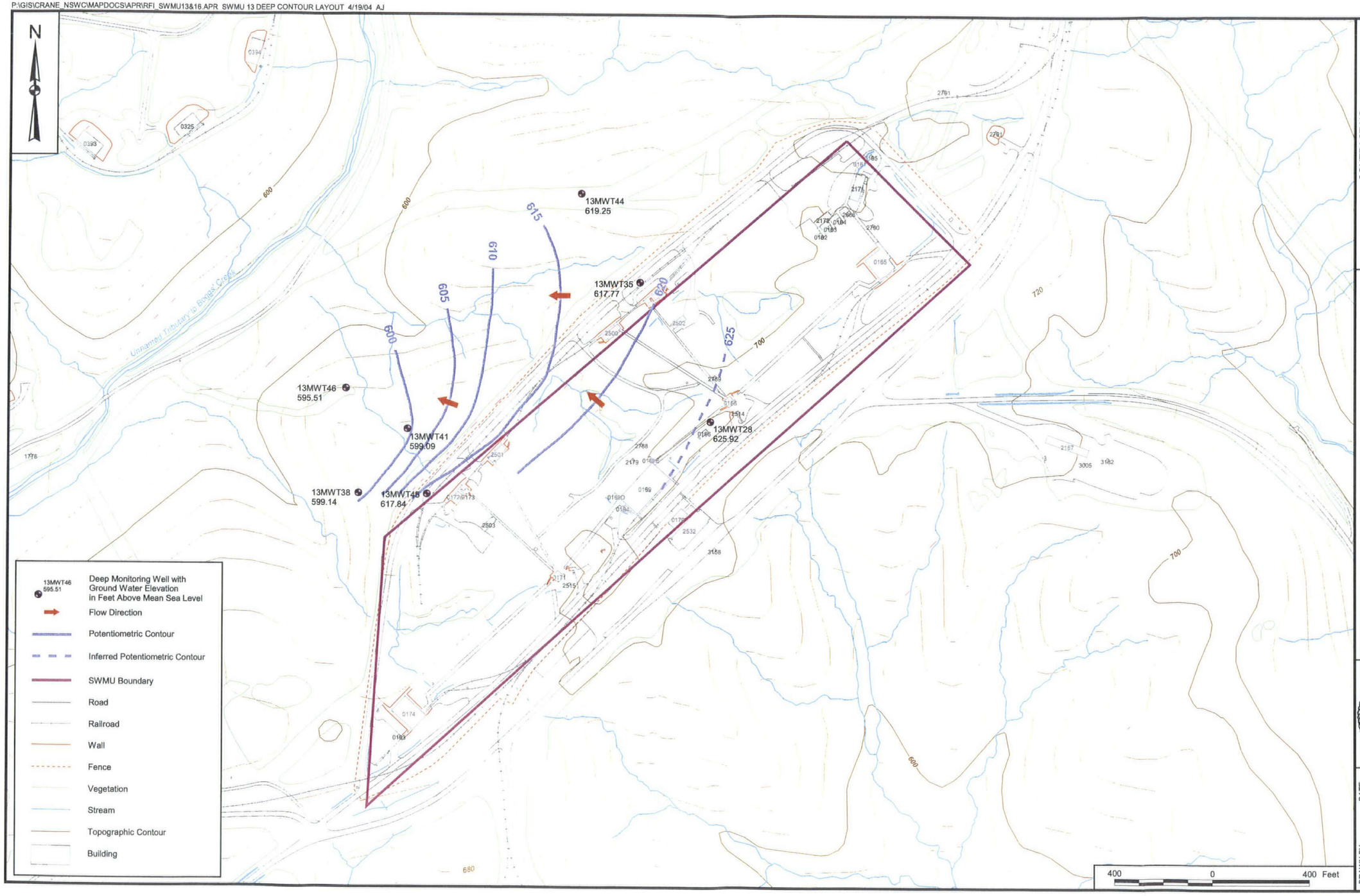


CONTRACT NO.
N7448

APPROVED BY ___ DATE ___

APPROVED BY ___ DATE ___

DRAWING NO. FIGURE 1 - 8

REV 0

POTENTIOMETRIC SURFACE ELEVATION MAP
FOR DEEP WELLS - JANUARY 24, 2004
SWMU 13 - MINE FILL B
NSWC CRANE
CRANE, INDIANA

DEPARTMENT OF THE NAVY * SOUTHERN DIV FACILITIES ENGINEERING COMD *

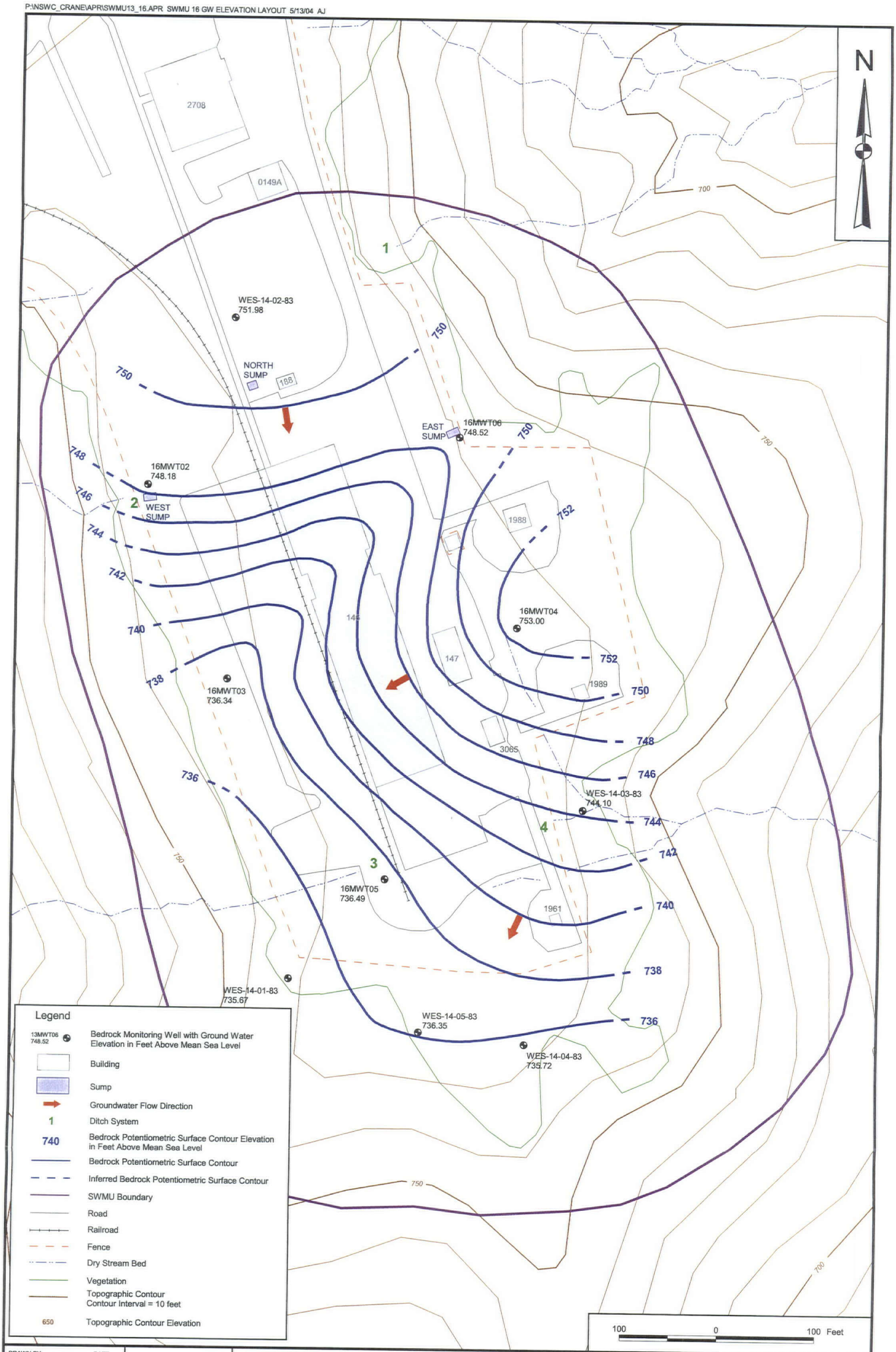
DRAWN BY A. JANOCHA — DATE 2/23/04

CHECKED BY F. RAMSER — DATE 3/17/04

COST/SCHED-AREA

SCALE AS NOTED

P:\NSWC_CRANE\APR\SWMU13_16.APR SWMU 16 GW ELEVATION LAYOUT 5/13/04 AJ



DRAWN BY	DATE	CONTRACT NUMBER
A. JANOCHA	6/19/03	7448
CHECKED BY	DATE	APPROVED BY / DATE
J. LUCAS	5/13/04	— / —
COST/SCHEDULE-AREA		APPROVED BY / DATE
		— / —
SCALE		DRAWING NO. / REV
AS NOTED		FIGURE 1 - 9 / 0

BEDROCK POTENTIOMETRIC SURFACE MAP ROUND 1 (MAY 30, 2003)

BEDROCK WELLS

SWMU 16 - CAST HIGH EXPLOSIVES FILL/B146 INCINERATOR

NSWC CRANE

CRANE, INDIANA

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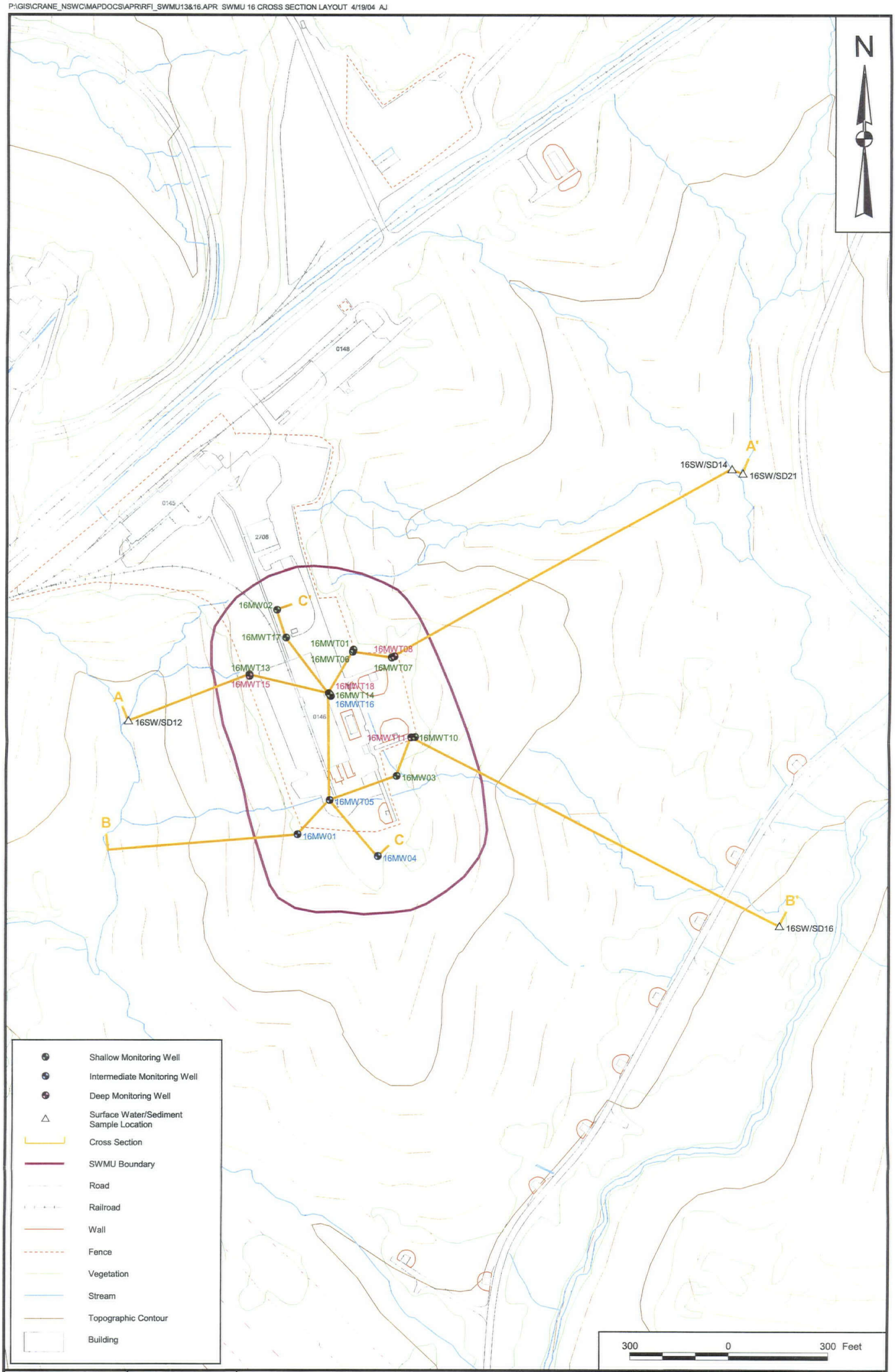
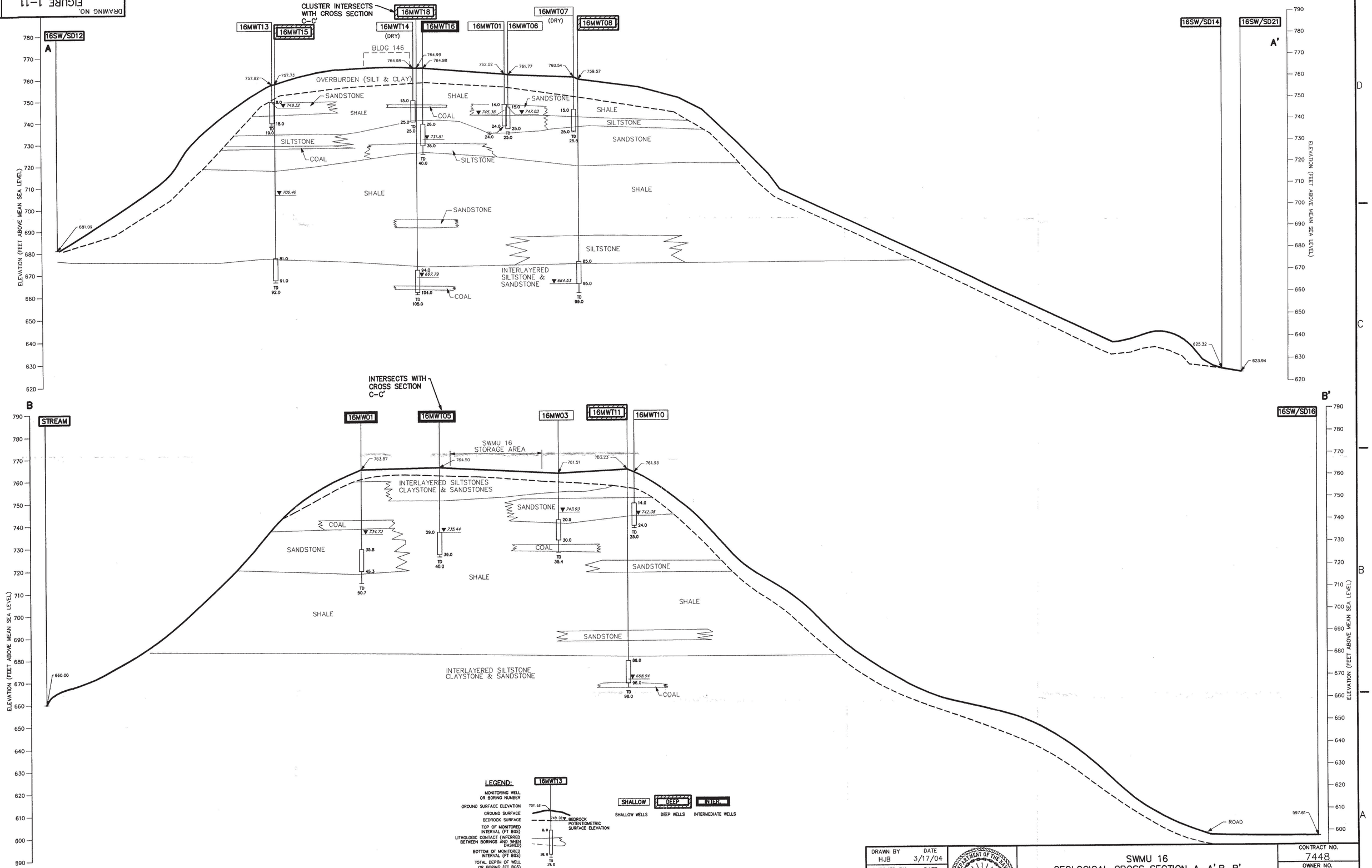


DRAWN BY A. JANOCHA	DATE 3/10/04	CROSS SECTION MAP SWMU 16 - CAST HIGH EXPLOSIVES FILL/BUILDING 146 INCINERATOR NSWC CRANE CRANE, INDIANA	CONTRACT NUMBER N7448
CHECKED BY F. RAMSER	DATE 3/17/04		APPROVED BY — DATE —
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 1 - 10 REV 0



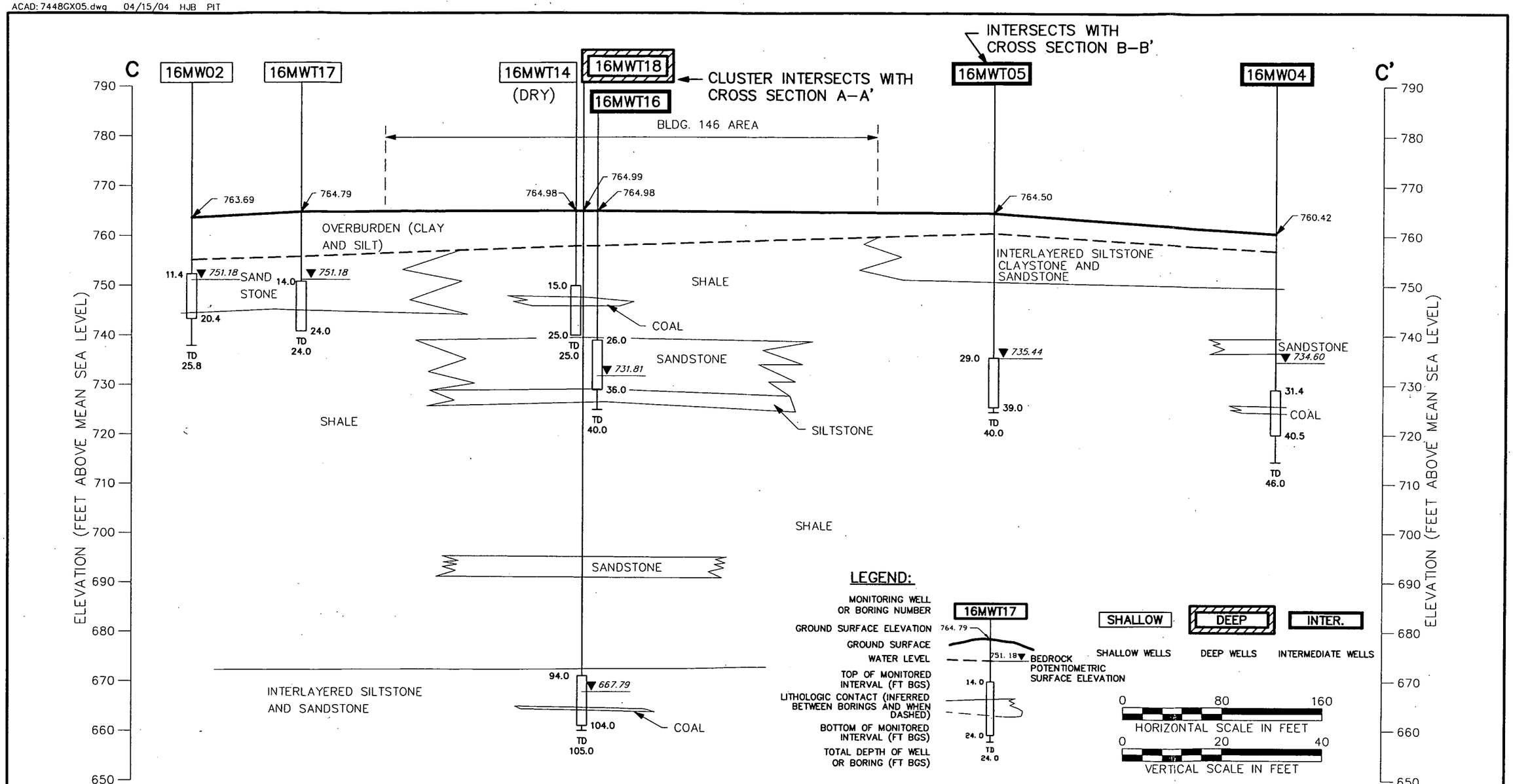
DRAWN BY HJB	DATE 3/17/04	SWMU 16 GEOLOGICAL CROSS SECTION A–A',B–B' NSWC CRANE CRANE, INDIANA	CONTRACT NO. 7448
CHECKED BY ----	DATE ----		OWNER NO. ----
REVISED BY ----	DATE ----		APPROVED BY / DATE
SCALE AS NOTED			DRAWING NO. FIGURE 1–11 / REV. 0

000572R02X

ACAD: 7448CX01.dwg 04/15/04 HJB PIT

DRAWING NO. FIGURE 1-11 REV. 0

ACAD: 7448GX05.dwg 04/15/04 HJB PIT



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJB DATE 2/19/04
CHECKED BY DATE
COST/SCHED–AREA
SCALE AS NOTED

DEPARTMENT OF THE NAVY · SOUTHERN DIV FACILITIES ENGINEERING COMD

SWMU 16
GEOLOGICAL CROSS SECTION C–C'
NSWC CRANE
CRANE, INDIANA

CONTRACT NO. 7448
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 1–12
REV. 0

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

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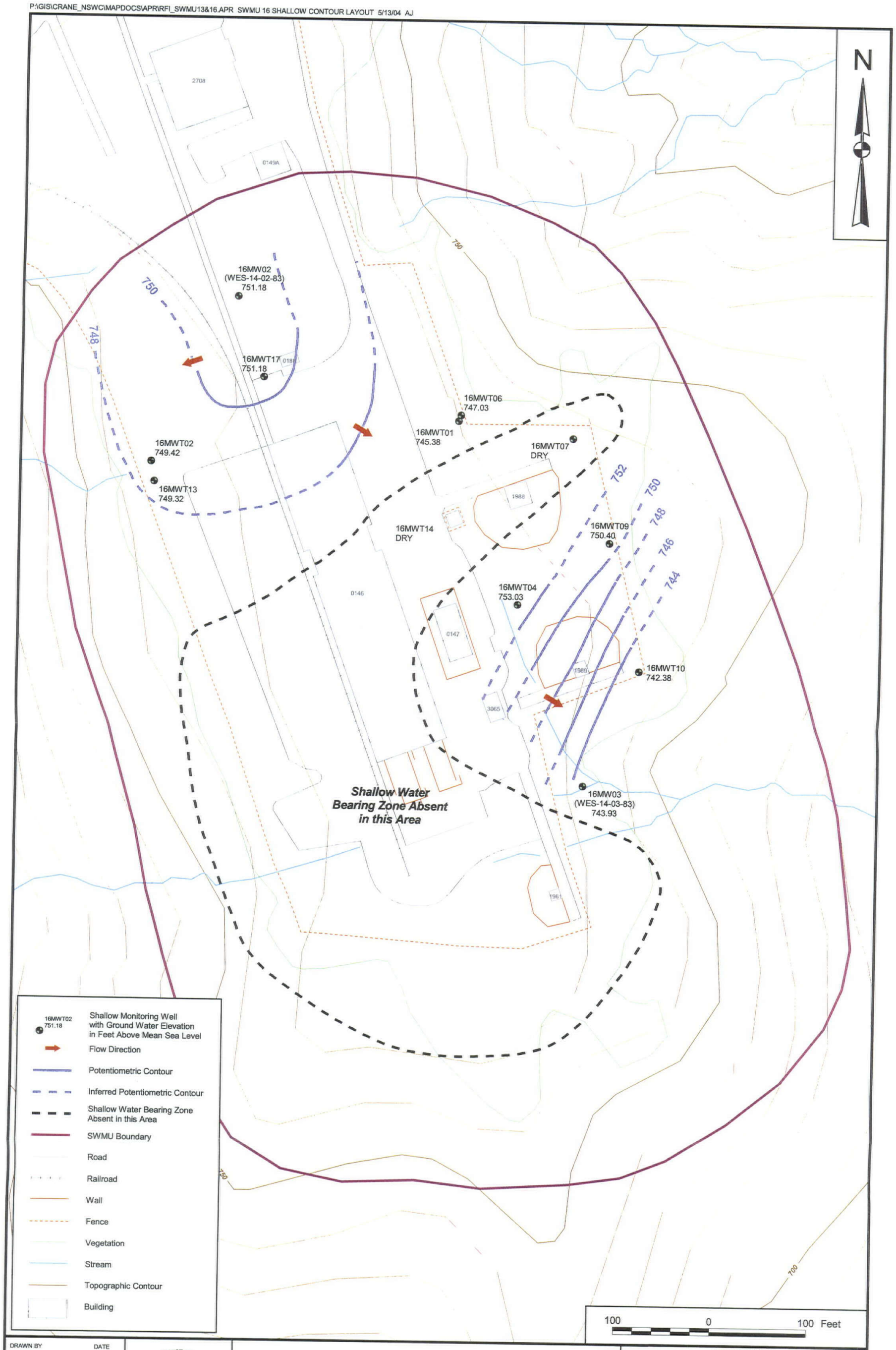
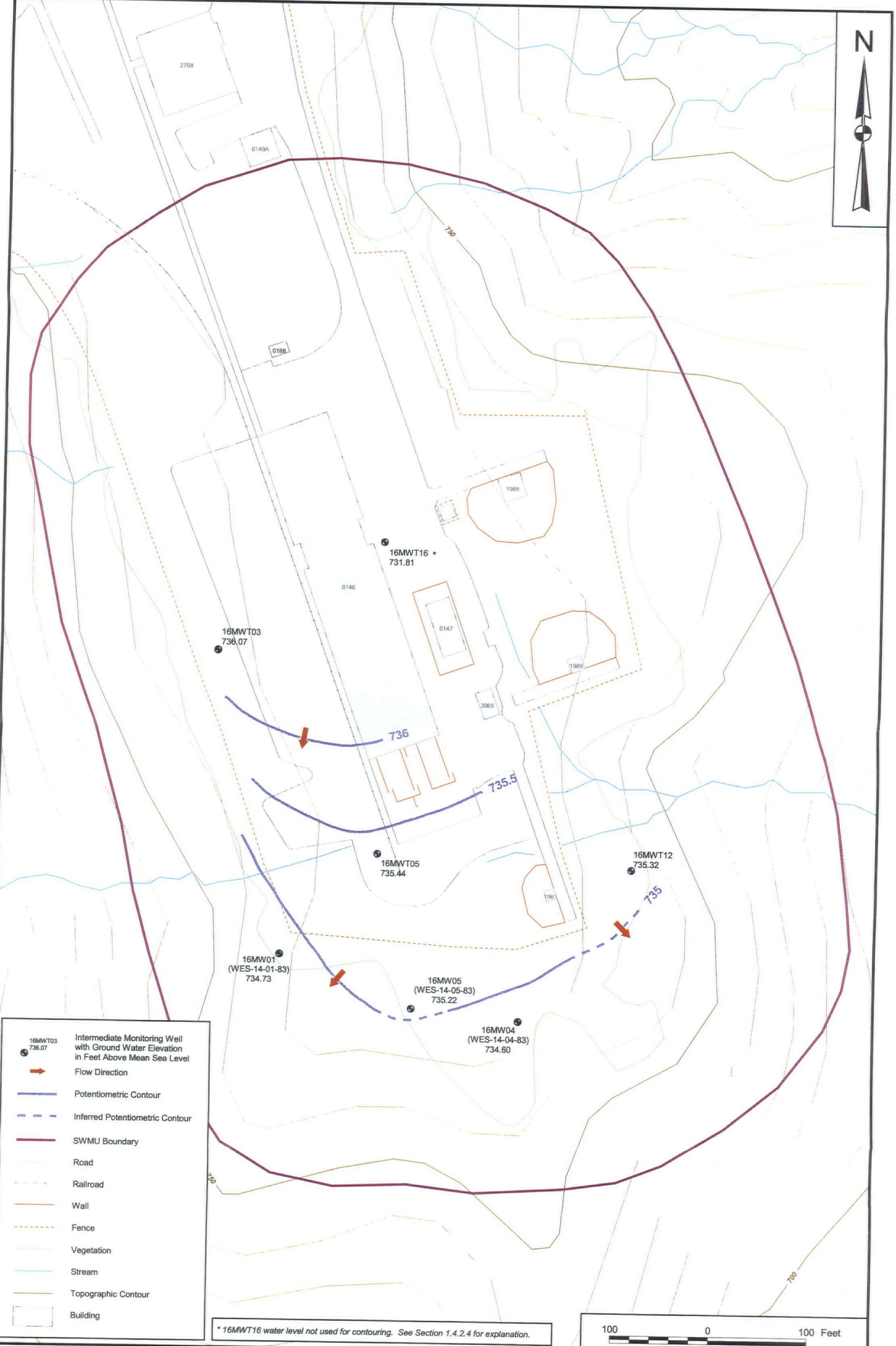


DRAWN BY A. JANOCHA	DATE 2/23/04	POTENTIOMETRIC SURFACE MAP FOR SHALLOW WELLS - JANUARY 24, 2004 SWMU 16 - CAST HIGH EXPLOSIVES FILL/BUILDING 146 INCINERATOR NSWC CRANE CRANE, INDIANA	CONTRACT NUMBER 7448
CHECKED BY J. LUCAS	DATE 5/13/04		APPROVED BY — DATE —
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 1 - 13 REV 0

P:\GIS\CRANE_NSWC\MAPDOCS\APR\RFI_SWMU13&16.APR SWMU 16 INTERMEDIATE CONTOUR LAYOUT 5/13/04 AJ



DRAWN BY A. JANOCHA	DATE 2/23/04	POTENTIOMETRIC SURFACE MAP FOR INTERMEDIATE WELLS - JANUARY 24, 2004 SWMU 16 - CAST HIGH EXPLOSIVES FILL/BUILDING 146 INCINERATOR NSWC CRANE CRANE, INDIANA	CONTRACT NUMBER 7448
CHECKED BY J. LUCAS	DATE 5/13/04		APPROVED BY — DATE —
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 1 - 14 REV 0

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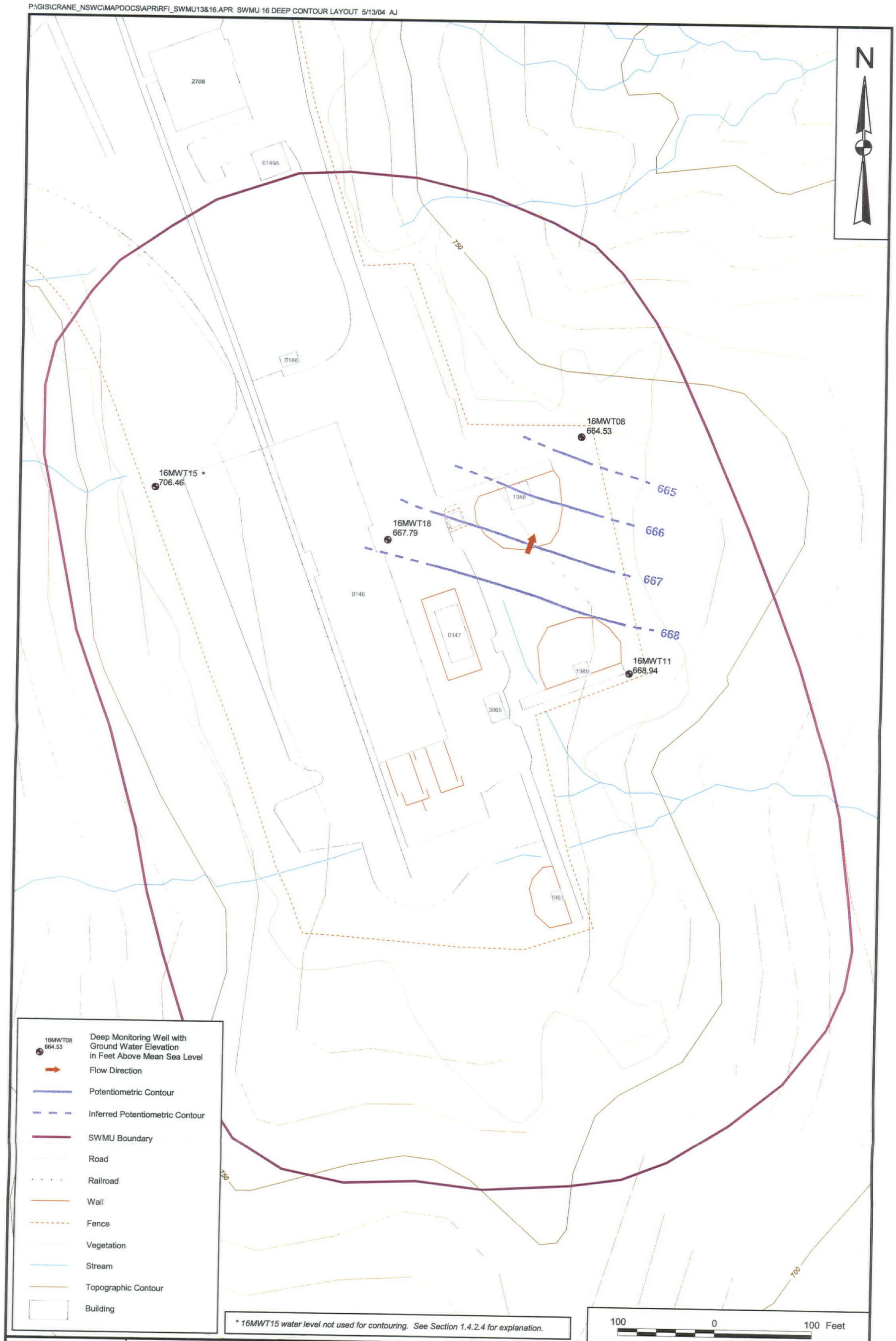
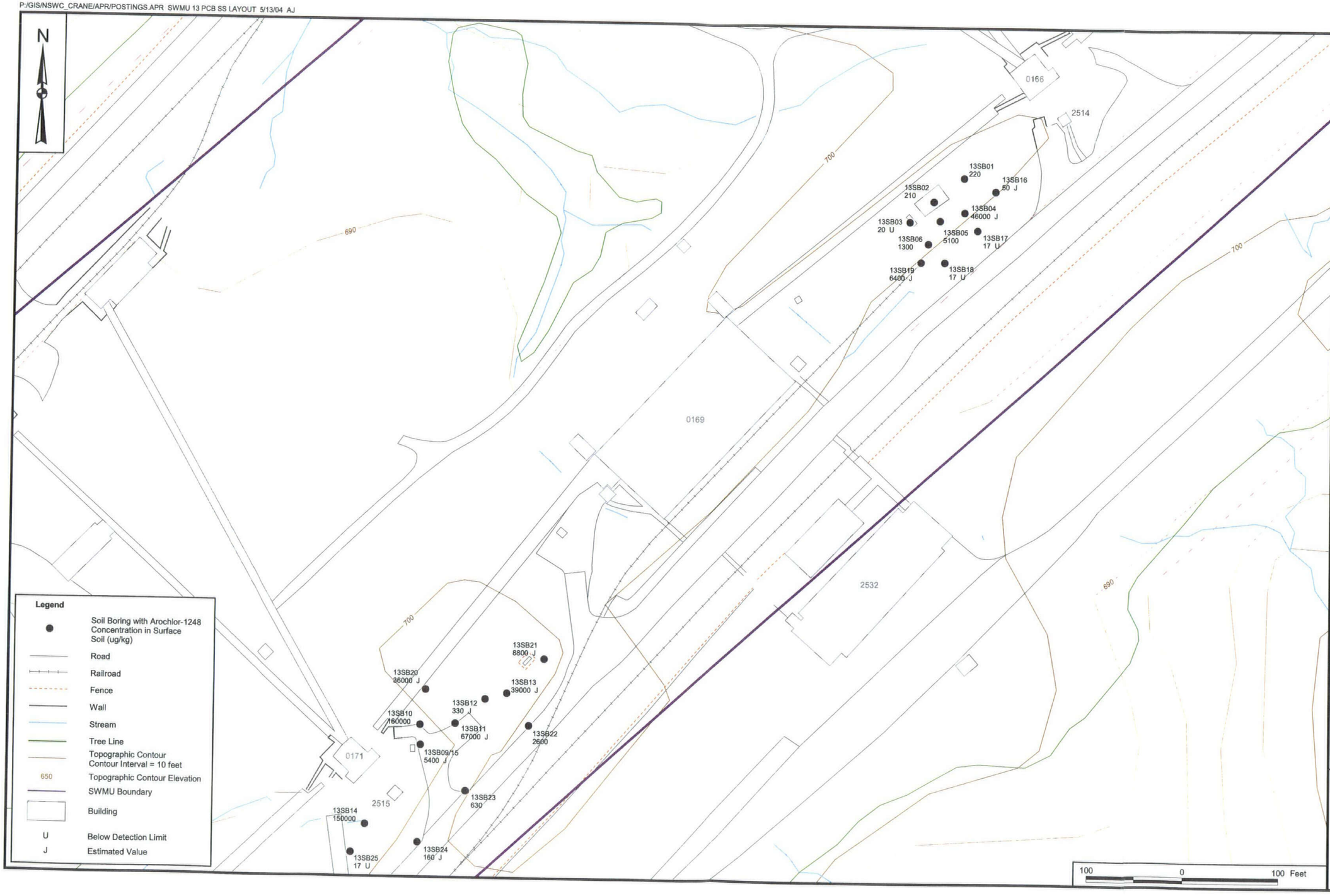


DRAWN BY A. JANOCHA	DATE 2/23/04	POTENTIOMETRIC SURFACE MAP FOR DEEP WELLS - JANUARY 24, 2004 SWMU 16 - CAST HIGH EXPLOSIVES FILL/BUILDING 146 INCINERATOR NSWC CRANE CRANE, INDIANA	CONTRACT NUMBER 7448
CHECKED BY J. LUCAS	DATE 3/17/04		APPROVED BY — DATE —
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 1 - 15 REV 0

P:/GIS/NSWC_CRANE/APR/POSTINGS.APR SWMU 13 PCB SS LAYOUT 5/13/04 AJ



CONTRACT NO. 7448

APPROVED BY J. LUCAS DATE 5/13/04

APPROVED BY — DATE —

DRAWING NO. FIGURE 1 - 16

REV 0

AROCLOR-1248 CONCENTRATIONS IN SURFACE SOIL (ug/kg) ROUND 1 AND ROUND 2 SWMU 13 - MINE FILL B NSWC CRANE CRANE, INDIANA

DEPARTMENT OF THE NAVY * SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMD *

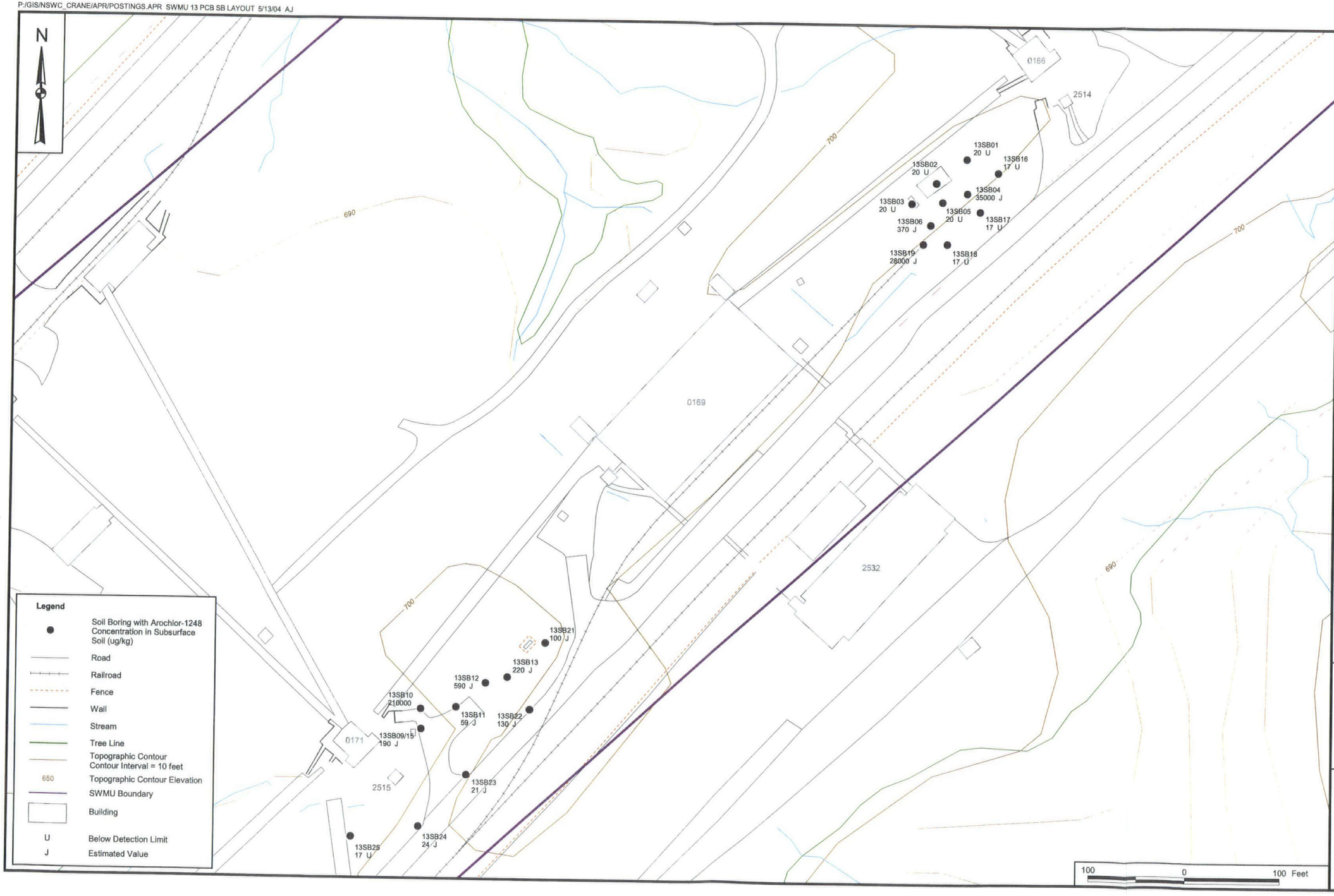
DRAWN BY A. JANOCHA DATE 9/05/03

CHECKED BY J. LUCAS DATE 5/13/04

COST/SCHED-AREA

SCALE AS NOTED

P:/GIS/NSWC_CRANE/APR/POSTINGS.APR SWMU 13 PCB SB LAYOUT 5/13/04 AJ



CONTRACT NO. 7448

APPROVED BY J. LUCAS — DATE 5/13/04

APPROVED BY ___ — DATE ___

DRAWING NO. FIGURE 1 - 17

REV 0

AROCLOR-1248 CONCENTRATIONS IN SUBSURFACE SOIL (ug/kg)
ROUND 1 AND ROUND 2
SWMU 13 - MINE FILL B
NSWC CRANE
CRANE, INDIANA

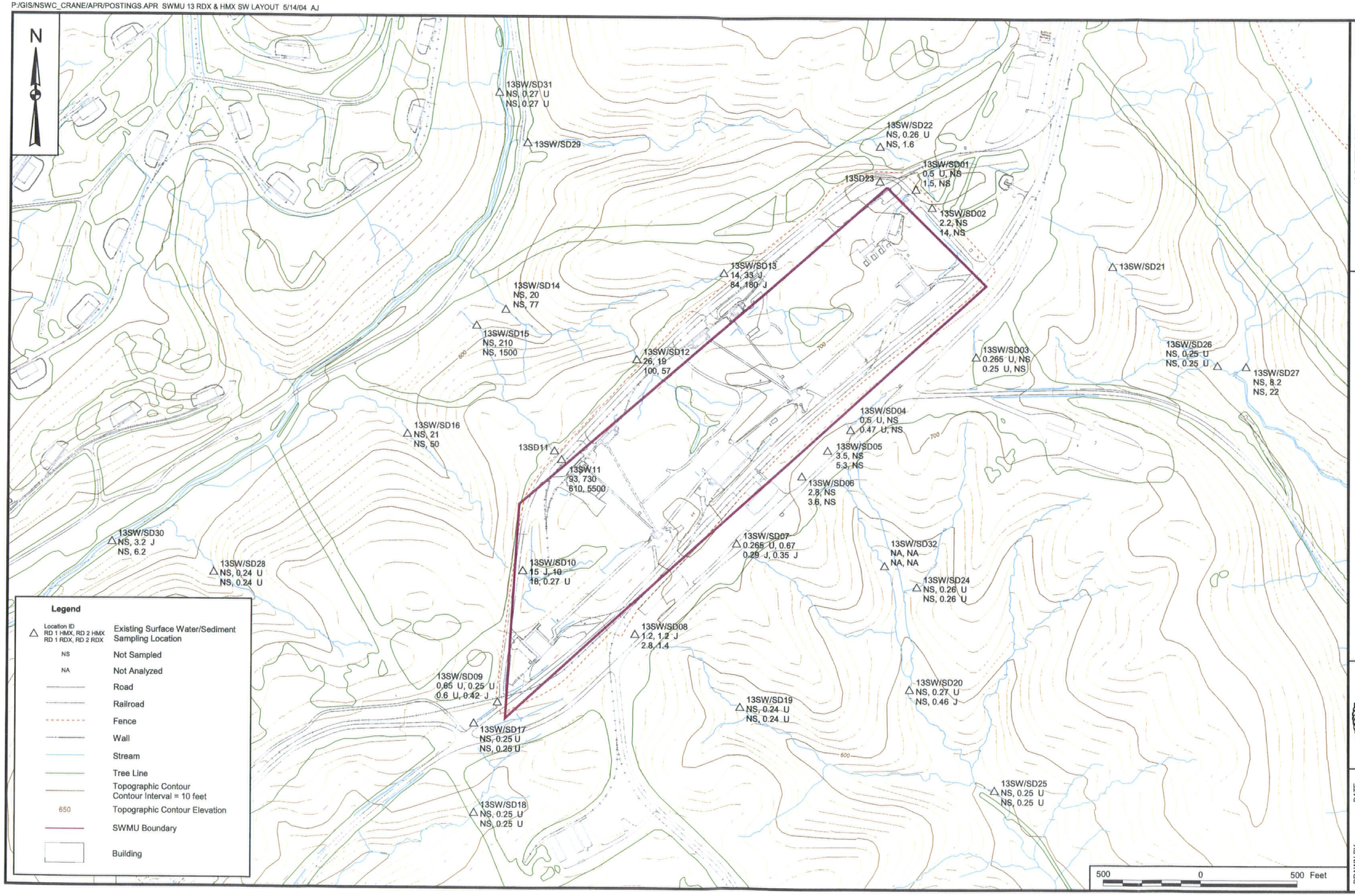
DRAWN BY A. JANOCHA — DATE 9/05/03

CHECKED BY J. LUCAS — DATE 5/13/04

COST/SCHED-AREA

SCALE AS NOTED

P:/GIS/NSWC_CRANE/APR/POSTINGS.APR SWMU 13 RDX & HMX SW LAYOUT 5/14/04 AJ



CONTRACT NO.
7448

APPROVED BY J. LUCAS	DATE 5/14/04
APPROVED BY	DATE
DRAWING NO.	REV 0

FIGURE 1 - 18

RDX AND HMX SURFACE WATER CONCENTRATIONS
FOR ROUNDS 1 AND 2 AT SWMU 13
NSWC CRANE
CRANE, INDIANA

DRAWN BY A. JANOCHA	DATE 5/14/04
CHECKED BY J. LUCAS	DATE 5/14/04
COST/SCHED-AREA	
SCALE AS NOTED	

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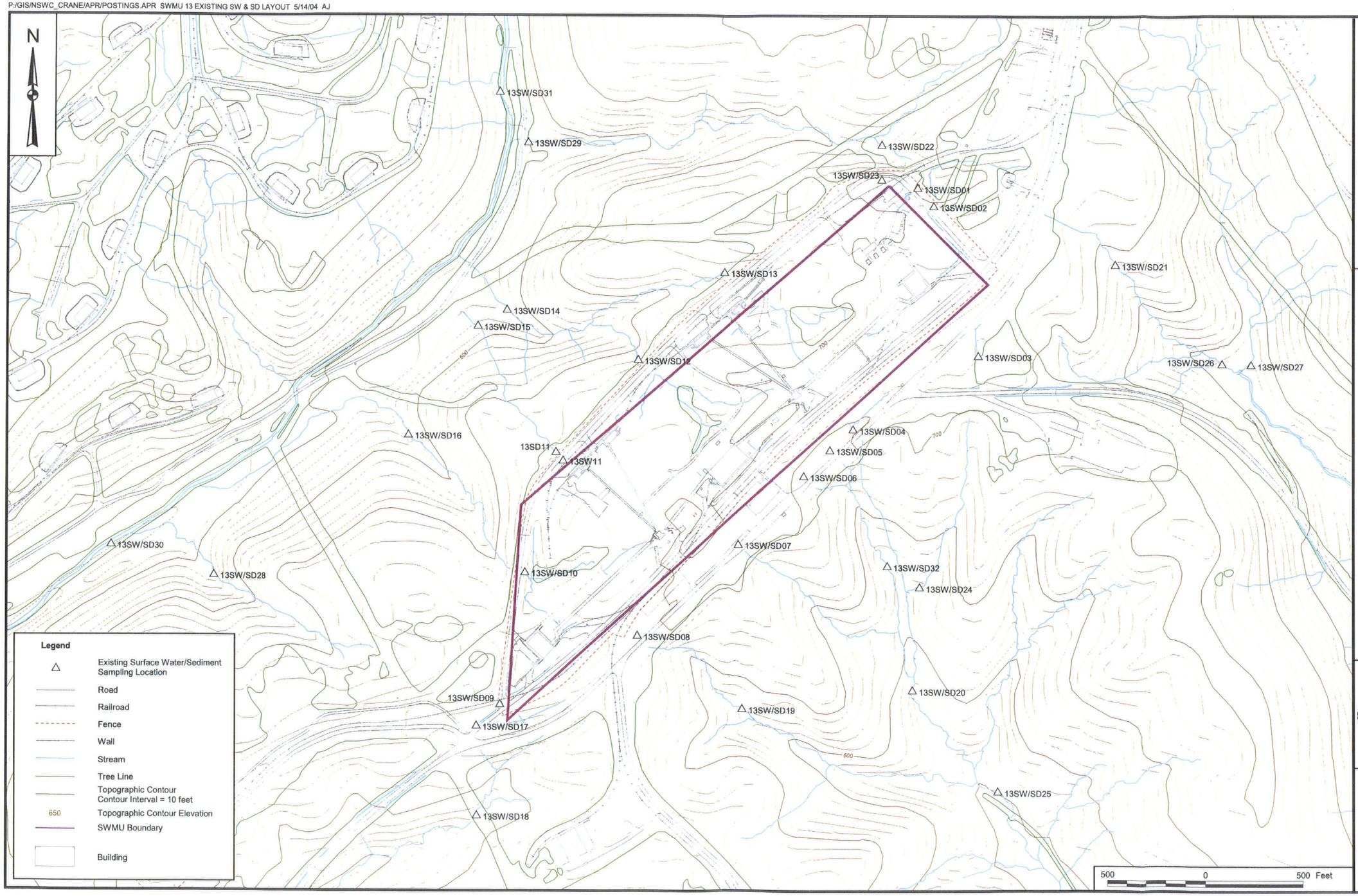


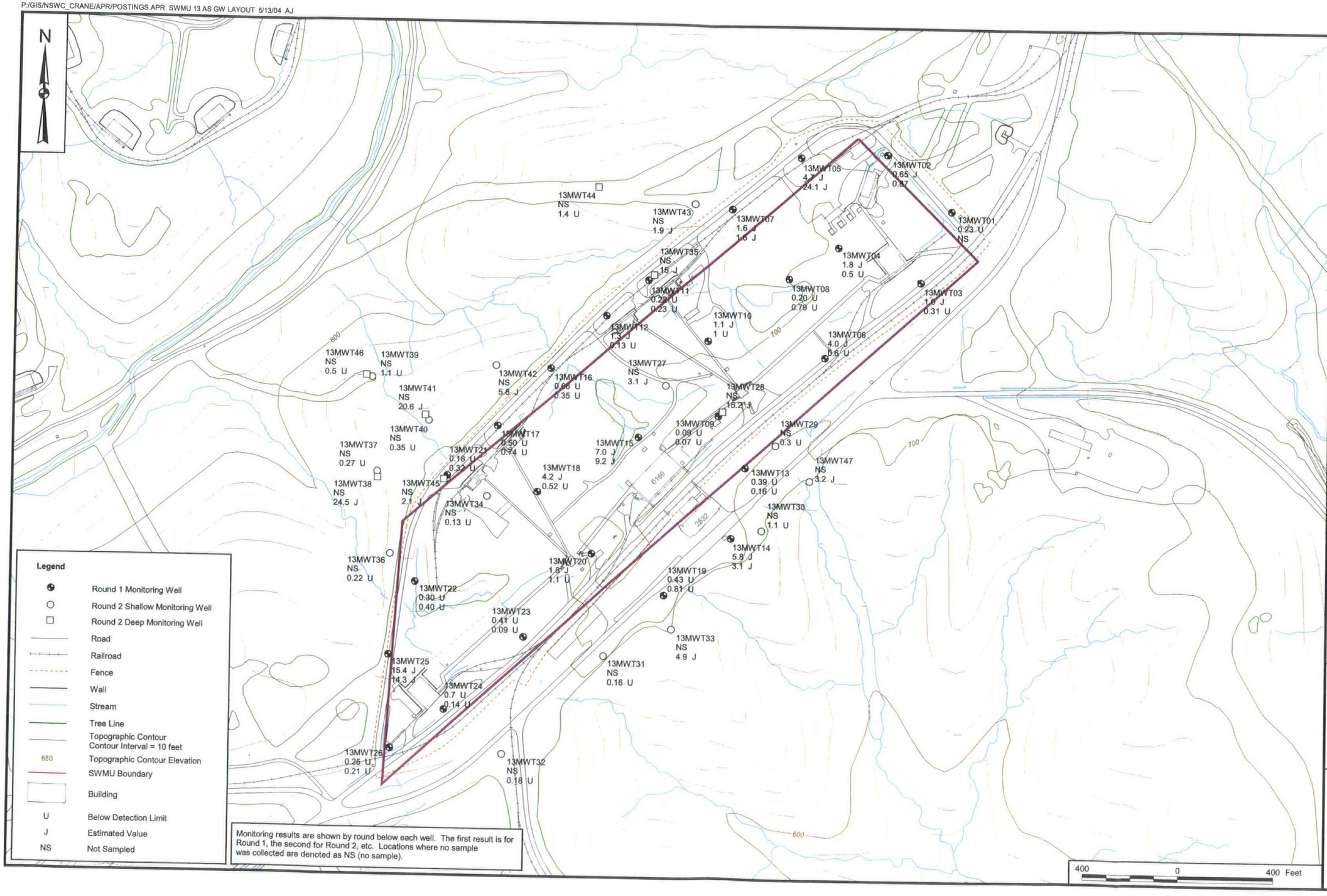
CONTRACT NO. 7448

APPROVED BY J. LUCAS	DATE 5/14/04
APPROVED BY	DATE
DRAWING NO. FIGURE 1 - 19	REV 0

SEDIMENT SAMPLING LOCATIONS
AT SWMU 13
NSWC CRANE
CRANE, INDIANA

DRAWN BY A. JANOCHA	DATE 5/14/04
CHECKED BY J. LUCAS	DATE 5/14/04
COST/SCHED-AREA	SCALE AS NOTED

P:/GIS/NSWC_CRANE/APR/POSTINGS.APR SWMU 13 AS GW LAYOUT 5/13/04 AJ



CONTRACT NO.
7448

APPROVED BY
J. LUCAS
DATE
5/13/04

APPROVED BY
DATE

DRAWING NO.
FIGURE 1 - 20

REV
0

TOTAL ARSENIC CONCENTRATIONS IN
GROUND WATER (ug/L) FOR
ROUND 1 AND ROUND 2
SWMU 13 - MINE FILL B
NSWC CRANE
CRANE, INDIANA

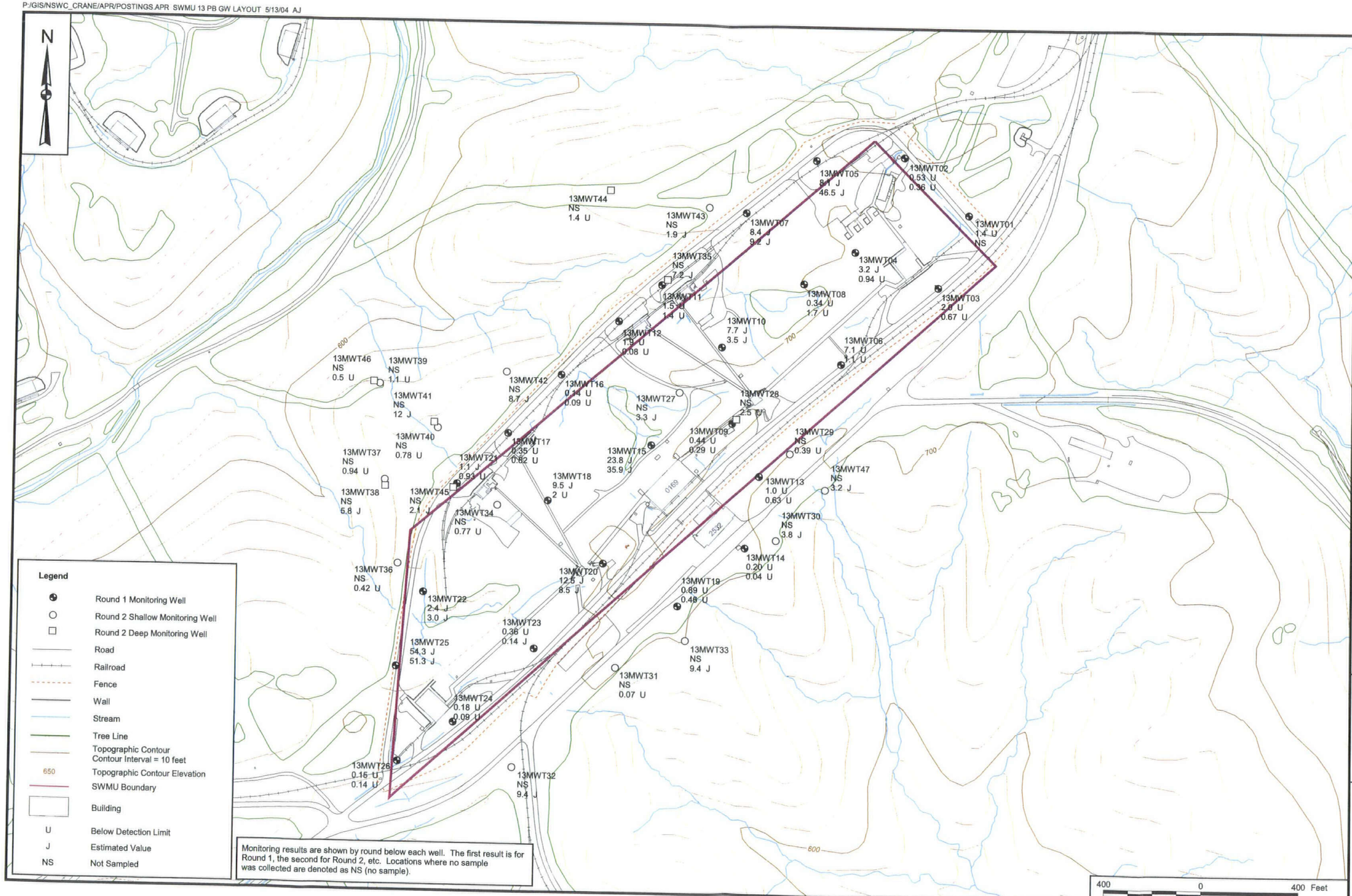
DRAWN BY
A. JANOCHA
DATE
9/05/03

CHECKED BY
J. LUCAS
DATE
5/13/04

COST/SCHED-AREA

SCALE
AS NOTED

P:/GIS/NSWC_CRANE/APR/POSTINGS.APR SWMU 13 PB GW LAYOUT 5/13/04 AJ



CONTRACT NO. 7448

APPROVED BY J. LUCAS — DATE 4/26/04

APPROVED BY — DATE

DRAWING NO. — FIGURE 1 - 21

REV 0

TOTAL LEAD CONCENTRATIONS IN GROUND WATER (ug/L) FOR ROUND 1 AND ROUND 2
SWMU 13 - MINE FILL B
NSWC CRANE
CRANE, INDIANA

DEPARTMENT OF THE NAVY ★ SOUTHERN DIV FACILITIES ENGINEERING COMD

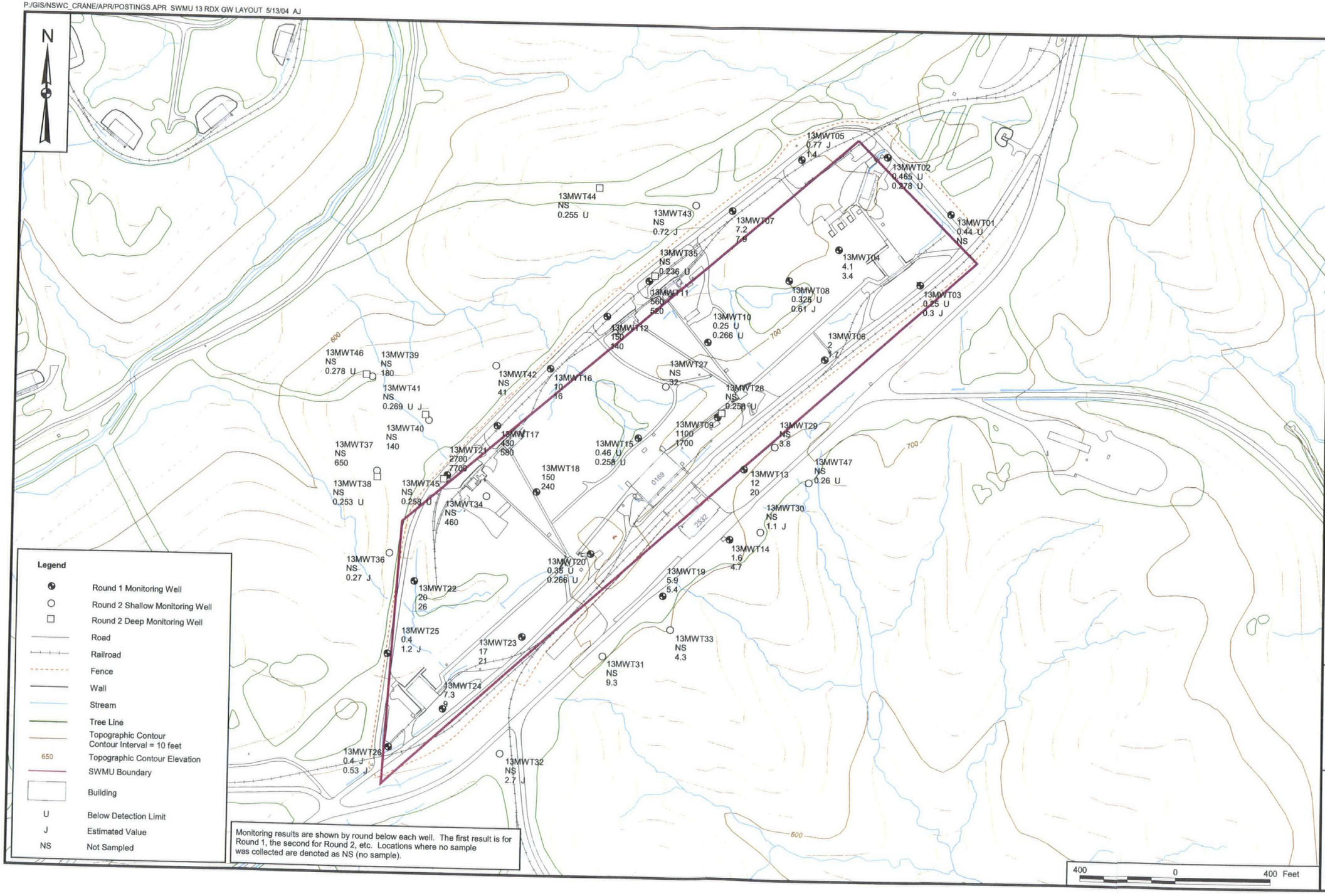
DRAWN BY A. JANOCHA — DATE 9/05/03

CHECKED BY J. LUCAS — DATE 5/13/04

COST/SCHED-AREA

SCALE AS NOTED

P:/GIS/NSWC_CRANE/APR/POSTINGS.APR SWMU 13 RDX GW LAYOUT 5/13/04 AJ



CONTRACT NO. 7448

APPROVED BY J. LUCAS — DATE 4/19/04

APPROVED BY ___ — DATE ___

DRAWING NO. FIGURE 1 - 22

REV 0

RDX CONCENTRATIONS IN GROUND WATER (ug/L) FOR ROUND 1 AND ROUND 2 SWMU 13 - MINE FILL B NSWC CRANE CRANE, INDIANA

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

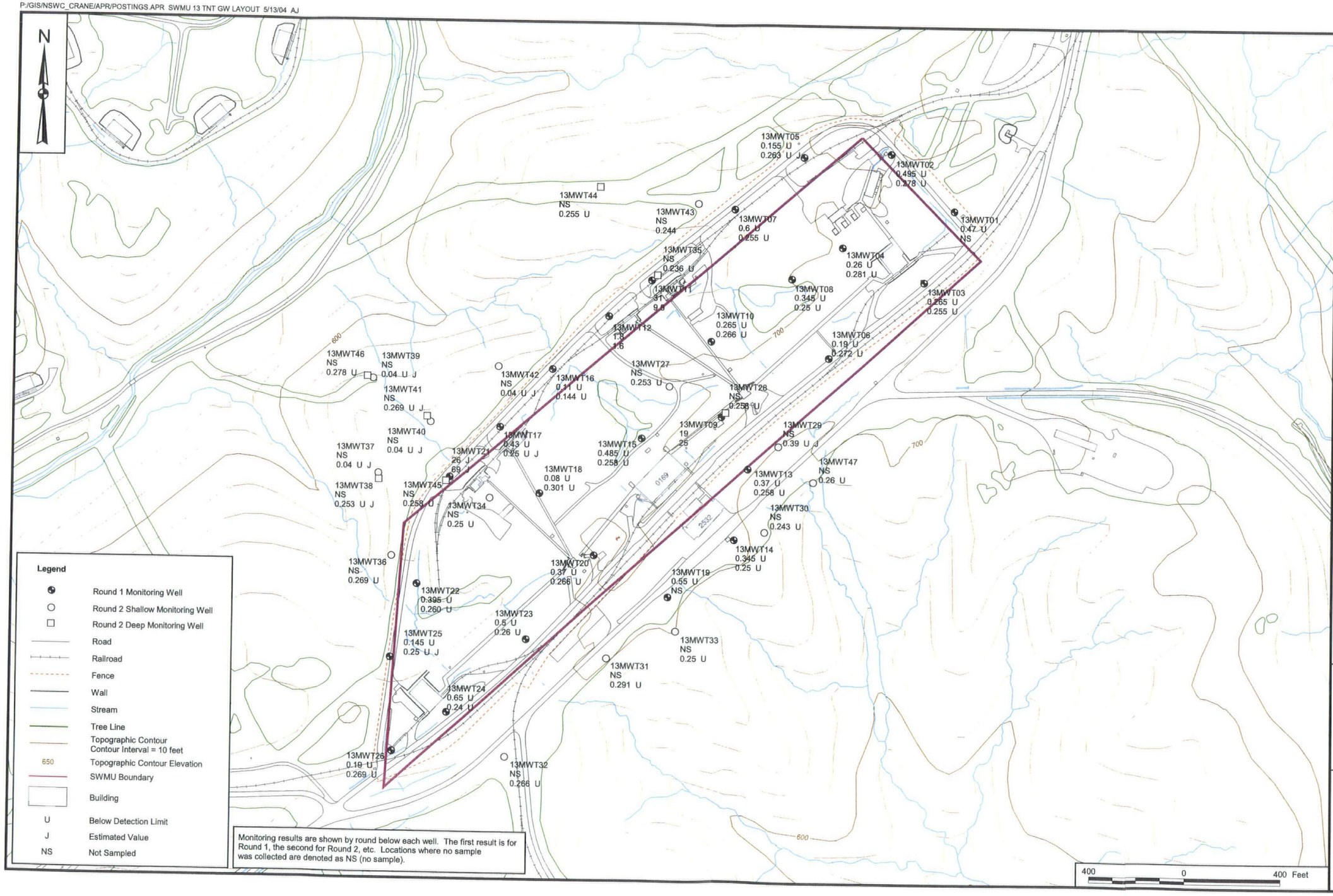
DRAWN BY A. JANOCHA — DATE 9/05/03

CHECKED BY J. LUCAS — DATE 5/13/04

COST/SCHED-AREA

SCALE AS NOTED

P:/GIS/NSWC_CRANE/APR/POSTINGS.APR SWMU 13 TNT GW LAYOUT 5/13/04 AJ



CONTRACT NO. 7448

APPROVED BY J. LUCAS — DATE 5/13/04

APPROVED BY — DATE

DRAWING NO. — FIGURE 1 - 23

REV 0

2,4,6-TRINITROTOLUENE CONCENTRATIONS IN GROUND WATER (ug/L) FOR ROUND 1 AND ROUND 2
SWMU 13 - MINE FILL B
NSWC CRANE
CRANE, INDIANA

DEPARTMENT OF THE NAVY * SOUTHERN DIV FACILITIES ENGINEERING COMD *

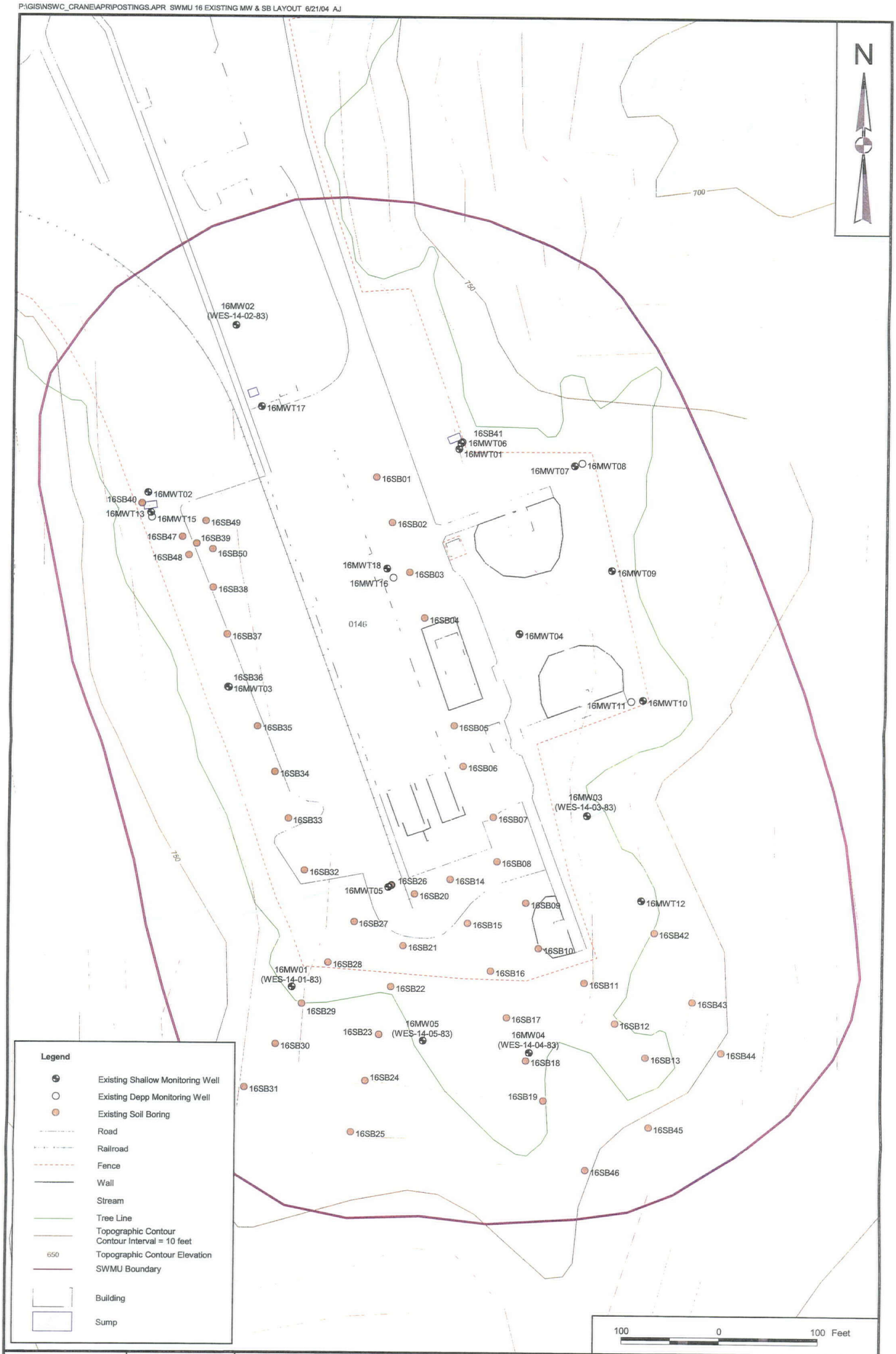
DRAWN BY A. JANOCHA — DATE 9/05/03

CHECKED BY J. LUCAS — DATE 5/13/04

COST/SCHED-AREA

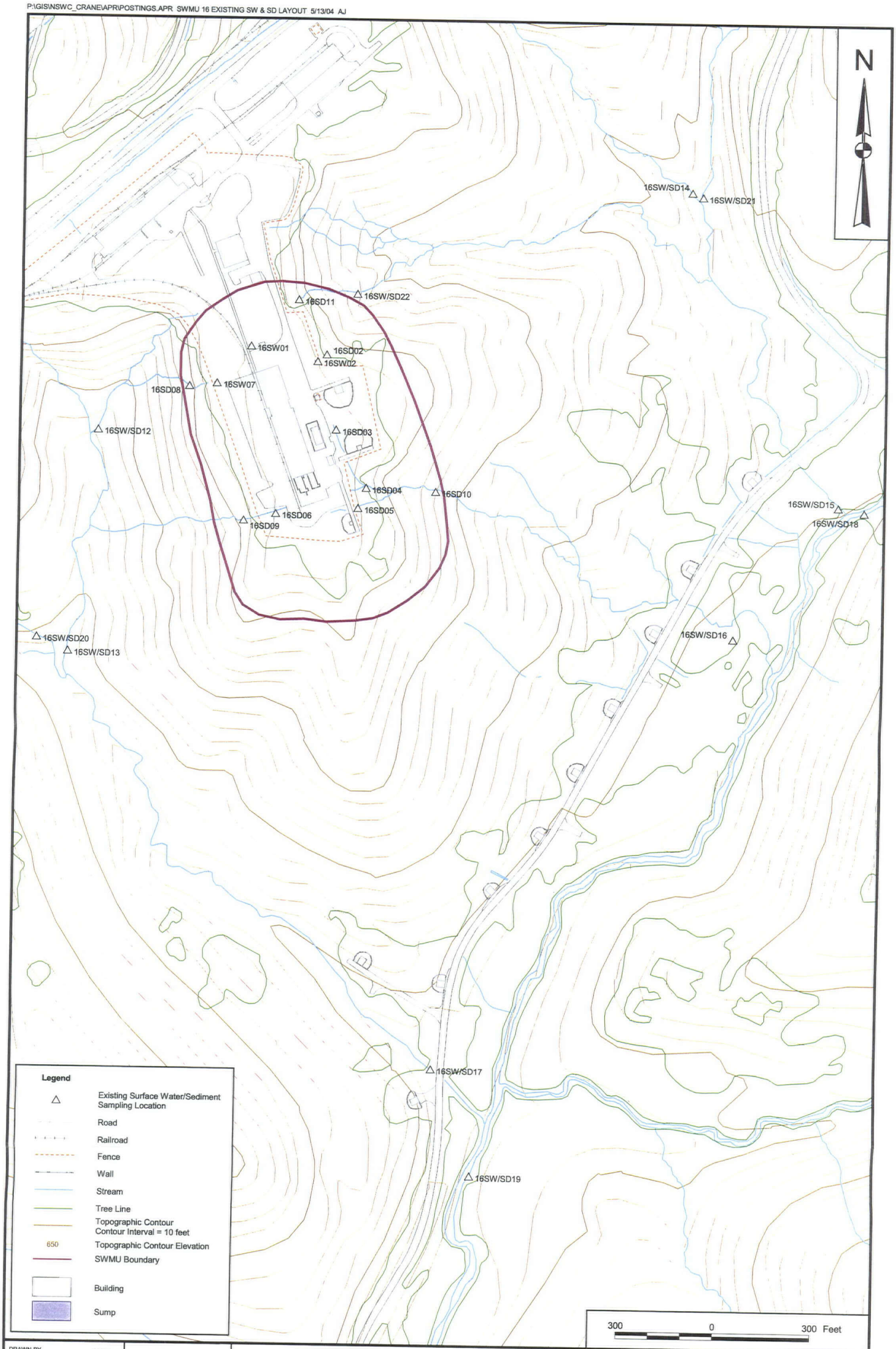
SCALE AS NOTED

P:\GIS\NSWC_CRANE\APR\POSTINGS.APR SWMU 16 EXISTING MW & SB LAYOUT 6/21/04 AJ



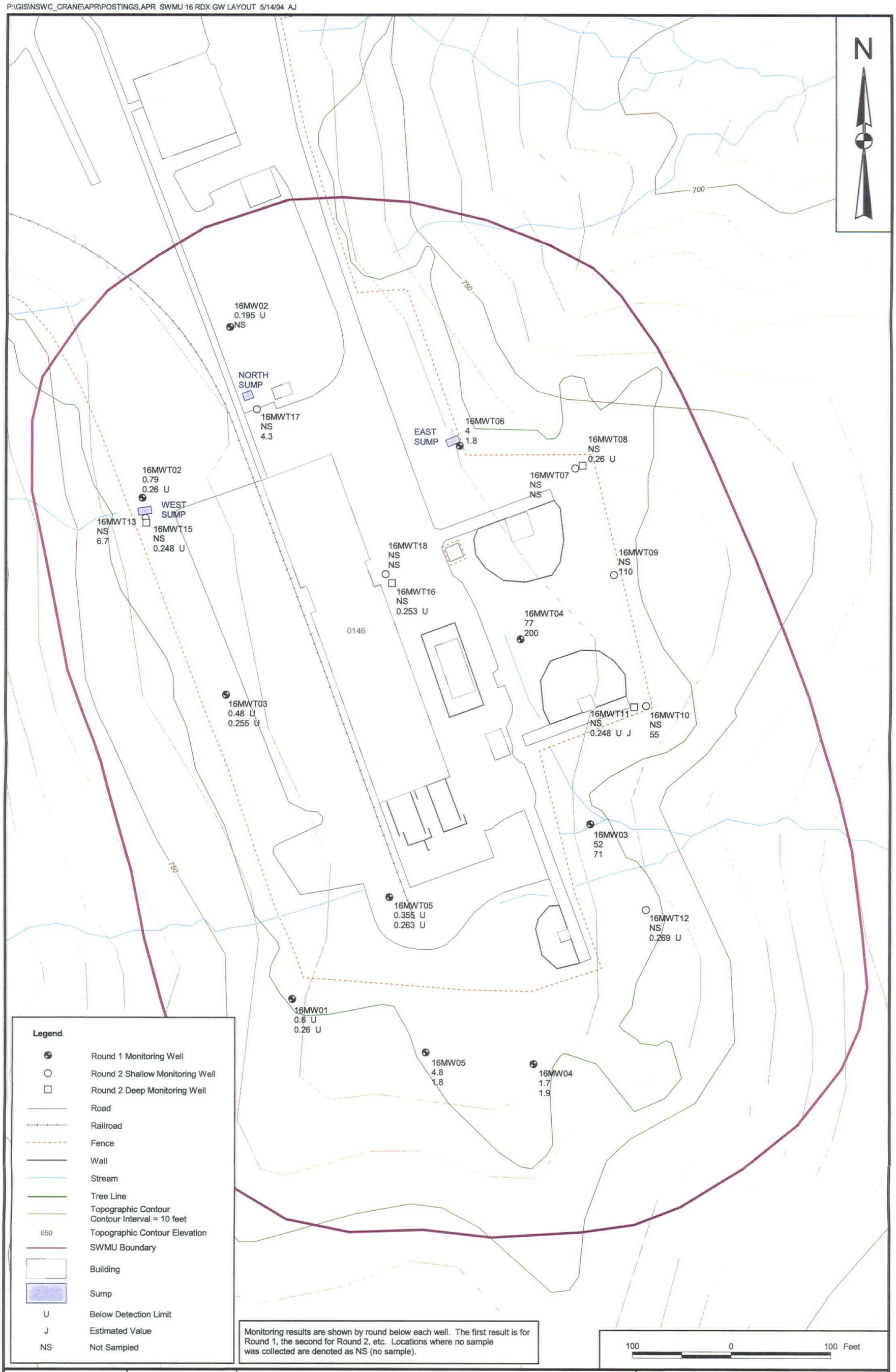
DRAWN BY A. JANOCHA	DATE 5/13/04	EXISTING SOIL AND GROUND WATER SAMPLING LOCATIONS SWMU 16 - CAST HIGH EXPLOSIVES FILL/B146 INCINERATOR NSWC CRANE CRANE, INDIANA	CONTRACT NUMBER 7448
CHECKED BY J. SCHUBERT	DATE 6/21/04		APPROVED BY J. SCHUBERT — DATE 6/21/04
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 1 - 24 — REV 0

P:\GIS\NSWC_CRANE\APR\POSTINGS.APR SWMU 16 EXISTING SW & SD LAYOUT 5/13/04 AJ



DRAWN BY A. JANOCHA	DATE 5/13/04	EXISTING SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS SWMU 16 - CAST HIGH EXPLOSIVES FILL/B146 INCINERATOR NSWC CRANE CRANE, INDIANA	CONTRACT NUMBER 7448
CHECKED BY J. LUCAS	DATE 5/13/04		APPROVED BY J. LUCAS — DATE 5/13/04
COST/SCHEDULE-AREA			APPROVED BY — — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 1 - 25 — REV 0

P:\GIS\NSWC_CRANE\APR\POSTINGS.APR SWMU 16 RDX GW LAYOUT 5/14/04 AJ



DRAWN BY	DATE
A. JANOCHA	9/05/03
CHECKED BY	DATE
J. LUCAS	5/14/04
COST/SCHEDULE-AREA	
SCALE	
AS NOTED	

RDX CONCENTRATIONS IN GROUND WATER (ug/L) FOR
ROUND 1 AND ROUND 2
SWMU 16 - CAST HIGH EXPLOSIVES FILL/B146 INCINERATOR
NWSC CRANE
CRANE, INDIANA

CONTRACT NUMBER	
7448	
APPROVED BY	DATE
J. LUCAS	5/14/04
APPROVED BY	DATE
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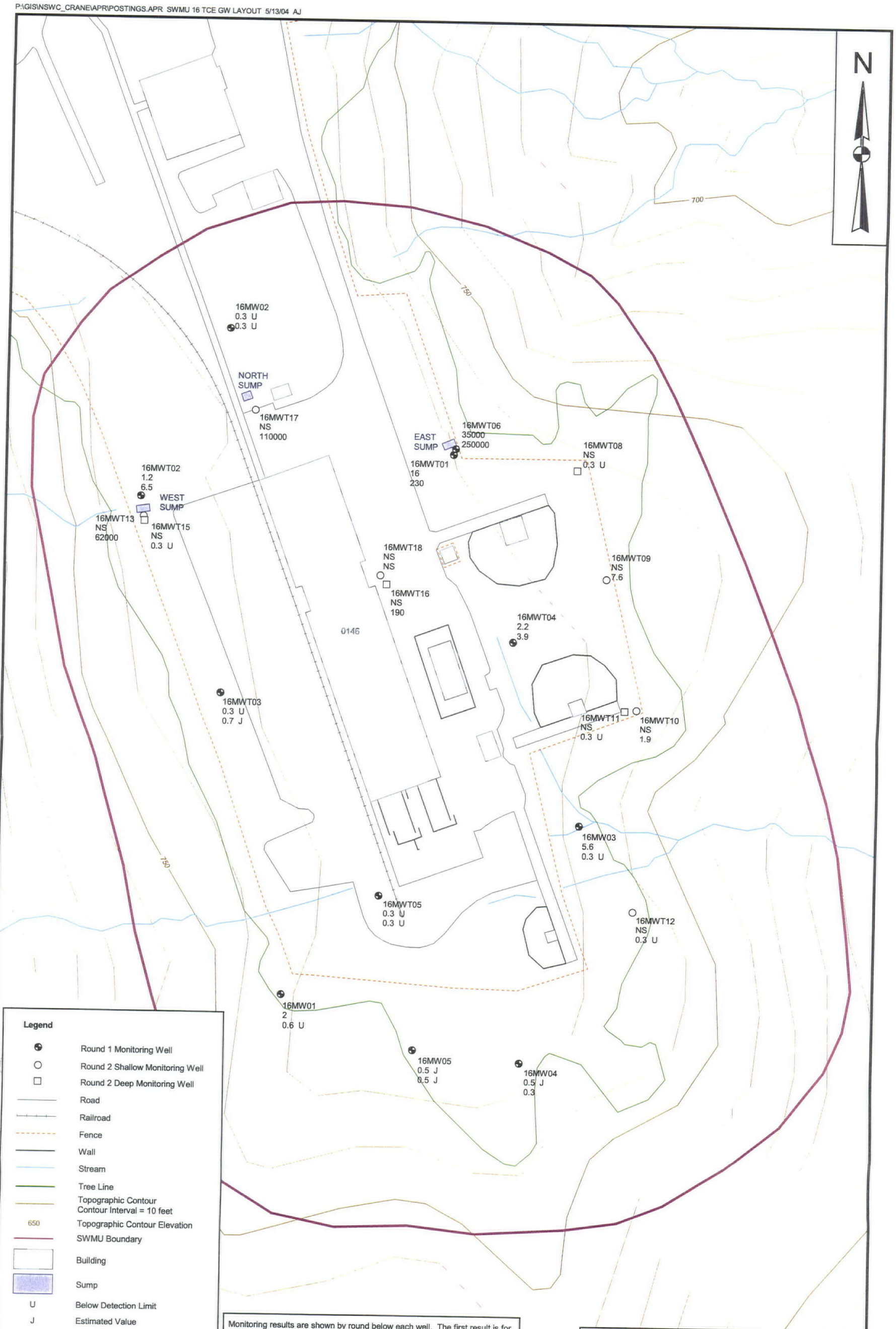
DRAWING NO.	REV
FIGURE 1 - 26	0

P:\GIS\NSWC_CRANE\APR\POSTINGS.APR SWMU 16 TCE GW LAYOUT 5/13/04 AJ



DRAWN BY A. JANOCHA	DATE 9/05/03	TRICHLOROETHENE CONCENTRATIONS IN GROUND WATER (ug/L) SWMU 16 - CAST HIGH EXPLOSIVES FILL/B146 INCINERATOR FOR ROUND 1 AND ROUND 2 NSWC CRANE CRANE, INDIANA	CONTRACT NUMBER 7448
CHECKED BY J. LUCAS	DATE 5/13/04		APPROVED BY J. LUCAS — DATE 5/13/04
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 1 - 27 — REV 0

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

This section presents the project management and organization for conducting field operations at NSWC Crane SWMUs 13 and 16 (Round 3). Staffing and coordination requirements are described in Section 2.0 of the approved Contract Task Order (CTO) 0166 QAPP (TtNUS, 2003a). Table 2-1 and Figure 2-1 were updated to include the most current contact information for the involved parties.

Laucks Testing Laboratories, Inc. of Seattle, Washington will perform all sample analyses for this field activity with the exceptions of the field analyses and the gases ethane, ethene, and methane. These gas analyses will be conducted by Microseeps, Inc. of Pittsburgh, Pennsylvania.

The subcontracted laboratories are responsible for analyzing all samples in accordance with the analytical methods and additional requirements specified in the attendant QAPP. It also will be the responsibility of the analytical laboratories to properly dispose of unused sample aliquots. Responsibilities of key laboratory personnel are outlined in Section 2.2.6 of the approved CTO 0166 QAPP (TtNUS, 2003a). Although an unexploded ordnance (UXO) specialist is identified in Sections 2.3 and 2.3.4 of the approved CTO 0166 QAPP, no UXO concerns exist for the work conducted under this QAPP Addendum No. 2 and a UXO specialist is not required. All other personnel and training requirements identified in the approved CTO 0166 QAPP apply.

TABLE 2-1

KEY PROJECT PERSONNEL
NAMES, PHONE NUMBERS, AND ADDRESSES
SWMUs 13 AND 16
QAPP ADDENDUM NO. 2
NSWC CRANE, CRANE, INDIANA
PAGE 1 OF 2

PERSON / TITLE / ORGANIZATION	ADDRESS	TELEPHONE
Peter Ramanauskas Project Manager U.S. EPA Region 5	U.S. EPA Region 5 77 West Jackson Blvd. Chicago, Illinois 60604	(312) 886-7890 FAX: (312) 353-4788
Allen Debus QA Coordinator U.S. EPA Region 5	U.S. EPA Region 5 77 West Jackson Blvd. Chicago, Illinois 60604	(312) 886-6186
Marty Harmless Office of Solid and Hazardous Waste Management IDEM	Office of Solid and Hazardous Waste Management 100 N. Senate Avenue Indianapolis, Indiana 46206-6015	(317) 234-0597
Doug Griffin Corrective Action Section Office of Land Quality Hazardous Waste Permits IDEM	Corrective Action Section Office of Land Quality Hazardous Waste Permits 100 N. Senate Avenue P. O. Box 6015 Indianapolis, Indiana 46206-6015	(317) 233-2710
Bill Gates Remedial Project Manager U.S. Navy NAVFAC EFD SOUTH	Department of Navy NAVFAC EFD SOUTH Code ES32 2155 Eagle Drive Charleston, South Carolina 29406	(843) 820-7360 FAX: (843) 820-7465
Tom Brent Environmental Site Manager NSWC Crane	NSWC Crane Code RP3-CF Building 3245 300 Highway 361 Crane, Indiana 47522-5009	(812) 854-6160 FAX: (812) 854-3981
Christine Freeman Environmental Site Manager NSWC Crane	NSWC Crane Code RP3-CF Building 3245 300 Highway 361 Crane, Indiana 47522-5009	(812) 854-4423 FAX: (812) 854-3981
Debra M. Humbert Program Manager Tetra Tech NUS	Tetra Tech NUS, Inc. 661 Andersen Drive Pittsburgh, Pennsylvania 15220-2745	(412) 921-8968 FAX: (412) 921-4040
Paul Frank Quality Assurance Manager Tetra Tech NUS	Tetra Tech NUS, Inc. 661 Andersen Drive Pittsburgh, Pennsylvania 15220-2745	(412) 921-8950 FAX: (412) 921-4040
Matt Soltis Health and Safety Manager Tetra Tech NUS	Tetra Tech NUS, Inc. 661 Andersen Drive Pittsburgh, Pennsylvania 15220-2745	(412) 921-8912 FAX: (412) 921-4040

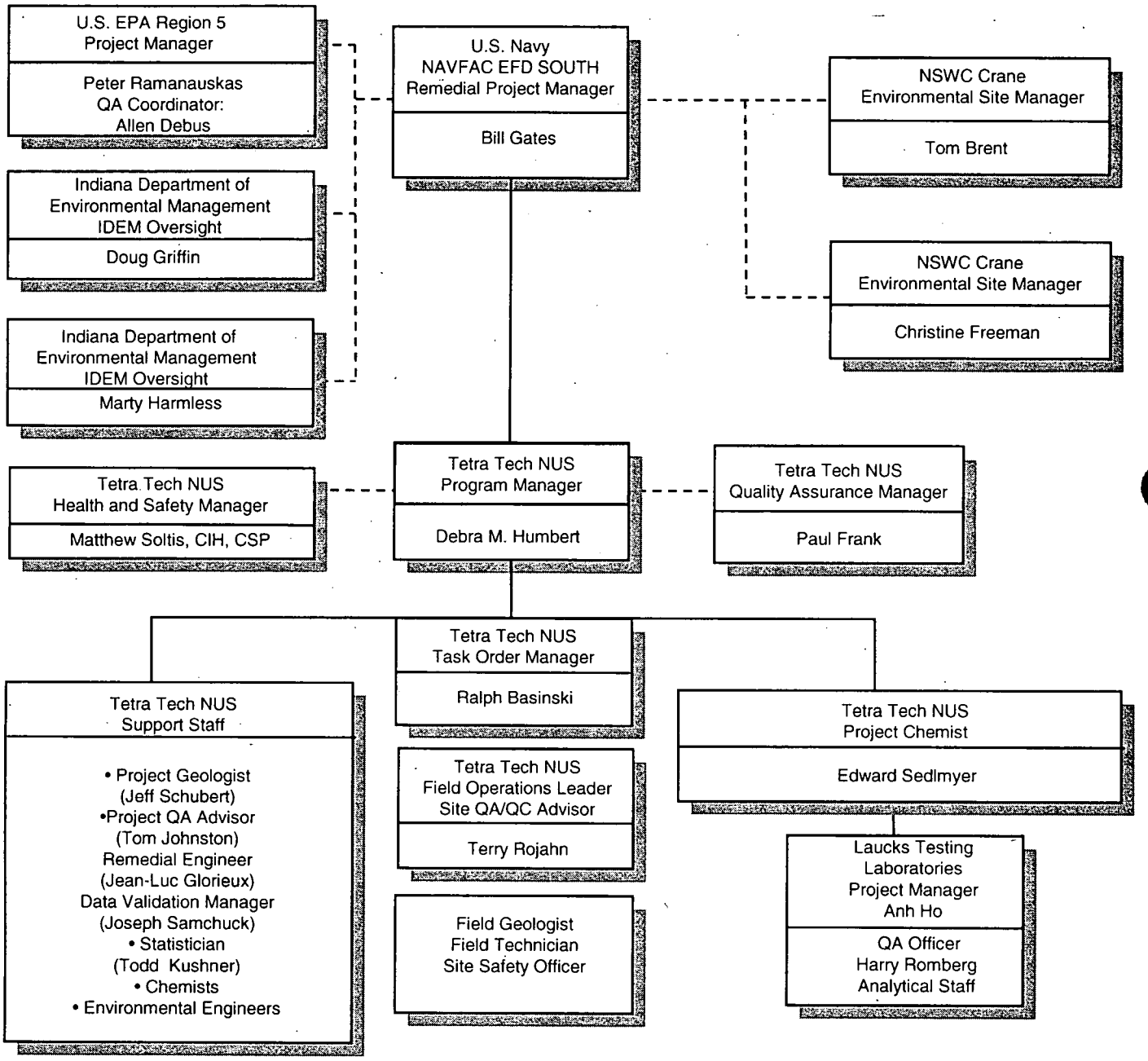
TABLE 2-1

KEY PROJECT PERSONNEL
NAMES, PHONE NUMBERS, AND ADDRESSES
SWMUs 13 AND 16
QAPP ADDENDUM NO. 2
NSWC CRANE, CRANE, INDIANA
PAGE 2 OF 2

PERSON / TITLE / ORGANIZATION	ADDRESS	TELEPHONE
Ralph Basinski Task Order Manager Tetra Tech NUS	Tetra Tech NUS, Inc. 661 Andersen Drive Pittsburgh, Pennsylvania 15220-2745	(412) 921-8308 FAX: (412) 921-4040
Terry Rojahn Field Operations Leader Tetra Tech NUS	Tetra Tech NUS, Inc. 661 Andersen Drive Pittsburgh, Pennsylvania 15220-2745	(412) 921-8857 FAX: (412) 921-4040
Joseph Samchuck Data Validation Manager Tetra Tech NUS	Tetra Tech NUS, Inc. 661 Andersen Drive Pittsburgh, Pennsylvania 15220-2745	(412) 921-8510 FAX: (412) 921-4040
Jeff Schubert Project Geologist Tetra Tech NUS	Tetra Tech NUS, Inc. 661 Andersen Drive Pittsburgh, Pennsylvania 15220-2745	(412) 921-8794 FAX: (412) 921-4040
Ed Sedlmyer Project Chemist Tetra Tech NUS	Tetra Tech NUS, Inc. 661 Andersen Drive Pittsburgh, Pennsylvania 15220-2745	(412) 921-7273 FAX: (412) 921-4040
Tom Johnston Quality Assurance Advisor Tetra Tech NUS	Tetra Tech NUS, Inc. 661 Andersen Drive Pittsburgh, Pennsylvania 15220-2745	(412) 921-8615 FAX: (412) 921-4040
Todd Kushner Statistician Tetra Tech NUS	Tetra Tech NUS, Inc. 661 Andersen Drive Pittsburgh, Pennsylvania 15220-2745	(412) 921-8539 Fax: (412) 921-4040
Anh Ho Project Manager Laucks Testing	Laucks Testing Laboratories, Inc. 940 South Harney Street Seattle, Washington 98108	(206) 957-2433 FAX: (206)767-5063
Harry Romberg Lab QA Manager Laucks Testing	Laucks Testing Laboratories, Inc. 940 South Harney Street Seattle, Washington 98108	(206) 767-5060 FAX: (206)767-5063

FIGURE 2-1

PROJECT ORGANIZATION CHART
SWMUs 13 and 16
QAPP ADDENDUM NO. 2
NSWC CRANE, CRANE, INDIANA



3.0 SAMPLING AND ANALYSIS PLAN

3.1 GENERAL APPROACH

This section describes sampling locations and rationales for the sampling activities and the equipment and procedures to be used for collecting, handling, preserving, and shipping the samples to the analytical laboratories in sample collection Rounds 3 through 9. The text references field standard operating procedures (SOPs) (included in Appendix C) and the Health and Safety Plan (HASP), when applicable.

Prior to sampling, the Task Order Manager (TOM) will ensure that all field personnel read and understand QAPP Addendum No. 2 and the HASP, the Field Operations Leader (FOL) will ensure that all required field equipment for non-health-and-safety-related operations is available and operational, and the Site Safety Officer (SSO) will ensure that all health-and-safety-related equipment is available and operational.

Investigations at the following two SWMUs are described in this Sampling and Analysis Plan:

- SWMU 13 Mine Fill B - Round 3 sampling of soils, surface water, and ground water and Rounds 4 through 9 sampling of ground water and surface water.
- SWMU 16 Cast High Explosives Fill - Round 3 sampling of soils, surface water, and ground water and Rounds 4 through 9 sampling of ground water and surface water.

Two rounds of drilling, well installation, and multimedia sampling have already been performed at SWMUs 13 and 16. A third round of drilling, sampling, and site characterization work at these two SWMUs is described in this QAPP Addendum No. 2 and is intended to further delineate the areas of contamination identified in the first and second sampling rounds. Six additional rounds (Rounds 4 through 9) of ground water samples will be collected at selected wells in SWMUs 13 and 16 to provide information on trends in ground water contamination for explosives (SWMUs 13 and 16) and TCE (SWMU 16).

All measurements (listed in Table 3-1) made with field instruments and visual observations concerning the subsurface materials encountered will be recorded on boring log sheets. Any encounters with metallic objects or discolored soil materials and any above-background measurements of VOCs will be immediately reported to the FOL and the SSO, and appropriate actions will be taken as specified in the HASP.

3.2 SAMPLE IDENTIFICATION SYSTEM

All samples will be properly labeled with an adhesive-backed sample label affixed to and a tag tied to each sample container in accordance with SOP CTO166-01. The sample labels and tags will include the following information: project name, project location, sample tracking number, sampling date, sampling time, type of analysis required, matrix type, preservative, initials of sampler, and name of the analytical laboratory to which the sample will be submitted.

Each collected sample will be assigned a unique sample tracking number. The sample tracking number for a soil sample is a four-segment, alphanumeric code beginning with the SWMU identification (13 or 16) followed by codes for the sample type, sample location, and sample depth. The sample tracking number for the other media is a five-segment, alphanumeric code identifying the SWMU ID, sample type, sample location, sampling round, and filtering indicator (for aqueous samples only). These numbering schemes are described in SOP CTO166-02. Any other pertinent information regarding sample identification will be recorded in the field logbooks and on sample log sheets.

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

Matrix spike and matrix spike duplicate (MS/MSD) samples will be designated on the field documentation and COC forms (see SOP CTO166-03).

3.3 UNEXPLODED ORDNANCE AVOIDANCE

The activities performed at both of the SWMUs, which included ordnance testing, test loading, and manufacturing, were performed using good housekeeping practices. The potential for encountering buried UXO is low, and proposed borings have been located in areas with the least likelihood of encountering UXO while still achieving project objectives. None of the borings, soil excavations, or other intrusive activities to date at the two SWMUs have encountered any UXO material. However, specific boring locations as identified by NSWC Crane may require screening using a magnetometer to check for the presence of UXO in accordance with the HASP. Prior to the initiation of intrusive site activities, a meeting will be held with NSWC Crane staff to determine whether any boring locations may require UXO screening. If potential ordnance is encountered during investigative activities, the activities will stop and

the Crane Environmental Site Manager will be notified (SWMU 13 – Christine Freeman/SWMU 16 – Tom Brent).

UXO screening is not anticipated to be conducted at SWMUs 13 or 16. At SWMU 13, only granular explosives were released, and most soils contaminated with explosives have been remediated. At SWMU 16, no ordnance items were managed on the ground. Released materials consisted only of ash and slag. UXO screening is conducted with a magnetometer, which is sensitive to magnetic material. Bulk explosives are not magnetic and would not be detected by a magnetometer. Visual inspection will be used to detect whether bulk explosives may be present.

3.4 SAMPLING LOCATIONS, ANALYSES, AND RATIONALES

This section presents sampling locations, quality assurance/quality control (QA/QC) samples to be collected, analyses to be performed, and rationales for the sampling and analytical program. Details regarding the handling, packaging, and shipping of the samples are included in Section 3.7. Sampling locations are shown on Figures 3-1 through 3-4.

3.4.1 Surface and Subsurface Soils

In Round 3, surface and subsurface soil samples will be collected at SWMUs 13 and 16, as described in the remainder of this section. The analyses to be performed on each soil sample are listed in Table 3-2. The rationales for parameter selection are discussed in Sections 1.4.1 and 1.4.2 and are detailed on Table 1-7.

Surface and subsurface soil sampling will most likely be performed using hand augering techniques and DPT at SWMUs 13 and 16. Details regarding soil sampling equipment and procedures are included in Section 3.5.2 and SOP CTO166-04.

QA/QC samples will be collected at frequencies listed in Table 3-3. Duplicate samples will be collected at a rate of one for every 20 regular soil samples and analyzed for the same analytes as the corresponding soil samples. MS/MSD samples will be collected and analyzed at a rate of one for every 20 soil samples. The total number of soil analyses for each analyte group is tabulated in Table 3-3.

3.4.1.1 SWMU 13 - Mine Fill B Soil Sampling Activities

Figure 3-1 presents locations for 22 soil borings to be completed as part of the Round 3 sampling activities at MFB. The actual locations of PCB samples at MFB will be situated during the field sampling

program based on factors such as topography, potential contaminant conduits, etc. The soil samples from these borings will be used to complete delineation of PCB contamination around the two former Therminol boilers that were the source of PCBs. As previously discussed in Section 1.0, PCB soil contamination exists in the vicinity of Buildings 166 and 171 due to historical leakage from the Therminol boilers. The boilers and some soil have been removed, but PCBs at concentrations greater that 10 mg/kg still remain in these areas. Based on the results of Round 1 and Round 2, sampling the extent of PCB contamination was not fully delineated.

Twenty-two new borings (13SB26 through 13SB47) will be completed around the perimeters of the areas where previous borings were installed (see Figure 3-1) to help define the lateral and vertical extent of PCB contamination in these two areas. Soil borings will be advanced to a depth of 4 feet in most borings, and two samples will be collected from each boring (0 to 2 and 2 to 4 feet bgs) as listed in Table 3-2. In four borings, the depth of soil sampling will be extended because previous soil samples from those locations at less than 4 feet deep possessed significant PCB concentrations. If obvious soil staining is observed in any of these borings, it will be described on the boring log. In addition, at the discretion of the site geologist, the boring may be advanced two more feet and an additional soil sample may be collected. All soil samples collected at SWMU 13 will be analyzed for PCBs only (Table 3-2).

3.4.1.2 SWMU 16 - Cast High Soil Sampling Activities

The soil source of TCE in ground water has not been delineated. It is suspected that TCE was released from sewer lines between Building 146 and the sumps. Samples will be collected along sewer lines to determine if VOCs are present. Figure 3-2 presents locations for 28 soil borings that will be installed at SWMU 16 during Round 3. Six additional sampling locations, 16SB79 and 16SB80, are not shown in Figure 3-2 because they are discretionary sampling locations for Round 3. Four other sampling locations (16SB81-16SB84) are not shown because they will be located inside B-146 and their exact location will be determined in the field. Five soil samples (16SB55-16SB89) will also be collected along the southeastern and southern border of the SWMU. These samples will be analyzed at two intervals (0-2' and 2-4') only to delineate metals in soil. To delineate the sources of TCE ground water contamination, 15 soil borings will be collected near the sumps and drain lines to the west, north, and east of Building 146. Fifteen additional samples will be collected in an outward direction from the sumps and drain lines. Samples will be collected at three depths as listed in Table 3-2. All samples will be analyzed for VOCs. The soil samples from these borings will be used to help delineate the extent of TCE contamination.

The soil samples for VOC analysis will be collected using EnCore Samplers. These samples will be collected from specific points within a sampling interval where the highest PID reading is measured. If no

elevated PID measurements are above background, then the samples will be collected from the middle of the sampling interval.

3.4.2 Ground Water Sampling Activities

Explosives contamination in ground water has not been completely delineated at SWMUs 13 and 16. Also, TCE contamination in ground water at SWMU 16 has not been completely delineated. Four additional wells (13MWT48, 13MWT49, 13MWT50, and 13MWT51) (see Table 3-4) will be installed in the valley to the northwest of SWMU 13 during Round 3, and three additional wells (16MWT19, 16MWT20, and 16MWT21) will be installed at SWMU 16 to complete the delineation of explosives (SWMUs 13 and 16) and TCE (SWMU 16) contamination in ground water.

The four new wells at SWMU 13 will be installed in the valley bottom northwest of the ridge on which the SWMU resides. These wells will be used to determine if and how RDX contaminated groundwater may be migrating down the hillside and might be entering the unnamed tributary stream.

The total depths and screened intervals for each new monitoring well will be determined in the field; the screen lengths will be 10 feet. Based on observations and information gathered during the drilling of each well boring, the total depth and the placement of the well screen will be determined at the discretion of the field geologist. Decisions concerning the monitored intervals and well depths will be based on the following (and possibly other) information collected while the well boring is being drilled and logged:

- The thickness of unconsolidated overburden and weathered bedrock at each drill site.
- The specific depths where the initial (shallow) and deeper water-yielding zones are encountered during drilling.
- The specific depths where above-average rates of ground water yield are observed during drilling.
- The specific depths where moderately to heavily fractured rock is encountered.
- The specific depth interval where potential contamination (i.e., VOCs), if any, is noted during drilling.

All of this information will be recorded on the boring log as each well boring is drilled.

Tables 3-4 and 3-5 provide information on Round 3 ground water analysis for SWMUs 13 and 16. Tables 3-6 and 3-7 provide information on Rounds 4 through 9 ground water analysis for SWMUs 13 and 16. Note that wells or parameters monitored in Rounds 4 through 9 may be deleted and/or added based on ongoing results.

Construction information for all existing monitoring wells at SWMU 13 is listed in Table 3-8. The physical characteristics for the four new wells at SWMU 13 are shown in Table 3-9. Construction information for all existing wells at SWMU 16 are given in Table 3-10. The physical characteristics for the two new wells to be installed at SWMU 16 are listed in Table 3-11.

New dedicated bladder pumps and Teflon tubing will be installed in each well that is part of the long-term monitoring program. Details of pumps and pump installation are presented in Section 3.5.6 and SOP CTO166-23.

3.4.2.1 SWMU 13 - Mine Fill B Ground Water Sampling

3.4.2.1.1 Round 3

In Round 3, all existing and newly installed wells will be analyzed for explosives and well stabilization parameters. These wells are listed in Table 3-4 and are shown in Figure 3-3. Table 3-5 provides a summary of the ground water analysis and QC samples.

3.4.2.2.2 Rounds 4 through 9

Explosives in ground water may be naturally degrading. If explosives are naturally degrading, concentrations of explosives would be expected to decrease over time. The primary purpose of Rounds 4 through 9 is to provide information on the temporal trends of concentrations of explosives and explosives degradation products in ground water. The information from these rounds will be utilized along with information from Rounds 1, 2, and 3 to establish long-term trends in concentrations of explosives in ground water and to estimate degradation rates.

The long-term monitoring program includes selected wells. Table 3-6 lists these wells and analyses for each round. Each sample will be analyzed for explosives. In even-numbered rounds (i.e., 4, 6, and 8), samples will also be analyzed for explosive degradation products. Table 3-7 provides a summary by round of the wells to be sampled, the ground water analyses to be performed, and QC samples to be collected.

3.4.2.2 SWMU 16 - Cast High Explosives Fill Ground Water Sampling

3.4.2.2.1 Round 3

In Round 3, all existing and newly installed wells at SWMU 16 will be analyzed for explosives, VOCs, natural attenuation parameters, and well stabilization parameters. These wells are listed in Table 3-4 and are shown in Figure 3-4. Table 3-5 provides a summary of the ground water sampling analyses and QC samples.

3.4.2.2.2 Rounds 4 through 9

Explosives in ground water may be naturally degrading at SWMU 16. If explosives are naturally degrading, concentrations of explosives would be expected to decrease over time. The primary purpose of Rounds 4 through 9 is to provide information on the temporal trends of concentrations of explosives and degradation products in ground water. The information from these rounds will be utilized along with information from Rounds 1, 2, and 3 to establish long-term trends in concentrations of explosives in ground water and to estimate degradation rates.

The long-term monitoring program includes 12 selected wells. Table 3-6 lists these wells and analyses for each round. Each sample will be analyzed for explosives and VOCs (Method 8260B). In even-numbered rounds (i.e., Rounds 4, 6, and 8), samples will also be analyzed for explosive degradation products. Table 3-7 includes a summary of the ground water analyses and QC samples.

3.4.3 Surface Water

Surface water sampling is proposed for SWMUs 13 and 16 in Round 3. For each proposed sampling location, a surface water sample will be collected when possible. Surface water may not be present at some of the sampling locations depending on flow conditions at the time of sampling.

Surface water samples will be collected using the methods described in Section 3.5.10. Each surface water sample will be analyzed for the analyte groups listed in Table 3-12. Surface water QA/QC samples will be collected as detailed in Table 3-13. No rinsate blanks will be collected because the sample bottles will be filled directly, as discussed in Section 3.5.10. The field duplicate will be analyzed for all parameters. The MSD will be analyzed for all parameters except inorganics, which will have an MS and a laboratory duplicate. The total number of analyses, including QA samples, for surface water samples is presented in Table 3-13.

3.4.3.1 SWMU 13 - Mine Fill B Surface Water

3.4.3.1.1 Round 3

For the investigation covered in this QAPP Addendum No.2, surface water samples will be collected from several existing and new sampling locations. The sampling locations and the parameters for which surface water will be analyzed are listed in Tables 3-12 and 3-13, respectively. The sampling locations are presented in Figure 3-3. The new sampling stations, 13SW/SD33, 13SW/SD34, and 13SW/SD35, are located in the western and northwestern portion of SWMU 13. All surface water samples will be analyzed for explosives, explosives degradation products, and nitrate + nitrite (see Table 3-12). Samples collected from several of the locations will be also be analyzed for total and dissolved metals (See Table 3-12).

3.4.3.1.2 Rounds 4 through 9

The surface water samples collected during Rounds 4 through 9 will be analyzed for explosives only. The information from these rounds will be utilized along with information from Rounds 1, 2, and 3 to establish long-term trends in concentrations of explosives in surface water at SWMU 13. Table 3-14 lists each surface water sample and analyses for each round. Table 3-15 provides a summary of analyses and QC samples for each round.

3.4.3.2 SWMU 16 – Cast High Explosives Fill Surface Water Sampling

3.4.3.2.1 Round 3

In Round 3, a surface water sample will be collected from each of several existing and new locations. The new locations are spread around the SMWU. All sampling locations and the parameters for which surface water will be analyzed are listed in Tables 3-12 and 3-13, respectively. The sampling locations are presented in Figure 3-4. Although water may not be available at the time of sampling all of these locations, the intent is to obtain enough data to refine the understanding of surface water contamination, especially regarding metals.

3.4.3.2.2 Rounds 4 through 9

Four surface water locations will be sampled during Rounds 4 through 9 and analyzed for VOCs and explosives. The information from these rounds will be utilized along with information from Rounds 1, 2, and 3 to establish long-term trends in concentrations of explosives and VOCs in surface water at SWMU

16. Tables 3-14 lists each surface water sample and analyses and QC samples. Table 3-15 provides a summary of analyses and QC samples.

3.4.4 Sediment

Sediment sampling is proposed for SWMUs 13 and 16 in Round 3. For each proposed sampling location one sediment sample will be collected. These samples will be collected using the methodology described in Section 3.5.11. Each sediment sample will be analyzed for the analyte groups listed in Table 3-16. Sediment QA/QC samples will be collected as detailed in Table 3-17. One field duplicate will be analyzed for all parameters; the other will only be analyzed for metals. The MSD will be analyzed for all parameters except inorganics, which will have an MS and a laboratory duplicate. The total number of analyses, including QA samples, for sediment samples is presented in Table 3-17.

3.4.4.1 SWMU 13 - Mine Fill B Sediment Sampling

3.4.4.1.1 Round 3

In Round 3, sediment samples will be collected to augment the current understanding of the extent of metals contamination in sediment. The intention is to revisit some previously sampled locations that exhibited elevated metals concentrations and to include some downgradient locations to monitor contaminant migration. The locations of the selected sampling points are shown on Figure 3-3 and the scheduled analyses are shown in Table 3-16.

3.4.4.1.2 Rounds 4 Through 9

No sediment samples will be collected at SWMU 13 during Rounds 4 through 9.

3.4.4.2 SWMU 16 - Cast High Explosives Fill Sediment Sampling

3.4.4.2.1 Round 3

In Round 3, sediment samples will be collected at three new locations (16SW/SD23, 16SW/SD24, and 16SW/SD25), which are shown in Figure 3-4. The sampling locations and parameters for which sediment samples will be analyzed are listed in Tables 3-16 and 3-17. The new sampling points are located approximately 0.25 miles east and southeast of SWMU 16. All sediment samples will be analyzed for metals only.

In Round 3, sediment samples will be collected to refine the understanding of the extent of metals and VOC contamination in sediment. The intent is to revisit some previously sampled locations that exhibited elevated metals or VOC concentrations and to include some additional downgradient locations to monitor contaminant migration. The number of locations at which VOCs will be analyzed is limited to locations near 16SW/SD12, which exhibited elevated VOC concentrations in the previous sampling round. The elevated VOC concentrations could indicate a discharge from the hillside so this area will be explored in more detail. The locations of the selected sampling points are shown on Figure 3-4 and the scheduled analyses are shown in Table 3-16.

3.4.4.2.2 Rounds 4 Through 9

No sediment samples will be collected at SWMU 16 during Rounds 4 through 9.

3.4.5 Vegetation Sampling (SWMU 13 Only)

Ground water is believed to discharge laterally from the bedrock into shallow soils along the hillsides. This ground water discharge is relatively slow and diffuse and results in areas of relatively wet soils and slow seepage into the gullies incised into the hillsides. Some portion of the ground water seepage flows to the larger drainage channels, with subsequent migration to further downgradient areas. However, much of the ground water seepage should be evaporated from wet soils into the atmosphere, or may be taken up by trees and understory vegetation and transpired, especially during spring, summer, and fall months. If a large portion of the ground water is being evaporated or transpired, then a large portion of the RDX may be accumulating in soils or vegetation along the hillside.

To determine whether RDX in ground water is being taken up by plants, a vegetation sampling program is being initiated during this field effort. Eighteen vegetation samples will be collected as part of this investigation from the general area designated as such on Figure 3-3. The exact locations from which vegetation samples will be collected will be determined in the field based on the availability of the plant species in the preferred areas. However, the vegetation samples will be spread throughout the area shown on Figure 3-3 to spatially cover the area. The samples will consist of leaves from trees, small shrubs, and acorns and will be collected according the SOP CTO166-24.

The samples to be collected are listed in Table 3-18 and the total number of vegetation samples, including QA/QC samples, to be collected is listed in Table 3-19. The exact locations from which vegetation samples will be collected will be based on the following factors:

- Availability of the leafy plants and trees.
- Size of plants (large plants with deep roots that span a large area are preferred).
- Accessibility (only plants with leaves that are safely accessible will be selected).

Additional detail is provided in Section 3.5.12.

3.5 INVESTIGATION EQUIPMENT AND PROCEDURES

3.5.1 UXO Screening of Selected Drilling Sites

Because of the prior uses of the areas to be investigated, there is only a very small possibility that UXO could be encountered during field operations. UXO clearance of drilling sites or other sites where intrusive activities are planned will **not** be performed unless specifically directed to do so by NSWC Crane. If this situation occurs, the activities at the specified location(s) will be conducted consistent with the UXO procedures discussed in the HASP. In addition, all UXO procedures and borehole clearance activities will be documented in the site UXO logbook.

3.5.2 DPT Sampling for Surface and Subsurface Soil

DPT (e.g., Geoprobe®) will be used to collect surface and subsurface soil samples from the unconsolidated overburden. The procedure for soil sampling using DPT is included in SOP CTO166-04. A new acetate liner will be used for each 2-foot section of soil core. Each removed soil core will be scanned for VOCs. The soil core will be visually inspected and logged by the field geologist, and the soil texture, grain size (sand, silt, or clay), color (and any unusual discoloration), moisture content, and the soil type will be identified by the field geologist using the soil type based on the Unified Soil Classification System (USCS).

After each soil core is retrieved, a photoionization detector (PID) will be used to scan the soil core for the presence of VOCs (see SOP CTO 166-06), and the soil cores will be logged by a geologist (see SOP CTO166-07). For samples requiring VOC analysis, the VOC sample will be collected from the point along the soil core that had the greatest PID reading using an Encore™ sampler (see SOP CTO 166-08). If no PID readings are greater than background, the VOC sample will be collected from any discolored area of the soil or from the midpoint of the core. However, VOC aliquots will be confined to depths of 1.0 to 2.0 feet bgs in the case of surface soil samples. The Encore™ samples will be collected from each core immediately after PID readings are collected. After the sample for VOC analysis has been collected, the remaining aliquot will be placed in a decontaminated stainless-steel mixing bowl, rocks, gravel, and other coarse debris will be removed, and the sample will be mixed using a decontaminated stainless-steel

spoon. The appropriate sample jars for remaining analyses will then be filled and properly labeled. The bowl and spoon will be decontaminated between each sample. Details regarding the collection and labeling of soil samples are included in SOP CTO166-01.

Up to two subsurface soil samples will be collected from each soil boring. Soil sample analytical information is presented in Table 3-2, and appropriate containers to be used for each sample aliquot are listed in Table 3-18. After the samples are containerized, labeled, tagged, and bagged (see SOPs CTO166-01 and 03), they will be placed in a cooler containing ice until they can be packaged and prepared for shipment (Section 3.7).

For each cooler containing soil samples identified for VOC analysis (i.e., Encore™ samplers), a trip blank will also be stored in the cooler and will continuously accompany the VOC samples until they have been analyzed. As samples are added to a cooler, the COC form will be updated to include each new sample (per SOP CTO166-03).

One duplicate soil sample will be collected for every 20 soil samples. Soil duplicates will be collected for those samples that have the greatest probability of containing contaminants (e.g., elevated levels of VOCs as indicated by PID readings). The duplicate samples will be placed in the same type of containers and handled in the same manner as the regular soil samples. The duplicate samples will be given unique QC sample identifications (see SOP CTO166-02). One rinsate blank will be collected for each specific equipment type. For soil samples, the rinsate blank will be collected by running distilled water over a decontaminated sampling spoon into a decontaminated mixing bowl. This water will be used to fill sample bottles for the rinsate blank. This process will continue until all the necessary bottles are filled for the rinsate sample.

Soil borings will be backfilled with either the soil cuttings (if visually uncontaminated) or bentonite pellets (if cuttings are visually contaminated) in accordance with Section 3.11.

When a boring has been sampled and backfilled, it will be identified by a tall wooden lath driven into the soil near the boring. In addition, a 2- by 2-inch wooden stake will be driven into the center of the backfilled boring. The stake and the lath will both have brightly colored flagging attached to them to increase visibility (for the survey crew), and both will be labeled using a waterproof marker with a unique soil boring number corresponding to the boring log.

3.5.3 Inspection and Repair of Existing Monitoring Wells

Existing monitoring wells at SWMUs 13 and 16 (see Table 3-4) will be sampled as part of this investigation. These wells may have broken casings, bent casings, missing caps, no locks, broken locks, obstructions, or other problems. In addition, it is possible that some of the wells may contain enough sediment at the bottom that the well screen may be partially or totally clogged. Therefore, at the beginning of field activities, the existing wells will be located, inspected, and repaired if possible. For example, broken or bent PVC riser pipes above the ground surface will be sawed off, and new riser pipes will be added. Caps and locks will be replaced if necessary. The height of casing above ground surface and the depth to the bottom of the well will be measured and recorded. This information will be compared to the boring logs and well construction logs to confirm that the wells are open through the screened interval. These activities are addressed in SOP CTO166-09. Each of the existing wells will be redeveloped, if needed (see SOP CTO166-10) prior to sampling.

3.5.4 Well Drilling and Installation

A total of six new shallow monitoring wells, one deep well and one intermediate well, will be installed at SWMUs 13 and 16 as part of this investigation. It is anticipated that the four new wells at SWMU 13 will be installed in overburden and the two new wells planned for SWMU 16 will be installed in bedrock. The soil and bedrock cores should provide an accurate characterization of stratigraphy, fracture distribution, and other features of the soil and rock units that occur at the base of the ridges at the two SWMUs.

Procedures for drilling and logging a boring in rock are included in SOP CTO166-11. The holes will be a minimum diameter of 5 inches prior to well installation activities. The rates of water produced during drilling will be carefully observed to identify zones that might be fractured and have above-average permeability characteristics. Drilling standby may be required to monitor for the presence of ground water.

A permanent monitoring well will be installed in each of the well borings. The wells will be constructed of 2-inch-diameter, Schedule 40, flush joint, PVC riser pipe and slotted screen (see SOP CTO166-12). In each well, the screen will be 10 feet long and have a slot size of 0.02 inch (factory slotted). All riser pipe and screen sections will be new and certified clean. Each well will consist of slotted screen and enough solid riser pipe so that the riser will extend approximately 2.5 feet above the ground surface.

A sand filter pack, bentonite seal, and cement-bentonite grout will be placed around the annulus of the well screen, from the bottom of the hole upward, according to SOP CTO166-12. An outer, black steel

protective casing will be installed around the PVC casing. The outer casing will extend at least 2 feet below the ground surface and no more than 4 inches above the inner PVC well cap. The steel casing will have a hinged cap or a removable cap and a padlock. A 6-inch-thick, 3- by-3-foot concrete surface pad will be constructed around each well at the ground surface. In addition, three barrier posts will be installed around the concrete pad. Details regarding well construction sand pack and grout materials, the outer protective casing, the well pad, and the protective barrier posts are included in SOP CTO166-12.

3.5.5 Well Development

All new monitoring wells will be developed in accordance with SOP CTO166-10 to remove fine sediment from inside and around the well screens. The method used to perform well development can be either vigorous on-and-off pumping or surge block and pumping, depending on which technique is most effective. Field measurements of pH, specific conductance, temperature, and turbidity will be collected at 5- to 10-minute intervals on the water retrieved from the well, in accordance with SOP CTO166-13. Well development will continue until the well water is clear to the unaided eye and until three subsequent consecutive readings of pH, specific conductance, and temperature are within 10 percent of each other and three consecutive turbidity readings are within 5 nephelometric turbidity units (NTUs) of each other. If the water-quality parameter criteria cannot be met after five well volumes of water have been removed, one additional well volume will be removed and well development will be considered complete.

All water removed from the well during the development process will be stored in a portable holding tank (already present at NSWC Crane) and discharged into a designated man-hole for treatment at the NSWC Crane water treatment facility (see SOP CTO166-14).

3.5.6 Bladder Pump Installation

Dedicated 1.66-inch-diamter, low-flow, bladder pumps (Teflon-lined PVC) will be installed in all the long-term monitoring wells prior to Round 3 ground water sampling. Each pump will be placed at the midpoint of the saturated well screen and, if possible, no less than 2 feet above the bottom of the well in order not to disturb any sediment located at the bottom of the well. Prior to pump installation, all the wells will be developed using a surge block and a submersible purge pump capable of reaching depths of 60 feet. In cases where well depths exceeded 60 feet, a bailer will be used instead of the submersible pump. The pumps will be certified contaminant free; this certification, as well as lot numbers, will be provided in an appendix in the RFI report. SOP166-23 (Appendix C) contains procedures for the installation/ replacement of dedicated pumps. This SOP also describes procedures for removal and reinstallation of pumps for well maintenance procedures, if necessary.

3.5.7 Water-Quality Field Measurements

Temperature, pH, oxidation-reduction potential (ORP), dissolved oxygen (DO), specific conductance, and turbidity will be measured for every aqueous sample collected, including all ground water and surface water. Field measurements of water-quality parameters will be collected from ground water in a flow-through cell attached to the pump discharge line. These measurements, except for DO and ORP, will be performed during well development (Section 3.5.5), and all of these measurements will be performed during low-flow well sampling (Section 3.5.8). These field measurements (temperature, pH, ORP, DO, and conductance) will be made using a YSI 6-Series Environmental Monitoring System or equivalent type of instrument. Turbidity measurements will be made using a LaMotte Turbidity Meter or equivalent. Calibration and measurements made with the field instruments will be in accordance with SOP CTO166-13. These same field water-quality parameters will be measured for each surface water and seep sample using procedures described in SOP CTO166-18.

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

3.5.8 Low-Flow Sampling of Monitoring Wells

Low-flow sampling procedures will be used to collect ground water samples from existing and new wells (see SOPs CTO166-05 and -15). If the depth to ground water is greater than 25 feet, a compressed air bladder pump or submersible pump will be used to slowly pump ground water from the well at about 100 milliliters per minute. Low-flow pumping will proceed until readings of temperature, pH, specific conductance, DO, ORP, and turbidity stabilize but for no longer than 4 hours. See SOP CTO166-15 for criteria for well stabilization. Appropriate sample bottles will be filled directly from the pump discharge tube. The bottles will be properly labeled, tagged, bagged, and placed in an ice-filled cooler as quickly as possible (see SOPs CTO166-01 and CTO166-03). A ground water collection log sheet will be completed for each ground water sample collected (see SOP CTO166-05).

The wells will be sampled in order of least contaminated to most contaminated, starting with the upgradient wells, proceeding to the far downgradient wells, and finishing with the source wells. This approach will lessen the possibility of cross contamination between wells. After each ground water sample is collected, the pump will be decontaminated (SOP CTO 166-16). Periodically, a rinsate blank

sample will be collected to ensure that decontamination of the pump is effectively accomplished. The rinsate blank will be collected by pumping distilled water through the pump and placing the pump discharge water directly into sample jars. The appropriate sample jars and preservatives for each analyte group are listed in Table 3-19.

For each cooler containing ground water samples identified for VOC analysis, a trip blank will be included in the cooler. The trip blank will accompany the VOC samples until they have been analyzed for VOCs. As samples are added to a cooler, the COC form will be updated to include each new sample container (see SOP CTO166-03).

3.5.9 Ground Water-Level Measurements

One synoptic round of water-level measurements and total well depth soundings will be obtained at all of the new and existing monitoring wells at the SWMUs during each round. All water-level measurements at a single SWMU will be taken within a 8-hour period using an electronic water-level meter. Water-level elevations will be recorded to within a 0.01-foot accuracy from a marked reference point on the well riser pipe. Detailed procedures regarding water-level measurements are included in SOP CTO166-17. Water levels will be recorded on a TtNUS water-level form. A blank water-level form is provided in SOP CTO166-17 for reference purposes. The water-level meter will be decontaminated between each well; decontamination procedures are addressed in SOP CTO166-16.

3.5.10 Surface Water Sampling

Surface water samples will be collected as grab samples from SWMUs 13 and 16 in accordance with SOP CTO166-18. It will be assumed that the water flowing at the sample locations is thoroughly mixed and that a sufficient volume of water is present for sample collection. If no water is present at a sampling location or if the water present is not perceptibly flowing, a surface water sample will not be collected from the location. Sample bottles will be filled directly in the flowing water. If the depth of water is not sufficient to lower the bottles into the water without disturbing bottom sediment, a decontaminated shovel will be used to dig a depression (i.e., a small pool) about 2 feet deep where the water can accumulate and pass through. After suspended sediment in the pool has settled out or is carried downstream, the unfiltered surface water sample, one sample per pool, will be collected. The bottles will be properly labeled (see SOP CTO166-01), tagged, bagged, and placed in an ice-filled cooler.

Field water-quality measurements (temperature, pH, ORP, dissolved oxygen, specific conductance, and turbidity) will be made at each surface water sampling location immediately after a sample has been collected. These data will be recorded on the surface water sample collection log sheet.

3.5.11 Sediment Sampling

Sediment samples will be collected as grab samples from SWMUs 13 and 16 in accordance with SOP CTO166-19. Sampling locations for sediment will be adjusted to positions along stream channels and gullies where sediment is available. This may be especially important in areas of gullies and streams where the bed is rocky. At these locations, sediment samples will be collected from beneath the water surface at the water's edge. If water is not visibly present, then the sediment sample will be collected from an area of deposition where the finest sediment is present and the sediment is moist or wet. Sample aliquots collected for VOC analysis will not be stirred or homogenized, and the sediment will be placed in a separate container for VOC analyses, with a minimum exposure to air. The appropriate sample jars for other parameters (Table 3-21) will then be filled directly from the sediment surface using disposable plastic spoons or trowels. Sample materials will be collected from 0 to 6 inches beneath the surface.

A 2- by 2-inch wooden stake with attached flagging material will be driven into each sediment sampling location, and the sample identification number will be marked on the stake with a black waterproof marker. Alternatively, stakes may be driven into the stream bank to mark the location of the sediment sample. This will be done so that the sampling location can be revisited at a later date, if necessary, for surveying or resampling purposes.

3.5.12 Vegetation Sampling

Eight samples of leaves will be collected from plants in accordance with SOP CTO166-24. Each sample will consist of multiple leaves from the same tree in order to obtain an adequate sample weight required by the analytical laboratory. Leaves from larger trees were selected for collection because the larger root system of those trees have a better likelihood of absorbing contaminated ground water than do smaller trees with smaller root systems. The samples will be spaced throughout the area identified on Figure 3-3, to spatially represent the likely area where contaminated ground water is present. Because the accumulation of RDX is species dependent the ten samples will be divided between the two most abundant tree species present in the area; five samples will be collected from each species.

In addition to the tree leaf samples, five non-woody shrub leaf samples will be collected close to the trees that are sampled. The shrub samples will be collected in areas with damp soil to ensure that their roots

are in contact with the ground water. Each sample will consist of a single shrub species but more than one plant may be needed for each sample in order to obtain an adequate sample weight required by the analytical laboratory. One to two different shrub species may be selected for collection based on their availability and abundance in the areas.

Seeds may have the greatest concentrations of RDX compared to the leaves, stems, or roots. Therefore, two acorn samples will be collected because the RDX concentrations may be greater in the acorns than the leaves. Each acorn sample will consist of multiple acorns and will be collected from the same tree as the leaves, if possible. It is expected that at least one of the trees selected for sampling will be an oak species.

All of the samples will be rinsed with distilled water immediately after collection to remove soil and dust particles from the sample so that only the portion of the explosives in the tissue will be analyzed. Two rinsate samples from the leaves (one from each tree species) and one rinsate sample from the shrub (the shrub that is more abundant) will be collected for analysis to determine if any explosives were bound to the outside of the plant.

3.5.13 Estimation of Stream Flow

The approximate flow rate of surface water at each surface water sampling and staff gauge location will be estimated at the times when the water samples are collected. These estimates will be approximate and will be accomplished by measuring the cross sectional width of the flowing water, the average depth of the flowing water, and the approximate water velocity, in accordance with SOP CTO 166-20. The information will be used to evaluate surface water flow in relation to each site's drainage system and to help evaluate potential impacts to downstream water bodies (e.g., Turkey Creek and Boggs Creek).

3.5.14 Aquifer Testing

Aquifer testing in the form of slug tests will be performed in each of the newly installed wells at each of the two SWMUs. Both rising- and falling-head tests will be performed in wells with submerged well screens; only rising-head tests will be performed in wells for which the screened interval intersects the water table. The slug tests will be performed in accordance with SOP CTO 166-21.

3.6 QUALITY CONTROL SAMPLES

This section focuses on field QC samples that will be collected as part of this environmental investigation, including field duplicates, source water blanks, equipment rinsate blanks, and trip blanks. Tables 3-3,

3-6, 3-7, 3-13, and 3-15 present the types and numbers of required field QC samples to be collected for soil, ground water, and surface water sampling activities, respectively, during the field investigation. Table 3-20 provides an overview of QC frequencies and corrective action measures. Section 7.0 of the originally approved QAPP (TtNUS, 2003a) provides definitions and details for these and all other QC checks to be used during this investigation. Field QC sample requirements for field duplicates, source water blanks, equipment rinsate blanks, and trip blanks required for this project are described below.

Field Duplicates. Field duplicates are obtained during a single act of sampling and are used to assess the overall precision of the sampling and analysis program. Duplicate samples will be collected at a rate of one for every 20 samples of each type of environmental medium. All duplicate samples will be analyzed for the same parameters in the laboratory as their environmental sample counterparts. Duplicate samples will be preferentially collected where field evidence (i.e., PID reading, odor, or analytical data from Rounds 1 and 2) indicates that contamination is likely to be present in the environmental sample.

Equipment Rinsate Blanks. Equipment rinsate blanks will be obtained under representative field conditions by running analyte-free water through sample collection equipment after decontamination and placing it in the appropriate sample containers for analysis. Equipment rinsate blanks will be collected for non-dedicated equipment. For surface and subsurface soil sampling activities, rinsate blanks will be collected by running analyte-free water over the decontaminated stainless-steel bowl and spoon used to mix soil before it is placed in sample jars. For ground water samples collected using non-dedicated pumps, analyte-free water will be pumped through a decontaminated pump and tubing used for ground water sampling. For groundwater samples collected with dedicated pumps, one batch blank will be collected by pumping analyte-free water through the pump and tubing. Equipment rinsate blanks will not be required for surface water and sediment samples. Surface water samples will be collected directly from the surface water body, and only new disposable spoons will be used to collect sediment samples.

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

Trip Blanks. Trip blank samples are 40-mL glass vials that contain analyte-free water and are prepared by the analytical laboratory prior to the start of field activities. They will be stored in a sealed container until they are needed. During sampling activities, one trip blank, consisting of one vial, will be placed in each cooler that contains environmental samples destined for VOC analysis. The trip blank will be properly labeled and added to the COC form for the cooler. Trip blanks are only analyzed for VOCs.

3.7 SAMPLE HANDLING, PACKAGING, AND SHIPPING

3.7.1 Sample Preservation

Preservation requirements for each of the chemicals of interest are provided in Tables 3-18 and 3-19. All soil samples are to be cooled to 4°C ± 2°C; no chemical preservatives are necessary. Sample bottles for aqueous samples will contain the proper amounts and types of preservatives before they are shipped to NSWC Crane (Table 3-17). The preservatives placed in the sample bottles will be certified that they are free of analytes being tested in the samples. All samples will be promptly chilled with ice to 4°C ± 2°C and packaged in an insulated cooler. Each cooler will include a temperature blank. Ice will be sealed in containers to prevent water leakage. Samples will not be frozen.

3.7.2 Sample Labeling

Before samples are packaged, the sample labels and tags will be checked to ensure that all information on the labels and tags is complete and correct (see SOP CTO166-01) and that it matches the information on the sample collection log sheets and the COC form.

3.7.3 Sample Packaging

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

The completed field COC document will be signed, placed in a sealed plastic envelope, and taped to the top inside cover of the shipping container (see SOP CTO166-03).

SOP CTO166-01 provides a detailed description of sample handling, packaging, and shipping procedures required for this project. The FOL will be responsible for ensuring the completion of the following forms:

- Sample labels and tags
- COC forms
- Custody seals for coolers
- Shipping labels for coolers
- Express mail air bills

3.7.4 Sample Shipping

Shipping containers (i.e., coolers) will be sealed with nylon strapping tape in at least two places, and custody seals will be signed, dated, and affixed in a manner that will allow the receiver to quickly identify any tampering that may have occurred during transport to the laboratory (see SOPs CTO166-01 and -03).

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

3.7.5 Sample Custody

Custody of samples must be maintained and documented at all times, in accordance with SOP CTO166-03, beginning with the collection of samples in the field. Sample custody procedures are addressed in the original approved QAPP (TtNUS, 2003a).

3.8 RECORD KEEPING

Standard forms, field notebooks, and a field logbook will be used to record all sample collection activities, field measurements, observations concerning site conditions, and other project-related information. These records include sample log sheets, daily activity records, field logbooks, drilling and well completion log sheets, and field instrument calibration log sheets, among others. More details regarding record keeping are included in SOP CTO166-03.

3.8.1 Field Log Books

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

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

3.8.2 Drilling and Well Completion Logs

A drilling log will be completed for every boring drilled during these field activities. A geologist will complete the drilling log, which will include information regarding date, time, personnel present, drilling and sampling equipment, geologic materials encountered, fracture locations and frequency (where appropriate), water yields, color, texture, odors, and readings made with the screening instruments (see SOPs CTO166-07 and CTO166-11).

A well completion log will be completed for every monitoring well constructed. These logs will include information concerning the date, times of events, quantities of construction materials used, lengths, depths, and diameters of riser pipe and well screen placed in the well, and other information, as described in SOP CTO166-12.

3.8.3 Well Development Log Sheets

During the development or redevelopment of each monitoring well, the date, times of events, development method and equipment, personnel present, amounts of water produced, measurements made by field water-quality meters, and depths to water will be recorded on a well development log sheet, as described in SOP CTO166-10.

3.8.4 Equipment Calibration Logs

An equipment calibration log sheet will be used to record each time an instrument is calibrated, recalibrated, or checked against a standard or background. The procedures and standards to be used for instrument calibration are discussed in Section 5.1 of the originally approved QAPP (TtNUS, 2003a) and SOPs CTO166-06 and CTO166-13.

3.8.5 Sample Collection Logs

All sample log sheets will be completed in accordance with SOP CTO166-03.

3.8.6 Chain-of-Custody Forms

A COC form will be completed for every cooler that contains samples being shipped to an off-site laboratory for analyses. These forms are a record of the people having custody of the samples from the time the samples are collected to the time they are analyzed and disposed (see SOP CTO166-03). The completed field COC document will be signed, placed in a sealed plastic envelope, and taped to the top inside cover of the shipping container before it is shipped. A copy of the COC document will be retained by the FOL.

3.8.7 Shipping Forms/Air Bills

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

3.8.8 Permanent Record File

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

3.9 SURVEYING

The location of every soil boring and surface water and sediment sample location will be marked with a wooden lath and flagging, and a boring hole number or sample ID will be marked on the lath. In addition, a 2- by 2-inch wooden stake, 6 inches long, will be driven into the ground at the center of each backfilled boring. This stake will have a piece of brightly colored flagging tacked onto its top, and the boring hole number will be indelibly marked on the side of the stake.

The horizontal locations and vertical elevations of all new monitoring wells, soil borings, surface water and sediment sampling locations, and staff gauges will be surveyed. Horizontal locations will be surveyed to the Indiana State Plane Coordinates System within the nearest foot and referenced to the 1983 North American Datum (NAD) 83. The vertical elevations of the ground surface and tops of casing for wells, the tops of the staff gauges, and the ground surface for the borings and surface water and sediment sampling locations will be measured to the nearest 0.01 foot and referenced to the North American Vertical Datum (NAVD) of 1988. The survey will be conducted by an Indiana-licensed surveyor.

3.10 EQUIPMENT DECONTAMINATION

All non-dedicated equipment used to collect soil and ground water samples will be decontaminated in accordance with SOP CTO166-16.

3.11 MANAGEMENT OF INVESTIGATION-DERIVED WASTE

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

- Personal protective equipment (PPE)
- Ground water sample tubing and DPT sample liners
- Well development and purge fluids
- Equipment decontamination fluids
- Waste cuttings from drilling activities

IDW will be handled as follows:

- All PPE, tubing, and DPT sample liners will be decontaminated and double bagged and placed in trash receptacles at NSWC Crane.

- All well development and purge fluids will be collected, stored, and discharged to the NSWC Crane permitted sanitary sewer system in accordance with SOP CTO166-14.

- All drilling equipment decontamination fluids will be combined with well development and purge fluids and handled in the same manner.

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

- For each boring, waste cuttings will be scanned for VOCs. If all readings from screening instruments are at background levels, the soil cuttings from soil borings will be mixed with bentonite, placed back into the hole, and tamped for compaction or spread on the ground adjacent to the borehole. Borings that contain contaminated cuttings or rock cores will be backfilled with bentonite pellets or a cement-bentonite slurry. Contaminated cuttings or rock cores from borings will be placed in black plastic

trash bags (or directly in drums if in larger quantities), labeled, and then placed in 55-gallon sealable drums. The bags will be tagged and the drums will be clearly labeled with the dates, locations, and depths from which the soils originated and the personnel (including phone number) placing the cuttings in the drum. When analytical results concerning contaminant concentrations in the soil samples are received from the laboratory, decisions will be made as to how to dispose of the soil materials (see SOP CTO166-14).

3.12 SAFETY

The health and safety activities described in the following sections will ensure that field activities are performed at a high level of safety.

3.12.1 Health and Safety Plan

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

3.12.2 Health and Safety Training

All workers involved with the site investigations shall have successfully completed the Occupational Safety and Health Administration (OSHA)-mandated 40-hour health and safety training and the follow-up annual 8-hour refresher courses when appropriate.

TtNUS and subcontractor personnel will supply OSHA documentation to the FOL before beginning work. Personnel who do not comply with this requirement must receive verbal approval to work from TtNUS corporate health and safety personnel.

3.12.3 Personal Protective Clothing and Equipment

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

3.12.4 Safety Meetings

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

3.13 ORGANIZATION AND LOGISTICS OF FIELD INVESTIGATIONS

3.13.1 Personnel

The duties, responsibilities, and line of command for each person working on the project are described in Section 2.0 and displayed on Figure 2-1. Staffing and coordination requirements are described in Section 2.0 of the approved QAPP (TtNUS, 2003a). Persons working on the project will be intimately familiar with their roles and responsibilities. In addition, they will be familiar with the mechanisms and procedures for coordinating tasks, improving communications, and reporting incidences or irregularities. The FOL is responsible for coordinating all on-site personnel and activities (Section 2.3.1). The SSO is responsible for health and safety monitoring and ensures that the HASP is adhered to during all field activities (Section 2.3.3). The SSO has the authority to stop work if an imminent safety hazard is encountered (Section 2.3).

3.13.2 Subcontractors

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

3.13.3 Mobilization and Demobilization

Following approval of the QAPP Addendum No.2, TtNUS will begin mobilization activities. All field team members will review the QAPP Addendum No. 2 (including the HASP) prior to mobilization. In addition, a field team orientation meeting will be held to familiarize personnel with the scope of the field activities. Items to be presented during that meeting include the following:

- Identification of the QAPP Addendum No. 2, the HASP, and applicable field SOPs (Appendix C).
- Site-specific safety concerns and requirements.
- Project objectives.

- Sampling designs and strategies for soil and ground water (including the relationship of soils data for this project to NSWC Crane background soils data).

- Site-specific particulars of field operations (e.g., locations of utilities, physical access to sampling locations, communication mechanisms, lines of authority and responsibility, scheduling requirements, sample shipping concerns, etc.).

- Laboratory and other subcontractor coordination.

- Site access requirements.

- Travel requirements.

The FOL will coordinate the mobilization activities for this project. The equipment required for the field activities will be mobilized from the TtNUS Pittsburgh office or from a third-party vendor. The FOL and crew will demobilize from the site upon completion of the field operations and transport field equipment back to the TtNUS Pittsburgh office, as necessary. All areas will be thoroughly checked, and trash will be removed and disposed properly.

TABLE 3-1

FIELD SCREENING AND MEASUREMENTS
SWMU 13 (ROUNDS 3-9) AND SWMU 16 (ROUNDS 3-9)
NSWC CRANE
CRANE, INDIANA

Parameter	Equipment	SOP	Calibration
Volatile Organics	Perkin-Elmer Photovac 2020 Photoionization Detector	SOP CTO166-06	Per Manufacturer
pH(1) Temperature(1) Oxidation-reduction potential(1) Specific Conductance(1) Dissolved Oxygen(1)	YSI 6-Series Environmental Monitoring System	SOP CTO166-13	Per Manufacturer
Turbidity(1)	LaMotte Turbidity Meter	SOP CTO166-13	Per Manufacturer
Water-Level Measurements	Heron Dipper-T (or equivalent)(2)	SOP CTO166-17	Per Manufacturer

1 Field measurements of water quality parameters are used to establish well stabilization prior to collecting ground water samples. Field measurements will also be collected at each surface water sample location.
2 Any electronic water-level indicator with the capability of measuring to depths of 100 feet may be used.
SOP = Standard Operating Procedure.

TABLE 3-2

LISTING OF SOIL SAMPLES AND LABORATORY ANALYSES[1]
SWMU 13 (ROUND 3) AND SWMU 16 (ROUND 3)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample Depth[2]	Volatiles		PCBs	Metals	
		SW-846 8260B	SW-846 8015B	SW-846 8082	Metals (except Mercury) SW-846 6020	Mercury SW-846 7471A
SWMU 13						
13SB26	0-2 ft bgs			1		
	2-4 ft bgs			1		
13SB27	0-2 ft bgs			1		
	2-4 ft bgs			1		
13SB28	2-4 ft bgs			1		
	4-6 ft bgs			1		
13SB29	0-2 ft bgs			1		
	2-4 ft bgs			1		
13SB30	0-2 ft bgs			1		
	2-4 ft bgs			1		
13SB31	4-6 ft bgs			1		
	6-8 ft bgs			1		
13SB32	0-2 ft bgs			1		
	2-4 ft bgs			1		
13SB33	0-2 ft bgs			1		
	2-4 ft bgs			1		
13SB34	0-2 ft bgs			1		
	2-4 ft bgs			1		
13SB35	0-2 ft bgs			1		
	2-4 ft bgs			1		
13SB36	0-2 ft bgs			1		
	2-4 ft bgs			1		
13SB37	0-2 ft bgs			1		
	2-4 ft bgs			1		
13SB38	0-2 ft bgs			1		
	2-4 ft bgs			1		
13SB39	0-2 ft bgs			1		
	2-4 ft bgs			1		
13SB40	0-2 ft bgs			1		
	2-4 ft bgs			1		
13SB41	4-6 ft bgs			1		
	6-8 ft bgs			1		
13SB42	4-6 ft bgs			1		
	6-8 ft bgs			1		
13SB43	4-6 ft bgs			1		
13SB44	4-6 ft bgs			1		
13SB45	4-6 ft bgs			1		
13SB46	4-6 ft bgs			1		
13SB47	4-6 ft bgs			1		
Total Soil Samples SWMU 13		0	0	39	0	0
SWMU 16						
16SB51	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			
16SB52	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			
16SB53	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			
16SB54	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			

TABLE 3-2

LISTING OF SOIL SAMPLES AND LABORATORY ANALYSES[1]
SWMU 13 (ROUND 3) AND SWMU 16 (ROUND 3)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample Depth[2]	Volatiles		PCBs	Metals	
		SW-846 8260B	SW-846 8015B	SW-846 8082	Metals (except Mercury) SW-846 6020	Mercury SW-846 7471A
16SB55	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			
16SB56	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			
16SB57	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			
16SB58	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			
16SB59	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			
16SB60	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			
16SB61	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			
16SB62	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			
16SB63	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			
16SB64	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			
16SB65	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			
16SB66	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			
16SB67	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			
16SB68	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			
16SB69	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			
16SB70	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			

TABLE 3-2

LISTING OF SOIL SAMPLES AND LABORATORY ANALYSES[1]
SWMU 13 (ROUND 3) AND SWMU 16 (ROUND 3)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample Depth[2]	Volatiles		PCBs	Metals	
		SW-846 8260B	SW-846 8015B	SW-846 8082	Metals (except Mercury) SW-846 6020	Mercury SW-846 7471A
16SB71	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			
16SB72	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			
16SB73	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			
16SB74	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			
16SB75	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			
16SB76	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			
16SB77	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			
16SB78	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			
16SB79 (discretionary)	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			
16SB80 (discretionary)	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			
16SB81	1-2 ft bgs	1	1			
	2-6 ft bgs	1	1			
	6 ft bgs to bedrock	1	1			
16SB82	1-2 ft bgs				1	1
	2-4 ft bgs				1	1
16SB83	1-2 ft bgs				1	1
	2-4 ft bgs				1	1
16SB84	1-2 ft bgs				1	1
	2-4 ft bgs				1	1
16SB85	1-2 ft bgs				1	1
	2-4 ft bgs				1	1
16SB86	1-2 ft bgs				1	1
	2-4 ft bgs				1	1
16SB87	1-2 ft bgs				1	1
	2-4 ft bgs				1	1
16SB88	1-2 ft bgs				1	1
	2-4 ft bgs				1	1
16SB89	1-2 ft bgs				1	1
	2-4 ft bgs				1	1
Total Soil Samples SWMU 16		93	93	0	16	16

1 See Table 1-6 of this QAPP Addendum No. 2 for specific analysis requirements and analyte lists.
2 Samples for VOC analysis will be collected from the point in the designated interval where the highest PID measurement occurs, or the center of the interval if no PID reading exceeds background.

TABLE 3-3

SUMMARY OF SOIL ANALYSES[1] AND QUALITY CONTROL SAMPLES
SWMU 13 (ROUND 3) AND SWMU 16 (ROUND 3)
NSWC CRANE
CRANE, INDIANA

Sample Type	Volatiles		PCBs	Metals	
	SW-846 8260B	SW-846 8015B	SW-846 8082	Metals (except Mercury) SW-846 6020	Mercury SW-846 7471A
SWMU 13 Samples	0	0	39	0	0
SWMU 16 Samples	93	93	0	16	16
Total Samples All SWMUs	93	93	39	16	16
Field Duplicate[2]	5	5	2	1	1
Trip Blank[3]	10	10	0	0	0
Rinsate Blank[4]	2	2	NA	1	1
Source Water Blank	1	1	1	1	1
Ambient Condition Blank[5]	TBD	TBD	TBD	TBD	TBD
Matrix Spike[6]	5	5	2	1	1
Matrix Spike Duplicate[7]	5	5	2	0	0

1 See Table 1-6 of this QAPP Addendum No. 2 for specific analysis requirements and analyte lists.
2 Field duplicates will be collected at a frequency of one per every 20 samples per SWMU.
3 Trip blanks will be submitted for analysis at a frequency of one per cooler containing samples for volatile analysis. Because the number of sample coolers shipped may vary, the number of trip blanks is estimated.
4 Rinsate blanks will be collected at a minumum frequency of one per sampling device or instrument. These amounts are estimates and may vary. Rinsates will not be collected for VOC samples that are collected using EnCore samplers.
5 Ambient condition blanks are optional samples that may be collected based on the judgment of the FOL.
6 Matrix spikes are collected for all organic and inorganic parameters at a frequency of one per every 20 field samples per matrix.
7 Matrix spike duplicates are collected for all organic parameters. Laboratory duplicates are analyzed for inorganic parameters in lieu of matrix spike duplicates. Matrix spike duplicates are collected at a frequency of one per every 20 field samples per matrix.

NA - Not applicable.
PCBs - Polychlorinated biphenyl.
TBD - To Be Determined by the FOL.

TABLE 3-4

GROUND WATER SAMPLES AND LABORATORY ANALYSES[1]
SWMU 13 (ROUND 3) AND SWMU 16 (ROUND 3)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample ID	Volatiles		Explosives		Miscellaneous				Metals	
		SW-846 8260B	SW-846 8015B	Nitroaromatics and Nitramines SW-846 8330	RDX Degradation Products SW-846-8330, Modified	Nitrate + Nitrite (as N) EPA 353.2	Sulfate	Chloride	Methane, Ethane, Ethene	Metals (except Mercury) SW-846 6020	Mercury SW-846 7470A
SWMU 13											
13MWT01	13GWT0103			1							
13MWT02	13GWT0203			1							
13MWT03	13GWT0303			1							
13MWT04	13GWT0403			1							
13MWT05	13GWT0503			1						1	1
13MWT06	13GWT0603			1							
13MWT07	13GWT0703			1							
13MWT08	13GWT0803			1							
13MWT09	13GWT0904			1							
13MWT10	13GWT1003			1							
13MWT11	13GWT1103			1							
13MWT12	13GWT1203			1							
13MWT13	13GWT1303			1							
13MWT14	13GWT1403			1							
13MWT15	13GWT1503			1							
13MWT16	13GWT1603			1							
13MWT17	13GWT1703			1							
13MWT18	13GWT1803			1							
13MWT19	13GWT1903			1							
13MWT20	13GWT2004			1						1	1
13MWT21	13GWT2103			1							
13MWT22	13GWT2203			1							
13MWT23	13GWT2303			1							
13MWT24	13GWT2403			1							
13MWT25	13GWT2503			1						1	1
13MWT26	13GWT2603			1							
13MWT27	13GWT2702			1							
13MWT28	13GWT2802			1							
13MWT29	13GWT2902			1							
13MWT30	13GWT3002			1							
13MWT31	13GWT3102			1							
13MWT32	13GWT3202			1							
13MWT33	13GWT3302			1						1	1
13MWT34	13GWT3402			1							
13MWT35	13GWT3502			1							
13MWT36	13GWT3602			1							

TABLE 3-4

GROUND WATER SAMPLES AND LABORATORY ANALYSES[1]
SWMU 13 (ROUND 3) AND SWMU 16 (ROUND 3)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample ID	Volatiles		Explosives		Miscellaneous				Metals	
		SW-846 8260B	SW-846 8015B	Nitroaromatics and Nitramines SW-846 8330	RDX Degradation Products SW-846-8330, Modified	Nitrate + Nitrite (as N) EPA 353.2	Sulfate	Chloride	Methane, Ethane, Ethene	Metals (except Mercury) SW-846 6020	Mercury SW-846 7470A
SWMU 13 (Continued)											
13MWT37	13GWT3702			1							
13MWT38	13GWT3802			1							
13MWT39	13GWT3902			1							
13MWT40	13GWT4002			1							
13MWT41	13GWT4102			1							
13MWT42	13GWT4202			1							
13MWT43	13GWT4302			1							
13MWT44	13GWT4402			1							
13MWT45	13GWT4502			1							
13MWT46	13GWT4602			1							
13MWT47	13GWT4702			1						1	1
13MWT48	13GWT4801			1						1	1
13MWT49	13GWT4901			1						1	1
13MWT50	13GWT5001			1						1	1
13MWT51	13GWT5101			1						1	1
SWMU 13 Total Samples		0	0	51	0	0	0	0	0	9	9
SWMU 16											
WES-14-01-83	16GW0103	1	1	1							
WES-14-02-83	16GW0204	1	1	1							
WES-14-03-83	16GW0303	1	1	1							
WES-14-04-83	16GW0403	1	1	1							
WES-14-05-83	16GW0503	1	1	1							
16MWT01	16GWT0103	1	1	1							
16MWT02	16GWT0203	1	1	1							
16MWT03	16GWT0303	1	1	1							
16MWT04	16GWT0403	1	1	1							
16MWT05	16GWT0503	1	1	1							
16MWT06	16GWT0604	1	1	1							
16MWT07	16GWT0702	1	1	1							
16MWT08	16GWT0802	1	1	1						1	1
16MWT09	16GWT0902	1	1	1							
16MWT10	16GWT1002	1	1	1							
16MWT11	16GWT1102	1	1	1						1	1
16MWT12	16GWT1202	1	1	1							
16MWT13	16GWT1302	1	1	1							

TABLE 3-4

GROUND WATER SAMPLES AND LABORATORY ANALYSES[1]
SWMU 13 (ROUND 3) AND SWMU 16 (ROUND 3)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample ID	Volatiles		Explosives		Miscellaneous				Metals	
		SW-846 8260B	SW-846 8015B	Nitroaromatics and Nitramines SW-846 8330	RDX Degradation Products SW-846-8330, Modified	Nitrate + Nitrite (as N) EPA 353.2	Sulfate	Chloride	Methane, Ethane, Ethene	Metals (except Mercury) SW-846 6020	Mercury SW-846 7470A
SWMU 16 (Continued)											
16MWT15	16GWT1502	1	1	1							
16MWT16	16GWT1602	1	1	1						1	1
16MWT17	16GWT1702	1	1	1							
16MWT18	16GWT1802	1	1	1							
16MWT19	16GWT1901	1	1	1						1	1
16MWT20	16GWT2001	1	1	1						1	1
16MWT21	16GWT2101	1	1	1						1	1
SWMU 16 Total Samples		25	25	25	0	0	0	0	0	6	6

1 See Table 1-6 of this QAPP Addendum No. 2 for specific analysis requirements and analyte lists.

TABLE 3-5

SUMMARY OF GROUND WATER ANALYSES[1] AND QUALITY CONTROL SAMPLES
SWMU 13 (ROUND 3) AND SWMU 16 (ROUND 3)
NSWC CRANE
CRANE, INDIANA

Sample Type	Volatiles		Explosives		Miscellaneous				Metals	
	SW-846 8260B	SW-846 8015B	Nitroaromatics and Nitramines SW-846 8330	RDX Degradation Products SW-846 8330, Modified	Nitrate + Nitrite (as N) EPA 353.2	Sulfate	Chloride	Methane, Ethane, Ethene	Metals (except Mercury) SW-846 6020	Mercury SW-846 7470A
SWMU 13 Samples	0	0	51	0	0	0	0	0	9	9
SWMU 16 Samples	25	25	25	0	0	0	0	0	6	6
Total Samples All SWMUs	**25**	**25**	**76**	0	**0**	**0**	**0**	**0**	**15**	**15**
Field Duplicate[2]	2	2	4	0	0	0	0	0	1	1
Trip Blank[3]	5	5	NA	NA	NA	NA	NA	NA	NA	NA
Rinsate Blank[4]	1	1	1	0	0	0	0	NA	1	1
Source Water Blank	1	1	1	0	0	0	0	NA	1	1
Ambient Condition Blank[5]	1	1	1	0	0	0	0	NA	1	1
Matrix Spike[6]	2	2	4	0	0	0	0	NA	1	1
Matrix Spike Duplicate[7]	2	2	4	0	NA	NA	NA	NA	1	1

1 See Table 1-6 of this QAPP Addendum No. 2 for specific analysis requirements and analyte lists.
2 Field duplicates will be collected at a frequency of one per every 20 samples per SWMU.
3 Trip blanks will be submitted for analysis at a frequency of one per cooler containing samples for volatile analysis. Because the number of sample coolers shipped may vary, the number of trip blanks are estimated.
4 Rinsate blanks will be collected at a frequency of one per sampling device or instrument. These amounts are estimates and may vary.
5 Ambient condition blanks are optional samples that may be collected based on the judgment of the FOL.
6 Matrix spikes are collected for all organic and inorganic parameters at a frequency of one per every 20 field samples per matrix.
7 Matrix spike duplicates are collected for all organic parameters. Laboratory duplicates are analyzed for inorganic parameters in lieu of matrix spike duplicates. Matrix spike duplicates are collected at a frequency of one per every 20 field samples per matrix.
NA - Not applicable.

TABLE 3-6

GROUND WATER SAMPLES AND LABORATORY ANALYSES[1]
LONG-TERM MONITORING PROGRAM FOR SELECTED WELLS
SWMU 13 (ROUNDS 4 THROUGH 9) AND SWMU 16 (ROUNDS 4 THROUGH 9)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample ID	Volatiles	Explosives		Miscellaneous			
		SW-846 8260B	Nitroaromatics and Nitramines SW-846 8330	RDX Degradation Products SW-846-8330, Modified	Nitrate + Nitrite (as N) EPA 353.2	Sulfate	Chloride	Methane, Ethane, Ethene
SWMU 13								
Round 4								
13MWT01	13GWT0104		1	1	1			
13MWT09	13GWT0905		1	1	1			
13MWT11	13GWT1104		1	1	1			
13MWT13	13GWT1304		1	1	1			
13MWT14	13GWT1404		1	1	1			
13MWT15	13GWT1504		1	1	1			
13MWT17	13GWT1704		1	1	1			
13MWT21	13GWT2104		1	1	1			
13MWT28	13GWT2803		1	1	1			
13MWT31	13GWT3103		1	1	1			
13MWT34	13GWT3403		1	1	1			
13MWT37	13GWT3703		1	1	1			
13MWT40	13GWT4003		1	1	1			
13MWT45	13GWT4503		1	1	1			
13MWT46	13GWT4603		1	1	1			
13MWT47	13GWT4703		1	1	1			
13MWT51	13GWT5102		1	1	1			
Round 5								
13MWT01	13GWT0105		1					
13MWT09	13GWT0906		1					
13MWT11	13GWT1105		1					
13MWT13	13GWT1305		1					
13MWT14	13GWT1405		1					
13MWT15	13GWT1505		1					
13MWT17	13GWT1705		1					
13MWT21	13GWT2105		1					
13MWT28	13GWT2804		1					
13MWT31	13GWT3104		1					
13MWT34	13GWT3404		1					
13MWT37	13GWT3704		1					
13MWT40	13GWT4004		1					
13MWT45	13GWT4504		1					
13MWT46	13GWT4604		1					
13MWT47	13GWT4704		1					
13MWT51	13GWT5103		1					

TABLE 3-6

GROUND WATER SAMPLES AND LABORATORY ANALYSES[1]
LONG-TERM MONITORING PROGRAM FOR SELECTED WELLS
SWMU 13 (ROUNDS 4 THROUGH 9) AND SWMU 16 (ROUNDS 4 THROUGH 9)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample ID	Volatiles	Explosives		Miscellaneous			
		SW-846 8260B	Nitroaromatics and Nitramines SW-846 8330	RDX Degradation Products SW-846-8330, Modified	Nitrate + Nitrite (as N) EPA 353.2	Sulfate	Chloride	Methane, Ethane, Ethene
Round 6								
13MWT01	13GWT0106		1	1	1			
13MWT09	13GWT0907		1	1	1			
13MWT11	13GWT1106		1	1	1			
13MWT13	13GWT1306		1	1	1			
13MWT14	13GWT1406		1	1	1			
13MWT15	13GWT1506		1	1	1			
13MWT17	13GWT1706		1	1	1			
13MWT21	13GWT2106		1	1	1			
13MWT28	13GWT2805		1	1	1			
13MWT31	13GWT3105		1	1	1			
13MWT34	13GWT3405		1	1	1			
13MWT37	13GWT3705		1	1	1			
13MWT40	13GWT4005		1	1	1			
13MWT45	13GWT4505		1	1	1			
13MWT46	13GWT4605		1	1	1			
13MWT47	13GWT4705		1	1	1			
13MWT51	13GWT5104		1	1	1			
Round 7								
13MWT01	13GWT0107		1					
13MWT09	13GWT0908		1					
13MWT11	13GWT1107		1					
13MWT13	13GWT1307		1					
13MWT14	13GWT1407		1					
13MWT15	13GWT1507		1					
13MWT17	13GWT1707		1					
13MWT21	13GWT2107		1					
13MWT28	13GWT2806		1					
13MWT31	13GWT3106		1					
13MWT34	13GWT3406		1					
13MWT37	13GWT3706		1					
13MWT40	13GWT4006		1					
13MWT45	13GWT4506		1					
13MWT46	13GWT4606		1					
13MWT47	13GWT4706		1					
13MWT51	13GWT5105		1					

TABLE 3-6

GROUND WATER SAMPLES AND LABORATORY ANALYSES[1]
LONG-TERM MONITORING PROGRAM FOR SELECTED WELLS
SWMU 13 (ROUNDS 4 THROUGH 9) AND SWMU 16 (ROUNDS 4 THROUGH 9)
NSWC CRANE
CRANE, INDIANA
PAGE 3 OF 5

Sample Location	Sample ID	Volatiles	Explosives		Miscellaneous			
		SW-846 8260B	Nitroaromatics and Nitramines SW-846 8330	RDX Degradation Products SW-846-8330, Modified	Nitrate + Nitrite (as N) EPA 353.2	Sulfate	Chloride	Methane, Ethane, Ethene
Round 8								
13MWT01	13GWT0108		1	1	1			
13MWT09	13GWT0909		1	1	1			
13MWT11	13GWT1108		1	1	1			
13MWT13	13GWT1308		1	1	1			
13MWT14	13GWT1408		1	1	1			
13MWT15	13GWT1508		1	1	1			
13MWT17	13GWT1708		1	1	1			
13MWT21	13GWT2108		1	1	1			
13MWT28	13GWT2807		1	1	1			
13MWT31	13GWT3107		1	1	1			
13MWT34	13GWT3407		1	1	1			
13MWT37	13GWT3707		1	1	1			
13MWT40	13GWT4007		1	1	1			
13MWT45	13GWT4507		1	1	1			
13MWT46	13GWT4607		1	1	1			
13MWT47	13GWT4707		1	1	1			
13MWT51	13GWT5106		1	1	1			
Round 9								
13MWT01	13GWT0109		1					
13MWT09	13GWT0910		1					
13MWT11	13GWT1109		1					
13MWT13	13GWT1309		1					
13MWT14	13GWT1409		1					
13MWT15	13GWT1509		1					
13MWT17	13GWT1709		1					
13MWT21	13GWT2109		1					
13MWT28	13GWT2808		1					
13MWT31	13GWT3108		1					
13MWT34	13GWT3408		1					
13MWT37	13GWT3708		1					
13MWT40	13GWT4008		1					
13MWT45	13GWT4508		1					
13MWT46	13GWT4608		1					
13MWT47	13GWT4708		1					
13MWT51	13GWT5107		1					
SWMU 13 Total Samples		0	102	51	51	0	0	0

TABLE 3-6

GROUND WATER SAMPLES AND LABORATORY ANALYSES[1]
LONG-TERM MONITORING PROGRAM FOR SELECTED WELLS
SWMU 13 (ROUNDS 4 THROUGH 9) AND SWMU 16 (ROUNDS 4 THROUGH 9)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample ID	Volatiles	Explosives		Miscellaneous			
		SW-846 8260B	Nitroaromatics and Nitramines SW-846 8330	RDX Degradation Products SW-846-8330, Modified	Nitrate + Nitrite (as N) EPA 353.2	Sulfate	Chloride	Methane, Ethane, Ethene
SWMU 16								
Round 4								
WES-14-02-83	16MW0204	1	1	1	1	1	1	1
WES-14-03-83	16MW0304	1	1	1	1	1	1	1
WES-14-04-83	16MW0404	1	1	1	1	1	1	1
16MWT04	16MWT0404	1	1	1	1	1	1	1
16MWT06	16MWT0605	1	1	1	1	1	1	1
16MWT09	16MWT0903	1	1	1	1	1	1	1
16MWT10	16MWT1003	1	1	1	1	1	1	1
16MWT11	16MWT1103	1	1	1	1	1	1	1
16MWT12	16MWT1203	1	1	1	1	1	1	1
16MWT13	16MWT1303	1	1	1	1	1	1	1
16MWT15	16MWT1503	1	1	1	1	1	1	1
16MWT17	16MWT1703	1	1	1	1	1	1	1
Round 5								
WES-14-02-83	16MW0205							
WES-14-03-83	16MW0305	1	1					
WES-14-04-83	16MW0405	1	1					
16MWT04	16MWT0405	1	1					
16MWT06	16MWT0606	1	1					
16MWT09	16MWT0904	1	1					
16MWT10	16MWT1004	1	1					
16MWT11	16MWT1104	1	1					
16MWT12	16MWT1204	1	1					
16MWT13	16MWT1304	1	1					
16MWT15	16MWT1504	1	1					
16MWT17	16MWT1704	1	1					
Round 6								
WES-14-02-83	16MW0206	1	1	1	1	1	1	1
WES-14-03-83	16MW0306	1	1	1	1	1	1	1
WES-14-04-83	16MW0406	1	1	1	1	1	1	1
16MWT04	16MWT0406	1	1	1	1	1	1	1
16MWT06	16MWT0607	1	1	1	1	1	1	1
16MWT09	16MWT0905	1	1	1	1	1	1	1
16MWT10	16MWT1005	1	1	1	1	1	1	1
16MWT11	16MWT1105	1	1	1	1	1	1	1
16MWT12	16MWT1205	1	1	1	1	1	1	1
16MWT13	16MWT1305	1	1	1	1	1	1	1
16MWT15	16MWT1505	1	1	1	1	1	1	1
16MWT17	16MWT1705	1	1	1	1	1	1	1

TABLE 3-6

GROUND WATER SAMPLES AND LABORATORY ANALYSES[1]
LONG-TERM MONITORING PROGRAM FOR SELECTED WELLS
SWMU 13 (ROUNDS 4 THROUGH 9) AND SWMU 16 (ROUNDS 4 THROUGH 9)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample ID	Volatiles	Explosives		Miscellaneous			
		SW-846 8260B	Nitroaromatics and Nitramines SW-846 8330	RDX Degradation Products SW-846-8330, Modified	Nitrate + Nitrite (as N) EPA 353.2	Sulfate	Chloride	Methane, Ethane, Ethene
Round 7								
WES-14-02-83	16MW0207	1	1					
WES-14-03-83	16MW0307	1	1					
WES-14-04-83	16MW0407	1	1					
16MWT04	16MWT0407	1	1					
16MWT06	16MWT0608	1	1					
16MWT09	16MWT0906	1	1					
16MWT10	16MWT1006	1	1					
16MWT11	16MWT1106	1	1					
16MWT12	16MWT1206	1	1					
16MWT13	16MWT1306	1	1					
16MWT15	16MWT1506	1	1					
16MWT17	16MWT1706	1	1					
Round 8								
WES-14-02-83	16MW0208	1	1	1	1	1	1	1
WES-14-03-83	16MW0308	1	1	1	1	1	1	1
WES-14-04-83	16MW0408	1	1	1	1	1	1	1
16MWT04	16MWT0408	1	1	1	1	1	1	1
16MWT06	16MWT0609	1	1	1	1	1	1	1
16MWT09	16MWT0907	1	1	1	1	1	1	1
16MWT10	16MWT1007	1	1	1	1	1	1	1
16MWT11	16MWT1107	1	1	1	1	1	1	1
16MWT12	16MWT1207	1	1	1	1	1	1	1
16MWT13	16MWT1307	1	1	1	1	1	1	1
16MWT15	16MWT1507	1	1	1	1	1	1	1
16MWT17	16MWT1707	1	1	1	1	1	1	1
Round 9								
WES-14-02-83	16MW0209	1	1					
WES-14-03-83	16MW0309	1	1					
WES-14-04-83	16MW0409	1	1					
16MWT04	16MWT0409	1	1					
16MWT06	16MWT0610	1	1					
16MWT09	16MWT0908	1	1					
16MWT10	16MWT1008	1	1					
16MWT11	16MWT1108	1	1					
16MWT12	16MWT1208	1	1					
16MWT13	16MWT1308	1	1					
16MWT15	16MWT1508	1	1					
16MWT17	16MWT1708	1	1					
SWMU 16 Total Samples		71	71	36	36	36	36	36

1 - See Table 1-6 of this QAPP Addendum No. 1 for specific analysis requirements and analyte lists.

TABLE 3-7

SUMMARY OF GROUND WATER ANALYSES[1] AND QUALITY CONTROL SAMPLES
SWMU 13 (ROUNDS 4 THROUGH 9) AND SWMU 16 (ROUNDS 4 THROUGH 9)
NSWC CRANE
CRANE, INDIANA

Sample Type	Volatiles	Explosives		Miscellaneous			
	SW-846 8260B	Nitroaromatics and Nitramines SW-846 8330	RDX Degradation Products SW-846 8330, Modified	Nitrate + Nitrite (as N) EPA 353.2	Sulfate	Chloride	Methane, Ethane, Ethene
SWMU 13 Samples	0	102	51	51	0	0	0
SWMU 16 Samples	71	71	36	36	36	36	36
Total Samples All SWMUs	**71**	**173**	**87**	**87**	**36**	**36**	**36**
Field Duplicate[2]	4	9	5	5	2	2	2
Trip Blank[3]	18	NA	NA	NA	NA	NA	NA
Rinsate Blank[4]	6	6	3	3	3	3	NA
Source Water Blank	6	6	3	3	3	3	NA
Ambient Condition Blank[5]	6	6	3	3	3	3	NA
Matrix Spike[6]	4	9	5	5	2	2	NA
Matrix Spike Duplicate[7]	4	9	5	NA	NA	NA	NA

1 See Table 1-6 of this QAPP Addendum No. 2 for specific analysis requirements and analyte lists.
2 Field duplicates will be collected at a minimum frequency of one per every 20 samples per round.
3 Trip blanks will be submitted for analysis at a frequency of one per cooler containing samples for volatile analysis. Because the number of sample coolers shipped may vary, the number of trip blanks are estimated.
4 Rinsate blanks will be collected at a frequency of one per sampling device per round.
5 Amibient condition blanks are optional samples that may be collected based on the judgment of the FOL per round.
6 Matrix spikes are collected for all organic and inorganic parameters at a frequency of one per 20 field samples per rou
7 Matrix spike duplicates are collected for all organic parameters. Laboratory duplicates are analyzed for inorganic parameters in lieu of matrix spike duplicates. Matrix spike duplicates are collected at a frequency of one per 20 field samples per round.
NA - Not applicable.

TABLE 3-8

MONITORING WELL CONSTRUCTION INFORMATION AND WATER-LEVEL MEASUREMENTS
SWMU 13 - MINE FILL B
NSWC CRANE
CRANE, INDIANA

Well Number	Installation Date	Northing (feet)	Easting (feet)	Ground Elevation (feet amsl)	Top of Riser Elevation (feet amsl)	Total Depth (feet bgs)[1]	Screened Interval				Water-Bearing Zone	May 5, 2003		May 11, 2003		January 20, 2004	
							Top (feet bgs)	Bottom (feet bgs)	Top (feet amsl)	Bottom (feet amsl)		Depth to Water (feet btor)	Ground Water Elevation (feet amsl)	Depth to Water (feet btor)	Ground Water Elevation (feet amsl)	Depth to Water (feet btor)	Ground Water Elevation (feet amsl)
13MWT01	3/30/2003	1310541.574	3025015.943	713.10	715.34	15.00	5.00	15.00	708.10	698.10	Psz	6.21	709.13	5.82	709.52	7.55	707.79
13MWT02	3/29/2003	1310776.555	3024743.547	702.10	704.72	27.00	17.00	27.00	685.10	675.10	Psz	17.15	687.57	17.10	687.62	16.24	688.48
13MWT03	3/30/2003	1310240.946	3024891.661	718.34	721.10	15.00	5.00	15.00	713.34	703.34	Psz	8.79	712.31	8.88	712.22	9.98	711.12
13MWT04	3/30/2003	1310383.396	3024546.113	704.37	706.84	15.00	5.00	15.00	699.37	689.37	Psz	12.98	693.86	12.75	694.09	14.09	692.75
13MWT05	3/29/2003	1310758.927	3024380.025	693.61	696.44	16.00	6.00	16.00	687.61	677.61	Psz	5.42	691.02	4.13	692.31	5.78	690.66
13MWT06	4/7/2003	1309916.177	3024495.270	715.30	717.93	15.00	5.00	15.00	710.30	700.30	Psz	15.11	702.82	15.62	702.31	11.91	706.02
13MWT07	3/29/2003	1310539.322	3024094.128	684.38	687.22	15.00	5.00	15.00	679.38	669.38	Psz	3.12	684.10	3.10	684.12	4.21	683.01
13MWT08	3/30/2003	1310247.860	3024337.560	698.42	700.56	15.00	5.00	15.00	693.42	683.42	Psz	3.17	697.39	2.92	697.64	3.88	696.68
13MWT09	4/1/2003	1309662.066	3024049.030	703.29	705.90	20.00	10.00	20.00	693.29	683.29	Psz	7.74	698.16	7.40	698.50	8.77	697.13
13MWT10	3/27/2003	1309979.693	3024001.262	697.77	700.15	25.00	15.00	25.00	682.77	672.77	Psz	13.65	686.50	13.11	687.04	14.96	685.19
13MWT11	3/28/2003	1310233.721	3023750.087	679.76	682.29	15.00	5.00	15.00	674.76	664.76	Psz	7.87	674.42	7.00	675.29	8.76	673.53
13MWT12	3/27/2003	1310080.207	3023574.945	679.96	682.12	20.00	10.00	20.00	669.96	659.96	Psz	7.88	674.24	7.78	674.34	10.75	671.37
13MWT13	4/23/2003	1309441.270	3024163.605	699.28	701.98	19.00	8.00	18.00	691.28	681.28	Psz	3.62	698.36	3.18	698.80	4.93	697.05
13MWT14	3/31/2003	1309142.232	3024110.167	703.15	705.50	23.00	13.00	23.00	690.15	680.15	Psz	13.25	692.25	13.08	692.42	14.17	691.33
13MWT15	3/25/2003	1309565.518	3023717.803	694.27	696.65	25.00	15.00	25.00	679.27	669.27	Psz	12.88	683.77	12.63	684.02	14.59	682.06
13MWT16	3/27/2003	1309854.276	3023341.916	682.13	684.35	15.00	5.00	15.00	677.13	667.13	Psz	8.49	675.86	8.61	675.74	11.01	673.34
13MWT17	3/26/2003	1309605.272	3023123.966	690.68	693.01	18.00	8.00	18.00	682.68	672.68	Psz	8.70	684.31	8.09	684.92	8.89	684.12
13MWT18	3/26/2003	1309326.980	3023293.416	700.05	702.92	30.00	20.00	30.00	680.05	670.05	Psz	19.06	683.86	19.04	683.88	20.21	682.71
13MWT19	3/31/2003	1308893.971	3023834.565	703.10	705.82	19.00	9.00	19.00	694.10	684.10	Psz	8.31	697.51	6.80	699.02	10.96	694.86
13MWT20	4/1/2003	1309066.757	3023527.233	699.33	702.07	20.00	10.00	20.00	689.33	679.33	Psz	4.22	697.85	4.00	698.07	5.00	697.07
13MWT21	3/28/2003	1309391.009	3022916.218	688.37	690.74	15.00	5.00	15.00	683.37	673.37	Psz	7.69	683.05	7.34	683.40	9.09	681.65
13MWT22	3/28/2003	1308936.338	3022785.672	669.53	671.96	15.00	5.00	15.00	664.53	654.53	Psz	7.44	664.52	7.25	664.71	8.18	663.78
13MWT23	4/1/2003	1308708.016	3023245.117	696.66	699.14	22.00	11.50	21.50	685.16	675.16	Psz	7.45	691.69	7.17	691.97	8.50	690.64
13MWT24	4/1/2003	1308397.230	3022916.484	691.33	693.93	22.00	12.00	22.00	679.33	669.33	Psz	8.45	685.48	8.23	685.70	9.25	684.68
13MWT25	3/28/2003	1308625.618	3022677.444	678.87	681.57	15.00	5.00	15.00	673.87	663.87	Psz	16.00	665.57	16.61	664.96	7.05	674.52
13MWT26	3/28/2003	1308232.686	3022690.142	684.86	687.49	20.00	10.00	20.00	674.86	664.86	Psz	9.10	678.39	8.93	678.56	10.05	677.44
13MWT27	11/5/2003	1309786.548	3023829.075	696.09	698.13	21.00	10.00	20.00	686.09	676.09	Psz	na	na	na	na	9.31	688.82

TABLE 3-10

MONITORING WELL CONSTRUCTION INFORMATION AND WATER-LEVEL MEASUREMENTS
SWMU 16 - CAST HIGH EXPLOSIVES FILL/B146 INCINERATOR
NSWC CRANE
CRANE, INDIANA

Well Number	Installation Date	Northing (feet)	Easting (feet)	Ground Elevation (feet amsl)	Top of Riser Elevation (feet amsl)	Total Depth (feet bgs)[1]	Screened Interval				Water-Bearing Zone	May 5, 2003		May 30, 2003		January 24, 2004	
							Top (feet bgs)	Bottom (feet bgs)	Top (feet amsl)	Bottom (feet amsl)		Depth to Water (feet btor)	Ground Water Elevaton (feet amsl)	Dept to Water (feet btor)	Ground Water Elevaton (feet amsl)	Dept to Water (feet btor)	Ground Water Elevaton (feet amsl)
16MWT01	4/8/2003	1321193.488	3032881.285	762.02	764.50	24.00	14.00	24.00	748.02	738.02	Psz	25.19	739.31	22.7	741.80	19.12	745.38
16MWT02	4/11/2003	1321146.42	3032559.16	757.60	760.36	18.00	8.00	18.00	749.60	739.60	Psz	6.55	753.81	12.18	748.18	10.94	749.42
16MWT03	4/10/2003	1320946.968	3032644.291	761.95	764.41	35.00	25.00	35.00	736.95	726.95	Piz	27.20	737.21	28.07	736.34	28.34	736.07
16MWT04	4/9/2003	1321003.281	3032946.466	763.88	766.14	25.00	15.00	25.00	748.88	738.88	Psz	8.05	758.09	13.14	753.00	13.11	753.03
16MWT05	4/9/2003	1320741.793	3032812.772	764.50	766.88	40.00	29.00	39.00	735.50	725.50	Piz	29.77	737.11	30.39	736.49	31.44	735.44
16MWT06	4/24/2003	1321199.519	3032883.373	761.77	764.44	25.00	15.00	25.00	746.77	736.77	Psz	22.33	742.11	15.92	748.52	17.41	747.03
16MWT07	11/11/2003	1321176.931	3033001.574	760.54	762.87	25.50	15.00	25.00	745.54	735.54	Psz	na	na	na	na	dry	dry
16MWT08	11/9/2003	1321179.449	3033009.24	759.57	761.56	99.00	85.00	95.00	674.57	664.57	Pdz	na	na	na	na	97.03	664.53
16MWT09	11/8/2003	1321068.489	3033041.444	762.43	764.28	25.00	15.00	25.00	747.43	737.43	Psz	na	na	na	na	13.88	750.40
16MWT10	11/9/2003	1320936.048	3033074.741	761.93	764.43	25.00	14.00	24.00	747.93	737.93	Psz	na	na	na	na	22.05	742.38
16MWT11	11/11/2003	1320934.642	3033062.786	763.23	765.24	98.00	86.00	96.00	677.23	667.23	Pdz	na	na	na	na	96.3	668.94
16MWT12	11/7/2003	1320729.139	3033074.921	753.23	755.45	26.50	16.00	26.00	737.23	727.23	Piz	na	na	na	na	20.13	735.32
16MWT13	11/11/2003	1321125.775	3032562.405	757.62	759.57	19.00	8.00	18.00	749.62	739.62	Psz	na	na	na	na	10.25	749.32
16MWT14	11/7/2003	na	na	764.98	Abn	25.00	15.00	25.00	749.98	739.98	Psz	na	na	na	na	na	dry
16MWT15	11/9/2003	1321120.81	3032563.53	757.73	759.69	92.00	81.00	91.00	676.73	666.73	Pdz	na	na	na	na	53.23	706.46
16MWT16	11/9/2003	1321059.41	3032814.52	764.98	764.74	40.00	26.00	36.00	738.98	728.98	Piz	na	na	na	na	32.93	731.81
16MWT17	11/8/2003	1321235.88	3032675.07	764.79	766.53	24.00	14.00	24.00	750.79	740.79	Psz	na	na	na	na	15.35	751.18
16MWT18	1/18/2004	1321068.96	3032807.84	764.99	764.44	105.00	94.00	104.00	670.99	660.99	Pdz	na	na	na	na	96.65	667.79
WES-14-01-83	1983	1320638.353	3032713.383	763.87	766.67	50.70	35.80	45.30	728.07	718.57	Piz	31.00	735.67	31.00	735.67	31.94	734.73
WES-14-02-83	1983	1321319.899	3032647.27	763.69	766.54	25.80	11.35	20.39	752.34	743.30	Psz	14.23	752.31	14.56	751.98	15.36	751.18
WES-14-03-83	1983	1320816.004	3033018.495	761.51	763.93	35.40	20.88	29.99	740.63	731.52	Psz	18.80	745.13	19.83	744.10	20	743.93
WES-14-04-83	1983	1320572.345	3032960.959	760.42	762.99	46.00	31.38	40.47	729.04	719.95	Piz	26.80	736.19	27.27	735.72	28.39	734.60
WES-14-05-83	1983	1320584.051	3032850.321	766.60	769.40	50.70	35.80	45.25	730.80	721.35	Piz	32.59	736.81	33.05	736.35	34.18	735.22

Notes:
1 = Total depth of boring, total depth of well may be less.
bgs = Below ground surface.
btor = Below top of riser.
amsl = Above mean sea level (NAVD88).
Psz = Pennsylvanian shallow water-bearing zone.
Piz = Pennsylvanian intermediate water-bearing zone.
Pdz = Pennsylvanian deep water-bearing zone.
na = Not available.
Abn = Abandoned.

TABLE 3-9

PHYSICAL CHARACTERISTICS OF PROPOSED MONITORING WELLS AT SWMU 13
IN ROUND 3
NSWC CRANE
CRANE, INDIANA

Monitoring Well Number	Approximate Ground Surface Elevation (feet amsl)	Approximate Total Depth (feet bgs)	Screen Length (feet)	Approximate Desired Well Screen Elevation[1]	
				Top (feet amsl)	Bottom (feet amsl)
13MWT48	TBD	TBD	10	TBD	TBD
13MWT49	TBD	TBD	10	TBD	TBD
13MWT50	TBD	TBD	10	TBD	TBD
13MWT51	TBD	TBD	10	TBD	TBD

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

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

TABLE 3-10

MONITORING WELL CONSTRUCTION INFORMATION AND WATER-LEVEL MEASUREMENTS
SWMU 16 - CAST HIGH EXPLOSIVES FILL/B146 INCINERATOR
NSWC CRANE
CRANE, INDIANA

Well Number	Installation Date	Northing (feet)	Easting (feet)	Ground Elevation (feet amsl)	Top of Riser Elevation (feet amsl)	Total Depth (feet bgs)[1]	Screened Interval				Water-Bearing Zone	May 5, 2003		May 30, 2003		January 24, 2004	
							Top (feet bgs)	Bottom (feet bgs)	Top (feet amsl)	Bottom (feet amsl)		Depth to Water (feet btor)	Ground Water Elevaton (feet amsl)	Dept to Water (feet btor)	Ground Water Elevaton (feet amsl)	Dept to Water (feet btor)	Ground Water Elevaton (feet amsl)
16MWT01	4/8/2003	1321193.488	3032881.285	762.02	764.50	24.00	14.00	24.00	748.02	738.02	Psz	25.19	739.31	22.7	741.80	19.12	745.38
16MWT02	4/11/2003	1321146.42	3032559.16	757.60	760.36	18.00	8.00	18.00	749.60	739.60	Psz	6.55	753.81	12.18	748.18	10.94	749.42
16MWT03	4/10/2003	1320946.968	3032644.291	761.95	764.41	35.00	25.00	35.00	736.95	726.95	Piz	27.20	737.21	28.07	736.34	28.34	736.07
16MWT04	4/9/2003	1321003.281	3032946.466	763.88	766.14	25.00	15.00	25.00	748.88	738.88	Psz	8.05	758.09	13.14	753.00	13.11	753.03
16MWT05	4/9/2003	1320741.793	3032812.772	764.50	766.88	40.00	29.00	39.00	735.50	725.50	Piz	29.77	737.11	30.39	736.49	31.44	735.44
16MWT06	4/24/2003	1321199.519	3032883.373	761.77	764.44	25.00	15.00	25.00	746.77	736.77	Psz	22.33	742.11	15.92	748.52	17.41	747.03
16MWT07	11/11/2003	1321176.931	3033001.574	760.54	762.87	25.50	15.00	25.00	745.54	735.54	Psz	na	na	na	na	dry	dry
16MWT08	11/9/2003	1321179.449	3033009.24	759.57	761.56	99.00	85.00	95.00	674.57	664.57	Pdz	na	na	na	na	97.03	664.53
16MWT09	11/8/2003	1321068.489	3033041.444	762.43	764.28	25.00	15.00	25.00	747.43	737.43	Psz	na	na	na	na	13.88	750.40
16MWT10	11/9/2003	1320936.048	3033074.741	761.93	764.43	25.00	14.00	24.00	747.93	737.93	Psz	na	na	na	na	22.05	742.38
16MWT11	11/11/2003	1320934.642	3033062.786	763.23	765.24	98.00	86.00	96.00	677.23	667.23	Pdz	na	na	na	na	96.3	668.94
16MWT12	11/7/2003	1320729.139	3033074.921	753.23	755.45	26.50	16.00	26.00	737.23	727.23	Piz	na	na	na	na	20.13	735.32
16MWT13	11/11/2003	1321125.775	3032562.405	757.62	759.57	19.00	8.00	18.00	749.62	739.62	Psz	na	na	na	na	10.25	749.32
16MWT14	11/7/2003	na	na	764.98	Abn	25.00	15.00	25.00	749.98	739.98	Psz	na	na	na	na	na	dry
16MWT15	11/9/2003	1321120.81	3032563.53	757.73	759.69	92.00	81.00	91.00	676.73	666.73	Pdz	na	na	na	na	53.23	706.46
16MWT16	11/9/2003	1321059.41	3032814.52	764.98	764.74	40.00	26.00	36.00	738.98	728.98	Piz	na	na	na	na	32.93	731.81
16MWT17	11/8/2003	1321235.88	3032675.07	764.79	766.53	24.00	14.00	24.00	750.79	740.79	Psz	na	na	na	na	15.35	751.18
16MWT18	1/18/2004	1321068.96	3032807.84	764.99	764.44	105.00	94.00	104.00	670.99	660.99	Pdz	na	na	na	na	96.65	667.79
WES-14-01-83	1983	1320638.353	3032713.383	763.87	766.67	50.70	35.80	45.30	728.07	718.57	Piz	31.00	735.67	31.00	735.67	31.94	734.73
WES-14-02-83	1983	1321319.899	3032647.27	763.69	766.54	25.80	11.35	20.39	752.34	743.30	Psz	14.23	752.31	14.56	751.98	15.36	751.18
WES-14-03-83	1983	1320816.004	3033018.495	761.51	763.93	35.40	20.88	29.99	740.63	731.52	Psz	18.80	745.13	19.83	744.10	20	743.93
WES-14-04-83	1983	1320572.345	3032960.959	760.42	762.99	46.00	31.38	40.47	729.04	719.95	Piz	26.80	736.19	27.27	735.72	28.39	734.60
WES-14-05-83	1983	1320584.051	3032850.321	766.60	769.40	50.70	35.80	45.25	730.80	721.35	Piz	32.59	736.81	33.05	736.35	34.18	735.22

Notes:
1 = Total depth of boring, total depth of well may be less.
bgs = Below ground surface.
btor = Below top of riser.
amsl = Above mean sea level (NAVD88).
Psz = Pennsylvanian shallow water-bearing zone.
Piz = Pennsylvanian intermediate water-bearing zone.
Pdz = Pennsylvanian deep water-bearing zone.
na = Not available.
Abn = Abandoned.

TABLE 3-11

PHYSICAL CHARACTERISTICS OF PROPOSED MONITORING WELLS AT SWMU 16 IN ROUND 3 NSWC CRANE CRANE, INDIANA

Monitoring Well Number	Approximate Ground Surface Elevation (feet amsl)	Approximate Total Depth (feet bgs)	Screen Length (feet)	Approximate Desired Well Screen Elevation[1]	
				Top (feet amsl)	Bottom (feet amsl)
16MWT19	TBD	TBD	10	TBD	TBD
16MWT20	TBD	TBD	10	TBD	TBD
16MWT21	TBD	TBD	10	TBD	TBD

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

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

TABLE 3-12

LISTING OF SURFACE WATER SAMPLES AND LABORATORY ANALYSES[1]
SWMU 13 (ROUND 3) AND SWMU 16 (ROUND 3)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample ID	Volatiles		Explosives		Metals		Miscellaneous
		SW-846 8260B	SW-846 8015B	Nitroaromatics and Nitramines SW-846 8330	RDX Degradation Products SW-846, Modified	Metals (Except Mercury) SW-846 6020	Mercury SW-846 7470A	Nitrate + Nitrite (as N)
SWMU 13								
13SW/SD01	13SW0102					1	1	
13SW/SD01	13SW0102-F					1	1	
13SW/SD14	13SW1402			1	1			1
13SW/SD14	13SW1402-F							
13SW/SD15	13SW1502			1	1			1
13SW/SD15	13SW1502-F							
13SW/SD16	13SW1602			1	1			1
13SW/SD16	13SW1602-F							
13SW/SD22	13SW2202					1	1	
13SW/SD22	13SW2202-F					1	1	
13SW/SD28	13SW2802					1	1	
13SW/SD28	13SW2802-F					1	1	
13SW/SD30	13SW3002			1	1	1	1	1
13SW/SD30	13SW3002-F					1	1	
13SW/SD31	13SW3102					1	1	
13SW/SD31	13SW3102-F					1	1	
13SW/SD33	13SW3301			1	1			1
13SW/SD33	13SW3301-F							
13SW/SD34	13SW3401			1	1			1
13SW/SD34	13SW3401-F							
13SW/SD35	13SW3501			1	1			1
13SW/SD35	13SW3501-F							
SWMU 13 Total Samples		0	0	7	7	10	10	7

TABLE 3-12

LISTING OF SURFACE WATER SAMPLES AND LABORATORY ANALYSES[1]
SWMU 13 (ROUND 3) AND SWMU 16 (ROUND 3)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample ID	Volatiles		Explosives		Metals		Miscellaneous
		SW-846 8260B	SW-846 8015B	Nitroaromatics and Nitramines SW-846 8330	RDX Degradation Products SW-846, Modified	Metals (Except Mercury) SW-846 6020	Mercury SW-846 7470A	Nitrate + Nitrite (as N)
SWMU 16								
16SW/SD03	16SW0301					1	1	
16SW/SD03	16SW0301-F					1	1	
16SW/SD04	16SW0401					1	1	
16SW/SD04	16SW0401-F					1	1	
16SW/SD05	16SW0501					1	1	
16SW/SD05	16SW0501-F					1	1	
16SW/SD06	16SW0601					1	1	
16SW/SD06	16SW0601-F					1	1	
16SW/SD08	16SW0801					1	1	
16SW/SD08	16SW0801-F					1	1	
16SW/SD09	16SW0901					1	1	
16SW/SD09	16SW0901-F					1	1	
16SW/SD10	16SW1001					1	1	
16SW/SD10	16SW1001-F					1	1	
16SW/SD11	16SW1101					1	1	
16SW/SD11	16SW1101-F					1	1	
16SW/SD12	16SW1202	1	1	1		1	1	1
16SW/SD12	16SW1202-F					1	1	
16SW/SD13	16SW1302	1	1	1		1	1	1
16SW/SD13	16SW1302-F					1	1	
16SW/SD16	16SW1601					1	1	
16SW/SD16	16SW1601-F					1	1	
16SW/SD19	16SW1901					1	1	

TABLE 3-12

LISTING OF SURFACE WATER SAMPLES AND LABORATORY ANALYSES[1]
SWMU 13 (ROUND 3) AND SWMU 16 (ROUND 3)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample ID	Volatiles		Explosives		Metals		Miscellaneous
		SW-846 8260B	SW-846 8015B	Nitroaromatics and Nitramines SW-846 8330	RDX Degradation Products SW-846, Modified	Metals (Except Mercury) SW-846 6020	Mercury SW-846 7470A	Nitrate + Nitrite (as N)
16SW/SD19	16SW1901-F					1	1	
16SW/SD23	16SW2301					1	1	
16SW/SD23	16SW2301-F					1	1	
16SW/SD24	16SW2401	1	1	1		1	1	1
16SW/SD24	16SW2401-F					1	1	
16SW/SD25	16SW2501					1	1	
16SW/SD25	16SW2501-F					1	1	
16SW/SD26	16SW2601	1	1			1	1	1
16SW/SD26	16SW2601-F					1	1	
16SW/SD27	16SW2701	1	1			1	1	
16SW/SD27	16SW2701-F					1	1	
16SW/SD28	16SW2801	1	1			1	1	
16SW/SD28	16SW2801-F					1	1	
16SW/SD29	16SW2901	1	1			1	1	
16SW/SD29	16SW2901-F					1	1	
16SW/SD30	16SW3001	1	1	1		1	1	
16SW/SD30	16SW3001-F					1	1	
SWMU 16 Total Samples		8	8	4	0	40	40	4

1 See Table 1-6 of this QAPP Addendum No. 2 for specific analysis requirements and analyte lists.

TABLE 3-13

SUMMARY OF SURFACE WATER ANALYSES[1] AND QUALITY CONTROL SAMPLES
SWMU 13 (ROUND 3) AND SWMU 16 (ROUND 3)
NSWC CRANE
CRANE, INDIANA

Sample Type	Volatiles		Explosives		Metals		Miscellaneous
	SW-846 8260B	SW-846 8015B	Nitroaromatics and Nitramines SW-846 8330	RDX Degradation Products SW-846 8330, Modified	Metals (except Mercury) SW-846 6020	Mecury SW-846 7470A	Nitrate + Nitrite (as N)
SWMU 13 Samples	0	0	7	7	10	10	7
SWMU 16 Samples	8	8	4	0	40	40	4
Total Samples All SWMUs	**8**	**8**	**11**	**0**	**50**	**50**	**11**
Field Duplicate[2]	1	1	1	0	3	3	2
Trip Blank[3]	2	2	NA	NA	0	0	NA
Rinsate Blank[4]	0	0	0	0	0	0	0
Source Water Blank	1	1	1	0	1	1	1
Ambient Condition Blank[5]	1	1	1	0	1	1	1
Matrix Spike[6]	1	1	1	0	3	3	1
Matrix Spike Duplicate[7]	1	1	1	0	0	0	NA

1 See Table 1-6 of this QAPP Addendum No. 2 for specific analysis requirements and analyte lists.
2 Field duplicates will be collected at a frequency of one per every 20 samples per SWMU.
3 Trip blanks will be submitted for analysis at a frequency of one per cooler containing samples for volatile analysis. Because the number of sample coolers shipped may vary, the number of trip blanks is estimated.
4 Environmental samples will be collected by directly filling the sample bottle. Therefore, no rinsate blanks are required for this matrix.
5 Ambient condition blanks are optional samples that may be collected based on the judgment of the FOL.
6 Matrix spikes are collected for all organic and inorganic parameters at a frequency of one per every 20 field samples per matrix.
7 Matrix spike duplicates are collected for all organic parameters. Laboratory duplicates are analyzed for inorganic parameters in lieu of matrix spike duplicates. Matrix spike duplicates are collected at a frequency of one per every 20 field samples per matrix.
NA - Not applicable.

TABLE 3-14

LISTING OF SURFACE WATER SAMPLES AND LABORATORY ANALYSES[1]
LONG-TERM MONITORING PROGRAM
SWMU 13 (ROUNDS 4 THROUGH 9) AND SWMU 16 (ROUNDS 4 THROUGH 9)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample ID*	Volatiles	Explosives
		SW-846 8260B	Nitroaromatics and Nitramines SW-846 8330
SWMU 13			
Round 4			
13SW/SD11	13SW1103		1
13SW/SD14	13SW1403		1
13SW/SD15	13SW1503		1
13SW/SD16	13SW1603		1
13SW/SD19	13SW1902		1
13SW/SD20	13SW2002		1
13SW/SD22	13SW2203		1
13SW/SD30	13SW3003		1
Round 5			
13SW/SD11	13SW1104		1
13SW/SD14	13SW1404		1
13SW/SD15	13SW1504		1
13SW/SD16	13SW1604		1
13SW/SD19	13SW1903		1
13SW/SD20	13SW2003		1
13SW/SD22	13SW2204		1
13SW/SD30	13SW3004		1
Round 6			
13SW/SD11	13SW1105		1
13SW/SD14	13SW1405		1
13SW/SD15	13SW1505		1
13SW/SD16	13SW1605		1
13SW/SD19	13SW1904		1
13SW/SD20	13SW2004		1
13SW/SD22	13SW2205		1
13SW/SD30	13SW3005		1
Round 7			
13SW/SD11	13SW1106		1
13SW/SD14	13SW1406		1
13SW/SD15	13SW1506		1
13SW/SD16	13SW1606		1
13SW/SD19	13SW1905		1
13SW/SD20	13SW2005		1
13SW/SD22	13SW2206		1
13SW/SD30	13SW3006		1
Round 8			
13SW/SD11	13SW1107		1
13SW/SD14	13SW1407		1
13SW/SD15	13SW1507		1
13SW/SD16	13SW1607		1
13SW/SD19	13SW1906		1
13SW/SD20	13SW2006		1
13SW/SD22	13SW2207		1
13SW/SD30	13SW3007		1

TABLE 3-14

LISTING OF SURFACE WATER SAMPLES AND LABORATORY ANALYSES[1]
LONG-TERM MONITORING PROGRAM
SWMU 13 (ROUNDS 4 THROUGH 9) AND SWMU 16 (ROUNDS 4 THROUGH 9)
NSWC CRANE
CRANE, INDIANA
PAGE 2 OF 2

Sample Location	Sample ID*	Volatiles	Explosives
		SW-846 8260B	Nitroaromatics and Nitramines SW-846 8330
Round 9			
13SW/SD11	13SW1108		1
13SW/SD14	13SW1408		1
13SW/SD15	13SW1508		1
13SW/SD16	13SW1608		1
13SW/SD19	13SW1907		1
13SW/SD20	13SW2007		1
13SW/SD22	13SW2208		1
13SW/SD30	13SW3008		1
Total Samples SWMU 13		0	48
SWMU 16			
Round 4			
16SW/SD10	16SW1002	1	1
16SW/SD12	16SW1203	1	1
16SW/SD13	16SW1303	1	1
16SW/SD30	16SW3002	1	1
Round 5			
16SW/SD10	16SW1003	1	1
16SW/SD12	16SW1204	1	1
16SW/SD13	16SW1304	1	1
16SW/SD30	16SW3003	1	1
Round 6			
16SW/SD10	16SW1004	1	1
16SW/SD12	16SW1205	1	1
16SW/SD13	16SW1305	1	1
16SW/SD30	16SW3004	1	1
Round 7			
16SW/SD10	16SW1005	1	1
16SW/SD12	16SW1206	1	1
16SW/SD13	16SW1306	1	1
16SW/SD30	16SW3005	1	1
Round 8			
16SW/SD10	16SW1006	1	1
16SW/SD12	16SW1207	1	1
16SW/SD13	16SW1307	1	1
16SW/SD30	16SW3006	1	1
Round 9			
16SW/SD10	16SW1007	1	1
16SW/SD12	16SW1208	1	1
16SW/SD13	16SW1308	1	1
16SW/SD30	16SW3007	1	1
Total Samples SWMU 16		24	24

1 See Table 1-6 of this QAPP Addendum No. 2 for specific analysis requirer analyte lists.

TABLE 3-15

SUMMARY OF SURFACE WATER ANALYSES[1] AND QUALITY CONTROL SAMPLES
SWMU 13 (ROUNDS 4 THROUGH 9) AND SWMU 16 (ROUNDS 4 THROUGH 9)
NSWC CRANE
CRANE, INDIANA

Sample Type	Volatiles	Explosives
	SW-846 8260B	Nitroaromatics and Nitramines SW-846 8330
Samples SWMU 13	0	48
Samples SWMU 16	24	24
Total Samples All SWMUs	**24**	**72**
Field Duplicates [2]	1	4
Rinsate Blanks [3]	0	0
Ambient Condition Blanks [4]	1	1
Matrix Spikes [5]	1	4
Matrix Spike Duplicates [6]	1	4

1 See Table 1-6 of this QAPP Addendum No. 2 for specific analysis requirements and analyte lists.
2 Field duplicates will be collected at a frequency of one per every 20 samples per SWMU.
3 Rinsate blanks will not be collected because sample bottles will be filled directly by dipping into the surface water.
4 Ambient condition blanks are optional samples that may be collected based on the judgment of the FOL.
5 Matrix spikes are collected for all organic and inorganic parameters at a frequency of per every 20 field samples per matrix.
6 Matrix spike duplicates are collected for all organic parameters. Laboratory duplicates are analyzed for inorganic parameters in lieu of matrix spike duplicates. Matrix spike duplicates are collected at a frequency of one per every 20 field samples per matrix.

TABLE 3-16

LISTING OF SEDIMENT SAMPLES AND LABORATORY ANALYSES[1]
SWMU 13 (Round 3) and SWMU 16 (Round 3)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample ID	VOCs		Metals	
		SW-846 8260B	SW-846 8015B	Metals Except Mercury SW-846 6020	Mercury SW-846 7471A
SWMU 13					
13SW/SD01	13SD0102			1	1
13SW/SD22	13SD2202			1	1
13SW/SD28	13SD2802			1	1
13SW/SD30	13SD3002			1	1
13SW/SD31	13SD3102			1	1
13SW/SD33	13SD3301			1	1
13SW/SD34	13SD3401			1	1
13SW/SD35	13SD3501			1	1
SWMU 13 Total Samples		0	0	8	8
SWMU 16					
16SW/SD03	16SD0302			1	1
16SW/SD04	16SD0402			1	1
16SW/SD05	16SD0502			1	1
16SW/SD06	16SD0602			1	1
16SW/SD08	16SD0802			1	1
16SW/SD09	16SD0902			1	1
16SW/SD10	16SD1002			1	1
16SW/SD11	16SD1102			1	1
16SW/SD12	16SD1202			1	1
16SW/SD13	16SD1302			1	1
16SW/SD16	16SD1602			1	1
16SW/SD19	16SD1902			1	1
16SW/SD23	16SD2302			1	1
16SW/SD24	16SD2401			1	1
16SW/SD25	16SD2501			1	1
16SW/SD26	16SD2601			1	1
16SW/SD27	16SD2701	1	1	1	1
16SW/SD28	16SD2801	1	1	1	1
16SW/SD29	16SD2901	1	1	1	1
16SW/SD30	16SD3001	1	1	1	1
SWMU 16 Total Samples		4	4	20	20

1 See Table 1-6 of this QAPP Addendum No. 2 for specific analysis requirements and analyte lists.

TABLE 3-17

SUMMARY OF SEDIMENT ANALYSES[1] AND QUALITY CONTROL SAMPLES
SWMU 13 (ROUND 3) AND SWMU 16 (ROUND 3)
NSWC CRANE
CRANE, INDIANA

Sample Type	VOCs		Metals	
	SW-846 8260B	SW-846 8015B	Metals SW-846 6020	Mercury SW-846 7471A
SWMU 13 Samples	0	0	8	8
SWMU 16 Samples	4	4	20	20
Total Samples All SWMUs	**4**	**4**	**28**	**28**
Field Duplicate[2]	1	1	2	2
Rinsate Blank[3]	1	1	1	1
Trip Blank	1	1	1	1
Ambient Condition Blank[4]	1	1	1	1
Matrix Spike[5]	1	1	2	2
Matrix Spike Duplicate[6]	1	1	NA	NA

1 See Table 1-6 of this QAPP Addendum No. 2 for specific analysis requirements and analyte lists.
2 Field duplicates will be collected at a frequency of one per every 20 samples per SWMU.
3 Rinsate blanks will be collected at a frequency of one per every 10 samples, with a minimum of one per day of sampling, per sampling device or instrument.
4 Ambient condition blanks are optional samples that may be collected based on the judgment of the FOL.
5 Matrix spikes are collected for all organic and inorganic parameters at a frequency of one per every 20 field samples per matrix.
6 Matrix spike duplicates are collected for all organic parameters. Lab duplicates are analyzed for inorganic parameters in lieu of matrix spike duplicates. Matrix spike duplicates are collected at a frequency of one per every 20 field samples per matrix.
NA - Not Applicable

TABLE 3-18

LISTING OF VEGETATION SAMPLES AND LABORATORY ANALYSES[1]
SWMU 13 (Round 3) and SWMU 16 (Round 3)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample ID	Explosives	
		Nitroaromatics and Nitramines SW-846 8330	RDX Degradation Products SW-846, Modified
SWMU 13[2]			
13VG001	13VG001XX0001	1	1
13VG002	13VG002XX0001	1	1
13VG003	13VG003XX0001	1	1
13VG004	13VG004XX0001	1	1
13VG005	13VG005XX0001	1	1
13VG006	13VG006XX0001	1	1
13VG007	13VG007XX0001	1	1
13VG008	13VG008XX0001	1	1
13VG009	13VG009XX0001	1	1
13VG010	13VG010XX0001	1	1
13VG011	13VG011XX0001	1	1
13VG012	13VG012XX0001	1	1
13VG013	13VG013XX0001	1	1
13VG014	13VG014XX0001	1	1
13VG015	13VG015XX0001	1	1
16 (Vegetation Rinse)[3]	13VGNNNXX0017	1	1
17 (Vegetation Rinse)[3]	13VGNNNXX0017	1	1
SWMU 13 Total Samples		17	17

2 "XX" is the species number. Numbers to be determined in the field.

3 Vegetation rinse samples represent surface matter from the vegetation (not rinsate blanks). These sample will be collected by rinsing the "as received" vegetation into a sample container.

TABLE 3-19

SUMMARY OF VEGETATION ANALYSES[1] AND QUALITY CONTROL SAMPLES
SWMU 13 (ROUND 3) AND SWMU 16 (ROUND 3)
NSWC CRANE
CRANE, INDIANA

Sample Type	Explosives	
	Nitroaromatics and Nitramines SW-846 8330	RDX Degradation Products SW-846 8330, Modified
SWMU 13 Samples	17	17
SWMU 16 Samples	0	0
Total Samples All SWMUs	**17**	**17**
Field Duplicate[2]	1	1
Rinsate Blank[3]	1	1
Source Water Blank	1	1
Matrix Spike[4]	1	1
Matrix Spike Duplicate[5]	1	1

1 See Table 1-6 of this QAPP Addendum No. 2 for specific analysis requirements and analyte lists.

2 Field duplicates will be collected at a frequency of one per every 20 samples.

3 Environmental samples will be collected after rinsing the vegetation clean of surface dust and other contamination. The rinsate blank will constitute rinse water collected after the vegetation has been rinsed clean.

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

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

NA - Not applicable.

TABLE 3-20

SUMMARY OF SAMPLE ANALYSIS, CONTAINER TYPES AND VOLUMES, PRESERVATION REQUIREMENTS, AND HOLDING TIMES FOR SOILS AND SEDIMENTS
SWMU 13 (ROUND 3) AND SWMU 16 (ROUND 3)
NSWC CRANE
CRANE, INDIANA

Parameter	Methodology	Sample Container	Container Volume	Preservation	Maximum Holding Time[1]
Volatiles	SW-846 8260B	3 Encore™ samplers	Four 5-gram	Cool to 4° C	48 hours to preservation[2];14 days to analysis
	SW-846 8015B	2 Encore™ samplers	Four 5-gram	Cool to 4° C	48 hours to preservation[2];14 days to analysis
PCBs	SW-846 8082	Wide-mouth jar, Teflon-lined cap	8-ounce	Cool to 4° C	Extraciton within 14 days; analysis within 40 days of extraction
Metals	SW-846 6020, 7471A	Wide-mouth jar, Teflon-lined plastic cap	8-ounce	Cool to 4° C	Analysis within 180 days; mercury analyses within 28 days

1 All holding times are from date of collection.
2 One Encore™ sampler extended into 5 mL H_2O and frozen. Second Encore™ sampler frozen as received. Third Encore™ sampler preserved with methanol for medium-level analsyis.
3 One Encore™ sampler extended into 5 mL H2O and frozen. Second Encore™ sampler frozen as received.
PCBs = Polychlorinated biphenyl.

TABLE 3-21

SUMMARY OF SAMPLE ANALYSIS, CONTAINER TYPES AND VOLUMES, PRESERVATION REQUIREMENTS, AND HOLDING TIMES FOR AQUEOUS SAMPLES
SWMU 13 (ROUND 3) AND SWMU 16 (ROUND 3)
NSWC CRANE
CRANE, INDIANA

Parameter	Methodology	Sample Container	Container Volume	Preservation	Maximum Holding Time[1]
Explosives	SW-846 8330	Amber glass, Teflon-lined cap	1000 mL (2 bottles each)	Cool to 4° C, dark	Extraction within 7 days; analysis within 40 days of extraction
Volatiles	SW-846 8260B	Glass, black phenolic plastic screw cap, Teflon-lined septum	40 mL (6 bottles each)	Cool to 4° C, dark, zero headspace, HCl to pH <2	14 days to analysis
	SW-846 8015B	Glass, black phenolic plastic screw cap, Teflon-lined septum	40 mL (6 bottles each)	Cool to 4° C, dark, zero headspace, HCl to pH <2	14 days to analysis
Metals	(except mercury) SW-846 6020	Polyehtylene plastic cap with plastic liner	1000 mL	HNO_3 to pH <2	Within 180 days; Mercury within 28 days.
	Mercury SW-846 7470A	Polyehtylene plastic cap with plastic liner	1000 mL	HNO_3 to pH <2	Within 180 days; Mercury within 28 days.
Vegetation	SW-846 8330	One gallon Ziploc bag	Approximately 50 g	Dry ice	Extraction within 7 days; analysis within 40 days of extraction

Aqueous samples include ground water, surface water, and aqueous QA samples.
1 All holding times are from date of collection.
HCl - Hydrochloric acid.

TABLE 3-22

NON-CALIBRATION QUALITY CONTROL SAMPLE USAGE FREQUENCIES, ACCEPTANCE LIMITS, AND CORRECTIVE ACTIONS
SMWU 13 (ROUND 3) AND SWMU 16 (ROUND 3)
NSWC CRANE
CRANE, INDIANA

QC Sample Type	Collection Frequency	Acceptance Limit	Corrective Action
Field Duplicate	1 per 20 investigative samples collected.	Aqueous = 30% RPD Soil/Sediment = 50% RPD	Qualify data according to data validation requirements.
Equipment Rinsate Blank	For pre-cleaned, dedicated, and/or disposable equipment (i.e., disposable plastic trowels, etc.), one rinsate blank will be collected and analyzed at a frequency of one per lot or "batch blank" for a specific equipment type.	< RL (soil and water)	Identify source of contamination, if possible. Qualify data according to validation criteria. Qualify use of data if contamination appears to have adversely affected its usability.
Source Water Blank	1 per source of water used for sampling equipment decontamination.	< RL (soil and water)	Identify source of contamination, if possible. Qualify data according to validation criteria. Qualify use of data if contamination appears to have adversely affected its usability.
Ambient Condition Blank	At discretion of FOL.	< RL (soil and water)	Identify source of contamination, if possible. Qualify data according to validation criteria. Qualify use of data if contamination appears to have adversely affected its usability.
Trip Blank	1 per cooler containing samples for volatile organics analysis.	< RL (soil and water)	Identify source of volatiles contamination, if possible. Qualify data according to validation criteria. Qualify use of data if contamination appears to have adversely affected its usability.
Internal Standard	At least one internal standard per sample for GC/MS analysis.	Retention times stable to ±30 seconds; area counts stable to within factor of 2.	Laboratory action taken per LTL-1008. TtNUS action taken per validation protocols and Section 11.2.
Laboratory Control Sample	1 per 20 environmental samples per matrix.	See Tables 7-2, 7-4, 7-6, 7-8, 7-10, 7-12, 7-14, 7-16 of the originally approved QAPP (TtNUS, 2003)	Laboratory action taken per LTL-1008. TtNUS action taken per validation protocols and Section 11.2.

TABLE 3-22

NON-CALIBRATION QUALITY CONTROL SAMPLE USAGE FREQUENCIES, ACCEPTANCE LIMITS, AND CORRECTIVE ACTIONS
SMWU 13 (ROUND 3) AND SWMU 16 (ROUND 3)
NSWC CRANE
CRANE, INDIANA

QC Sample Type	Collection Frequency	Acceptance Limit	Corrective Action
Laboratory Duplicate	1 per 20 environmental samples analyzed for inorganic target analytes.	See Tables 7-1, 7-3, 7-5, 7-7, 7-9, 7-11, 7-13, 7-15 of the originally approved QAPP (TtNUS, 2003a)	Laboratory action taken per LTL-1008. TtNUS action taken per validation protocols and Section 11.2.
Laboratory Method Blank	1 per 20 environmental samples or per preparation batch, whichever is more frequent.	< RL (soil and water)	Laboratory action taken per LTL-1008. TtNUS action taken per validation protocols and Section 11.2.
Matrix Spike*	1 per 20 environmental samples.	See Tables 7-1, 7-3, 7-5, 7-7, 7-9, 7-11, 7-13, 7-15 of the originally approved QAPP (TtNUS, 2003a)	Laboratory action taken per LTL-1008. TtNUS action taken per validation protocols and Section 11.2.
Matrix Spike Duplicate*	1 per 20 environmental samples analyzed for organic target analytes.	See Tables 7-1, 7-3, 7-7, 7-9, 7-11, 7-13, 7-15 of the originally approved QAPP (TtNUS, 2003a)	Laboratory action taken per LTL-1008. TtNUS action taken per validation protocols and Section 11.2.
Post-digestion Spike	Only if out-of-control matrix spike exists (metals only)	100 ± 20%	Laboratory action taken per LTL-1008. TtNUS action taken per validation protocols and Section 11.2.
Surrogate	At least one per sample for organic chromatographic analyses (GC, GC/MS, and HPLC).	See Tables 7-1, 7-3, 7-7, 7-9, 7-11, 7-13, 7-15 of the originally approved QAPP (TtNUS, 2003a)	Laboratory action taken per LTL-1008. TtNUS action taken per validation protocols and Section 11.2.
Temperature Blank	One blank per sample cooler.	4°C ± 2 °C	Laboratory action taken per LTL-1008. TtNUS action taken per validation protocols and Section 11.2.

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

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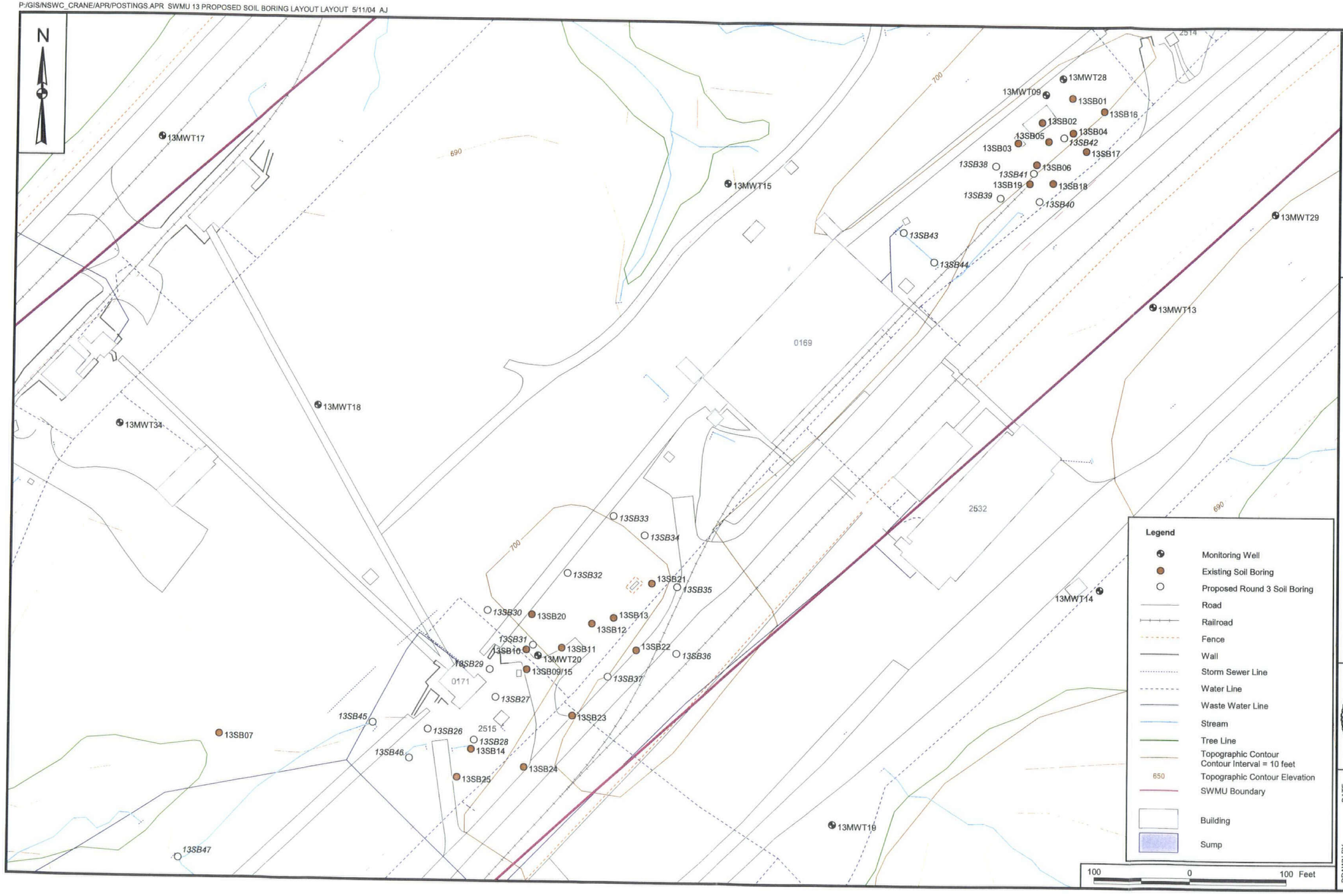


CONTRACT NO. 7448

APPROVED BY J. LUCAS — DATE 5/07/04

APPROVED BY — DATE

DRAWING NO. — FIGURE 3 - 1 — REV 0

PROPOSED SOIL SAMPLING LOCATIONS AT SWMU 13 - MINE FILL B FOR ROUND 3 NSWC CRANE CRANE, INDIANA

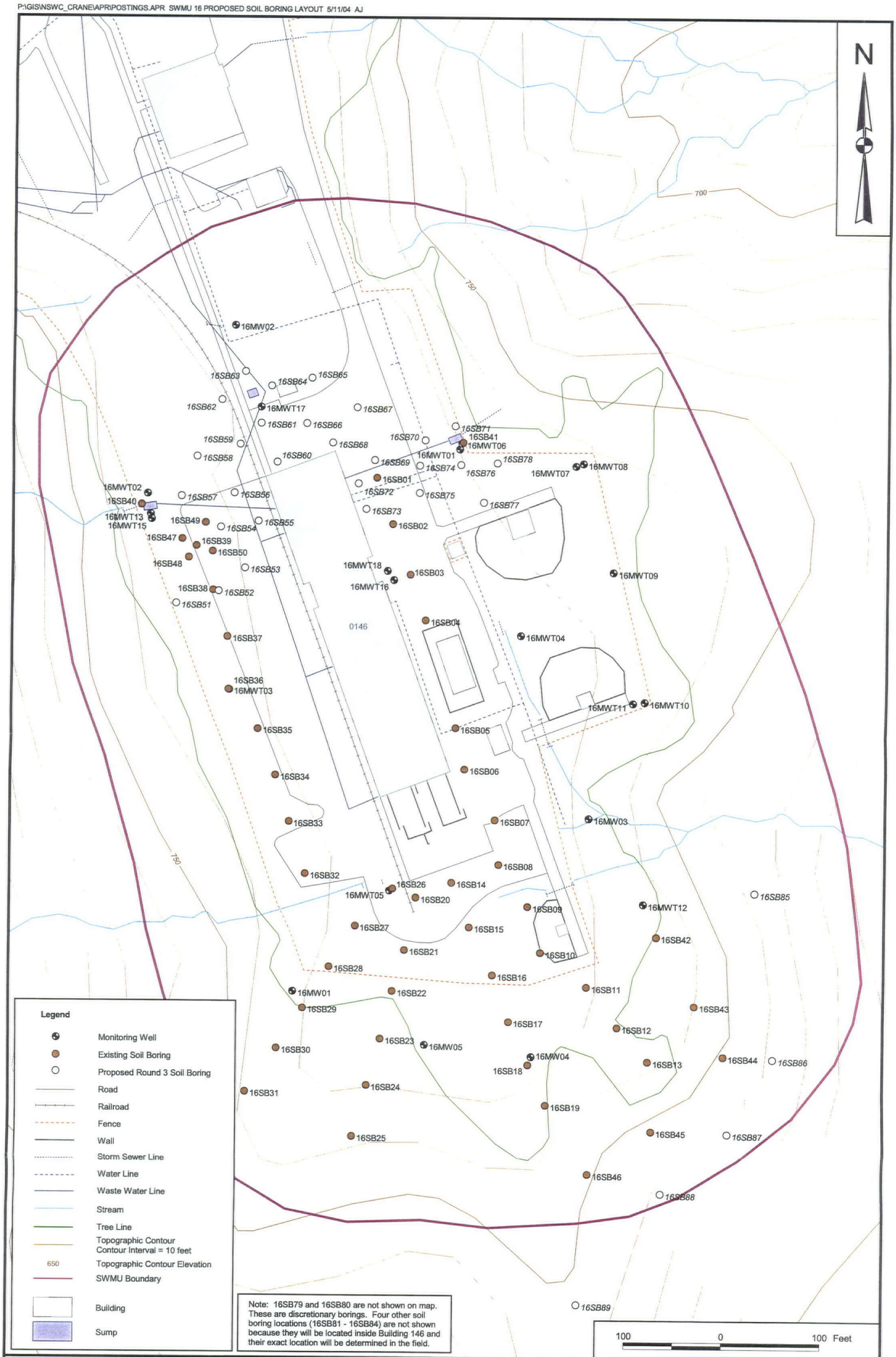
DRAWN BY A. JANOCHA — DATE 4/26/04

CHECKED BY J. LUCAS — DATE 5/11/04

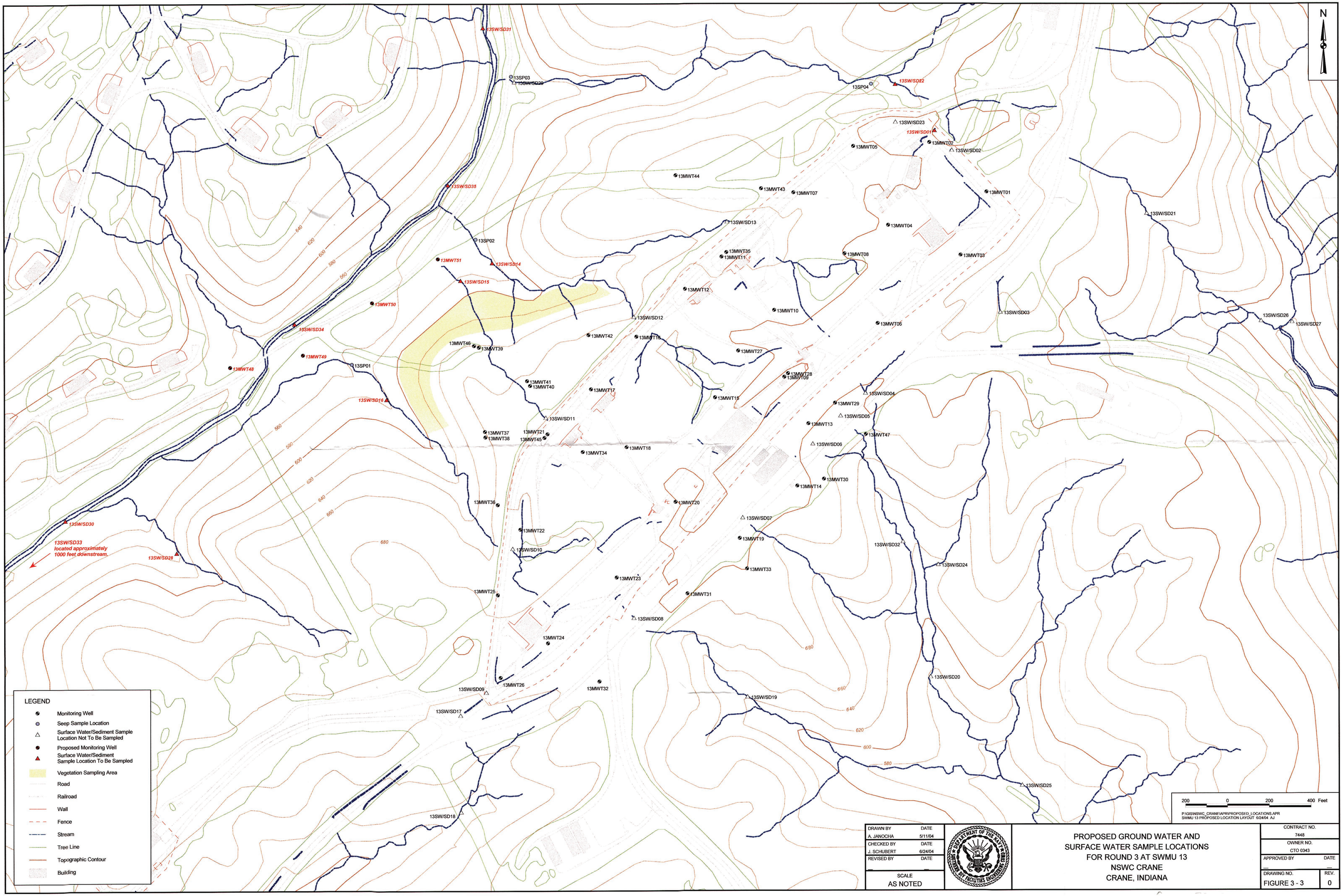
COST/SCHED-AREA

SCALE AS NOTED

P:\GIS\NSWC_CRANE\APR\POSTINGS.APR SWMU 16 PROPOSED SOIL BORING LAYOUT 5/11/04 AJ



DRAWN BY A. JANOCHA	DATE 4/26/04	PROPOSED SOIL SAMPLING LOCATIONS AT SWMU 16 - CAST HIGH EXPLOSIVES FILL/B146 INCINERATOR FOR ROUND 3 NSWC CRANE CRANE, INDIANA	CONTRACT NUMBER N7448
CHECKED BY J. LUCAS	DATE 5/11/04		APPROVED BY J. LUCAS — DATE 5/11/04
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 3 - 2 — REV 0



DRAWN BY	DATE
A. JANOCHA	5/11/04
CHECKED BY	DATE
J. SCHUBERT	6/24/04
REVISED BY	DATE
—	—

SCALE
AS NOTED

DEPARTMENT OF THE NAVY · NAVAL FACILITIES ENGINEERING COMMAND

PROPOSED GROUND WATER AND
SURFACE WATER SAMPLE LOCATIONS
FOR ROUND 3 AT SWMU 13
NSWC CRANE
CRANE, INDIANA

CONTRACT NO.	
7448	
OWNER NO.	
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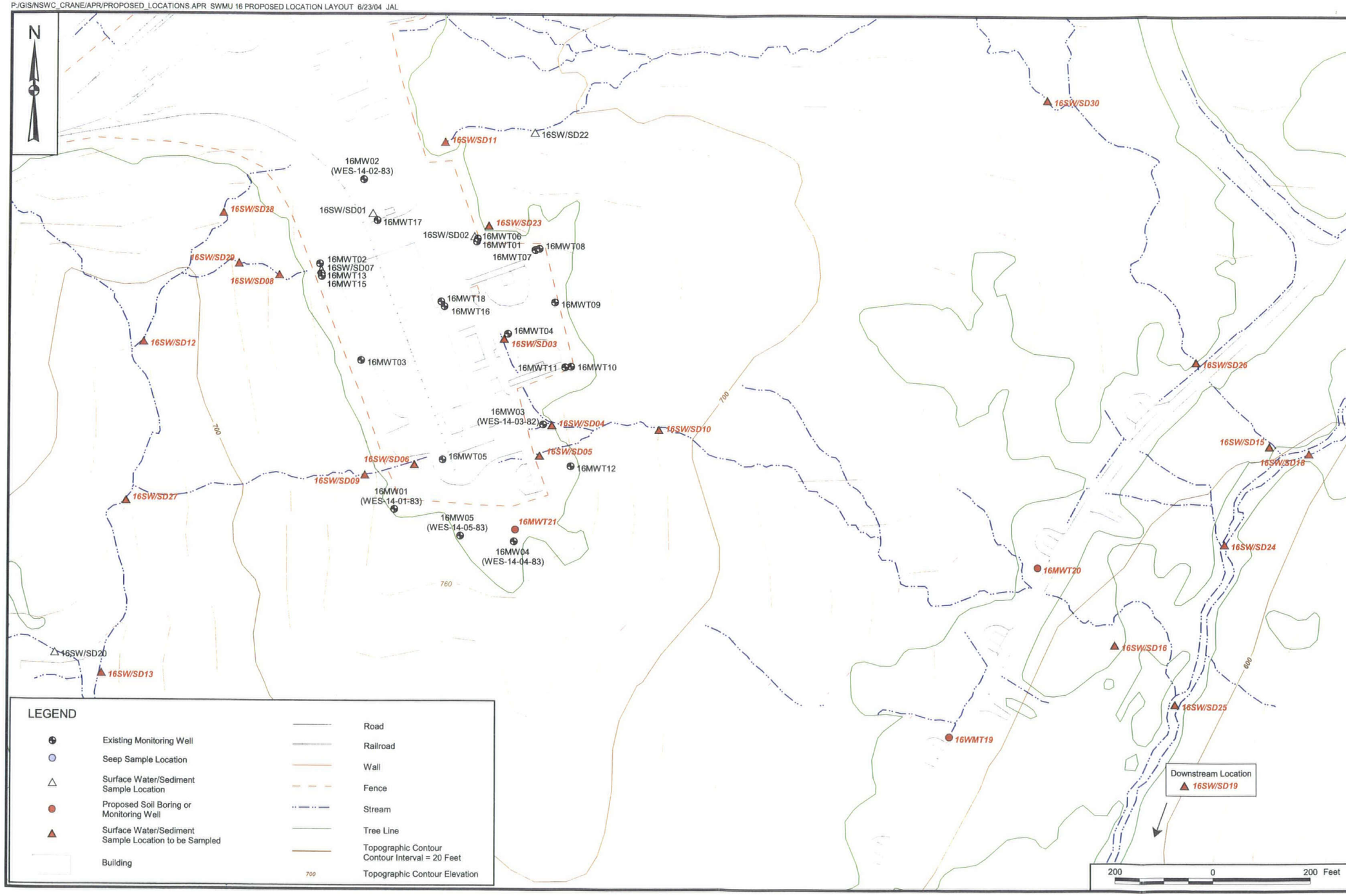
DRAWING NO.	REV.
FIGURE 3 - 3	0

P:/GIS/NSWC_CRANE/APR/PROPOSED_LOCATIONS.APR SWMU 16 PROPOSED LOCATION LAYOUT 6/23/04 JAL



CONTRACT NO. 7448

APPROVED BY J. SCHUBERT — DATE 6/21/04

APPROVED BY ___ — DATE ___

DRAWING NO. FIGURE 3 - 4

REV 0

PROPOSED GROUND WATER, SURFACE WATER, SOIL, AND SEDIMENT SAMPLE LOCATIONS AT SWMU 16 - CAST HIGH EXPLOSIVES FILL/B146 INCINERATOR FOR ROUND 3
NSWC CRANE
CRANE, INDIANA

DEPARTMENT OF THE NAVY * SOUTHERN DIV. FACILITIES ENGINEERING COMD *

DRAWN BY A. JANOCHA — DATE 5/11/04

CHECKED BY J. SCHUBERT — DATE 6/22/04

COST/SCHED-AREA

SCALE AS NOTED

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