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TECHNICAL MEMORANDUM WORK PLAN FOR SUPPLEMENTAL SAMPLING ACTIVITIES UNEXPLODED ORDNANCE 7 (UXO 7) RANGES NSA CRANE IN
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Technical Memorandum: Work Plan for Supplemental Sampling Activities at UXO 7 Ranges

Naval Support Activity Crane
Crane, Indiana

Contract Task Order F272

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TECHNICAL MEMORANDUM

DATE: August 28, 2011

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Project File – CTO F272

SUBJECT: NSA Crane UXO 7 – Small Arms Ranges - Supplemental Work Plan

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1.0 Site Description

UXO 7 is located within Naval Support Activity (NSA) Crane (**Figure 1**) and formerly consisted of a 500-yard Firing Range, West Trap Range, East Trap Range, and South Pistol Range. **Figure 2** identifies the locations of the former UXO 7 small arms ranges. None of the aforementioned ranges are currently in use at UXO 7 and are closed. Samples were collected during 2007 as part of a Resource Conservation and Recovery Act (RCRA) Facility Investigations (RFI) to determine whether contamination was present.

2.0 RFI Results

Lead from bullets and shot, and polynuclear aromatic hydrocarbons (PAHs) from clay targets were the primary constituents of concern during the 2007 RFI at UXO 7. Soil samples collected during the RFI from areas within the former small arms ranges contained lead and/or PAHs at concentrations above specific screening levels for human health and/or ecological receptors. The RFI soil sampling program was performed to support human health and ecological risk assessments for typical small arms range contaminants. The resulting RFI environmental data for UXO 7, although adequate for risk assessment purposes, was not sufficiently robust to fully delineate the nature and extent of lead and/or PAH contamination within the former range soil for focused removal actions.

The conceptual site model (CSM) for small arms ranges presumes that typically lead, whether from lead shot or lead bullets, and PAHs from clay pigeons will generally be restricted to the top one-foot of soil. However, if there has been any post-range use disturbance of this area, the extent of lead in soil could extend deeper than one foot below the ground surface. During the UXO 7 RFI, surface soil samples (typically from the surface to two feet below ground surface) were collected from various locations within the small arms ranges across the UXO 7 area. As indicated in **Figure 2**, the primary range infrastructure features from the former 500-yard rifle range (firing position berms, main target berm and barricade, etc,) are still present and visible at UXO 7. Only the dirt mound between the 300- and 400-yard firing positions is believed to be the result of operations that occurred after firing range activities at the site had permanently ended. Although the aboveground structures (i.e., trap houses and concrete firing positions) from the former trap ranges in the Central Zone of UXO 7 (depicted in **Figure 2**) have been removed from the range, minor amounts of trap house debris and electrical wiring observed at the site aided in locating the former range trap house sites. Furthermore, the distribution of lead and PAH contamination in range soil at the site is consistent with the areas of defined lead accumulation (range berms) and identified PAH accumulation (near the trap range centers about 75-175 feet from the firing line) which would be expected to occur on a typical small arms range. Therefore, based on these data, it appears that there has not been extensive disturbance of the soil in the former range areas of UXO 7.

The resulting analytical soil data were compared against human health and ecological screening levels in the RFI Report (Tetra Tech, July 2009). The results showed excess risk to humans (residential receptors) from PAHs and to ecological receptors (mammals and birds) from lead. During an initial review of the Draft-Final RFI Report for UXO 7, and in consultation with Naval Facilities Engineering Command (NAVFAC) and the United States Environmental Protection Agency (USEPA) Region V, an ecological screening concentration of 192 milligrams per kilogram (mg/kg) for lead in soil was identified for UXO 7. For the purpose of risk evaluation, the UXO 7 former small arms range area was divided into three zones consisting of a northern zone, a central zone, and a southern zone, based on the geographic position within the UXO 7 site (**Figure 2**).

3.0 Supplemental Delineation Sampling for Lead Concentrations in Soil

This proposed supplemental soil sampling program is focused on identified soil sampling locations from the RFI where the analytical data indicated elevated concentrations of lead present in the former small arms range soil. The collection of the supplemental soil sampling data will provide more detailed information on the nature and extent of the contaminated areas in the soil at the site (both laterally and vertically), and will guide the development of subsequent focused interim removal actions.

Table 1 provides a summary of the number of lead samples to be collected during the supplemental sampling field effort. The information below provides details on the sampling effort for the lead soil sample collection.

Real-time X-ray fluorescence (XRF) analyses will be used as a field-screening tool to determine the nature and extent of lead in soil. A screening value of 125 parts per million (ppm) lead will be used for the XRF screening of soil samples. This conservative XRF field screening value is nearly one-half the previously identified ecological lead screening concentration of 192 mg/kg and nearly one-quarter of the human health screening level of 400 mg/kg. The indicated XRF screening value for lead (125 mg/kg) was selected as a conservative concentration for field screening purposes and is not directly tied to a specific ecological or human health screening value. The more conservative XRF screening value provides the field team greater confidence in supporting field decisions for supplemental sampling locations (identifying the limits of soil lead contamination, supporting real-time decisions for additional step-out samples, or requiring the collection of soils samples from greater depths). It is the goal of this UXO 7 supplemental sampling to have the discrete areas of elevated soil lead concentrations fully bounded by field-screened XRF soil samples that display lead concentrations below the selected XRF screening value (both vertically and horizontally). These XRF data will be used to confirm that all areas of elevated soil lead have been clearly identified based on the XRF field screening process and serve as the basis for selecting a subset of collected soil samples for verification of lead concentrations by analysis at a fixed-base laboratory (FBL).

The XRF analyses will be performed on soil samples encircling the former RFI sample locations with elevated lead concentrations. These supplemental sampling locations will include samples initially collected from the surface to one-foot below ground surface (bgs). Should the 0 to 1-foot bgs soil sample exhibit an XRF lead concentration greater than the established XRF lead screening value of 125 ppm, then additional vertical samples will be collected at that location in one-foot increments until the lead XRF concentration is below the established XRF field screening concentration. Horizontal step-out samples will also be collected in approximate 5-foot increments until the lead XRF concentration is below the established XRF field screening concentration. The collection of vertical samples from each location will be used to confirm the base of the lead contamination in the former range soil while the horizontal samples will ensure that the soil areas with elevated lead concentrations have been fully delineated. Representative soil samples evaluated by the field XRF approach will be submitted for FBL analysis to determine the overall accuracy of the XRF field screening process and to add greater credibility to the XRF data through a correlation analysis of the FBL and field data. This approach will guide the development of a subsequent soil removal action to address the lead-contaminated soil at UXO 7.

Three discrete areas within UXO 7 were identified where the soil lead concentrations were greater than the 192 mg/kg ecological screening level and all were located in the northern zone (**Figure 3**). Based on the XRF analysis of the soil samples collected from the northern zone, additional samples may be collected (using a step-out technique) to better delineate specific areas of elevated soil lead concentrations from those areas that do not exhibit elevated soil lead via XRF analysis.

The northernmost of the three soil lead areas occurs in a depression on the rifle range floor near a small drainage that passes through the range between the 400- and 500-yard firing positions (**Figure 3**). The soil lead contamination in this location has been partially bounded laterally. A sampling approach featuring 17 locations surrounding the three RFI sample locations with lead concentrations greater than 192 mg/kg will be initiated, with each sample location featuring two sampling depths (as previously described) (**Figure 4**). In the event that the XRF soil samples collected from the inner ring around the RFI soil lead hot spot exhibit field XRF lead concentrations greater than 125 ppm, then samples from the second ring of sampling locations will be added to the data set until the soil contamination is fully delineated vertically and laterally. Up to 24 secondary ring samples may be collected as necessary to clearly distinguish lead impacted soil (>192 mg/kg) from lower risk soil on the range.

A second area along the 400-yard firing location berm features a linear area with three RFI soil sample points containing elevated soil lead concentrations above 192 mg/kg (**Figure 3**). While the lead contamination in this area was partially bounded laterally during the RFI (i.e., there were several adjacent sampling locations below the 192 mg/kg ecological screening level for lead), the complete lateral extent of the contamination in the area has not been fully characterized (**Figure 5**). Furthermore, because this firing position was constructed to be elevated above the range floor, there is the potential that some lead contamination may be present at depth (past sampling only considered the surface to two-foot depth of soil). A series of 18 XRF sample locations are proposed to encircle the previously identified RFI soil lead hot spots with each sampling location featuring two sampling depths (as previously described and as presented in **Table 1**) . These primary rings of six soil sample locations each will be used to delineate the lateral and vertical extent of the soil lead based on field XRF screening. In the event that the XRF soil samples collected from the inner rings around the RFI soil lead hot spots exhibit field XRF lead concentrations greater than 125 ppm, then additional soil samples from a series of secondary rings of sampling locations will be added to the data set until the soil lead contamination is fully delineated vertically and laterally. Up to 26 secondary ring samples may be collected as necessary to clearly distinguish lead impacted soils (>192 mg/kg) from lower risk soils on the range.

The third area in the northern zone consists of a dirt mound area between the 300- and 400-yard firing positions and had two discrete sampling points with elevated soil lead concentrations above 192 mg/kg (**Figure 3**). While the lead contamination in this area has been partially bounded laterally (i.e., there were several adjacent sampling locations below the 192 mg/kg ecological screening level for lead), the complete extent of the contamination in the area has not been fully characterized. Furthermore, because this location was elevated above the range floor, it is possible that there may be some lead contamination present in subsurface soils (past sampling only considered the surface to two-foot depth of soil). A series of 12 XRF sample locations (two sample depths per location as previously described, and as shown in **Table 1**) are proposed to initially surround the RFI soil lead hot spots in this area (**Figure 6**).

In the event that the XRF soil samples collected from the inner rings around the RFI soil lead hot spots exhibit field XRF lead concentrations greater than 125 ppm, then additional soil samples from secondary rings of sampling locations will be added to the data set until the soil lead contamination is fully delineated vertically and laterally. Up to 20 secondary ring samples may be collected as necessary to clearly distinguish lead impacted soils (>192 mg/kg) from lower risk soils on the range.

The goal of the supplemental sampling is to better delineate the lateral and vertical limits within each of the three areas where soil lead concentrations exceed the 192 mg/kg ecological screening level for lead.

Additional soil characterization testing in the form of a seven-point composite sample will be collected within the boundaries of each of the three lead-impacted soil areas for the purpose of supporting toxicity characteristic leaching procedure (TCLP) analyses. The TCLP testing will determine whether the specific soil to be excavated and removed from the site will require management as hazardous (based on leachable lead concentrations) or may be managed and transported as non-hazardous soil. The cost for the soil disposal is entirely dependent on its characterization as hazardous for lead or non-hazardous. An improved delineation of these elevated soil lead areas in the northern zone will aid in the development of limited removal soil actions to address these areas and reduce the average post-removal lead concentrations at UXO 7 to more acceptable concentrations.

4.0 Supplemental Delineation Sampling for PAH Concentrations in Soil

This proposed supplemental soil sampling program is focused on identified soil sampling locations from the RFI where the analytical data indicated elevated concentrations of PAHs present in the former small arms range soil. The collection of the supplemental soil sampling data will provide more detailed information on the nature and extent of the contaminated areas in the surface soil at the site (both laterally and vertically), and will guide the development of subsequent focused interim removal actions.

During the 2007 RFI, surface soil samples were collected for analysis of PAH compounds which were commonly used as a binding agent (pitch tar) in the manufacture of clay trap and skeet targets. The soil PAH concentrations are typically higher on older trap and skeet ranges (when the clay targets contained pitch tars), especially in those areas of the range where the clay target shards impact and accumulate on the range floor below the aerial locations where the targets were successfully shot and broken in the air. In the UXO 7 central zone there were two separate trap ranges (East Trap Range and West Trap Range) that were sampled for soil PAHs (**Figure 7**).

As with the lead delineation sampling, a similar sampling approach is proposed for the PAH areas, except that there will be no field screening step. All proposed vertical and horizontal PAH soil samples as shown on **Figures 8 and 9**, and identified in **Table 1**, will be collected and shipped to the FBL. Due to the limited extraction time associated with PAH analysis, the FBL will be instructed to extract all samples, but to initially analyze only those samples collected from the 0- to 1-foot depth of the inner rings of the sample areas. Based on the analyses for these samples, the FBL will then be instructed by Tetra Tech to analyze only those particular samples from the outer rings and deeper depths associated with those samples exceeding the PAH screening levels which will delineate the extent of PAH contamination within that area.

As an example, if a inner ring soil sample (0- to 1-foot bgs) establishes that the PAH contamination is localized and does not extend beyond one-foot deep and does not continue laterally beyond the first ring of samples (approximately 15-feet from the known point of soil PAH contamination), then that area of elevated PAH compounds in soil has been fully delineated and a soil removal activity may be designed to address that PAH-contaminated soil area as it was delineated by the supplemental sampling. For the stated example, the outer ring of soil samples would not require analysis because the identified PAH contamination had been fully encircled by "clean" (PAHs below screening level) samples and will have identified the limits of the soil above PAH screening levels. Consequently, if soil samples collected from the 0- to 1-foot and the 1- to 2-foot depth still exceed PAH screening levels, then additional soil samples would need to be collected from greater step-out distances and depths (performed in a subsequent sampling event) to fully bound the extent of PAH contamination in soil. The PAH project action limits (PALs) are presented and discussed later in this Supplemental Work Plan.

In the East Trap Range there were two soil samples with PAHs above screening levels and additional soil samples should be collected and analyzed to bound the extent of the PAH contamination in the surface soil (**Figure 8**). The current approach is to encircle each PAH hotspot with an inner ring of six samples collected at a distance of 15 feet from the subject hotspot (two sampling depths – 0 to 1- and 1 to 2-feet bgs). These samples will be shipped to the FBL for extraction and PAH analysis.

Two larger outer rings at a radius of 30 feet from each hotspot will have 10 sampling points (again with each point featuring two sampling depths – 0 to 1- and 1 to 2-feet bgs). This sampling approach produces 16 sampling points and 32 soil samples per hotspot. The outer rings of samples will also be shipped to the FBL to be extracted, but held for PAH analysis. The FBL will be instructed to perform the PAH analysis only on those outer ring samples where a respective inner circle location exceeded the PAH screening level; otherwise, the outer ring samples will be discarded.

A similar situation exists for the West Trap Range, except there were four soil samples with PAH concentrations above screening levels (**Figure 9**). The four areas of PAH-impacted soils (above relevant PAH compound-specific screening levels) occur in the central area of the former trap range and are sufficiently close to one another that portions of the proposed sampling rings around the PAH hot spots overlap to some extent. Consequently, as shown on **Figure 9**, there are 22 proposed sampling locations along the inner rings surrounding the PAH hot spots (with two sample depths per location). There are an additional 20 sampling locations with each point available to supplement the inner sample ring data, as necessary, to clearly distinguish PAH impacted soils (above screening levels) from lower risk soils on the trap range. The outer ring of samples will also be shipped to the FBL to be extracted and held for PAH analysis. The FBL will be instructed to perform the PAH analysis only on those outer ring samples where a respective inner ring location exceeded the PAH screening level; otherwise, the outer ring samples will be discarded.

As described in the RFI results section of this Technical Memorandum, there is minimal indication of small arms range soil disturbance following the end of the small arms range operations. For this reason, deeper contamination (below a depth of 2-feet bgs) is not anticipated for UXO 7. The CSM for trap and skeet ranges indicate that skeet fragments and residues are likely restricted to the top few inches of soil. Those skeet materials were deposited onto the ground surface after falling to the ground from the point in the air where the skeet target was impacted by shot from the shotgun shell, The skeet residues that occur then fall through the air to the ground surface and would not be expected to occur at depth.

Similar to the supplemental soil lead sampling program for UXO 7, the end goal of the supplemental PAH soil sampling program is to better delineate the lateral and vertical extent of the soil PAHs that exceed human health or ecological screening levels for the individual PAH compounds in the former trap range soil. An improved delineation of these areas of elevated PAHs in central zone soil will support development of limited soil removal actions to address these areas and reduce the average post-removal PAH soil concentrations at UXO 7 to more acceptable concentrations.

4.1 PAH Project Action Levels

The table presented below summarizes the project action limits (PALs) for which the PAHs in the East and West Trap Range areas will be compared.

PAH Compound	Project Action Limit (PAL) (µg/kg)
2-METHYLNAPHTHALENE	31,000
ACENAPHTHENE	340,000
ACENAPHTHYLENE	340,000
ANTHRACENE	1,700,000
BENZO(A)ANTHRACENE	150
BENZO(A)PYRENE	15
BENZO(B)FLUORANTHENE	150
BENZO(G,H,I)PERYLENE	170,000
BENZO(K)FLUORANTHENE	1,500
CHRYSENE	15,000
DIBENZO(A,H)ANTHRACENE	15
FLUORANTHENE	230,000
FLUORENE	230,000
INDENO(1,2,3-CD)PYRENE	150
NAPTHALENE	14,000
PHENANTHRENE	170,000
PYRENE	170,000
BAP EQUIVALENT-HALFND	15
BAP EQUIVALENT-POS	15

The United States Environmental Protection Agency (USEPA) has identified seven PAHs as potentially carcinogenic: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno-(1,2,3-cd)-pyrene (highlighted in the above table). Of these PAHs, benzo(a)pyrene has been subjected to the most toxicological study and the USEPA has used the toxicological data to establish quantitative toxicological parameters (cancer slope factors and inhalation unit risks) for benzo(a)pyrene. All seven of these PAHs have a similar chemical structure and similar chemical properties. Laboratory studies suggest that these chemicals act similarly from the perspective of carcinogenicity and that the carcinogenic potency of the individual PAHs can be evaluated with reference to the carcinogenic potency of benzo(a)pyrene. Therefore, the USEPA has developed a toxicity equivalency factor (TEF) for each potentially carcinogenic PAH that can be used to convert the concentration of that PAH to an equivalent concentration of benzo(a)pyrene. Since benzo(a)pyrene is often abbreviated BaP, this process is known as determining the BaP equivalent concentration.

Therefore, in addition to a direct comparison to individual PAH PALs, a total for calculated BaP equivalents will also be done. The calculated screening value for BaP is 15 micrograms per kilogram (µg/kg).

5.0 Quality Assurance and Quality Control

The proposed field effort will be conducted in accordance with the field Standard Operating Procedures (SOPs) included as Attachment A. The analytical quality assurance/quality control (QA/QC) requirements for this sampling activity at UXO 7 will be in accordance with the FBL SOPs included as Attachment B. Field duplicates are regarded as a typical approach to assess project field sampling quality and field sample duplicates are planned for collection as part of the UXO 7 supplemental sampling effort. Sample summaries and QC samples are identified in **Table 2**.

TABLE 1

FIELD SAMPLE SUMMARY

UXO 07 – SUPPLEMENTAL SOIL SAMPLING

NSA CRANE

CRANE, INDIANA

Sample Location[1]	Sample ID[2]	LEAD (XRF[3])	LEAD (SW 846-6010C)	PAHs (SW 846-8270C)
Soil Samples				
X7-SB200	X7-SS200-0001	---	---	1
	X7-SS200-0102	---	---	1
X7-SB201	X7-SS201-0001	---	---	1
	X7-SS201-0102	---	---	1
X7-SB202	X7-SS202-0001	---	---	1
	X7-SS202-0102	---	---	1
X7-SB203	X7-SS203-0001	---	---	1
	X7-SS203-0102	---	---	1
X7-SB204	X7-SS204-0001	---	---	1
	X7-SS204-0102	---	---	1
X7-SB205	X7-SS205-0001	---	---	1
	X7-SS205-0102	---	---	1
X7-SB206	X7-SS206-0001	---	---	1
	X7-SS206-0102	---	---	1
X7-SB207	X7-SS207-0001	---	---	1
	X7-SS207-0102	---	---	1
X7-SB208	X7-SS208-0001	---	---	1
	X7-SS208-0102	---	---	1
X7-SB209	X7-SS209-0001	---	---	1
	X7-SS209-0102	---	---	1
X7-SB210	X7-SS210-0001	---	---	1
	X7-SS210-0102	---	---	1
X7-SB211	X7-SS211-0001	---	---	1
	X7-SS211-0102	---	---	1
X7-SB212	X7-SS212-0001	---	---	1

Sample Location[1]	Sample ID[2]	LEAD (XRF[3])	LEAD (SW 846-6010C)	PAHs (SW 846-8270C)
	X7-SS212-0102	---	---	1
X7-SB213	X7-SS213-0001	---	---	1
	X7-SS213-0102	---	---	1
X7-SB214	X7-SS214-0001	---	---	1
	X7-SS214-0102	---	---	1
X7-SB215	X7-SS215-0001	---	---	1
	X7-SS215-0102	---	---	1
X7-SB216	X7-SS216-0001	---	---	1
	X7-SS216-0102	---	---	1
X7-SB217	X7-SS217-0001	---	---	1
	X7-SS217-0102	---	---	1
X7-SB218	X7-SS218-0001	---	---	1
	X7-SS218-0102	---	---	1
X7-SB219	X7-SS219-0001	---	---	1
	X7-SS219-0102	---	---	1
X7-SB220	X7-SS220-0001	---	---	1
	X7-SS220-0102	---	---	1
X7-SB221	X7-SS221-0001	---	---	1
	X7-SS221-0102	---	---	1
X7-SB222	X7-SS222-0001	---	---	1
	X7-SS222-0102	---	---	1
X7-SB223	X7-SS223-0001	---	---	1
	X7-SS223-0102	---	---	1
X7-SB224	X7-SS224-0001	---	---	1
	X7-SS224-0102	---	---	1
X7-SB225	X7-SS225-0001	---	---	1
	X7-SS225-0102	---	---	1
X7-SB226	X7-SS226-0001	---	---	1
	X7-SS226-0102	---	---	1
X7-SB227	X7-SS227-0001	---	---	1
	X7-SS227-0102	---	---	1
X7-SB228	X7-SS228-0001	---	---	1
	X7-SS228-0102	---	---	1
X7-SB229	X7-SS229-0001	---	---	1

Sample Location[1]	Sample ID[2]	LEAD (XRF[3])	LEAD (SW 846-6010C)	PAHs (SW 846-8270C)
	X7-SS229-0102	---	---	1
X7-SB230	X7-SS230-0001	---	---	1
	X7-SS230-0102	---	---	1
X7-SB231	X7-SS231-0001	---	---	1
	X7-SS231-0102	---	---	1
X7-SB232	X7-SS232-0001	---	---	1
	X7-SS232-0102	---	---	1
X7-SB233	X7-SS233-0001	---	---	1
	X7-SS233-0102	---	---	1
X7-SB234	X7-SS234-0001	---	---	1
	X7-SS234-0102	---	---	1
X7-SB235	X7-SS235-0001	---	---	1
	X7-SS235-0102	---	---	1
X7-SB236	X7-SS236-0001	---	---	1
	X7-SS236-0102	---	---	1
X7-SB237	X7-SS237-0001	---	---	1
	X7-SS237-0102	---	---	1
X7-SB238	X7-SS238-0001	---	---	1
	X7-SS238-0102	---	---	1
X7-SB239	X7-SS239-0001	---	---	1
	X7-SS239-0102	---	---	1
X7-SB240	X7-SS240-0001	---	---	1
	X7-SS240-0102	---	---	1
X7-SB241	X7-SS241-0001	---	---	1
	X7-SS241-0102	---	---	1
X7-SB242	X7-SS242-0001	---	---	1
	X7-SS242-0102	---	---	1
X7-SB243	X7-SS243-0001	---	---	1
	X7-SS243-0102	---	---	1
X7-SB244	X7-SS244-0001	---	---	1
	X7-SS244-0102	---	---	1
X7-SB245	X7-SS245-0001	---	---	1
	X7-SS245-0102	---	---	1
X7-SB246	X7-SS246-0001	---	---	1

Sample Location[1]	Sample ID[2]	LEAD (XRF[3])	LEAD (SW 846-6010C)	PAHs (SW 846-8270C)
	X7-SS246-0102	---	---	1
X7-SB247	X7-SS247-0001	---	---	1
	X7-SS247-0102	---	---	1
X7-SB248	X7-SS248-0001	---	---	1
	X7-SS248-0102	---	---	1
X7-SB249	X7-SS249-0001	---	---	1
	X7-SS249-0102	---	---	1
X7-SB250	X7-SS250-0001	---	---	1
	X7-SS250-0102	---	---	1
X7-SB251	X7-SS251-0001	---	---	1
	X7-SS251-0102	---	---	1
X7-SB252	X7-SS252-0001	---	---	1
	X7-SS252-0102	---	---	1
X7-SB253	X7-SS253-0001	---	---	1
	X7-SS253-0102	---	---	1
X7-SB254	X7-SS254-0001	---	---	1
	X7-SS254-0102	---	---	1
X7-SB255	X7-SS255-0001	---	---	1
	X7-SS255-0102	---	---	1
X7-SB256	X7-SS256-0001	---	---	1
	X7-SS256-0102	---	---	1
X7-SB257	X7-SS257-0001	---	---	1
	X7-SS257-0102	---	---	1
X7-SB258	X7-SS258-0001	---	---	1
	X7-SS258-0102	---	---	1
X7-SB259	X7-SS259-0001	---	---	1
	X7-SS259-0102	---	---	1
X7-SB260	X7-SS260-0001	---	---	1
	X7-SS260-0102	---	---	1
X7-SB261	X7-SS261-0001	---	---	1
	X7-SS261-0102	---	---	1
X7-SB262	X7-SS262-0001	---	---	1
	X7-SS262-0102	---	---	1
X7-SB263	X7-SS263-0001	---	---	1

Sample Location[1]	Sample ID[2]	LEAD (XRF[3])	LEAD (SW 846-6010C)	PAHs (SW 846-8270C)
	X7-SS263-0102	---	---	1
X7-SB264	X7-SS264-0001	---	---	1
	X7-SS264-0102	---	---	1
X7-SB265	X7-SS265-0001	---	---	1
	X7-SS265-0102	---	---	1
X7-SB266	X7-SS266-0001	---	---	1
	X7-SS266-0102	---	---	1
X7-SB267	X7-SS267-0001	---	---	1
	X7-SS267-0102	---	---	1
X7-SB268	X7-SS268-0001	---	---	1
	X7-SS268-0102	---	---	1
X7-SB269	X7-SS269-0001	---	---	1
	X7-SS269-0102	---	---	1
X7-SB270	X7-SS270-0001	---	---	1
	X7-SS270-0102	---	---	1
X7-SB271	X7-SS271-0001	---	---	1
	X7-SS271-0102	---	---	1
X7-SB272	X7-SS272-0001	---	---	1
	X7-SS272-0102	---	---	1
X7-SB273	X7-SS273-0001	---	---	1
	X7-SS273-0102	---	---	1
X7-SB274	X7-SS274-0001	1	TBD[4]	---
	X7-SS274-0102	2	TBD[4]	---
X7-SB275	X7-SS275-0001	1	TBD[4]	---
	X7-SS275-0102	2	TBD[4]	---
X7-SB276	X7-SS276-0001	1	TBD[4]	---
	X7-SS276-0102	2	TBD[4]	---
X7-SB277	X7-SS277-0001	1	TBD[4]	---
	X7-SS277-0102	2	TBD[4]	---
X7-SB278	X7-SS278-0001	1	TBD[4]	---
	X7-SS278-0102	2	TBD[4]	---
X7-SB279	X7-SS279-0001	1	TBD[4]	---
	X7-SS279-0102	2	TBD[4]	---
X7-SB280	X7-SS28-0001	1	TBD[4]	---

Sample Location[1]	Sample ID[2]	LEAD (XRF[3])	LEAD (SW 846-6010C)	PAHs (SW 846-8270C)
	X7-SS280-0102	2	TBD[4]	---
X7-SB281	X7-SS281-0001	1	TBD[4]	---
	X7-SS281-0102	2	TBD[4]	---
X7-SB282	X7-SS282-0001	1	TBD[4]	---
	X7-SS282-0102	2	TBD[4]	---
X7-SB283	X7-SS283-0001	1	TBD[4]	---
	X7-SS283-0102	2	TBD[4]	---
X7-SB284	X7-SS284-0001	1	TBD[4]	---
	X7-SS284-0102	2	TBD[4]	---
X7-SB285	X7-SS285-0001	1	TBD[4]	---
	X7-SS285-0102	2	TBD[4]	---
X7-SB286	X7-SS286-0001	1	TBD[4]	---
	X7-SS286-0102	2	TBD[4]	---
X7-SB287	X7-SS287-0001	1	TBD[4]	---
	X7-SS287-0102	2	TBD[4]	---
X7-SB288	X7-SS288-0001	1	TBD[4]	---
	X7-SS288-0102	2	TBD[4]	---
X7-SB289	X7-SS289-0001	1	TBD[4]	---
	X7-SS289-0102	2	TBD[4]	---
X7-SB290	X7-SS290-0001	1	TBD[4]	---
	X7-SS290-0102	2	TBD[4]	---
X7-SB291	X7-SS291-0001	1	TBD[4]	---
	X7-SS291-0102	2	TBD[4]	---
X7-SB292	X7-SS292-0001	1	TBD[4]	---
	X7-SS292-0102	2	TBD[4]	---
X7-SB293	X7-SS293-0001	1	TBD[4]	---
	X7-SS293-0102	2	TBD[4]	---
X7-SB294	X7-SS294-0001	1	TBD[4]	---
	X7-SS294-0102	2	TBD[4]	---
X7-SB295	X7-SS295-0001	1	TBD[4]	---
	X7-SS295-0102	2	TBD[4]	---
X7-SB296	X7-SS296-0001	1	TBD[4]	---
	X7-SS296-0102	2	TBD[4]	---
X7-SB297	X7-SS297-0001	1	TBD[4]	---

Sample Location[1]	Sample ID[2]	LEAD (XRF[3])	LEAD (SW 846-6010C)	PAHs (SW 846-8270C)
	X7-SS297-0102	2	TBD[4]	---
X7-SB298	X7-SS298-0001	1	TBD[4]	---
	X7-SS298-0102	2	TBD[4]	---
X7-SB299	X7-SS299-0001	1	TBD[4]	---
	X7-SS299-0102	2	TBD[4]	---
X7-SB300	X7-SS300-0001	1	TBD[4]	---
	X7-SS300-0102	2	TBD[4]	---
X7-SB301	X7-SS301-0001	1	TBD[4]	---
	X7-SS301-0102	2	TBD[4]	---
X7-SB302	X7-SS302-0001	1	TBD[4]	---
	X7-SS302-0102	2	TBD[4]	---
X7-SB303	X7-SS303-0001	1	TBD[4]	---
	X7-SS303-0102	2	TBD[4]	---
X7-SB304	X7-SS304-0001	1	TBD[4]	---
	X7-SS304-0102	2	TBD[4]	---
X7-SB305	X7-SS305-0001	1	TBD[4]	---
	X7-SS305-0102	2	TBD[4]	---
X7-SB306	X7-SS306-0001	1	TBD[4]	---
	X7-SS306-0102	2	TBD[4]	---
X7-SB307	X7-SS307-0001	1	TBD[4]	---
	X7-SS307-0102	2	TBD[4]	---
X7-SB308	X7-SS308-0001	1	TBD[4]	---
	X7-SS308-0102	2	TBD[4]	---
X7-SB309	X7-SS309-0001	1	TBD[4]	---
	X7-SS309-0102	2	TBD[4]	---
X7-SB310	X7-SS310-0001	1	TBD[4]	---
	X7-SS310-0102	2	TBD[4]	---
X7-SB311	X7-SS311-0001	1	TBD[4]	---
	X7-SS311-0102	2	TBD[4]	---
X7-SB312	X7-SS312-0001	1	TBD[4]	---
	X7-SS312-0102	2	TBD[4]	---
X7-SB313	X7-SS313-0001	1	TBD[4]	---
	X7-SS313-0102	2	TBD[4]	---
X7-SB314	X7-SS314-0001	1	TBD[4]	---

Sample Location[1]	Sample ID[2]	LEAD (XRF[3])	LEAD (SW 846-6010C)	PAHs (SW 846-8270C)
	X7-SS314-0102	2	TBD[4]	---
X7-SB315	X7-SS315-0001	1	TBD[4]	---
	X7-SS315-0102	2	TBD[4]	---
X7-SB316	X7-SS316-0001	1	TBD[4]	---
	X7-SS316-0102	2	TBD[4]	---
X7-SB317	X7-SS317-0001	1	TBD[4]	---
	X7-SS317-0102	2	TBD[4]	---
X7-SB318	X7-SS318-0001	1	TBD[4]	---
	X7-SS318-0102	2	TBD[4]	---
X7-SB319	X7-SS319-0001	1	TBD[4]	---
	X7-SS319-0102	2	TBD[4]	---
X7-SB320	X7-SS320-0001	1	TBD[4]	---
	X7-SS320-0102	2	TBD[4]	---
X7-SB391	X7-SS391-0001	1	TBD[4]	---
	X7-SS391-0102	2	TBD[4]	---
X7-SB392	X7-SS392-0001	1	TBD[4]	---
	X7-SS392-0102	2	TBD[4]	---
X7-SB393	X7-SS393-0001	1	TBD[4]	---
	X7-SS393-0102	2	TBD[4]	---
X7-SB394	X7-SS394-0001	1	TBD[4]	---
	X7-SS394-0102	2	TBD[4]	---
X7-SB395	X7-SS395-0001	1	TBD[4]	---
	X7-SS395-0102	2	TBD[4]	---
X7-SB396	X7-SS396-0001	1	TBD[4]	---
	X7-SS396-0102	2	TBD[4]	---
Total Soil Samples		**106**	**TBD[4]**	**148**
Potential Step-Out Samples (collected as needed)				
X7-SB321 thru X7-SB390	X7-SS321-0001 thru X7-SS390-0001	69	TBD[4]	---
	X7-SS321-0102 thru X7-SS390-0102	69	TBD[4]	---
X7-SB397 thru X7-SB406	X7-SS397-0001 thru X7-SS406-0001	10	TBD[4]	---
	X7-SS397-0102 thru X7-SS406-0102	10	TBD[4]	---
Total Potential Step-Out Soil Samples		**158[5]**	**TBD[4]**	**0**

FBL = Fixed-base laboratory
PAH = Polynuclear aromatic hydrocarbons
ppm = parts per million
TBD = To be determined
XRF = X-ray fluorescence

1 X7 = UXO 7. SB = Soil boring.
2 SS = Surface soil. Last four digits of sample ID indicate depth below ground surface in feet.
3 1 = Sample analyzed in the field via XRF. 2 = Sample analyzed in the field via XRF if respective sample (0 to 1 foot bgs) exceeds field screening value of 125 ppm.
4 All soil samples used to define the interface between "contaminated" and "non-contaminated" soils will be selected for confirmatory lead analysis at the FBL.
5 Additional "step-out" lead soil samples may be collected in order to define the extent of lead contamination in the field based on XRF analysis.

TABLE 2

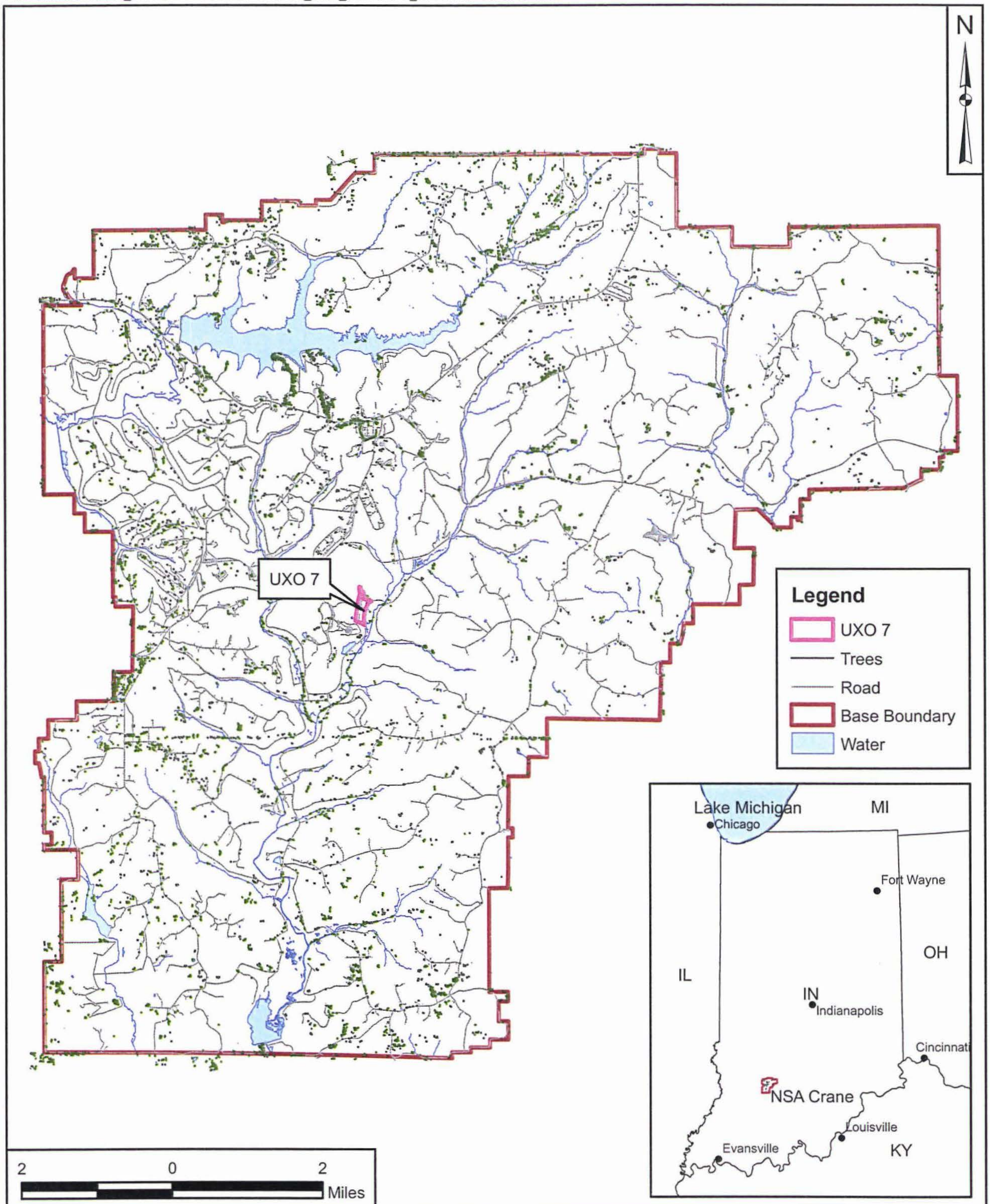
FIXED-BASE LABORATORY SAMPLE SUMMARY
UXO 07 – SUPPLEMENTAL SOIL SAMPLING
NSA CRANE
CRANE, INDIANA

Matrix	Analytical Group	Concentration Level	Samples	Field Duplicates(1)	MS/MSDs(1)	Rinsate Blanks(2)	Total Samples to Lab
Solid	Lead SW 846-6010C(3)	Low to Moderate	45(4)	3	3	1	52
Solid	PAHs SW 846-8270C(3)	Low to Moderate	148	8	8	1	165

MS/MSD = Matrix spike/matrix spike duplicate

1 Field duplicates and MS/MSD samples will be collected at a frequency of 1 per 20 samples per analyte.
2 Rinsate blanks will be collected at a frequency of one per type of non-dedicated equipment.
3 Analysis to be performed by Empirical Laboratories.
4 Actual number of lead samples may vary slightly and are dependent on field XRF screening results.

PGH P:\GIS\CRANE_NSWC\MAPDOCS\MXD\UXO7_SITE_LOCATION_MAP.MXD 07/07/11 JEE

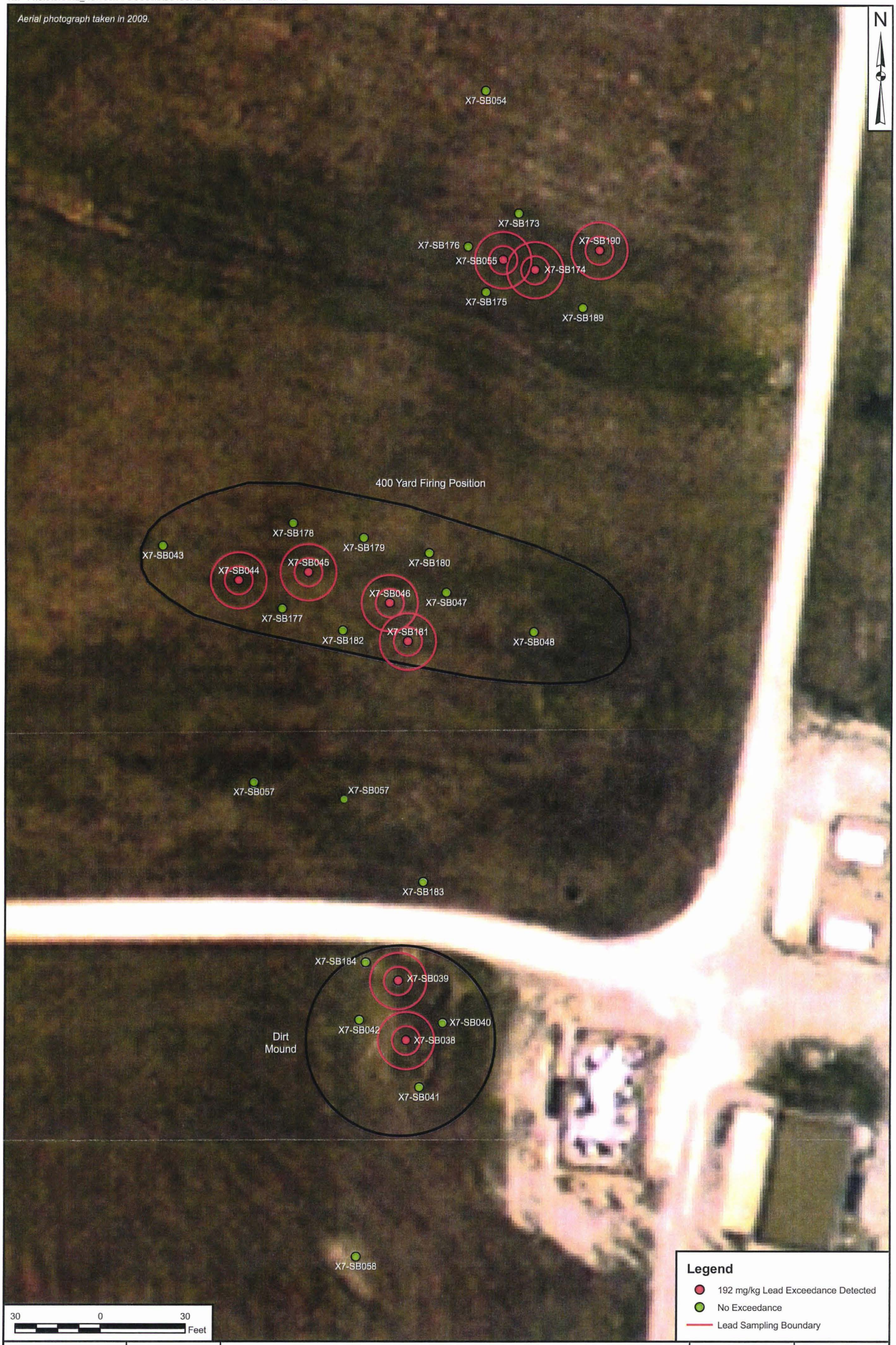


DRAWN BY	DATE		SITE LOCATION MAP UXO 7 - SUPPLEMENTAL SAMPLING WORK PLAN NSA CRANE CRANE, INDIANA	CONTRACT NUMBER CTO F272	
T. WHEATON	05/12/10			APPROVED BY	DATE
CHECKED BY	DATE			___	___
J. GOERDT	07/08/11			APPROVED BY	DATE
REVISED BY	DATE			___	___
___	___			FIGURE NO.	REV
SCALE AS NOTED		NAVFAC		FIGURE 1	0

PGH P:\GIS\CRANE_NSWC\MAPDOCS\MXD\UXO7_SITEMAP.MXD 07/07/11 JEE

DRAWN BY J. ENGLISH	DATE 07/07/11	TETRA TECH	CONTRACT NUMBER ___ / CTO NUMBER F272
CHECKED BY J. GOERDT	DATE 07/08/11	UXO 7 SMALL ARMS RANGES UXO 7 - SUPPLEMENTAL SAMPLING WORK PLAN NSA CRANE CRANE, INDIANA	APPROVED BY ___ / DATE ___
REVISED BY ___	DATE ___		APPROVED BY ___ / DATE ___
SCALE AS NOTED			FIGURE NO. 2 / REV 0

KoP P:\GIS\CRANE_NSWC\MAPDOCS\MXD\FIGURE 3 UXO 7.MXD 09/28/11 MKB



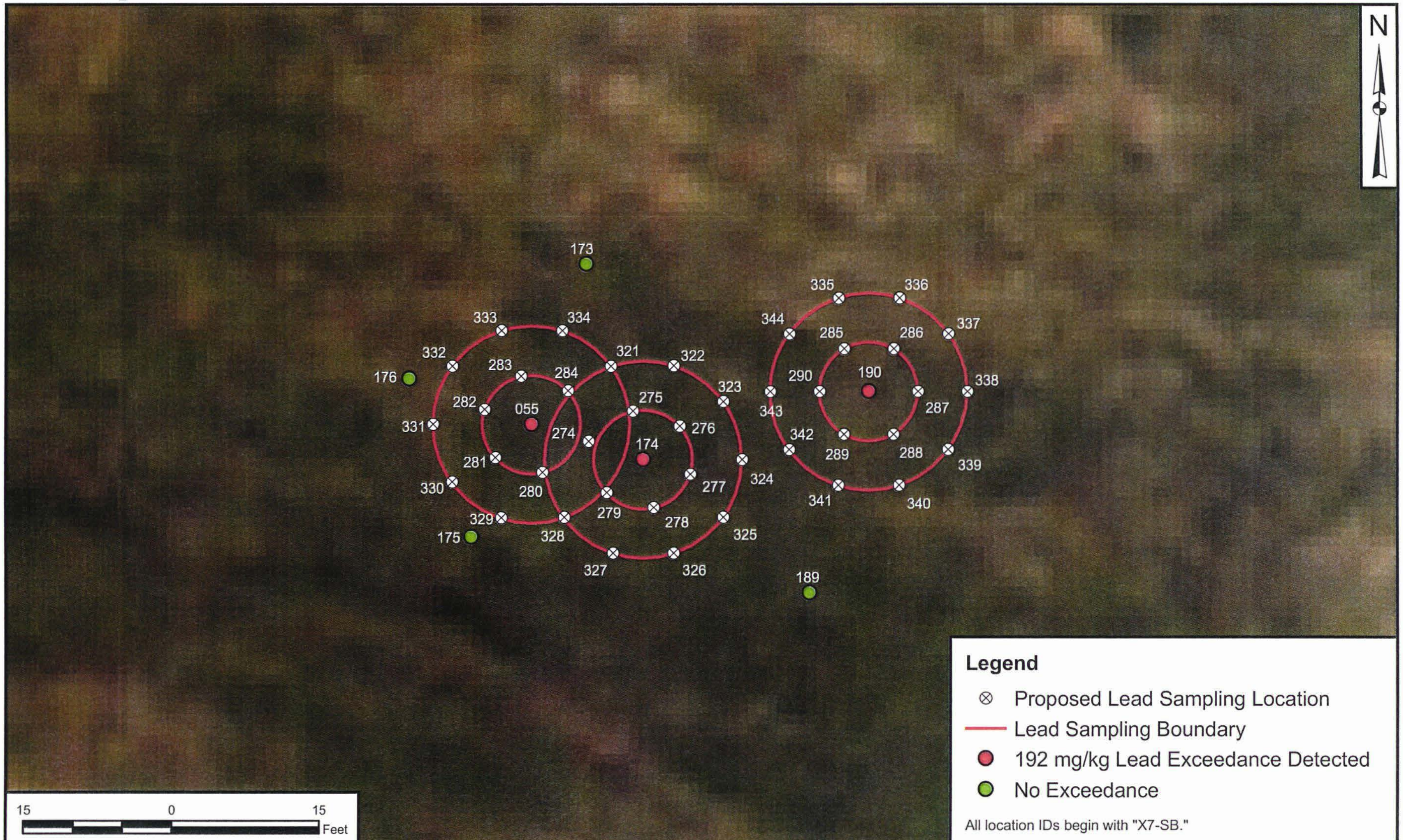
DRAWN BY J. ENGLISH DATE 07/05/11
CHECKED BY J. GOERDT DATE 07/07/11
REVISED BY DATE
SCALE AS NOTED

NAVFAC

SUPPLEMENTAL LEAD SOIL SAMPLING AREAS
NORTHERN ZONE
UXO 7 - SUPPLEMENTAL SAMPLING WORK PLAN
NSA CRANE
CRANE, INDIANA

CONTRACT NUMBER
CTO NUMBER F272
APPROVED BY DATE
APPROVED BY DATE
FIGURE NO. 3
REV 0

KoP P:\GIS\CRANE_NSWC\MAPDOCS\MXD\FIGURE 4 UXO 7.MXD 09/28/11 MKB

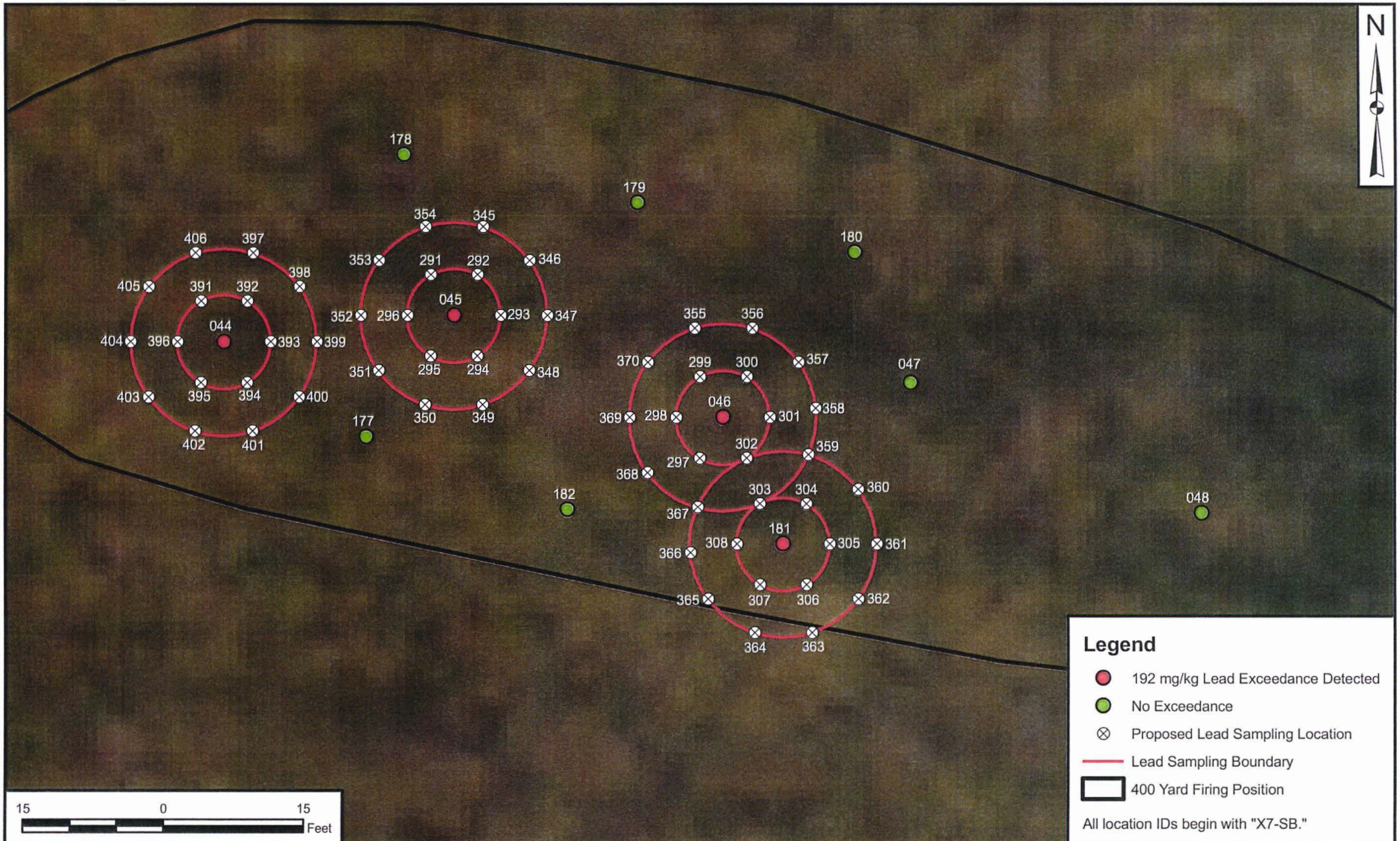


DRAWN BY	DATE
J. ENGLISH	07/05/11
CHECKED BY	DATE
J. GOERDT	07/08/11
REVISED BY	DATE
MK BOND	09/28/11
SCALE AS NOTED	

NAVFAC

PROPOSED SUPPLEMENTAL LEAD SOIL SAMPLING
NORTHERNMOST AREA OF NORTHERN ZONE
UXO 7 - SUPPLEMENTAL SAMPLING WORK PLAN
NSA CRANE
CRANE, INDIANA

CONTRACT NUMBER	CTO NUMBER
—	F272
APPROVED BY —	DATE —
APPROVED BY —	DATE —
FIGURE NO. 4	REV 0



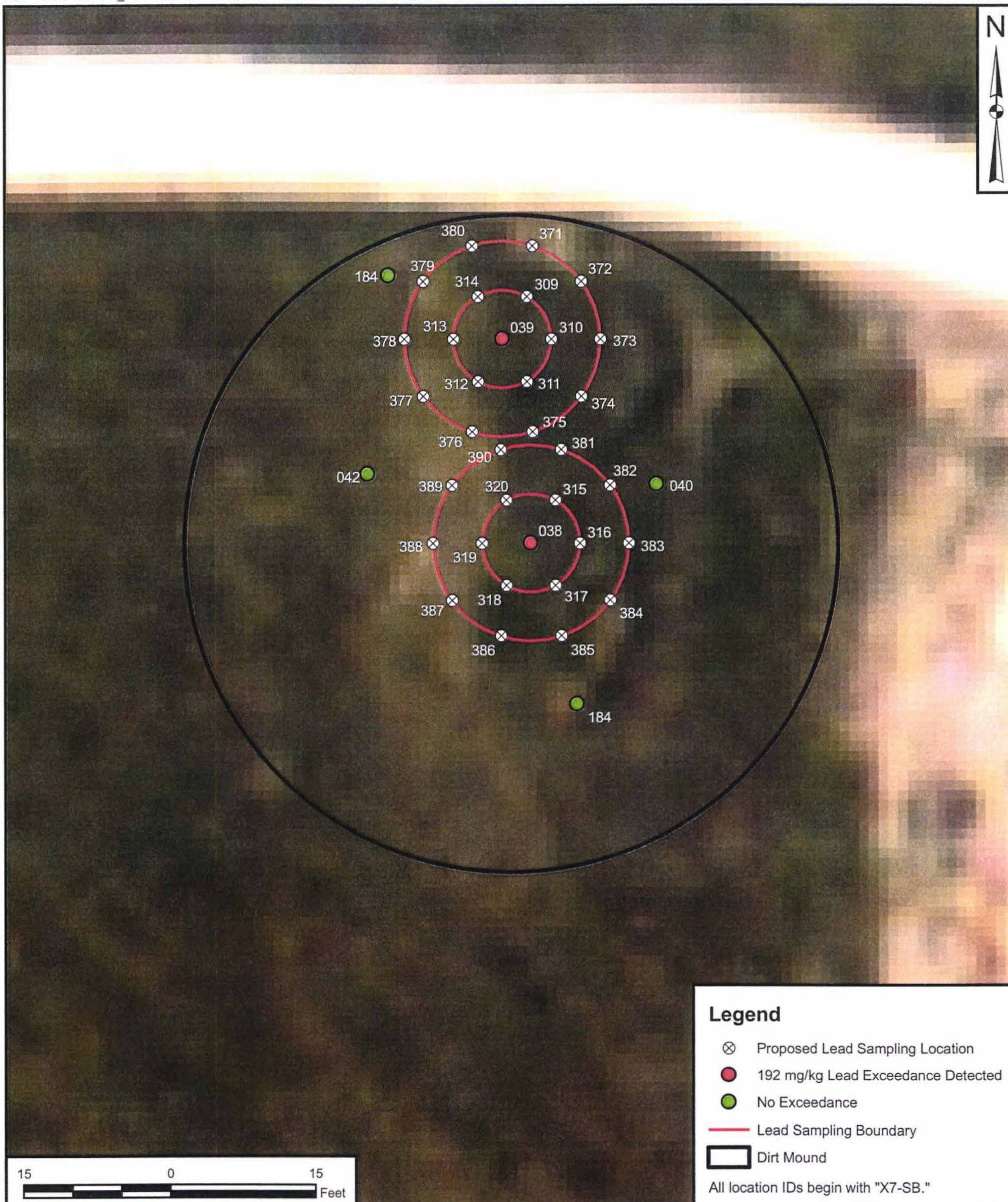
DRAWN BY	DATE
J. ENGLISH	07/05/11
CHECKED BY	DATE
J. GOERDT	07/28/11
REVISED BY	DATE
MK BOND	07/28/11
SCALE AS NOTED	

NAVFAC

PROPOSED SUPPLEMENTAL LEAD SOIL SAMPLING
CENTRAL AREA OF NORTHERN ZONE
UXO 7 - SUPPLEMENTAL SAMPLING WORK PLAN
NSA CRANE
CRANE, INDIANA

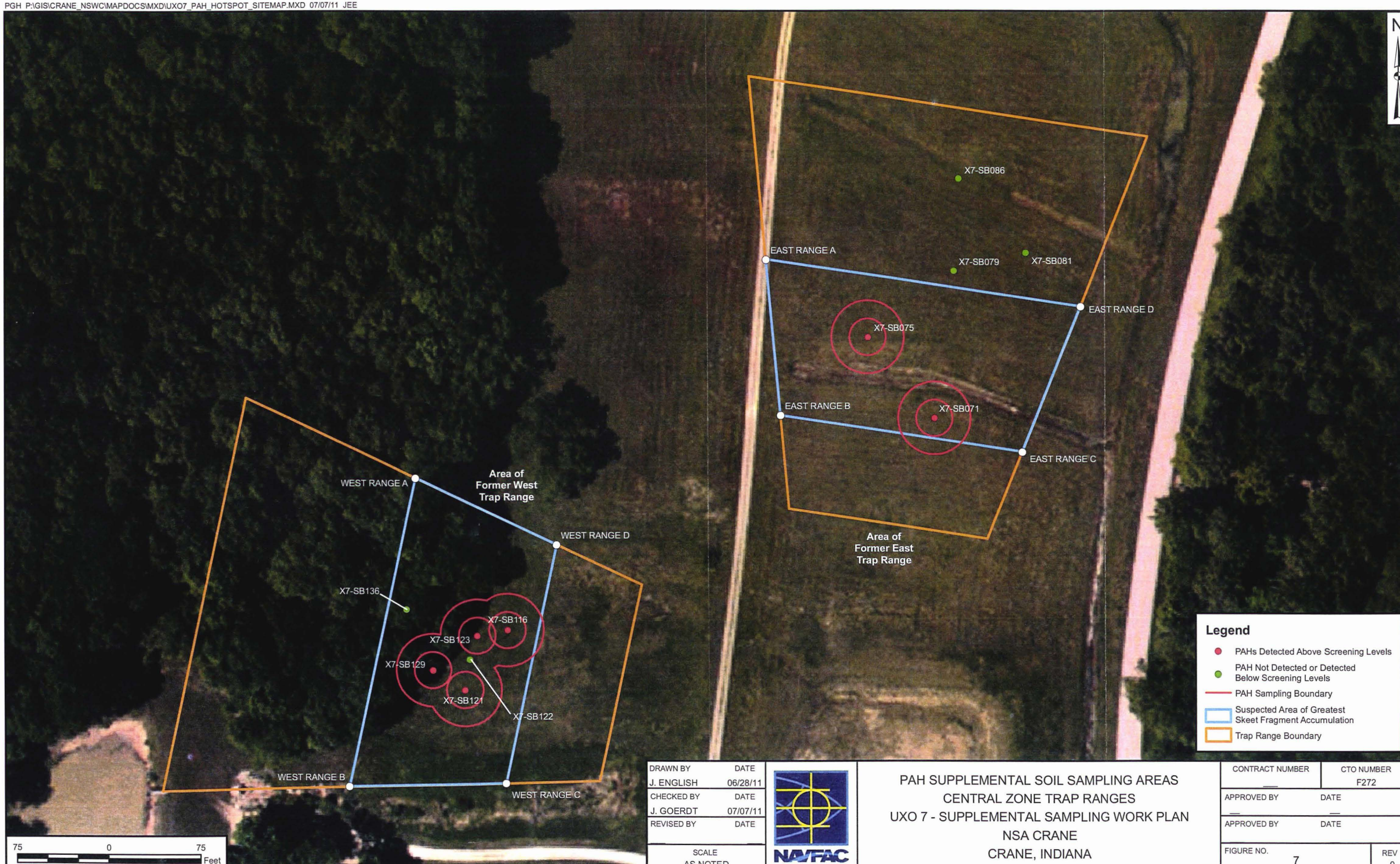
CONTRACT NUMBER	CTO NUMBER
—	F272
APPROVED BY —	DATE —
APPROVED BY —	DATE —
FIGURE NO. 5	REV 0

KoP P:\GIS\CRANE_NSWC\MAPDOCS\MXD\FIGURE 6 UXO 7.MXD 09/28/11 MKB



DRAWN BY	DATE	PROPOSED SUPPLEMENTAL LEAD SOIL SAMPLING	CONTRACT NUMBER	CTO NUMBER
J. ENGLISH	07/05/11	SOUTHERNMOST AREA OF NORTHERN ZONE		F272
CHECKED BY	DATE	UXO 7 - SUPPLEMENTAL	APPROVED BY	DATE
J. GOERDT	09/28/11	SAMPLING WORK PLAN		
REVISED BY	DATE	NSA CRANE	APPROVED BY	DATE
MK BOND	09/28/11	CRANE, INDIANA		
SCALE AS NOTED		NAVFAC	FIGURE NO. 6	REV 0

PGH P:\GIS\CRANE_NSWC\MAPDOCS\MXD\UXO7_PAH_HOTSPOT_SITEMAP.MXD 07/07/11 JEE



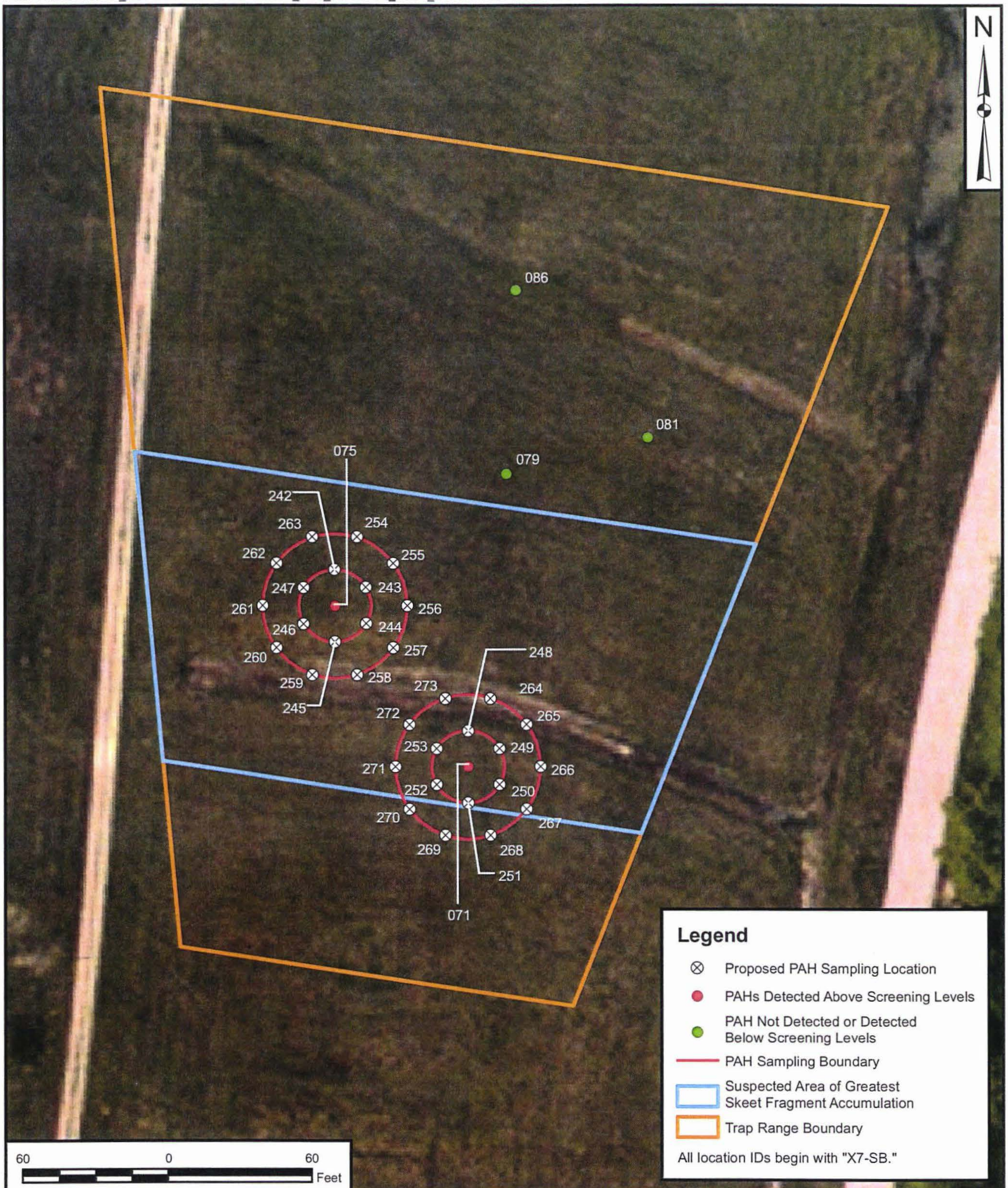
DRAWN BY	DATE
J. ENGLISH	06/28/11
CHECKED BY	DATE
J. GOERDT	07/07/11
REVISED BY	DATE
SCALE AS NOTED	

NAVFAC

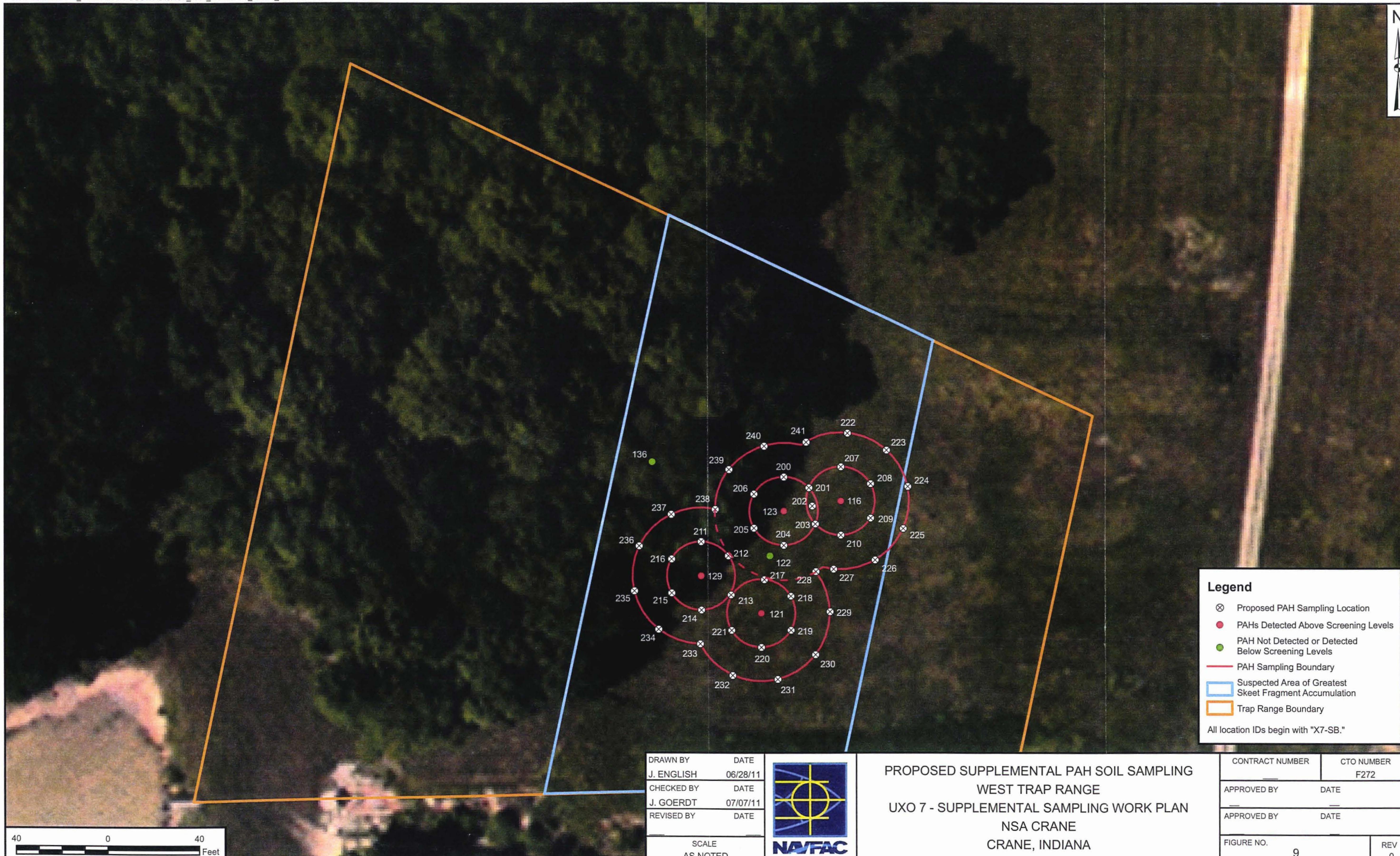
PAH SUPPLEMENTAL SOIL SAMPLING AREAS
CENTRAL ZONE TRAP RANGES
UXO 7 - SUPPLEMENTAL SAMPLING WORK PLAN
NSA CRANE
CRANE, INDIANA

CONTRACT NUMBER	CTO NUMBER
—	F272
APPROVED BY	DATE
—	—
APPROVED BY	DATE
FIGURE NO. 7	REV 0

PGH P:\GIS\CRANE_NSWC\MAPDOCS\MXD\UXO7_PAH_HOTSPOT_EAST_RANGE.MXD 07/07/11 JEE



DRAWN BY	DATE		PROPOSED SUPPLEMENTAL PAH SOIL SAMPLING	CONTRACT NUMBER	CTO NUMBER
J. ENGLISH	06/28/11		EAST TRAP RANGE	___	F272
CHECKED BY	DATE		UXO 7 - SUPPLEMENTAL	APPROVED BY	DATE
J. GOERDT	07/07/11		SAMPLING WORK PLAN	___	___
REVISED BY	DATE		NSA CRANE	APPROVED BY	DATE
				___	___
SCALE AS NOTED		NAVFAC	CRANE, INDIANA	FIGURE NO. 8	REV 0



DRAWN BY	DATE
J. ENGLISH	06/28/11
CHECKED BY	DATE
J. GOERDT	07/07/11
REVISED BY	DATE
SCALE AS NOTED	

NAVFAC

PROPOSED SUPPLEMENTAL PAH SOIL SAMPLING
WEST TRAP RANGE
UXO 7 - SUPPLEMENTAL SAMPLING WORK PLAN
NSA CRANE
CRANE, INDIANA

CONTRACT NUMBER	CTO NUMBER
	F272
APPROVED BY	DATE
APPROVED BY	DATE
FIGURE NO. 9	REV 0

ATTACHMENT A

**FIELD STANDARD OPERATING PROCEDURES
UXO 7 – SMALL ARMS RANGES
NSA CRANE
CRANE, INDIANA**

Table of Contents

STANDARD OPERATING PROCEDURE

SOP-01

SAMPLE LABELING

1.0 PURPOSE

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

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Writing utensil (preferably black pen with indelible ink)
Disposable medical-grade gloves (e.g. latex, nitrile)
Sample log sheets
Required sample containers: All sample containers for analysis by fixed-base laboratories will be supplied and deemed certified clean by the laboratory.
Sample labels
Chain-of-custody records
Sealable polyethylene bags
Heavy-duty cooler
Ice

3.0 PROCEDURES

3.1 The following information will be electronically printed on each sample label prior to mobilizing for field activities. Additional "generic" labels will also be printed prior to mobilization to be used for field QC and backups.

- Project number (CTO F272)
- Sample location ID
- Contract Task Order number
- Sample ID
- Matrix

- Preservative
- Analysis to be performed
- Laboratory name

3.2 Select the container(s) that are appropriate for a given sample. Select the sample-specific ID label(s), complete date, time, and sampler name, and affix to the sample container(s).

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

3.4 Place the sample container in a bubble wrap sleeve and/or sealable polyethylene bag and place in a cooler containing ice.

Example of a sample label is attached at the end of this SOP.

4.0 ATTACHMENTS

1. Sample Label

ATTACHMENT 1
SAMPLE LABEL

Tetra Tech NUS, Inc. 661 Andersen Drive Pittsburgh, 15220 (412)921-7090	Project: Location: CTO:	
Sample No:		Matrix:
Date:	Time:	Preserve:
Analysis:		
Sampled by:		Laboratory

STANDARD OPERATING PROCEDURE

SOP-02

SAMPLE IDENTIFICATION NOMENCLATURE

1.0 PURPOSE

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

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

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

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Pen with indelible ink

Sample tags

Sample container labels

3.0 SAMPLE IDENTIFICATION NOMENCLATURE

3.1 Confirmation Samples

All confirmation samples will be properly labeled with a sample label affixed to the sample container. Each sample will be assigned a unique sample tracking number.

3.1.1 Confirmation Sample numbering Scheme

The sample tracking number will consist of a four- or five-segment alpha-numeric code that identifies the sample's associated Unexploded Ordnance (UXO) site or Area of Concern (AOC), sample type, location, and sample depth. For soil samples, the final four tracking numbers will identify the depth in units of feet below ground surface (bgs) at which the sample was collected (rounded to the nearest foot). For sediment samples, the final four tracking numbers will identify the depth in units of inches bgs at which the sample was collected.

The alphanumeric coding to be used is explained in the following diagram and subsequent definitions:

AN	**AA**	**NNNA**	**NNNN (Soils and Sediment only)**
UXO or AOC Number	Matrix	Sample Location Number and Grab or Composite	Sequential depth interval from freshly exposed surface

Character Type:

A = Alpha

N = Numeric

UXO Number (AN):

X7 = UXO 7

Matrix Code (AA):

SS = Surface Soil Sample

SB = Subsurface Soil Sample

Location Number (NNNA):

Sequential number for each matrix, followed by a letter indicating grab (G) or composite (C) sample, if appropriate.

Depth Interval (NNNN):

This code section will be used for soil and sediment samples only. For soil samples, the final four tracking numbers will identify the depth in units of feet. Surface soil samples will be collected from 0- to 2-feet bgs. Subsurface soil samples will be collected at depths greater than 2-feet bgs. For sediment samples, the final four tracking numbers will identify the depth in units of inches. Sediment samples will be collected from 0- to 6-inches below the sediment/water interface.

The depth code is used to note the depth bgs at which a soil or sediment sample is collected. The first two numbers of the four-number code specify the top interval, and the third and fourth specify the bottom interval of the sample depth. The depths will be noted in whole numbers only; further detail, if needed, will be recorded on the sample log sheet, boring log, logbook, etc. (If composite samples are collected: "location" refers to a particular sampling grid represented by a composite sample.

3.1.2 Examples of Confirmation Sample Nomenclature

A surface soil sample collected at UXO 7, sampling location 025, at a depth of 1-foot bgs would be labeled as "X7-SS025-0001".

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

Field QA/QC samples are described in the UXO 7 Technical Memorandum. They will be designated using a different coding system than the one used for regular field samples.

3.3.1 QC Sample Numbering

The QC code will consist of a four-segment alpha-numeric code that identifies the sample QC type, the date the sample was collected, and the number of this type of QC sample collected on that date.

AN	AA	NNNNNN	NN
UXO of AOC Number	QC Type	Date	Sequence Number (per day)

The QC types are identified as:

RB = Rinsate Blank
FD = Field Duplicate

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

3.3.2 Examples of Field QA/QC Sample Nomenclature

The first duplicate of the day at UXO 7 for a surface soil sample collected on October 26, 2011 would be designated as FD102611-01.

The third duplicate of the day taken at UXO 7 of a surface soil sample collected on September 3, 2011 would be designated as FD090311-03.

The first rinsate blank associated with samples collected on September 3, 2011 would be designated as RB090311-01.

STANDARD OPERATING PROCEDURE

SOP-03

SAMPLE CUSTODY AND DOCUMENTATION OF FIELD ACTIVITIES

1.0 PURPOSE

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

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following logbooks, forms, labels, and equipment are required.

Writing utensil (preferably black pen with indelible ink)
Site logbook
Field logbook
Sample label
Chain-of-Custody Form
Custody seals
Equipment calibration log
Soil and Sediment Sample Log Sheet

3.0 PROCEDURES

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

3.1 Site Logbook

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

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

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

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

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

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

3.2 Field Logbooks

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

3.3 Sample Labels

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

3.4 Chain-of-Custody Form

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

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

3.5 Custody Seal

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

3.6 Equipment Calibration Log

The Equipment Calibration Log is used to document calibration of measuring equipment used in the field, if applicable. The Equipment Calibration Log documents that the manufacturer's instructions were followed for calibration of the equipment, including frequency and type of standard or calibration device. An Equipment Calibration Log must be maintained for each electronic measuring device requiring calibration. Entries must be made for each day the equipment is used.

3.7 Sample Log Sheets

The Soil and Sediment Sample Log Sheets are used to document the sampling of soil and sediment (see SOP-05).

4.0 ATTACHMENTS

1. Chain-of-Custody Record
2. Equipment Calibration Log
3. Soil and Sediment Sample Log

ATTACHMENT 1
CHAIN-OF-CUSTODY RECORD

CHAIN OF CUSTODY | NUMBER | PAGE ____ OF ______

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

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

CONTAINER TYPE PLASTIC (P) or GLASS (G)

PRESERVATIVE USED

TYPE OF ANALYSIS

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

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

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

3/99
FORM NO. TtNUS-001

Tetra Tech NUS, Inc.

EQUIPMENT CALIBRATION LOG

PROJECT NAME : ______________________ INSTRUMENT NAME/MODEL: ______________________

SITE NAME: ______________________ MANUFACTURER: ______________________

PROJECT No.: ______________________ SERIAL NUMBER: ______________________

Date of Calibration	Instrument I.D. Number	Person Performing Calibration	Instrument Settings		Instrument Readings		Calibration Standard (Lot No.)	Remarks and Comments
			Pre-calibration	Post-calibration	Pre-calibration	Post-calibration		

ATTACHMENT 2
EQUIPMENT CALIBRATION LOG

ATTACHMENT 3

SOIL AND SEDIMENT SAMPLE LOG SHEET

SOIL & SEDIMENT SAMPLE LOG SHEET

Page___ of ___

Project Site Name: ____________________
Project No.: ____________________

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

Sample ID No.: ____________
Sample Location: ____________
Sampled By: ____________
C.O.C. No.: ____________

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

GRAB SAMPLE DATA:

Date:	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time:			
Method:			
Monitor Reading (ppm):			

COMPOSITE SAMPLE DATA:

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

SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other

OBSERVATIONS / NOTES:

MAP:

Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s):

STANDARD OPERATING PROCEDURE
SOP-04

SAMPLE PRESERVATION, PACKAGING, AND SHIPPING

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures for sample preservation, packaging, and shipping to be used in handling soil and aqueous samples.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Shipping labels
Custody seals
Chain-of-custody (COC) form(s)
Sample containers with preservatives: All sample containers for analysis by fixed-base laboratories will be supplied, with preservatives added (if required) and deemed certified clean by the laboratory.
Sample shipping containers (coolers): All sample shipping containers are supplied by the laboratory.
Packaging material: Bubble wrap, sealable polyethylene bags, strapping tape, etc.

3.0 PROCEDURES FOR SAMPLE PRESERVATION, PACKAGING, AND SHIPPING

3.1 The laboratory provides sample containers with preservative already included (as required) for the analytical parameter for which the sample is to be analyzed. All samples will be held, stored, and shipped at or below 6°C, but above freezing. This will be accomplished through refrigeration (used to hold samples prior to shipment) and/or ice.

3.2 The sampler shall maintain custody of the samples until the samples are relinquished to another custodian or to the common carrier.

3.3 Check that each sample container is properly labeled, the container lid is securely fastened, and the container is sealed in a polyethylene bag.

3.4 If the container is glass, place the sample container into a bubble-out shipping bag and seal the bag using the self-sealing, pressure sensitive tape supplied with the bag.

3.5 Inspect the insulated shipping cooler. Check for any cracks, holes, broken handles, etc. If the cooler has a drain plug, make certain it is sealed shut, both inside and outside of the cooler. If the cooler is questionable for shipping, the cooler must be discarded.

3.6 Line the cooler with large plastic bag, and line the bottom of the cooler with a layer of bubble wrap. Place the sample containers into the shipping cooler in an upright position (containers will be upright, with the exception of any 40-ml vials). Continue filling the cooler with ice until the cooler is nearly full and the movement of the sample containers is limited.

3.7 Wrap the large plastic bag closed and secure with tape.

3.8 Place the signed copy of the COC form inside a sealable polyethylene bag. Tape the bag to the inside of the lid of the shipping cooler.

3.9 Close the cooler and seal the cooler with approximately four wraps of strapping tape at each end of the cooler. Prior to wrapping the last wrap of strapping tape, apply a signed and dated custody seal to each side of the cooler (one per side). Cover the custody seal with the last wrap of tape. This will provide a tamper evident custody seal system for the sample shipment.

3.10 Affix shipping labels to each of the coolers, ensuring all of the shipping information is filled in properly. Overnight (e.g., FedEx Priority Overnight) courier services will be used for all sample shipments.

3.11 All samples will be shipped to the laboratory no more than 72 hours after collection. Under no circumstances should sample hold times be exceeded.

STANDARD OPERATING PROCEDURE

SOP-05

SOIL CORING AND SAMPLING USING HAND AUGER TECHNIQUES

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures for collecting surface and subsurface soil cores from unconsolidated overburden materials using hand augering techniques.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Disposable medical-grade gloves (e.g., latex, nitrile)
Writing utensil (preferably black pen with indelible ink)
Indelible marker
Stainless Steel Auger Buckets
Stainless Steel Extension Rods
Cross Handle
Required decontamination materials
Bentonite pellets
Sealable polyethylene bags
Sample labels
Shipping containers (containing ice)
Disposable plastic trowels or stainless steel trowels
Stainless steel mixing bowls
Sample containers: Sample containers are certified clean by the laboratory supplying the containers.
Soil Sample Log Forms
Daily Activity Logs
Chain-of-Custody Form

3.0 SOIL SAMPLING USING A HAND AUGER

Hand Augers may be employed to collect the soil cores. A hand augering system generally consists of a variety of all stainless steel bucket bits (i.e. cylinders 6-1/2" long and approximately 2-3/4", 3-1/4", or 4" in diameter), a series of extension rods (available in various lengths), a cross handle.

3.1 The hand auger can be used in a wide variety of soil conditions. It can be used to sample soil, both from the surface, or to depths in excess of 12 feet. However, the presence or rock layers and the collapse of the borehole normally contribute to its limiting factors.

Attach a properly decontaminated bucket bit into a clean extension rod and further attach the cross handle to the extension rod.

3.2 Clear the area to be sampled of any surface debris (vegetation, twigs, rocks, letter, etc.)

3.3. Turn the hand auger sampler into the ground to a depth of 6-inches. The 0- to 6-inch depth soil interval is considered to be the surface soil.

3.4 After reaching the desired depth, slowly and carefully withdraw the apparatus from the borehole.

3.4 Utilizing a properly decontaminated stainless steel trowel or disposable trowel, remove the sample material from the bucket bit and place into a sealable polyethylene bag. Note in a field notebook or on a standardized data sheet any changes in the color, texture or odor of the soil.

3.5 Thoroughly homogenize the sample material and write sample ID, date, and time on the bag with an indelible marker.

3.6 Complete required information on the Soil Sample Log Sheet (copy attached at the end of this SOP). Update the Chain-of-Custody (COC) Form.

3.7 Excess soil core materials will be returned to the hole and tamped. If insufficient soil is available to fill the hole to the ground surface, then bentonite pellets mixed with the soil will be used to backfill the hole, and hydrated with potable water.

3.8 Decontaminate all soil sampling equipment in accordance with SOP-08 before collecting the next sample.

3.9 Soil samples shipped to a fixed-base laboratory for analysis will be in sample containers supplied by the laboratory. The sample labels will be completed and affixed to the sample container. The samples will then be packaged and shipped to the fixed-base laboratory in accordance with SOP-04.

4.0 ATTACHMENTS

1. Soil and Sediment Sample Log Sheet

ATTACHMENT 1

SOIL AND SEDIMENT SAMPLE LOG SHEET

SOIL & SEDIMENT SAMPLE LOG SHEET

Page___ of ___

Project Site Name: ____________________
Project No.: ____________________

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

Sample ID No.: ____________________
Sample Location: ____________________
Sampled By: ____________________
C.O.C. No.: ____________________

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

GRAB SAMPLE DATA:

	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Date:			
Time:			
Method:			
Monitor Reading (ppm):			

COMPOSITE SAMPLE DATA:

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

SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other

OBSERVATIONS / NOTES:

MAP:

Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s):

STANDARD OPERATING PROCEDURE
SOP-06

SOIL SAMPLE LOGGING

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the standard procedures and technical guidance on the logging of soil samples.

2.0 FIELD FORMS AND EQUIPMENT

Knife
Ruler (marked in tenths and hundredths of feet)
Boring Log: An example of this form is attached.
Writing utensil (preferably black pen with indelible ink)

3.0 RESPONSIBILITIES

A field geologist or engineer is responsible for supervising all activities and assuring that each soil sample is properly and completely logged.

4.0 PROCEDURES FOR SAMPLE LOGGING

To maintain a consistent classification of soil, it is imperative that the field geologist understands and accurately uses the field classification system described in this SOP. This identification is based on visual examination and manual tests.

4.1 USCS Classification

Soils are to be classified according to the Unified Soil Classification System (USCS). This method of classification is detailed in Figure 1 (attached to this SOP).

This method of classification identifies soil types on the basis of grain size and cohesiveness.

Fine-grained soils, or fines, are smaller than the No. 200 sieve and are of two types: silt (M) and clay (C). Some classification systems define size ranges for these soil particles, but for field classification purposes, they are identified by their respective behaviors. Organic material (O) is a common component of soil but has no distinguishable size range; it is recognized by its composition. The careful study of the USCS will aid in developing the competence and consistency necessary for the classification of soils.

Coarse-grained soils will be divided into categories: rock fragments, sand, or gravel. The terms "sand" and "gravel" not only refer to the size of the soil particles but also to their depositional history. To insure accuracy in description, the term "rock fragments" will be used to indicate angular granular materials resulting from the breakup of rock. The sharp edges that are typically observed indicate little or no transport from their source area; and therefore, the term provides additional information in reconstructing the depositional environment of the soils encountered. When the term "rock fragments" is used, it will be followed by a size designation such as "(1/4 inch-1/2 inch)" or "coarse-sand size" either immediately after the entry or in the remarks column. The USCS classification would not be affected by this variation in terms.

4.2 Color

Soil colors will be described utilizing a single color descriptor preceded, when necessary, by a modifier to denote variations in shade or color mixtures. A soil could therefore be referred to as "gray" or "light gray" or "blue-gray." Because color can be utilized in correlating units between sampling locations, it is important for color descriptions to be consistent from one boring to another.

Colors must be described while the sample is still moist. Soil samples will be broken or split vertically to describe colors. Samplers tend to smear the sample surface, creating color variations between the sample interior and exterior.

The term "mottled" will be used to indicate soils irregularly marked with spots of different colors. Mottling in soils usually indicates poor aeration and lack of good drainage.

4.3 Relative Density and Consistency

To classify the relative density and/or consistency of a soil, the geologist is to first identify the soil type. Granular soils contain predominantly sands and gravels. They are non-cohesive (particles do not adhere well when compressed). Finer-grained soils (silts and clays) are cohesive (particles will adhere together when compressed).

Granular soils are given the USCS classifications GW, GP, GM, SW, SP, SM, GC, or SC (see Figure 1).

The consistency of cohesive soils is determined by performing field tests and identifying the consistency as shown in the following table.

CONSISTENCY FOR COHESIVE SOILS

Consistency	Standard Penetration Resistance (Blows per Foot)	Unconfined Compressive Strength (Tons/Sq. Foot by pocket penetration)	Field Identification
Very soft	0 to 2	Less than 0.25	Easily penetrated several inches by fist.
Soft	2 to 4	0.25 to 0.50	Easily penetrated several inches by thumb.
Medium stiff	4 to 8	0.50 to 1.0	Can be penetrated several inches by thumb with moderate effort.
Stiff	8 to 15	1.0 to 2.0	Readily indented by thumb but penetrated only with great effort.
Very stiff	15 to 30	2.0 to 4.0	Readily indented by thumbnail.
Hard	Over 30	More than 4.0	Indented with difficulty by thumbnail.

Cohesive soils are given the USCS classifications ML, MH, CL, CH, OL, or OH (see Figure 1).

The consistency of cohesive soils is determined by hand by determining the resistance to penetration by the thumb. The thumb determination methods are conducted on a selected sample of the soil, preferably the lowest 0.5 foot of the sample. The sample will be broken in half and the thumb pushed into the end of the sample to determine the consistency. Do not determine consistency by attempting to penetrate a rock fragment. If the sample is decomposed rock, it is classified as a soft decomposed rock rather than a hard soil. One of the other methods will be used in conjunction with it. The designations used to describe the consistency of cohesive soils are shown in the above-listed table.

4.4 Weight Percentages

In nature, soils are consist of particles of varying size and shape and are combinations of the various grain types. The following terms are useful in the description of soil:

Terms of Identifying Proportion of the Component	Defining Range of Percentages by Weight
Trace	0 - 10 percent
Some	11 - 30 percent
Adjective form of the soil type (e.g., sandy)	31 - 50 percent

Examples:

- Silty fine sand: 50 to 69 percent fine sand, 31 to 50 percent silt.
- Medium to coarse sand, some silt: 70 to 80 percent medium to coarse sand, 11 to 30 percent silt.
- Fine sandy silt, trace clay: 50 to 68 percent silt, 31 to 49 percent fine sand, 1 to 10 percent clay.
- Clayey silt, some coarse sand: 70 to 89 percent clayey silt, 11 to 30 percent coarse sand.

4.5 Moisture

Moisture content is estimated in the field according to four categories: dry, moist, wet, and saturated. In dry soil, there appears to be little or no water. Saturated samples obviously have all the water they can hold. Moist and wet classifications are somewhat subjective and often are determined by the individual's judgment. A suggested parameter for this would be calling a soil wet if rolling it in the gloved hand or on a porous surface liberates water (i.e., dirties or muddies the surface). Whatever method is adopted for describing moisture, it is important that the method used by an individual remains consistent throughout an entire field activity.

4.6 Classification of Soil Grain Size for Chemical Analysis

To determine the gross grain size classification (e.g., clay, silt, and sand) from the USCS classification described above, the following table will be used.

Gross Soil Grain Size Classification	USCS Abbreviation	Description
Clay	CL	inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
	CH	inorganic clays of high plasticity, fat clays.
	OH	organic clays of medium to high plasticity, organic silts.
Silt	ML	inorganic silts and very fine sands, rock four, silty or clayey fine sands with slight plasticity.
	OL	organic silts and organic silty clays of low plasticity.
	MH	inorganic silts, micaceous or diatomaceous fine sand or silty soils.
Sand	SW	well graded sands, gravelly sands, little or no fines.

Gross Soil Grain Size Classification	USCS Abbreviation	Description
	SP	poorly graded sands, gravelly sands, little or no fines.
	SM	silty sands, sand-silt mixtures.
	SC	clayey sands, sand-clay mixtures.

4.7 Summary of Soil Classification

In summary, soils will be classified in a similar manner by each geologist/engineer at a project site. The hierarchy of classification is as follows:

- Density and/or consistency
- Color
- Plasticity (optional)
- Soil types
- Moisture content
- Other distinguishing features
- Grain size
- Depositional environment

5.0 ATTACHMENTS

1. Figure 1 - Unified Soil Classification System
2. Boring Log

ATTACHMENT 1

FIGURE 1 - UNIFIED SOIL CLASSIFICATION SYSTEM

Unified Soil Classification System

Coarse Grained Soils (more than half of soil > No. 200 sieve)	Gravels (More than half of coarse fraction > no. 4 sieve size)	GW	Well graded gravels or gravel-sand mixtures, little or no fines
		GP	Poorly graded gravels or gravel-sand mixtures, little or no fines
		GM	Sandy gravels, gravel-sand-silt mixtures
		GC	Clayey gravels, gravel-sand-silt mixtures
	Sands (More than half of coarse fraction < no. 4 sieve size)	SW	Well graded sands or gravelly sands, little or no fines
		SP	Poorly graded sands or gravelly sands, little or no fines
		SM	Silty sands, sand-silt mixtures
		SC	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
Fine Grained Soils (more than half of soil < No. 200 sieve)	Silts and Clays LL = < 50	ML	Inorganic silts and very fine sands, rock flour, silty fine sands or clayey silts with slight plasticity
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, lean clays
		OL	Organic silts and organic silty clays of low plasticity
	Silts and Clays LL = > 50	MH	Inorganic silts, micaceous or diatomaceous fine sand or silty soils, elastic silts
		CH	Inorganic silts of high plasticity, fat clays
		OH	Organic clays of high plasticity, organic silty clays, organic silts
Highly Organic Soils		Pt	Peat and other highly organic soils

Grain Size Chart

Classification	Range of Grain Sizes: U.S. Standard Sieve Size	Range of Grain Sizes: Grain Size In Millimeters
Boulders	Above 12"	Above 305
Cobbles	12" to 3"	305 to 76.2
Gravel	3" to No. 4	76.2 to 7.76
coarse	3" to 3/4"	76.2 to 4.76
fine	3/4" to No.4	19.1 to 4.76
Sand	No. 4 to No. 200	4.76 to 0.074
coarse	No.4 to No. 10	4.76 to 2.00
medium	No. 10 to No. 40	2.00 to 0.420
fine	No. 40 to No. 200	0.420 to 0.074
Silt and Clay	Below No. 200	Below 0.074

Relative Density (SPT)

SANDS AND GRAVELS	BLOWS/FOOT
VERY LOOSE	0 – 4
LOOSE	4 – 10
MEDIUM DENSE	10 – 30
DENSE	32 – 50
VERY DENSE	OVER 50

Consistency (SPT)

SILTS AND CLAYS	BLOWS/FOOT
VERY SOFT	0 – 2
SOFT	2 – 4
MEDIUM STIFF	4 – 8
STIFF	8 – 16
VERY STIFF	16 – 22
HARD	OVER 32

ATTACHMENT 2

BORING LOG

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME: ____________________ BORING No.: ____________________
PROJECT NUMBER: ____________________ DATE: ____________________
DRILLING COMPANY: ____________________ GEOLOGIST: ____________________
DRILLING RIG: ____________________ DRILLER: ____________________

					MATERIAL DESCRIPTION					PID/FID Reading (ppm)			
Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	U S C S *	Remarks	Sample	Sampler BZ	Borehole**	Driller BZ**

* When rock coring, enter rock brokenness.

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

Drilling Area
Background (ppm): ____

Remarks: ____

Converted to Well: Yes ________ No ________ Well I.D. #: ____________________

STANDARD OPERATING PROCEDURE

SOP-07

DECONTAMINATION OF FIELD SAMPLING EQUIPMENT

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedures to be followed when decontaminating non-dedicated field sampling equipment during the field investigations.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Writing utensil (preferably black pen with indelible ink)
Non-latex rubber or plastic gloves
Cotton gloves
Field logbook
Potable water
Deionized water
Isoproponal (optional)
LiquiNox detergent
Brushes, spray bottles, paper towels, etc.
Container to collect and transport decontamination fluids

3.0 DECONTAMINATION PROCEDURES

3.1 Don non-latex and/or cotton gloves and decontaminate sampling equipment (in accordance with the following steps) prior to field sampling and between samples.

3.2 Rinse the equipment with potable water. Rinsing may be conducted by spraying with water from a spray bottle or by dipping. Collect the potable water rinsate into a container.

3.3 Wash the equipment with a solution of LiquiNox detergent. Prepare the LiquiNox wash solution in accordance with the instructions on the LiquiNox container. Collect the LiquiNox wash solution into a container. Use brushes or sprays as appropriate for the equipment. If oily residue has accumulated on the sampling equipment, remove the residue with an isopropanol wash and repeat the LiquiNox wash.

3.4 Rinse the equipment with potable water. Rinsing may be conducted by spraying with water from a spray bottle or by dipping. Collect the potable water rinsate into a container.

3.5 Rinse the equipment with deionized water. Rinsing may be conducted by spraying with water from a spray bottle or by dipping. Collect the deionized water rinsate into a container.

3.6 Remove excess water by air drying, shaking, or by wiping with paper towels as necessary.

3.7 Document decontamination by recording it in the field logbook.

3.8 Containerized decontamination solutions will be managed in accordance with the procedures described in SOP-08.

STANDARD OPERATING PROCEDURE
SOP-08

MANAGEMENT OF INVESTIGATION-DERIVED WASTE

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes how investigation-derived waste (IDW) will be collected, segregated, classified, and managed during the field investigations at NSA Crane. The following types of IDW will be generated during this investigation:

- Soil sampling residues
- Decontamination solutions
- Personal protective equipment and clothing (PPE)
- Miscellaneous trash and incidental items

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Health and safety equipment (with PPE)
Hand augers, plastic or stainless steel trowels
Bucket (with collected decon water)
Decontamination equipment
Field logbook
Writing utensil (preferably black pen with indelible ink)
Plastic sheeting and/or tarps
Plastic garbage bags

3.0 PROCEDURES

Management of IDW includes the collection, segregation, temporary storage, classification, final disposal, and documentation of the waste-handling activities if necessary.

3.1 Liquid Wastes

Liquid wastes that will be generated during the site activities include decontamination solutions from sampling equipment. These wastes will be collected and containerized in a central location at NSA Crane for proper disposal.

3.2 Solid Wastes

Solid wastes that may be generated during site activities include soil and sediment sampling residues. Excess soil core/sampling materials will be returned to the hole and tamped. If insufficient soil is available to fill the hole to the ground surface, then bentonite pellets mixed with the soil will be used to backfill the hole, and hydrated with potable water. Excess sediment sampling materials will be returned to the point of collection. The disposition of this materials will be carried out in a manner such as not to contribute further environmental degradation or pose a threat to public health or safety.

3.3 PPE and Incidental Trash

All PPE wastes and incidental trash materials (e.g., wrapping or packing materials from supply cartons, waste paper) will be decontaminated (if contaminated), double bagged, securely tied shut, and placed in a designated waste receptacle at NSA Crane.

STANDARD OPERATING PROCEDURE

SOP-09

GLOBAL POSITIONING SYSTEM

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide the Field Technicians with basic instructions for operating a handheld Global Positioning System (GPS) unit allowing them to set GPS parameters in the receiver, record GPS positions on the field device, and update existing Geographic Information System (GIS) data. This SOP is specific to GIS quality data collection for Trimble-specific hardware and software.

If possible, the Trimble GeoXM or GeoXH Operators Manual should be downloaded onto the operator's personal computer for reference before or while in the field. The manual can be downloaded at http://trl.trimble.com/docushare/dsweb/Get/Document-311749/TerraSyncReferenceManual.pdf

Unless the operator is proficient in the setup and operation of the GPS unit, the Project Manager (or designee) should have the GPS unit shipped to the project-specific contact listed below in the Pittsburgh, Pennsylvania office at least five working days prior to field mobilization so project-specific shape files, data points, background images, and correct coordinate systems can be uploaded into the unit.

Tetra Tech NUS, Inc.
Attn: Kevin Moore
661 Anderson Drive, Bldg #7
Pittsburgh, PA 15220

2.0 REQUIRED EQUIPMENT

The following hardware and software should be utilized for locating and establishing GPS points in the field:

2.1 Required GPS Hardware

- Hand-held GPS Unit capable of sub-meter accuracy (i.e. Trimble GeoXM or Trimble GeoXH). This includes the docking cradle, a/c adapter, stylus, and USB cable for data transfer.

Optional Accessories:

- External antenna
- Range pole
- Hardware clamp (for mounting Geo to range pole)
- GeoBeacon

- Indelible marker
- Non-metallic pin flags for temporary marking of positions

2.2 Required GPS Software

The following software is required to transfer data from the handheld GPS unit to a personal computer:

- Trimble TerraSync version 2.6 or later (pre-loaded onto GPS unit from vendor)

- Microsoft ActiveSync version 4.2 or later. Download to personal computer from: http://www.microsoft.com/windowsmobile/en-us/downloads/eulas/eula_activesync45_1033.mspx?ProductID=76

- Trimble Data Transfer Utility (freeware version 2.1 or later). Download to personal computer from: http://www.trimble.com/datatransfer.shtml

3.0 START-UP PROCEDURES

Prior to utilizing the GPS in the field, ensure the unit is fully charged. The unit may come charged from the vendor, but an overnight charge is recommended prior to fieldwork.

The Geo-series GPS units require a docking cradle for both charging and data transfer. The Geo-series GPS unit is docked in the cradle by first inserting the far domed end in the top of the cradled, then gently seating the contact end into the latch. The power charger is then connected to the cradle at the back end using the twist-lock connector. Attach a USB cable as needed between the cradle (B end) and the laptop/PC (A end).

It is recommended that the user also be familiar and check various Windows Mobile settings. One critical setting is the Power Options. The backlight should be set as needed to conserve power when not in use.

Start Up:

1) Power on the GPS unit by pushing the small green button located on the lower right front of the unit.

2) Utilizing the stylus that came with the GPS unit, launch **TerraSync** from the Windows Operating System by tapping on the start icon located in the upper left hand corner of the screen and then tap on **TerraSync** from the drop-down list.

3) If the unit does not default to the Setup screen, tap the Main Menu (uppermost left tab, just below the Windows icon) and select Setup.

4) If the unit was previously shipped to the Pittsburgh office for setup, you can skip directly to Section 4.0. However, to confirm or change settings, continue on to Section 3.1.

3.1 Confirm Setup Settings

Use the Setup section to confirm the TerraSync software settings. To open the Setup section, tap the Main Menu and select Setup.

1) Coordinate System
   a. Tap on the Coordinate System.
   b. Verify the project specs are correct for your specific project by scrolling through the various settings. Edit as needed and then tap OK; otherwise, tap Cancel to return to Setup Menu. **Note:** It is always best to utilize the Cancel tab rather than the OK tab if no changes are made since configurations are easily changed by mistake.
   c. Tap on the Units.
   d. Verify the user preferences are correct for your specific project by scrolling through the various settings. Edit as needed and then tap OK; otherwise, tap Cancel to return to Setup Menu.
   e. Tap Real-time Settings.
   f. Verify the Real-time Settings are correct for your specific project by scrolling through the various settings. Edit as needed and then tap OK; otherwise, tap Cancel to return to Setup Menu.
   g. The GPS unit is now configured correctly for your specific project.

4.0 ANTENNA CONNECTION

1) If a connection has been properly made with the internal antenna, a satellite icon along with the number of usable satellites will appear at the top of the screen next to the battery icon. If no connection is made (e.g.: no satellite icon), tap on the GPS tab to connect antenna.
2) At this point the GPS unit is ready to begin collecting data.

5.0 COLLECTING NEW DATA IN THE FIELD

1) From the Main Menu select Data.
2) From the Sub Menu (located below the Data tab) select New which will bring up the New Data File menu.
3) An auto-generated filename appears and should be edited for your specific project. If the integral keyboard does not appear, tap the small keyboard icon at the bottom of the screen.
4) After entering the file name, tap Create to create the new file.
5) Confirm antenna height if screen appears. Antenna height is the height that the GPS unit will be held from the ground surface (Typically 3 to 4 feet).
6) The Choose Feature screen appears.

5.1 Collecting Features

1) If not already open, the Collect Feature screen can be opened by tapping the Main Menu and selecting Data. The Sub Menu should default to Collect.
2) **Do not begin the data logging process until you are at the specific location for which you intend to log the data.**
3) A known reference or two should be shot at the beginning and at the end of each day in which the GPS unit is being used. This allows for greater accuracy during post-processing of the data.
4) Upon arriving at the specific location, tap on Point_generic as the Feature Name.
5) Tap Create to begin data logging.
6) In the Comment Box enter sample ID or location-specific information.
7) Data logging can be confirmed by viewing the writing pencil icon in the upper part of the screen. Also, the logging counter will begin. As a Rule of Thumb, accumulate a minimum of 20 readings on the counter, per point, as indicated by the logging counter before saving the GPS data.
8) Once the counter has reached a minimum number of counts (i.e. 20), tap on OK to save the data point to the GPS unit. Confirm the feature. All data points are automatically saved within the GPS unit.
9) Repeat steps 2 through 8, giving each data point a unique name or number.

Note: If the small satellite icon or the pencil icon is blinking, this is an indication the GPS unit is not collecting data. A possible problem may be too few satellites. While still in data collection mode, tap on Main Menu in upper left hand corner of the screen and select Status. Skyplot will display as the default showing the number of available satellites. To increase productivity (number of usable satellites) use the stylus to move the pointer on the productivity and precision line to the left. This will decrease precision, but increase productivity. The precision and productivity of the GPS unit can be adjusted as the number of usable satellites changes throughout the day. To determine if GPS is correctly recording data, see Section 5.2.

5.2 Viewing Data or Entering Additional Data Points to the Current File

1) To view the stored data points in the current file, tap on the Main Menu and select Map. Stored data points for that particular file will appear. Use the +/- and <-/-> icons in lower left hand corner of screen to zoom in/out and to manipulate current view.
2) To return to data collection, tap on the Main Menu and select Data. You are now ready to continue to collect additional data points.

5.3 Viewing Data or Entering Data Points from an Existing File

1) To view data points from a previous file, tap on Main Menu and select Data, then select File Manager from the Sub Menu.
4) Highlight the file you want to view and select Map from the Main Menu.
5) To add data points to this file, tap on Main Menu and select Data. Continue to collect additional data points.

6.0 NAVIGATION

This section provides instructions on navigating to saved data points in an existing file within the GPS unit.

1) From the Main Menu select Map.
2) Using the Select tool, pick the point on the map to where you want to navigate.
3) The location you select will have a box placed around the point.
4) From the Options menu, choose the Set Nav Target (aka set navigation target).
5) The location will now have double blue flags indicating this point is you navigation target.
6) From the Main Menu select Navigation.
7) The dial and data on this page will indicate what distance and direction you need to travel to reach the desired target.

8) Follow the navigation guide until you reach the point you select.
9) Repeat as needed for any map point by going back to Step 1.

7.0 PULLING IN A BACKGROUND FILE

This section provides instructions on pulling in a pre-loaded background file. These files are helpful in visualizing your current location.

1) From the Main Menu select Map, then tap on Layers, select the background file from drop down list.
2) Select the project-specific background file from the list of available files.
3) Once the selected background file appears, the operator can manipulate the screen utilizing the +/- and <-/-> functions at the bottom of the screen.
4) In operating mode, the operator's location will show up on the background file as a floating "x".

8.0 DATA TRANSFER

This section provides instructions on how to transfer stored data on the handheld GPS unit to a personal computer. Prior to transferring data from the GPS unit to a computer, Microsoft ActiveSync and Trimble Data Transfer Utility software must be downloaded to the computer from the links provided in Section 2.2 (Required GPS Software). If a leased computer is utilized in which the operator can not download files, see the Note at the end of Section 8.0.

1) See Attachment A at the end of this SOP for instructions on how to transfer data from the GPS to a personal computer.

Note: If you are unable to properly transfer data from the GPS unit to a personal computer, the unit should be shipped to the project-specific contact listed in Section 1.0 where the data will be transferred and the GPS unit then shipped back to the vendor.

9.0 SHUTTING DOWN

This section provides instruction for properly shutting down the GPS unit.

1) When shutting down the GPS unit for the day, first click on the "X" in the upper right hand corner.
2) You will be prompted to ensure you want to exit TerraSync. Select Yes.
3) Power off the GPS unit by pushing the small green button located on the bottom face of the unit.

4) Place the GPS unit in its cradle to recharge the battery overnight. Ensure the green charge light is visible on the charging cradle.

ATTACHMENT A

How to Transfer Trimble GPS Data between Data Collector and PC
original 11/21/06 (5/1/08 update)

Remember – Coordinate System, Datum, and Units are critical!!!

Trimble Data Collection Devices:
Standard rental systems include the Trimble ProXR/XRS backpack and the newer handheld GeoXT or GeoXH units. Some of the older backpack system may come with either a RECON "PDA-style" or a TSCe or TSC1 alpha-numeric style data collector.

The software on all of the above units should be Trimble TerraSync (v 2.53 or higher – current version is 3.20) and to the user should basically look and function similar. The newer units and software versions (which should always be requested when renting) include enhancements for data processing, real-time display functions, and other features.

Data Transfer:
Trimble provides a free transfer utility program to aid in the transfer of GIS and field data. The Data Transfer Utility is a standalone program that will run on a standard office PC or laptop.

To connect a field data collector such as a RECON, GeoXM, GeoXT, GeoXH, or ProXH, you must first have Microsoft ActiveSync installed to allow the PC and the data collector to talk to one another. A standard USB cable is also needed to connect the two devices.

A CD or USB drive is provided with the data collector for use in data transfer. If needed, these programs are also available without charge via the web at:

· **Trimble Data Transfer Utility** (v 1.38) program to download the RECON or GeoXH field data to your PC: http://www.trimble.com/datatransfer.shtml

· **ActiveSync** from Microsoft to connect the data collector to the PC. The latest version (v4.5) can be found at: http://www.microsoft.com/windowsmobile/activesync/default.mspx
(see page 2 for data transfer instructions)

To Transfer Data Collected in the Field:

- Install the Data Transfer and ActiveSync software installed on your PC
- Connect the RECON or GeoXH to your PC via an A/B USB cable (blade end and square end type "HP printer" style)
- ActiveSync should auto-detect the connection and recognize the data collector
- Make sure the data file desired is CLOSED in TerraSync prior to transfer
- Connect via ActiveSync as a guest (not a partnership)
- Run the Trimble Data Transfer Utility program on your PC
- Select "***GIS Datalogger on Windows CE***" or similar selection
- Hit the green connect icon to the right - the far right area should say "***Connected to ....***" if successful
- Select the "***Receive***" data tab (under device)
- Select "***Data***" from file types on the right
- Find the file(s) needed for data transfer. You can sort the data files by clicking on the date/time header
- Select or browse to a C-drive folder you can put this file for emailing
- When the file appears on the list, hit the "***Transfer All***"
- Go to your Outlook or other email, send a message to: kevin.moore@tetratech.com (or GIS department)
- Attach the file(s) you downloaded from your C-drive. For each TerraSync data file created you should have a packet of multiple data files. All need to be sent as a group – make sure you attach all files (the number of files may vary – examples include: ssf, obx, obs, gix, giw, gis, gip, gic, dd, and car)

To Transfer GIS Data from PC to the Field Device (must be converted in Pathfinder Office):

- Obtain GIS file(s) desired from GIS Department and have converted to Trimble extension
- Contact Kevin Moore (kevin.moore@tetratech.com) if needed for file conversion and upload support
- The GIS file(s) can be quickly converted if requested and sent back to the field user in the needed "Trimble xxx.imp" extension via email – then quickly downloaded from Outlook to your PC for transfer
- Install the Data Transfer and ActiveSync software installed on your PC
- Connect the RECON or GeoXH to your PC via an A/B USB cable (blade end and square end type "HP printer" style)
- ActiveSync should auto-detect the connection and recognize the data collector
- Connect via ActiveSync as a guest (not a partnership)
- Run the Trimble Data Transfer Utility program on your PC
- Select "***GIS Datalogger on Windows CE***" or similar selection
- Hit the green connect icon to the right - the far right area should say "***Connected to ....***" if successful
- Select the "**Send**" data tab (under device)
- Select "**Data**" from file types on the right (you can also send background files)
- Browse to the location of the data on your PC (obtain the file from Pathfinder Office or from the person who converted the data for field use)
- Select the options as appropriate for the name and location of the data file to go on the data collector (usually you can choose main memory or a data storage card)
- When the file(s) appears on the list, hit the "***Transfer All***"
- Run TerraSync on the field device and open the existing data files. Your transferred file should appear (make sure you have selected Main Memory, Default, or Storage Card as appropriate)

STANDARD OPERATING PROCEDURE
SOP-10

FIELD PORTABLE X-RAY FLUORESCENCE ANALYSIS OF SOIL AND SEDIMENT SAMPLES USING THE INNOV-X ALPHA SERIES INSTRUMENT

1.0 PURPOSE

This procedure is for the semiquantitative analysis of metallic lead particles and chemical compounds of lead in soil using a field portable x-ray fluorescence (FPXRF) spectrometer. This procedure is based on the United States Environmental Protection Agency (USEPA)-approved XRF field screening method for elemental analysis (Method 6200).

2.0 SCOPE, APPLICATION, AND LIMITATIONS

2.1 Scope of Procedure

Analysis of any other elements besides lead using FPXRF may require changes to this Standard Operating Procedure (SOP), and are therefore outside the scope of this SOP.

Although it is possible to use FPXRF to measure analytes in situ, this SOP requires removal of a soil sample from its native environment prior to analysis. By removing, drying, and homogenizing the sample prior to analysis, more precise and accurate results are obtained.

2.2 Analyst Training

Use of this method is restricted to personnel both trained and knowledgeable in the operation of the Innov-X alpha series XRF instrument or under the supervision of a trained and knowledgeable individual. Proper training for the safe operation of the instrument should be completed by the analyst prior to analysis. This training may be obtained directly from INNOV-X, an INNOV-X instrument distributor or lessor, or another trained Tetra Tech person.

3.0 ACRONYMS AND ABBREVIATIONS

FPXRF: Field portable x-ray fluorescence.

mg/kg: milligrams per kilogram.

MDL: Method detection limit.

PQL: Practical quantitation limit.

QC: Quality control.

RPD: Relative percent difference.

USGS: United States Geological Survey.

XRF: X-ray fluorescence.

4.0 RESPONSIBILITIES

Analyst/Chemist - Responsible for all aspects of sample preparation and analysis including equipment maintenance. Also responsible for maintaining chain-of-custody of samples after receipt from sampling personnel.

5.0 PROCEDURES

5.1 Safety

5.1.1 Radiation Safety

Radiation safety practices for the INNOV-X instrument can be found in the operator's manual (typically shipped with unit). Protective shielding should never be removed by the analyst or any personnel other than the manufacturer.

An additional hazard present with x-ray tubes is the danger of electric shock from the high voltage supply. The danger of electric shock is as substantial as the danger from radiation but is often overlooked because of its familiarity.

5.1.2 Protective Equipment

Analysts must wear disposable plastic gloves whenever sample aliquots are being transferred from one vessel to another. Consult the health and safety plan for other protection requirements.

5.2 Apparatus and Materials

Apparatus and materials consist of the following:

INNOV-X Alpha Series FPXRF spectrometer with data processing unit (iPAQ) pocket personnel computer):

INNOV-X Alpha Series XRF instrument manual to match the INNOV-X Alpha Series instrument.

Aluminum drying pans or aluminum foil: Sized suitably to hold as much as 50 grams of sample and fit into the drying oven.

Calibration verification check sample: A National Institute of Standards and Technology (NIST) or other Standard reference material (SRM) that contains lead in a concentration range that is compatible with the project objectives to verify the accuracy of the instrument. SRMs are shipped with the unit. Acceptable limits for SRM percent recoveries are usually provided with the SRMs. In their absence, a limit of ± 30 percent will be used as a guideline.

Instrument Blank: May be silicon dioxide, a Teflon block, a quartz block, "clean" sand, or lithium carbonate and is typically shipped with the unit.

Lead calibration check standard: Supplied by the FPXRF manufacturer.

Method blank material for performing method blank checks: May be lead-free silica sand or lithium carbonate that undergoes the same preparation procedure as the samples.

Battery charger.

Polyethylene sample cups: 31 millimeters (mm) to 40 mm in diameter with collar, or equivalent (appropriate for FPXRF instrument).

X-ray window film: Mylar™, Kapton™, Spectrolene™, polypropylene, or equivalent; 2.5 to 6.0 micrometers (µm) thick.

Sample containers: glass or plastic to store samples.

Sieves: 60-mesh Stainless steel, Nylon, or equivalent for preparing soil and sediment samples if necessary.

Trowels: for collecting soil samples.

Plastic bags: used for collection and homogenization of soil samples. May also be used as sample presentation device.

Drying oven: standard convection or toaster oven, for soil samples that require drying.

Rolling pin (optional): Wooden rolling pin for crushing dried samples.

5.3 Sample Collection, Preservation, and Handling

Samples shall be provided to the FPXRF analyst in plastic bags. The analyst is responsible for maintaining chain-of-custody of all samples until all analyses have been successfully completed. No sample preservation is necessary. All samples shall be handled in accordance with sample handling SOPs in effect for the field event.

5.4 Preventive Maintenance

Refer to the instrument manual for specific manufacturer's recommendations.

5.5 Instrument Start-Up

5.5.1 Ensure the pocket PC (iPAQ) is plugged into the FPXRF instrument body and install a fully charged battery into the instrument.

5.5.2 Press the ON/OFF button on the base of the pistol grip of the instrument. If the iPAQ does not automatically power up, press the Power button in the right corner of the iPAQ.

5.5.3 Tap the Microsoft icon at the upper left corner of the iPAQ.

5.5.4 Choose START.

5.5.5 Tap "Soil Mode" on the menu or choose Mode (bottom of screen) and then choose Soil Mode from the drop down menu.

5.5.6 Allow the instrument to warm up (approximately 3 minutes).

5.5.7 Release the manual trigger lock.

5.5.8 Standardize the instrument in accordance with Section 5.6.

5.6 Standardization/Calibration Check

It is not possible to start an analysis if the instrument has not been standardized. To verify proper calibration of the instrument it is necessary to periodically standardize it using the automated standardization procedure. This must be done anytime the instrument is restarted and every 4 hours of operation, although re-standardization may be done at any other time (e.g., when instrument drift is suspected).

5.6.1 Click the standardization piece (supplied with the instrument) on the front of the instrument, verifying that the solid portion of the standard completely covers the analysis window. If using a manufacturer supplied test stand, lay the standardization plate over the analysis window.

5.6.2 Select "Tap here to Standardize" or select *File → Standardize*. The red light on top of the instrument will blink indicating that the instrument is producing x-rays and the shutter is open. The amber light on the rear of the instrument will also be illuminated and a status bar will appear to display the progress of the standardization.

5.6.3 Upon successful standardization the message "Successful Standardization" will appear along with the instrument resolution. In this case tap "ok" to dismiss the completion message. If problems are encountered, either follow the prompts that appear and/or repeat the standardization. Contact the FOL if problems persist. Take note of any error messages that appear as they may be useful if the instrument manufacturer must be contacted. Additional assistance is also available in the manufacturer's instrument manual.

5.7 Quality Control

The quality control (QC) program includes analysis of blanks, calibration verification checks, duplicate analyses, and field duplicate samples. For all the above areas, any identified problems and corrective action must be documented in the instrument run log, analysis narrative report, and instrument maintenance log or standards log (as applicable). Identical operating conditions will be used for each sample.

5.7.1 Laboratory Blanks

Two types of blank samples shall be analyzed for FPXRF analysis: instrument blanks and method blanks.

5.7.1.1 At the beginning of each day, at the end of each day, and after every 20th sample or when potential contamination of the instrument is suspected, analyze an instrument blank to verify that no contamination exists in the spectrometer or on the probe window.

If the lead concentration in the blank exceeds the method detection limit (MDL, see Section 5.9.3) check the probe window and other potentially contaminated instrument components for contamination. If contamination is not causing the elevated blank readings, "zero" the instrument according to manufacturer's instructions.

5.7.1.2 After every 20th sample analyze a method blank. If the method blank lead concentration exceeds the practical quantitation limit (PQL, see Section 5.9.4), identify the cause of the elevated lead concentration and reanalyze all samples since the last acceptable method blank.

5.7.2 Calibration Verification Checks

5.7.2.1 After performing each blank check (Section 5.7.2), analyze a calibration verification check sample to check the accuracy of the instrument and to assess the stability and consistency of the analysis for the analytes of interest.

5.7.2.2 If the measured lead percent recovery (See Section 5.9.1) is less than 60 percent or greater than 135 percent, reanalyze the check sample. If the value continues to fall outside this acceptance range, the instrument should be recalibrated, or restandardized according to the manufacture instructions and the batch of samples analyzed before the unacceptable calibration verification check must be reanalyzed.

5.7.3 XRF Duplicate Samples

XRF duplicate samples are two portions of the same sample that have been prepared and homogenized together, and then split and analyzed in the same manner by the XRF analyst.

5.7.3.1 Analyze an XRF duplicate at a frequency of 1 per 20 or once per day, whichever is more frequent.

5.7.3.2 If the computed RPD (See Section 5.9.2) exceeds 50 percent reanalyze both samples. If the RPD again exceeds 50 percent RPD consider whether the high degree of imprecision is caused by sample heterogeneity or other causes. This assessment may be aided by repeating the analysis of a sample that was analyzed previously. If the observed imprecision is attributed to sample heterogeneity, increase the number of readings made per sample to try to limit the imprecision and repeat the analyses. If this does not correct the problem notify the FOL.

5.8 Sample Analysis

Note:

This section provides sample analysis instructions, assuming that appropriate instrument start-up and calibration checks have been completed. The longer the instrument count time, the lower the detection limits and the less uncertainty there is with a recorded result. Count time is user-selectable through the instrument's software. Because the XRF data will be used in a screening capacity to make preliminary decisions concerning the soil concentrations relative to 400 mg/kg, it is not necessary to obtain a high degree of accuracy or precision with the instrument. Therefore, count times should be limited to less than 180 seconds unless an usually high degree of precision is expected. To change the count time, select Options → Setup Testing and enter the same value (in seconds) to minimum and maximum count times.

Note:

Section 5.7 identifies the appropriate frequencies for conducting various QC sample analyses and the associated acceptance limits and corrective actions for potentially unsuitable conditions. The specified QC analysis frequencies are minimum frequencies. More frequent QC sample analyses are permitted, especially when diagnosing quality problems.

5.8.1 Ensure that calibration checks and blanks have been analyzed according to Sections 5.6, 5.7.1, and 5.7.2. Count times shall be at least 60 seconds but generally less than 180 seconds.

5.8.2 Acquire enough soil sample to fill an 8-ounce jar and separate from it all particles greater than the size of a pea.

5.8.3 Homogenize the remaining finer grained portion of the sample by simple mixing until it appears as uniform in texture and composition as practicable. Mixing may be done in a beaker or other suitable lead-free container. If the sample is moist and has high clay content, it may be kneaded in a plastic bag. Mixing shall continue for at least two minutes to ensure that the sample is well mixed. To aid mixing, the sample may be placed into a thick-walled (3 mil or thicker) gallon-sized freezer bag (e.g., ZipLoc®) and rolled flat with a rolling pin to break up large chunks of dirt.

5.8.4 Place approximately 20 to 50 grams (one U.S. nickel weighs about 5 grams) in a suitable container (e.g., aluminum drying pan) for drying.

5.8.5 Dry the homogenized sample from Step 5.8.4 for approximately 20 to 30 minutes in the oven at a temperature not greater than 150°C (a setting of approximately 300°F). If the sample is not visibly dry after this initial drying time, place the sample back into the oven until the sample is dry.

5.8.6 Re-homogenize the dried sample aliquot in a beaker or other suitable lead-free container to obtain a well mixed soil sample. Mixing shall continue for at least one minute.

5.8.7 Place a portion (approximately 1.5 cubic inches) of the dried, homogenized sample aliquot into the instrument manufacturer's recommended sample cup (e.g., a 31.0-mm polyethylene sample cup (or equivalent) or place it in a thin-walled (1.0 mil or thinner) plastic sandwich bag (e.g., ZipLoc®).

5.8.8 If using a disposable plastic sample cup, ensure the cup is at least three-quarters full and cover with mylar (or other) film per the manufacturer's recommendations.

5.8.9 Present a portion of the sample to the instrument in Soil Mode.

5.8.10 Perform a single pull of the trigger to start the count. The count time shall be the same as was used for the calibrations, calibration checks, and blank analyses. The message "Test in progress" will appear on the instrument and the red light on top of the instrument and will illuminate.

5.8.11 When the predetermined count period has expired the message "Test complete" will appear on the instrument. A slight delay may also be incurred during which time the message "calculating" may appear to indicate that results are being computed.

5.8.12 Record the displayed results for lead concentration in mg/kg on Figure 1.

CAUTION

Inconsistent positioning of samples in front of the probe window is a potential source of error because the x-ray signal decreases by the square of the distance from the radioactive source. This error is minimized by maintaining the same distance between the window and each sample. For the best results, the window of the probe should be in direct contact with the sample, which means that the sample surface should be flat and smooth to provide a good contact surface.

5.8.13 Rotate the sample cup approximately one-third of a turn, or if using a thin plastic baggie, read another 1/3 portion of the sample bag. Acquire another measurement by repeating Steps 5.8.10 through 5.8.12.

5.8.14 Repeat Steps 5.8.10 through 5.8.11 a third time, and calculate the average concentration.

5.8.15 Based on the degree of precision demonstrated by the three individual measurements, determine whether additional readings should be acquired on the sample. This determination shall be based on professional judgment of the FPXRF analyst and shall consider the degree of precision observed during calibration checks and previous sample analyses. The objective will be to ensure that the average reading reported for each sample is representative of the true sample concentration. If the analyst feels that non-representative readings are being obtained the analyst shall correct the analytical system or notify the FOL prior to continuing with analyses.

5.8.16 Ensure that measured results are reported to the following standards

- Results < 1000 mg/kg (or parts per million) are reported to two significant figures and results > 1000 mg/Kg are reported to three significant figures.
- All values < MDL shall be reported as the MDL and flagged with the letter "U".
- All values > MDL and < PQL shall be reported as is and flagged with the letter "B".

5.9 Calculations

5.9.1 Percent Recovery: The equation for determining percent recovery of calibration verification check standards and standard reference materials is:

$$\%R = \frac{\text{Experimental Concentration}}{\text{Certified or Known Concentration}} \text{ X } 100\%$$

5.9.2 Relative Percent Difference: The equation for determining relative percent difference for laboratory and field duplicate samples is:

$$RPD = \frac{|\text{Amount in Sample 1} - \text{Amount in Sample 2}|}{0.5\,(\text{Amount in Sample 1} + \text{Amount in Sample 2})} \text{ X } 100\,\%$$

5.9.3 Method Detection Limit (MDL): Because the analyses governed by this SOP are semi-quantitative, the manufacturer-specified detection limit will be reported as the MDL unless the specified detection limit is less than 20 mg/kg. Care will taken to ensure that the appropriate count time is consistent with the reported detection limit. However, no value less than 20 mg/kg will be reported as an MDL.

5.9.4 Practical Quantitation Limit (PQL): Multiply the MDL by 3 to obtain the PQL: PQL = MDL*3

6.0 REFERENCES

Innov-X Systems, Inc. Innov-X Systems X-Ray Fluorescence Spectrometers Instruction Manual. Woburn, MA. June 2002.

Stephen Shefsky, NITON Corporation. Comparing Field Portable X-Ray Fluorescence (XRF) To Laboratory Analysis of Heavy Metals In Soil. Presented at the International Symposium of Field Screening Methods for Hazardous Wastes and Toxic Chemicals. Las Vegas, Nevada. January 29-31, 1997.

USEPA (U.S. Environmental Protection Agency), Method 6200: Field Portable X-Ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment, Office of Solid Waste, Washington, D.C. January 1998.

USEPA, Region I, Northeast Waste Management Officials' Association (NEWMOA) Technology Review Committee Advisory Opinion. Innovative Technology: X-Ray Fluorescence Field Analysis. September 21, 1999.

FIGURE 1

FIELD PORTABLE XRF SAMPLE ANALYSIS LOG SHEET

Page___ of ___

Project Site Name: ______________________ Run Length/Duration: ______________________

Project No.: ______________________ Measurement Units: ______________________

Analyzed By: ______________________ Reference/Calibration: ______________________

SAMPLING AND FIELD PORTABLE XRF RESULTS DATA

SAMPLE ID	ANALYSIS DATE	ANALYSIS TIME	ELEMENT ANALYSIS	RESULT RUN 1	RESULT RUN 2	RESULT RUN 3	RESULTS AVERAGE	ERROR RUN 1	ERROR RUN 2	ERROR RUN 3	ERROR AVERAGE

ATTACHMENT B

ANALYTICAL STANDARD OPERATING PROCEDURES
UXO 7 – SMALL ARMS RANGES
NSA CRANE
CRANE, INDIANA

Table of Contents

Certifications:

Low-level PAH Analysis

ATTACHMENT B

ANALYTICAL STANDARD OPERATING PROCEDURES
UXO 7 – SMALL ARMS RANGES
NSA CRANE
CRANE, INDIANA

(Provided on enclosed CD)