Final
TNT Areas A and C
Remedial Investigation
Former Plum Brook Ordnance Works
Sandusky, Ohio

(Volume 4 – Focused Feasibility Study for Soil and Sediment)

Prepared for:

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List of Acronyms

ADNT	amino dinitrotoluene
ARAR	applicable or relevant and appropriate requirements
ATS	alternate treatment standard
bgs	below ground surface
BHHRA	baseline human health risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
C/N	carbon to nitrogen
cm	centimeter
COC	chemical of concern
COPC	chemical of potential concern
cy	cubic yard
°C	degrees Celsius
DERP	Defense Environmental Restoration Program
DNT	dinitrotoluene
EHQ	ecological hazard quotient
ERA	ecological risk assessment
FFS	focused feasibility study
FS	feasibility study
HI	hazard index
HQ	hazard quotient
ILCR	incremental lifetime cancer risk
ISCO	in situ chemical oxidation
IT	IT Corporation
lb	pound
LDR	land disposal restriction
LOAEL	lowest observed adverse effect level
MDC	maximum detected concentration
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MnO2	manganese dioxide
NASA	National Aeronautics and Space Administration
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NMR	nuclear magnetic resonance

NOAEL	no observed adverse effect level
NT	nitrotoluene
OEPA	Ohio Environmental Protection Agency
O&M	operation and maintenance
PAH	polynuclear aromatic hydrocarbon
PBOW	Former Plum Brook Ordnance Works
PCB	polychlorinated biphenyl
ppm	parts per million
RAB	Restoration Advisory Board
RAO	remedial action objective
RBRC	risk-based remediation criterion
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RGO	remedial goal option
RI	remedial investigation
SACM	Superfund Accelerated Cleanup Model
SLERA	screening-level ecological risk assessment
SOD	soil oxidant demand
SRA	sum-of-ratios approach
SVOC	semivolatile organic compound
TAT	2,4,6-triaminotoluene
TBC	to be considered
TCLP	toxicity characteristic leaching procedure
TNT	trinitrotoluene
TNTA	TNT Area A
TNTB	TNT Area B
TNTC	TNT Area C
TSCA	Toxic Substances Control Act
TSDF	treatment, storage, and disposal facility
UHC	underlying hazardous constituent
USACE	U. S. Army Corps of Engineers
USEPA	U. S. Environmental Protection Agency
UTS	universal treatment standard

Executive Summary

This report presents the results of the focused feasibility study (FFS) performed for contaminated soil at TNT Area A (TNTA) and contaminated soil and sediment at TNT Area C (TNTC) located at the former Plum Brook Ordnance Works (PBOW) in Sandusky, Ohio. The U.S. Army Corps of Engineers contracted Shaw Environmental, Inc. (Shaw), formerly IT Corporation (IT), to conduct this FFS under Delivery Orders 003 and 004 of Contract Number DACA62-00-D-0002. The purpose of this FFS is to select, evaluate, compare, and recommend remedial alternatives that address the soil and sediment contamination at TNTA and TNTC.

The 9,009-acre PBOW site was built in early 1941 as a manufacturing plant for 2,4,6-trinitrotoluene (TNT), dinitrotoluene (DNT), and pentolite. Twelve process lines were used in the manufacture of TNT at PBOW, with four lines at TNTA, three lines at TNTB, and five lines at TNTC. The three lines at TNTB are not included as part of this FFS.

Located in the northeastern part of PBOW, TNTA occupies approximately 114 acres of land and Columbus Avenue bisects the site. TNTA is partially wooded (less than 25 percent) and consists predominantly of large open areas of grasslands. The National Aeronautics and Space Administration Engineering/Administration building is located on a portion of TNTA.

TNTC is located in the southwestern portion of PBOW and occupies approximately 119 acres of land. Currently, TNTC is mostly overgrown with trees and brush. However, some of the roads, building foundations, and remnants of utilities from former TNT manufacturing operations are still recognizable at both TNTA and TNTC.

Fieldwork for the remedial investigation was conducted from June through October 2000. Surface and subsurface soil samples were collected at TNTA (430 samples) and TNTC (385 samples) for screening analysis of nitroaromatic compounds. To supplement the screening analysis, confirmation soil samples were collected at TNTA (49 samples) and TNTC (30 samples). Locations for confirmation soil sample collection were based on the screening results and were used to support the development of human health and ecological risk assessments for both sites. To further investigate possible contaminant migration, 20 surface water samples (9 at TNTA, 10 at TNTC, and 1 off site) and 30 sediment samples (10 at TNTA, 15 at TNTC, and 5 off site) were collected. Confirmation soil samples and all surface water and sediment samples were analyzed for nitroaromatic compounds, volatile organic compounds, semivolatile organic compounds, target analyte list metals, and polychlorinated biphenyls (PCB).

A baseline human health risk assessment separately evaluated the human health risks associated with TNTA and TNTC. Potential cancer and noncancer risks associated with exposure to TNTA total soil (i.e., combined surface and subsurface soil) under the residential and construction worker scenarios were found to exceed the respective Ohio Environmental Protection Agency (OEPA) cancer and noncancer risk management ranges. The highest cancer and noncancer risks were estimated for the resident. No cancer or noncancer risks exceeding the respective OEPA risk management ranges were associated with exposure to surface water and sediment at TNTA. Nine chemicals of concern (COC) were identified for total soil at TNTA; these COCs and their respective remedial goal options (RGO) are listed in Table ES-1 on the following page.

Potential cancer and noncancer risks associated with exposure to TNTC total soil under the residential and construction worker scenarios were found to exceed the respective OEPA risk management ranges. Also, cancer and noncancer risks to the groundskeeper, indoor worker, and hunter exposed to surface soil were found to exceed the respective OEPA risk management ranges. The highest TNTC soil cancer and noncancer risks were estimated for the resident. Potential risks associated with exposure to sediment under the residential and construction worker scenarios also exceeded the OEPA criteria for noncancer risk. This elevated noncancer risk was based on 1 of 14 sediment sampling locations; the highest sediment risks were estimated for the construction worker. No cancer or noncancer risks exceeding the respective OEPA risk management ranges were associated with exposure to TNTC surface water. Thirteen COCs were identified for soil and three COCs for sediment at TNTC; these COCs and their respective RGOs are listed in Table ES-1.

Potential ecological risks were evaluated separately for TNTA and TNTC in the screening-level ecological risk assessment. Elevated ecological hazard quotients (EHQ) were estimated for terrestrial receptors (mice, rabbits, shrews, and wrens) and aquatic receptors (raccoons and mallards) based on constituents detected in soil and sediment at both TNTA and TNTC. EHQs were not elevated for exposure associated with TNTA or TNTC surface water. EHQs are not risk measures and cannot, by themselves, justify a remedial action. Because remediation of TNTA and TNTC is recommended based on human health risks, an evaluation of the ecological protectiveness of the cleanup to human health risk RGOs was performed. This evaluation indicates that further study or remediation (beyond that proposed to address human health risks) on the basis of ecological concerns is unwarranted.

Based on the results of the human health risk assessment, remedial action objectives (RAO) were developed for soil and sediment. Note that RAOs were not developed for groundwater, as groundwater will be evaluated at a later date. RAOs for soil and sediment at TNTA and TNTC are presented below:

- Remedial actions will be taken at TNTA to prevent human exposure via any exposure route (ingestion, inhalation, or dermal contact) to total soil containing any of the COCs in the following table at concentrations that exceed the RGOs. RGOs for TNTA are listed in the second column of the table.

- Remedial actions will be taken at TNTC to prevent human exposure via any exposure route (ingestion, inhalation, or dermal contact) to total soil and sediment containing any of the COCs in the following table at concentrations that exceed the RGOs. RGOs for TNTC are listed in the third and fourth columns of the following table.

Table ES-1

RGOs for TNTA and TNTC

Chemical of Concern	TNT Area A Soil RGO (mg/kg)	TNT Area C Soil RGO (mg/kg)	TNT Area C Sediment RGO (mg/kg)
Nitroaromatics			
2-amino-4,6-DNT	1.3	1.7	5.0
4-amino-2,6-DNT	1.7	1.3	5.0
2,4-DNT	6.0	6.5	-
2,6-DNT	1.5	1.0	-
2-Nitrotoluene	31	-	-
4-Nitrotoluene	9	-	-
2,4,6-TNT	8	8	41
Polychlorinated Biphenyls			
Aroclor 1254[a]	-	1	-
Aroclor 1260[a]	1	1	-
Metals			
Lead	400	400	-
Polynuclear Aromatic Hydrocarbons (PAH)[b]			
Benzo(a)anthracene	-	1	-
Benzo(a)pyrene	-	1	-
Benzo(b)fluoranthene	-	1	-
Dibenz(a,h)anthracene	-	1	-
Indeno(1,2,3-cd)pyrene	-	1	-

Note: "-" indicates the compound was not identified as a contaminant of concern in the given medium.
[a]RGO value shown is for total PCB.
[b]RGO value is based on total polynuclear aromatic hydrocarbon (PAH) concentration of the PAH COCs listed.
mg/kg - Milligrams per kilogram.
PCB - Polychlorinated biphenyl.

In order to achieve the RAOs for soil and sediment, the following process options and technologies were screened In the FFS based on an evaluation of effectiveness, implementability, and cost:

- Capping
- Excavation
- Off-site and on-site disposal
- Ex situ chemical stabilization
- In situ chemical oxidation
- Windrow composting.

Based on the results of the technology screening, the following five alternatives were developed for detailed analysis in the FFS:

- ***Alternative 1 – No Action.***

- ***Alternative 2 – Excavation, Windrow Composting, and On-Site/Off-Site Disposal.*** Excavation of contaminated soil. Windrow composting of nitroaromatic- and PAH-contaminated soil (23,887 cubic yards), followed by on-site disposal of treated compost. Off-site treatment and/or disposal of hazardous lead- and PCB-contaminated soil (736 cubic yards) at a Subtitle C hazardous waste treatment, storage, and disposal facility (TSDF).

- ***Alternative 3 – Excavation, Ex situ Stabilization, and Off-Site Disposal.*** Excavation of contaminated soil. Ex situ chemical stabilization of soil classified as a hazardous waste (5,633 cubic yards), followed by disposal of stabilized soil and nonhazardous soil (18,871 cubic yards) in a Subtitle D industrial waste landfill. Disposal of PCB-contaminated soil (119 cubic yards) at a hazardous waste TSDF.

- ***Alternative 4 – Excavation and Off-Site Disposal.*** Excavation of contaminated soil. Disposal of nonhazardous soil (18,871 cubic yards) at a Subtitle D industrial waste landfill. Off-site treatment and/or disposal of hazardous nitroaromatic-, lead-, and PCB-contaminated soil (5,752 cubic yards) at a Subtitle C hazardous waste TSDF.

- ***Alternative 5 - Excavation, Windrow Composting, Ex Situ Stabilization, and On-Site/Off-Site Disposal.*** Excavation of contaminated soil. Windrow composting of nitroaromatic- and PAH-contaminated soil (23,887 cubic yards), followed by on-site disposal of treated compost. Ex situ chemical stabilization of hazardous lead-contaminated soil (617 cubic yards), followed by off-site disposal at a Subtitle D industrial waste TSDF. Disposal of PCB-contaminated soil (119 cubic yards) at a hazardous waste TSDF.

All of the alternatives, with the exception of Alternative 1, would permanently treat/remove contaminated soil, thereby reducing human health risks to within the risk management range. Alternatives 2 through 5 may also benefit ecological receptors by significantly reducing the EHQs associated with soil contamination at the sites. Alternatives 2 through 5 may provide a corollary benefit to long-term groundwater and surface water quality by removing or mitigating the most significant source areas that contribute to contamination in these media. Alternative 1 does not employ removal, containment, or treatment response actions that would mitigate the impact of source areas on receptors or other environmental media.

All of the alternatives, with the exception of Alternative 1, would comply with the chemical-, location-, and action-specific applicable or relevant and appropriate requirement (ARAR). Alternative 1 would not comply with the chemical-specific ARAR for total PCBs. Action- and location-specific ARARs are not applicable for Alternative 1 because no action would be taken.

All of the alternatives, with the exception of Alternative 1, would reduce the magnitude of residual risk at the sites to levels within the risk management range. No long-term controls would be required at the sites for Alternatives 2 though 5.

Alternatives 2 and 5 would satisfy the statutory preference for selecting remedial actions that employ treatment technologies that permanently and significantly reduce the toxicity, mobility, or volume of hazardous substances as their principal element. Alternatives 5 and 2 would treat the vast majority of the contaminated soil excavated at TNTA and TNTC (99.5 and 97.0 percent, respectively). In contrast, Alternative 3 would treat only 23 percent of the contaminated soil excavated from TNTA and TNTC. Alternatives 1 and 4 would not employ on-site treatment as an element of the alternative, although some off-site treatment would be required under Alternative 4 to comply with land disposal restrictions (LDR).

The composting component of Alternatives 2 and 5 provides essentially irreversible treatment by coupling biodegradation and biotransformation processes to reduce the toxicity and mobility of soil contaminants. Alternative 3 employs chemical stabilization to reduce the mobility of contaminants. While chemical stabilization is not an irreversible process, the combination of stabilization and off-site disposal at an industrial landfill should prevent the contaminants in the treated soil from leaching back into the environment. Although Alternative 4 would remove contamination from the site, it would not result in any total reduction of contaminant mass. The disposal of excavated soil in an appropriate TSDF would minimize the potential for contaminants to leach into the environment. Alternative 1 would have no effect on the toxicity, volume, or mobility of soil contamination.

Alternatives 2 through 5 would all provide adequate safeguards for site workers and the community during remediation. Only small volumes of contaminated soil excavated under Alternatives 2 and 5 would require off-site management. All the contaminated soil excavated under Alternatives 3 and 4 would require off-site management. No threatened or endangered animal or plant species will be significantly affected or destroyed by remedial actions at TNTA and TNTC. In the event threatened and/or endangered plant species are later discovered in the proposed remediation areas, care will be taken to minimize disturbance. There will be short-term disturbances to ecological habitat as a result of the proposed remediation; however, the re-establishment of vegetative cover following the action will allow displaced species to recolonize these disturbed areas.

Remedial time frames for the various alternatives are presented in the table below. The remedial duration is presented for each site individually as well as a combined time interval for remediating both sites during one field event. The combined time period for both sites under each alternative is less than the sum of the individual time intervals for each site because the combined time period accounts for efficiencies in executing remedial tasks concurrently. Alternative 1 would not require any time, as no remedial action would be taken. Alternatives 4 and 3 would have the second and third shortest remedial durations. Alternative 2 would have the next to longest remedial duration and Alternative 5 would require the longest period of time to complete.

Site	Alternative 1 (months)	Alternative 2 (months)	Alternative 3 (months)	Alternative 4 (months)	Alternative 5 (months)
TNTA	0	30 to 36	16 to 22	12 to 18	31 to 37
TNTC	0	22 to 28	13 to 19	10 to 16	23 to 29
Combined	0	41 to 47	20 to 26	16 to 22	42 to 48

All of the technologies in these alternatives are well developed and have been implemented on a full-scale basis on numerous projects. Equipment, technical specialists, and materials are available for all the alternatives. The effectiveness of the alternatives can be monitored by sampling and analysis of excavation areas and treated soil. All of the alternatives would require the approval of OEPA for disposal of material off site. None of the alternatives would preclude additional actions if the technologies were not completely effective.

Remedial costs for TNTA and TNTC are presented in the table below. Costs are presented for each site individually as well as a combined cost for remediating both sites during one field event. The combined cost of each alternative is less than the sum of the individual site costs because the combined costs account for the economies of scale in executing concurrent remedial actions. Of Alternatives 2 through 5, Alternative 3 is the lowest cost alternative. Chemical stabilization of the hazardous fraction of the excavated soil allows all soil (expect PCB remediation waste) to be disposed off site as a nonhazardous waste. The cost to stabilize the hazardous soil is less than the differential between hazardous and nonhazardous waste disposal costs. Alternative 4 is the second lowest cost alternative. Alternatives 2 and 5 are the two highest cost alternatives. Alternative 2 is slightly lower in cost than Alternative 5 because there is not enough lead-contaminated soil at elevated concentrations for the increased costs of chemical stabilization to offset the cost of disposal as a hazardous waste. The table shows that a cost savings can be realized with Alternatives 2 and 5 when remediation is conducted concurrently, although the actual savings would be significantly less than the difference between the combined cost and the sum of the individual costs because certain cost elements (e.g., concrete treatment slab, fabric structure, treatment equipment) would be double counted in adding costs for TNTA and TNTC.

Site	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
TNTA	$0	$7,688,000	$4,655,000	$4,923,000	$7,815,000
TNTC	$0	$5,377,000	$3,102,000	$3,119,000	$5,504,000
Combined	$0	$10,987,000	$7,096,000	$7,736,000	$11,099,000

Although the public has not yet had an opportunity to comment officially on the remedial selection process at TNTA and TNTC, the Restoration Advisory Board (RAB) has been presented with some preliminary information on the various remedial options that are under consideration at these sites. Verbal comments received from members of the RAB at periodic public meetings indicate a clear preference for alternatives that include windrow composting as a component of the remedy. The public has also indicated a concern for remedial alternatives that would involve significant off-site management of contaminated soil, particularly at local landfills.

The comparative analysis of remedial alternatives indicates that Alternative 2: Excavation, Windrow Composting, On-Site and Off-Site Disposal should be selected as the recommended remedial alternative for both TNTA and TNTC. The alternative meets the threshold criteria of protection of human health and the environment, and it complies with all ARARs.

Alternative 2 is selected over Alternatives 3 and 4 because it utilizes on-site treatment to a high degree, satisfying the statutory preference for alternatives that employ treatment technologies that permanently and significantly reduce the toxicity, mobility, or volume of hazardous substances as their principal element. The composting technology used in Alternative 2 results in an irreversible biodegradation and biotransformation of the nitroaromatic and PAH contaminants in soil, while chemical stabilization does not destroy the contaminants and the process may be reversible under the right conditions. Soil contaminated with high concentrations of nitroaromatic compounds may also be difficult to successfully stabilize. As previously mentioned, preliminary comments from members of the RAB indicate a strong preference for composting over other technologies discussed, in particular those requiring significant management of contaminated soil off-site.

Alternative 2 is selected over Alternative 5 because it is more cost effective to chemically stabilize the small volume of lead-contaminated soil at an off-site TSDF than at an on-site batch treatment plant. This approach also precludes the disposal of contaminated soil at local landfills, because the soil shipped off site is a hazardous waste and must be treated at a Subtitle C TSDF to meet requirements of land disposal restrictions prior to disposal.

1.0 Introduction

This report presents the results of the focused feasibility study (FFS) for TNT Area A (TNTA) and TNT Area C (TNTC) soil and sediment at the former Plum Brook Ordnance Works (PBOW) in Sandusky, Ohio. The U.S. Army Corps of Engineers (USACE) is conducting studies under the Defense Environmental Restoration Program (DERP) to determine the environmental impact of suspected hazardous waste sites at previously owned U.S. Department of Defense properties. PBOW is an Army DERP project currently managed and technically overseen by the Huntington, West Virginia, and Nashville, Tennessee, USACE District Offices.

The FFS was completed in a manner consistent with U.S. Environmental Protection Agency (USEPA) remedial investigation (RI)/feasibility study (FS) guidance, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA, 1988) and subsequent guidance materials, including *Guidance on Implementation of the Superfund Accelerated Cleanup Model (SACM) under CERCLA and the NCP* (USEPA, 1992). The FFS was completed in compliance with the requirements of the statement of work for delivery orders 003 and 004 of contract number DACA62-00-D-0002.

1.1 Purpose

The purpose of this FFS is to provide an evaluation of remediation alternatives to address contaminated soil at TNTA and TNTC within PBOW. Groundwater at TNTA and TNTC will be addressed in future area-specific and downgradient groundwater studies and is therefore not addressed as part of this FFS.

The FFS is based on the RI report of findings (IT Corporation [IT], 2001a), baseline human health risk assessment (BHHRA) (IT, 2001b), and screening level ecological risk assessment (SLERA) (IT, 2001c). These documents comprise the first three volumes of a four-volume set; the FFS is the fourth volume.

1.2 Summary of Site Conditions

The 9,009-acre PBOW site was built in early 1941 as a manufacturing plant for 2,4,6-trinitrotoluene (TNT), dinitrotoluene (DNT), and pentolite (International Consultants Incorporated, 1995). The site is located approximately 4 miles south of Sandusky, Ohio, and 59 miles west of Cleveland (Figure 1-1). Although primarily in Perkins and Oxford Townships, the eastern edge of the site extends into Huron and Milan Townships. PBOW is bounded on the north by Bogart Road, on the south by Mason Road, on the west by County Road 43, and on the east by U.S. Highway 250. The area surrounding PBOW is mostly agricultural and residential.

The PBOW site is currently owned by the National Aeronautics and Space Administration (NASA) and is operated as the Plum Brook Station of the John Glenn Research Center at Lewis Field. Most of the aerospace testing facilities built at the site in the 1960s are in standby or inactive status. On April 18, 1978, NASA declared approximately 2,152 acres of PBOW as excess property. The Perkins Township Board of Education acquired 46 acres of the excess acreage and uses this area as a bus transportation center. The General Services Administration retains the remainder of the 2,152 acres and currently has a use agreement with the Ohio National Guard for 604 acres of the land. NASA presently controls approximately 6,400 acres and is using the site to conduct space research as a satellite operation of the John Glenn Research Center at Lewis Field in Cleveland, Ohio. The details of these land transactions are listed in the site management plan (International Consultants Incorporated, 1995) and can be found at the NASA Plum Brook Station.

TNTA occupies approximately 114 acres of land in the northeastern part of PBOW, with Columbus Avenue bisecting the site (Figure 1-2). NASA constructed its administration building on the east side of Columbus Avenue in the central portion of TNTA. The NASA Administration Building and associated parking areas cover a small portion of the site and one of the former TNT process buildings (Building 121, Mono House). The rest of TNTA is partially wooded (less than 25 percent) and consists predominantly of large, open areas of grasslands. Several aboveground features are still evident at TNTA that indicate former PBOW facilities were present. These include roads, fire hydrants, water valves, railroad track line foundations, and sections of former building pad foundations (Building 111, Mono House, and Building 142, Bi-Tri House). Several below-ground features are also present: manholes, drains, and underground lines (indicated by aboveground water valves). TNTA is slightly hilly, generally increasing in elevation from southeast to northwest. Lindsley Ditch and smaller connecting ditches transect the site. The smaller ditches are dry during periods with little rainfall.

Soil at TNTA generally consists of glacially derived clayey silts or silty clays with some bedrock shale fragments. Sand found at many of the former building locations is a fill material that was used to cover the building area after demolition activities. Bedrock at TNTA is encountered at depths ranging from 4 feet below ground surface (bgs) (Building 192, DNT Sweating & Graining House) to 19.50 feet bgs (Building 116, Wash House). Overburden groundwater at TNTA is believed to be a discontinuous water table made of horizontal, discontinuous lenses that have limited lateral and vertical migration pathways. Depth to the overburden groundwater, therefore, depends upon the amount of local rainfall and the volume of residual material above the bedrock.

TNTC occupies approximately 119 acres of land in the southwestern portion of PBOW, as shown on Figure 1-2. Presently, the area is mostly overgrown with trees and brush. Several aboveground features are still evident at TNTC that indicate former PBOW facilities were present. These include roads, fire hydrants, water valves, a water valve control well, railroad track line foundations, and former building pad foundations (Building 667, Maintenance Shop; Building 689, Acid & Fume Recovery; and Building 657, Wastewater Settling Basin). Several below-ground features are also present: manholes, drains, and underground lines (indicated by aboveground water valves). There are no NASA buildings on the site, and NASA does not currently use the area. One building present on the site was constructed and used by the USEPA to do testing in the 1980s. The building is near the former Wash House (Building 606) in Process Line 10. TNTC is transected by several small intermittent streams that are tributaries to Pipe Creek.

Like TNTA, soil at TNTC generally consists of glacially derived clayey silts or silty clays with some bedrock shale fragments. Sand found at many of the former building locations is thought to be a fill material used to cover the building area after demolition activities. The average depth to bedrock at TNTC is generally deeper below the ground surface than at TNTA. Depths ranged from 7 feet (Building 621, Mono House) to 17 feet bgs (Building 681, Acid & Fume Recovery House). Overburden groundwater at TNTC is also believed to be a discontinuous water table with limited lateral and vertical migration pathways, similar to TNTA. Depth to the overburden groundwater, therefore, depends upon the amount of local rainfall and the volume of residual material above the bedrock. The ditches and streams on TNTA and TNTC are too small to support fishing. However, TNTA and TNTC provide habitat for deer and other wildlife.

Production of explosives at PBOW began on December 16, 1941, and continued until 1945. It is estimated that more than 1 billion pounds of nitroaromatic explosives were manufactured during the 4-year operating period. Twelve process lines were used in the manufacture of TNT at PBOW, with four lines at TNTA, three lines at TNT Area B (TNTB), and five lines at TNTC. The three lines at TNTB are not included as part of this FFS because soil remediation activities have already been conducted.

Significant remediation activities have been performed at TNTA and TNTC since 1941. The U.S. Army began decontamination and decommissioning procedures at all TNT and DNT lines in September 1945. Typical decontamination and decommissioning methods involved removing and relocating any explosives waste in a building or structure to a burning ground for open burning. Buildings and structures were demolished and burned where possible. Steam lines and drain lines were flushed and dismantled, but no records were found indicating the washout location. By December 1945, it was estimated that 65 percent of the necessary decontamination was complete (Morrison-Knudsen Ferguson Corporation, 1994).

From January 1 to June 30, 1946, the USACE assumed responsibility for maintenance and custodial activities. Further decontamination activities were conducted, and the extent of contamination was certified (Morrison-Knudsen Ferguson Corporation, 1994).

From 1954 through 1958, the USACE through Ravenna Arsenal performed additional decontamination efforts. Significant subsurface contamination was removed from TNTA, including underground flumes and sewer lines. Approximately 16,000 lbs of TNT were removed from TNTA. The decontamination procedures were also to be conducted at TNTC, but no documentation has been found that this was accomplished (Dames & Moore, Inc., 1997).

1.3 Summary of the Remedial Investigation

Four hundred thirty surface and subsurface soil samples were collected for screening analysis of nitroaromatics at TNTA, and 385 were collected at TNTC. The screening samples were submitted to a fixed-base laboratory and analyzed using a modified Method 8330, as described in Chapter 3.0 of the report of findings (IT, 2001a).

To supplement the screening analysis, 49 confirmation soil samples were collected from TNTA, and 30 confirmation soil samples were collected from TNTC. The confirmation sampling locations were selected based on the results of the screening samples. The purpose of the confirmation sampling was to verify the results of the screening analyses. Specifically, the modified Method 8330 used for nitroaromatic analyses has the potential for reporting false positive results. Therefore, the confirmation samples were selected from locations that had the widest range of nitroaromatic concentrations present. A small percentage (approximately 15 percent) of the confirmation samples were collected from screening locations that did not have detections of nitroaromatics. In addition, the confirmation samples provided key information on soil heterogeneity and its effect on contaminant distribution. Specifically, it was discovered that the confirmation samples yielded analytical results for nitroaromatic compounds that were both higher and lower than the co-located screening sample results, and there were roughly equal numbers of higher and lower results. This data suggests that the differences in the screening and confirmation results may be linked more to the highly variable nature of the contaminant distribution than to differences in analytical technique. Confirmation samples were analyzed using standard laboratory methods (SW-846) and were independently validated. Because only the confirmation samples were validated, the screening soil samples were not used in the BHHRA and SLERA. The screening results were, however, subsequently used along with the confirmation data in estimating the volume of soil requiring remedial action, as the larger combined data set should result in more accurate volume estimates.

Surface water and sediment samples were collected to further investigate possible contaminant migration. Nine surface water samples were collected from TNTA, 10 surface water samples from TNTC, and 1 surface water sample from off site. A total of 30 sediment samples were collected: 10 from TNTA, 15 from TNTC, and 5 from off-site locations. Surface water and sediment samples were analyzed by GPL Laboratory for nitroaromatic compounds using USEPA Method 8330 (Modified), for volatile organic compounds using Method 8260B, for semivolatile organic compounds (SVOC) using Method 8270C, for target analyte list metals using Methods 6010B/7470A, and for polychlorinated biphenyls (PCB) using Methods 3540B/8082. These surface water and sediment samples were independently validated and were used in the BHHRA and SLERA. For additional information, please refer to the RI report of findings (IT, 2001a). RI field activities were conducted from the last week of June through mid-October 2000.

1.4 Summary of Risk Assessment

1.4.1 Summary of Human Health Risks

A BHHRA was performed to evaluate the potential risk to plausible receptors exposed to contaminants in various media at TNTA and TNTC (IT, 2001b). Following risk assessment guidance (USEPA, 1989), only validated samples were used to evaluate risks. Therefore, confirmation soil samples were used in the BHHRA, but the screening samples were not because their analytical results were not independently validated. As a result, some of the building areas were not specifically evaluated in the BHHRA. Also, some of the areas evaluated as not exceeding Ohio Environmental Protection Agency (OEPA) risk management levels based on confirmation samples have screening samples that, based on the exposure assumptions used in the BHHRA, clearly exceed the OEPA risk management criteria (incremental lifetime cancer risk [ILCR] > 1E-5 or hazard index [HI] > 1).

The following receptors were selected as representative of current and future land-use scenarios: groundskeeper, indoor worker, construction worker, hunter, child venison consumer, and a future on-site resident. Environmental source media evaluated in the risk assessment include surface soil, total soil, surface water, and sediment. Note that "total soil" is the term given to the combination of surface and subsurface soil data. The combination was formed by selecting as chemicals of potential concern (COPC) for total soil each COPC identified in either surface or subsurface soil. The higher source-term concentration estimated for the chemical in surface or subsurface soil was selected as the source-term concentration for total soil.

Chemicals of concern (COC) were selected in the BHHRA based on estimated risks to the receptors. For carcinogenic COCs, the BHHRA used the USEPA (1990) risk management range for ILCR of 1E-6 to 1E-4 for COC selection. OEPA policy, however, defines a total ILCR of 1E-5 summed across chemicals for a given receptor as the upper limit of the risk management range for which further action is not required. Therefore, COCs listed in the FFS were selected to comply with OEPA policy. The results of the BHHRA for the TNTA and TNTC areas and the COCs selected based on the OEPA risk-based criteria are presented in subsections 1.4.1.1 and 1.4.1.2.

As mentioned, screening samples were not evaluated in the BHHRA, but some of the building areas had screening samples with concentrations that exceed remediation goal objectives (RGO). Also, some of the building areas evaluated in the BHHRA did not exceed the upper limits of the OEPA risk management range for cancer (ILCR<1E-5) and noncancer risks (HI $\leq$ 1) but had individual samples that exceed an RGO. Risks associated with these types of building areas are presented in Section 1.4.1.3.

1.4.1.1 BHHRA Summary of TNTA

Total HI and ILCR estimates for each receptor and each source medium for TNT A are summarized in Table 1-1. The groundskeeper, indoor worker, child venison consumer, and hunter were evaluated for exposure only to surface soil. Total HI estimates for these receptors are below the OEPA noncancer risk management criterion of 1. Total ILCR estimates for these receptors likewise are below or within the upper bound of the OEPA cancer risk management range (1E-5). It is concluded that exposure to surface soil meets the OEPA risk management criteria for noncancer hazard and cancer risk for the groundskeeper, indoor worker, child venison consumer, and adult hunter.

The construction worker and future on-site resident were evaluated for exposure to total soil, surface water, and sediment. Total HI estimates summed across all media for these receptors (61 and 219, respectively) exceed the OEPA noncancer HI criterion of 1 (Table 1-1). Also, total ILCR estimates summed across all media for the construction worker (4E-4) and future resident (3E-2) exceed the OEPA cancer risk management range (ILCR > 1E-5). However, HI sums for surface water and sediment are below 0.1, defined as the point of departure for significant contribution to noncancer hazard. Also, ILCR sums for surface water and sediment are below

1E-6, defined as the point of departure for significant contribution to cancer risk. Therefore, it is concluded that only contaminants in total soil contribute significantly to cancer risk and noncancer hazard for the construction worker and future on-site resident.

The following nine chemicals were identified as COCs for TNTA total soil (surface and subsurface):

- 2-amino-4,6-dinitrotoluene (2-ADNT)
- 4-amino-2,6-dinitrotoluene (4-ADNT)
- 2-Nitrotoluene (2-NT)
- 4-Nitrotoluene (4-NT)
- 2,4,6-TNT
- 2,4-DNT
- 2,6-DNT
- Aroclor 1260
- Lead.

RGOs developed for all nine COCs are presented in Section 2.2.2.

Human health risks were also evaluated in the BHHRA, individually, for each former building area of TNTA at which confirmation soil samples were collected. Cancer risks and noncancer hazards were estimated for the construction worker and future on-site resident for each former building area. This information is presented in Table 1-2. The shading on Table 1-2 indicates that exposure to soil in the area of the former building exceeds OEPA risk management criteria. Entries that are not shaded indicate areas around former buildings that do not exceed either the OEPA cancer or noncancer risk management range, based on the results of the BHHRA. Refer to Section 1.4.1.3 for further evaluation of specific confirmation and surface soil sampling locations.

1.4.1.2 BHHRA Summary of TNTC

Total HI and ILCR estimates for each receptor and each source medium for TNTC are summarized in Table 1-3. The groundskeeper, indoor worker, and hunter were evaluated for exposure only to surface soil. The total ILCR estimates for the groundskeeper (5E-4), indoor worker (2E-4), and hunter (3E-5) exceeded the upper bound of the OEPA cancer risk management range (1E-5). Total HI estimates for the groundskeeper (95), indoor worker (41), and hunter (5) exceeded the OEPA noncancer risk management HI criterion of 1.

The construction worker and future on-site resident were evaluated for exposure to total soil, surface water, and sediment. The total ILCR values summed across all media for the construction worker (5E-5) and future on-site resident (3E-3) exceeded the upper limit of the OEPA risk management range. Total HI estimates summed across all media for the construction worker (374) and future on-site resident (1250) far exceeded the OEPA risk management HI criterion of 1.

The following 10 COCs were identified for surface soil at TNTC:

- 2-ADNT
- 4-ADNT
- 2,4,6-TNT
- 2,4-DNT
- 2,6-DNT
- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Dibenz(a,h)anthracene
- Aroclor 1260.

The following 13 COCs were identified for total soil at TNTC:

- 2-ADNT
- 4-ADNT
- 2,4,6-TNT
- 2,4-DNT
- 2,6-DNT
- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Dibenz(a,h)anthracene
- Indeno(1,2,3-cd)pyrene
- Aroclor 1254
- Aroclor 1260
- Lead.

As is noted from Table 1-3, cancer risks and noncancer hazards associated with future residential exposure are greater than those for the construction worker or the four receptors used solely to evaluate surface soil. Because it is the desire of NASA to release the site without land-use restrictions, RGOs were developed only for the more conservative residential scenario (Section 2.2.3.1) and for total soil. It is noted that each of the surface soil COCs is also a total soil COC; use of the total soil RGOs for surface soil is, therefore, conservative.

The human health risks were also evaluated for each former building area of TNTC at which confirmation soil samples were collected. Cancer risk and noncancer hazard were estimated for the construction worker and future on-site resident for each former building area (Table 1-4). The shading on Table 1-4 indicates that exposure to soil in the area of the former building exceeds OEPA risk management criteria. Entries that are not shaded indicate areas around former buildings that do not exceed either the OEPA cancer or noncancer risk management range, based on the results of the BHHRA. Refer to Section 1.4.1.3 for further evaluation of specific confirmation and surface soil sampling locations.

Surface water is not implicated as a significant contributor to noncancer hazard or cancer risk for either receptor, as surface water noncancer hazards and cancer risks are de minimis (i.e., HI <0.1 and ILCR<1E-6). The construction worker and future on-site resident are also exposed to sediment, which contributed significantly to noncancer hazard for both receptors. Three COCs were identified for sediment at TNTC. All three chemicals are nitroaromatic compounds (2-ADNT, 4-ADNT, and 2,4,6-TNT). RGOs were developed for these three sediment COCs (Section 2.2.3.2).

1.4.1.3 Additional Human Health Risk Issues for Determining Remediation Areas

Two issues must be addressed in the risk management of TNTA and TNTC:

1) Some of the areas that do not exceed the OEPA cumulative risk criteria (i.e., unshaded areas in Tables 1-2 and 1-4) have individual confirmation samples that exceed an RGO (refer to Section 2.2).

2) The BHHRA evaluated the confirmation samples but not the (nonvalidated) screening samples.

The following paragraphs present the risk evaluation of confirmation and screening samples related to the two issues listed above, which are not specifically addressed in the BHHRA. HIs are derived using RGOs based on individual samples as described in Appendix A. RGOs are described and presented in Section 2.2. It is necessary to use them in the following paragraphs so that risk-related issues are appropriately characterized in the FFS.

Areas That Do Not Exceed Risk Management Criteria But Have RGO Exceedances. Three building areas are included in the first category presented above: Building Area 611, Building Area 626, and Building Area 693.

- ***Building Area 611.*** 2-ADNT (1.97 mg/kg) and 4-ADNT (1.46 mg/kg) marginally exceeded the respective RGOs (1.7 and 1.3 mg/kg) in 1 of 9 samples. This screening sample, AB0383, had an associated TNT concentration of 0.662 mg/kg. Each of these concentrations is the maximum detected concentration (MDC) for Building Area 611. The HI associated with these MDC values would be 0.9 (Appendix A), which is less than the OEPA risk management criterion of 1. A confirmation sample was also collected from the same depth and location as Sample AB0383. The concentrations of 2-ADNT (0.182 mg/kg), 4-ADNT (0.192 mg/kg), and TNT (0.0956 mg/kg) in this confirmation sample were far less than the RGO values. It is noted that no HI could be calculated in the BHHRA because no noncancer site-related COPCs were identified for Building Area 611 based on the confirmation samples alone.

- ***Building Area 626.*** 2-ADNT is the only COC that exceeds its RGO in Building Area 626. In Building Area 626, the RGO (1.7 mg/kg) for 2-ADNT is exceeded in 1 of 18 samples at a concentration of 2.67 mg/kg. It was detected in only one other Building Area 626 sample and at a much lower concentration (0.237 mg/kg). The single exceedance (Sample AB0431) of 2-ADNT (2.67 mg/kg) was collocated with the only Building Area 626 detection of 4-ADNT (0.784 mg/kg). If these concentrations are combined with the TNT concentration detected in this sample (1.41 mg/kg), the resultant HI equals 0.9 (Appendix A), which is less than the OEPA risk management criterion of 1. It is noted that the HI of Building Area 626 as calculated in the BHHRA (including all chemicals evaluated, not just the COCs) is equal to the OEPA risk management criterion.

- ***Building Area 693.*** 2-ADNT, 4-ADNT, and TNT were each detected at concentrations exceeding the respective RGOs in 1of 9 Building Area 693 samples. The 4-ADNT (2.26 mg/kg) and TNT (8.07 mg/kg) exceedances were both detected in the same sample (AB0443), with an associated 2-ADNT concentration of 1.28 mg/kg. The resultant HI (Appendix A) for Sample AB0443 of 1 (1.1 prior to rounding) equals the OEPA risk management criterion. 2-ADNT exceeded its RGO only in Sample AB0408, at a concentration of 2.29 mg/kg. 4-ADNT (0.275 mg/kg) and TNT (0.33 mg/kg) were also detected in Sample AB0408 but at concentrations below the respective RGOs. The resultant HI for Sample AB0408 is 0.6 (Appendix A), which is less than the OEPA risk management criterion. The HI values for these two individual samples are consistent with the BHHRA, in which an HI of 0.9 was calculated (Table 1-4).

Areas Represented by Screening Samples Only. The second category above includes 9 TNTA and 13 TNTC building areas. No confirmation samples were collected at any of these areas; instead, they were investigated during the RI using screening samples only. Of these 22 "screening only" building areas, only one had a sample with an RGO exceedance that clearly exceeds either of the OEPA risk management criteria; this building area (Building Area 133) is proposed for remediation. Sixteen others had no RGO exceedances and five building areas had at least one sample that marginally exceeded an RGO. Risk evaluation is limited to these latter five areas and is presented below.

- ***Building Area 113.*** TNT at 10.8 mg/kg marginally exceeds the RGO (8 mg/kg) in one of nine screening samples. The detected concentrations of 2-ADNT and 4-ADNT in this sample (AA0121) (0.52 mg/kg and 1.05 mg/kg, respectively) are the MDCs for Building Area 113. The HI associated with these concentrations of TNT and the ADNT isomers would be 0.7.

- ***Building Area 123.*** 2-ADNT at 1.69 mg/kg marginally exceeds the RGO (1.3 mg/kg) in one of six screening samples. The detected concentrations of 4-ADNT and TNT in this sample (AA0167) (1.01 mg/kg and 0.451 mg/kg, respectively) are the MDCs for Building Area 123. The HI associated with these concentrations of TNT and the ADNT isomers would be 0.7.

- ***Building Area 128.*** 2-ADNT at 1.50 mg/kg marginally exceeds the RGO (1.3 mg/kg) in one of five screening samples. The detected concentrations of 4-ADNT and TNT in this sample (AA0146) (0.912 mg/kg and 1.24 mg/kg, respectively) are the MDCs for Building Area 128. The HI associated with these concentrations of TNT and the ADNT isomers would be 0.6.

- ***Building Area 132.*** 2-ADNT marginally exceeded the RGO (1.3 mg/kg) in two of twelve screening samples, AA0052 (at 1.65 mg/kg) and AA0054 (at 1.57 mg/kg). TNT and 4-ADNT were detected in Sample AA0052 at 5.04 and 1.18 mg/kg, respectively. The HI associated with concentrations of TNT and the ADNT isomers in sample AA0052 would be 0.9; all three of these concentrations are MDCs for Building Area 132. TNT and 4-ADNT were detected in Sample AA0054 at 4.08 and 1.01 mg/kg, respectively. The HI associated with concentrations of TNT and the ADNT isomers in sample AA0054 would be 0.8

- ***Building Area 691.*** 4-ADNT marginally exceeded the RGO (1.3 mg/kg) at 1.72 mg/kg in one of eight screening samples. The HI for this sample would, therefore, be 0.4. 2-ADNT was not detected in this sample (AB0021), and TNT was not detected in any Building Area 691 samples. 2-ADNT was detected in only one screening sample, at a concentration of 0.156 mg/kg. If this concentration of 2-ADNT is combined with the exceedance of 4-ADNT found at AB0021, the resulting HI would be 0.5.

Each of the above samples has an associated HI value less than the OEPA risk management criterion of 1. Note that, in each building area, the MDCs were used for HI estimations. This adds conservativeness to the HI estimates for these areas. Additionally, each exceedance of an RGO for these samples is marginal.

1.4.2 Summary of Ecological Risks

A SLERA has been performed as part of the RI for TNTA and TNTC (IT, 2001c). Results of this assessment indicate that the impact of contaminated soil on terrestrial plants is insignificant, and the limited aquatic habitat at the site reduces the concern for impact to aquatic biota. Terrestrial receptors (especially mice, rabbits, shrews, and wrens) and aquatic receptors (especially mallards and raccoons) were predicted to incur elevated hazards, based on estimated ecological hazard quotients (EHQ), from exposure to TNT, 4-ADNT, 2-ADNT, lead, and Aroclor 1260 in soil; 4-ADNT, 2-ADNT, TNT, Aroclor 1260, and selenium in sediment; and aluminum and iron in surface water. Details on the underlying assumptions (e.g., dietary factors, wildlife area use factors, basis for the toxicity data used) of the estimated EHQs are provided in the SLERA (IT, 2001c). It is important to note that ecological hazard quotients are not risk measures and therefore, by themselves, cannot justify either a removal action or a remedial action. In the RI, removal action objectives (RAO) based solely on ecological risk were not recommended, due to uncertainties of toxicity, and limited aquatic habitat at the site. Also, no rare, threatened, or endangered animal species have been confirmed at the site, and no rare, threatened or endangered plant species (found only at TNTC) were in areas of the site proposed for remediation. Further ecological risk assessment study would be required to document and/or provide compelling weight of evidence for realistic measures of ecological risk that might warrant removal or remedial actions at the sites based solely on ecological concerns. As mentioned in Section 1.4.1 and described in Chapter 2.0, remediation of the site is based on potential human health risks. Therefore, an evaluation of the protectiveness to ecological receptors based on human health remedial RGOs was performed (Section 2.3) which indicates that further study or remediation on the basis of ecological concerns alone is unwarranted.

1.5 Nature and Extent of Contamination

The following sections discuss the findings of the TNTA and TNTC RI. All soil analytical results are presented on Figures 1-3 through 1-19 for TNTA and Figures 1-20 through 1-34 for TNTC. The discussion below is limited to those sites that exceed either OEPA cancer risk or noncancer risk criteria or have one or more samples with concentrations of COCs that exceed RGOs. Analytical results for other sites can be found in the RI report of findings (IT, 2001a).

As mentioned in Section 1.4.1, only independently validated data were used in the BHHRA. For soils, this means that the analytical results of only confirmation samples were used to evaluate risks in the BHHRA. However, no confirmation samples were collected from some building areas. Also, at some of the building areas, exposure associated with the concentrations found in confirmation samples did not result in risks that exceeded OEPA risk management levels, but concentrations associated with either individual confirmation or screening samples clearly exceeded the RGOs. Therefore, the following building areas are proposed for potential remediation based on either the results of the BHHRA or a comparison of the confirmation and screening samples to the RGOs for TNTA and TNTC:

TNTA

1. Building areas with risks exceeding the OEPA risk management criteria (cumulative ILCR > 1E-5 or cumulative HI > 1) as shown in the BHHRA are:

   - Building 112
   - Building 119
   - Building 126
   - Building 131
   - Building 139
   - Building 141
   - Building 146
   - Building 182
   - Building 192
   - Building 195

2. Building areas not shown in the BHHRA to exceed OEPA risk management criteria (because either the confirmation samples were not collected or they exhibited relatively low concentrations) but with analytical results in at least one sample (either confirmation or screening) that exceed RGOs are:

   - Building 111
   - Building 116
   - Building 129
   - Building 133
   - Building 142
   - Building 143
   - Building 148

   It is noted that each of the TNTA building areas listed above had at least one sample with concentrations that would have exceeded either or both of the OEPA risk management criteria for cumulative risk (i.e., ILCR >1E-5 and HI > 1).

TNTC

1. Building areas with risks exceeding the OEPA risk management criteria (cumulative ILRC > 1E-5 or cumulative HI > 1) as shown in the BHHRA are:

   - Building 603
   - Building 606
   - Building 616
   - Building 629
   - Building 682
   - Building 683
   - Building 686
   - Building 689
   - Building 692
   - Building 696

2. Building areas not shown in the BHHRA to exceed OEPA risk management criteria (because the confirmation samples exhibited relatively low concentrations) but with analytical results in at least one sample (either confirmation or screening) that exceed RGOs are:

   - Building 602
   - Building 626
   - Building 657
   - Building 693

   Building area 602 is proposed for remediation because one of the screening samples (ABO377) has concentrations that clearly would have exceeded the OEPA risk management criterion for cumulative noncancer risk (HI > 1). Potential risks associated with Building Areas 626 and 693 are discussed in Section 1.4.1.3; all samples at both of these areas are within OEPA risk management criteria. Building areas 626 and 693 are proposed for remediation because of their clear exceedances of at least one RGO in one or more samples. However, the USACE recommends that Building Areas 626 and 693 be further discussed by the project team (i.e., USACE, OEPA, and the Restoration Advisory Board [RAB]) prior to commencement of site remediation so that an appropriate risk management decision can be made. Even though Building 657 meets OEPA risk management criteria, it is proposed for remediation based on a marginal exceedance of the RGO for polynuclear aromatic hydrocarbons (PAH), which is based on OEPA policy rather than risk. Additionally, several building areas with COC concentrations that marginally exceed one or more RGOs, but are less than the OEPA risk management criteria, are not proposed for remediation (refer to Section 1.4.1.3 and Appendix A); these areas are not discussed in the following subsections.

1.5.1 TNTA

Findings of the current RI are summarized by medium and by TNT process line in the following subsections.

1.5.1.1 Soil

As mentioned in Section 1.3, a total of 430 screening and 49 confirmation soil samples were collected from TNTA during the RI. The confirmation samples were collected from depth/location pairings at which screening samples were already taken. In some cases, one of the samples (e.g., screening sample) at a given depth/location was found to exceed an RGO but the other sample collected (e.g., confirmation sample) from this same depth/location pairing was not. Based on a review of the analytical data, it was determined that these differences are, in general, likely attributable to soil heterogeneity. For purposes of soil volume estimations, the higher-concentration sample at such depth/location pairings was assumed to be representative of COC concentrations at that location. Note that groundwater levels are presented in the following discussions to demarcate the transition from vadose zone to saturated soil. This information is used in Section 2.4 to calculate remedial soil volumes.

DNT Process Buildings. Three of the four DNT process buildings investigated at TNTA showed elevated concentrations of nitroaromatics in surface and/or subsurface soils. These were Building 182 (DNT Sweating and Graining House), Building 192 (DNT Sweating and Graining House), and Building 195 (DNT Nitrating Building).

- ***Building 182.*** One or more nitroaromatic compounds (DNT, and 2,4-DNT and 2,6-DNT [both as a SVOCs]) in 3 of the 16 soil samples collected were detected at concentrations significantly above RGOs to a depth of 7 feet bgs (Figure 1-3). The depth of contamination above RGOs is believed to extend to bedrock, which was encountered at 7 feet bgs during sampling activities. Groundwater was encountered during September 2000 drilling of temporary piezometer GW-09 immediately above the bedrock. Groundwater was measured in the piezometer at a depth of 5.40 feet bgs before sampling.

- ***Building 192.*** One or more nitroaromatic compounds (DNT, 2,4-DNT and 2,6-DNT [both as SVOCs], 2,4,6-TNT, and 4-ADNT) in 6 of the 28 soil samples collected were detected at concentrations above RGOs, to a depth of 4 feet bgs (Figure 1-4). The depth of contamination above RGOs is believed to extend to bedrock, which was encountered at 4 feet bgs during sampling activities. Groundwater was encountered during September 2000 drilling of temporary piezometer GW-07 immediately above the bedrock at a depth of 3.8 feet bgs.

- ***Building 195.*** One or more nitroaromatic compounds (2,4-DNT, 2,4-DNT and 2,6-DNT [both as SVOCs], 2,4,6-TNT, and 4-ADNT) in 4 of the 20 soil samples collected were detected at concentrations above RGOs, to a depth of 6 feet bgs (Figure 1-5). The ultimate depth of contamination above RGOs is not precisely known, as samples below this depth were not collected. Contamination likely extends to bedrock, which was encountered at 7 feet bgs during sampling activities. Groundwater was not encountered during October 2000 or August 2001 drilling activities.

Process Line 1 Buildings. Four of the five TNT manufacturing buildings of process line 1 showed elevated concentrations of nitroaromatics and/or lead and PCB contamination in surface and/or subsurface soils. These include Building 111 (Mono House), Building 112 (Bi-Tri House), Building 116 (Wash House), and Building 119 (Acid and Fume Recovery).

- ***Building 111.*** Three nitroaromatic compounds (2A-4,6-DNT, 4-ADNT, and 2-4-DNT) were detected above RGOs in 1 soil sample, AA0361, a screening sample collected at a depth of 4 to 6 feet bgs (Figure 1-6). The sample collected from this same borehole at a depth of 8 to 10 feet bgs (AA0362) had no RGO exceedances, nor did a confirmation sample collected from this same location at 8 to 10 bgs (AA0469). Also, a confirmation sample (AB0468) collected from this same location at 4 to 6 feet bgs had no RGO exceedances. Bedrock was encountered during October 2000 drilling activities at a depth of 10 feet bgs. Groundwater was encountered at 6 feet bgs in the boring (A-361/362) for installation of temporary piezometer GW-01.

- ***Building 112.*** One or more nitroaromatic compounds (2A-4,6-DNT, 4-ADNT, 2,4-DNT, and 2,4,6-TNT) were above RGOs in 11 of the 34 soil samples collected (Figure 1-7). Contamination is present over a widespread area and up to depths of at least 10 feet bgs. Bedrock was encountered during October 2000 drilling of GW-02 at a depth of 15 feet bgs, and groundwater was measured in GW-02 at a depth of 9.54 feet bgs.

- ***Building 116.*** Two nitroaromatic compounds (2A-4,6-DNT and 4-ADNT) were detected above RGOs in 1 of 21 soil samples. This screening soil sample, AA0404, was collected at a depth of 8 to 10 feet bgs (Figure 1-8). No RGO exceedances were present in the confirmation sample collected from 8 to 10 feet bgs at this same location (A0473). Bedrock was encountered during October 2000 drilling activities at a depth of 19.5 feet bgs. A lens of groundwater was encountered at 3.5 feet bgs in boring A-472/473 during installation of temporary piezometer GW-04.

- ***Building 119.*** One or more nitroaromatic compounds (2,4-DNT, 2,4-DNT and 2,6-DNT [both as SVOCs], 2A-4,6-DNT, 4-ADNT, 2,4,6-TNT, 2-NT, and 4-NT) were detected above RGOs in 6 of the 35 soil samples collected (Figure 1-9). Lead and PCB Aroclor 1260 were also detected above RGOs in one of the samples (AA0440) at a depth of 2 to 3 feet bgs, but were not above RGOs in the sample collected from the same borehole at a depth of 4 to 6 feet bgs (AA0465). Nitroaromatic contamination was detected above RGOs as deep as 9 feet bgs at Building 119. Concentrations of 2-NT and 4-NT were above RGOs at depths of 4 to 9 feet bgs. The depth of contamination above RGOs is interpreted as extending to bedrock, which was encountered at 9 feet bgs during October 2000 sampling activities. Groundwater was not encountered during drilling of temporary piezometer GW-03, but groundwater was subsequently measured at a depth of 1.62 feet bgs.

Process Line 2 Buildings. Two of the five TNT manufacturing buildings of process line 2 showed elevated concentrations of nitroaromatics in surface and/or subsurface soils. These were Building 126 (Wash House) and Building 129 (Acid and Fume Recovery).

- ***Building 126.*** One or more of the nitroaromatic compounds (2A-4,6-DNT, 4-ADNT, and 2,4,6-TNT) were detected above RGOs in 9 of the 40 soil samples collected (Figure 1-10). Contamination extends to a depth of at least 10 feet bgs, which was the greatest depth at which soil samples were collected. Bedrock was not encountered during drilling of temporary piezometer GW-06, which was installed to a depth of 15 feet bgs, but groundwater was subsequently measured in temporary piezometer GW-06 at an approximate depth of 12.9 feet bgs. In October 2000 groundwater was encountered during drilling of subsurface boring A-371/372 (Figure 1-10) at a depth of 8 feet bgs.

- ***Building 129.*** One nitroaromatic compound (2,4-DNT) was detected above its RGO in 1 of 16 soil samples collected (Figure 1-11). The detection above the RGO was from a depth of 2 to 3 feet bgs in screening sample AA0303, but 2,4-DNT was not detected in the confirmation sample at 2 to 3 feet bgs from this same location (AA0452) nor in samples collected at this location from greater depths. Bedrock was not encountered during October 2000 drilling of boring A-371/372, which was advanced to a total depth of 10 feet bgs. Perched groundwater was encountered in this boring at 7 feet bgs.

Process Line 3 Buildings. Three of the five TNT manufacturing buildings of process line 3 showed elevated concentrations of nitroaromatics and/or lead and PCB contamination in surface and/or subsurface soils. These were Building 131 (Mono House), Building 133 (Fortifier House), and Building 139 (Acid and Fume Recovery).

- ***Building 131.*** Two or more nitroaromatic compounds (2A-4,6-DNT, 4-ADNT, 2,4-DNT and 2,6-DNT [both as SVOCs], 2,4-DNT, DNT, 2,4,6-TNT, 2-NT, and 4-NT) were detected above RGOs in 4 of the 10 soil samples collected (Figure 1-12). Contamination extends to a depth of at least 10 feet bgs, the greatest depth at which soil samples were collected. Bedrock was not encountered during drilling activities. Perched groundwater was measured in October 2000 temporary piezometer GW-08 at a depth of 6.04 feet bgs.

- ***Building 133.*** Three nitroaromatic compounds (2A-4,6-DNT, 4-ADNT, and 2,4,6-TNT) were detected above RGOs in 1 of the 9 soil samples collected (Figure 1-13). This sample, AA0348, was collected at a depth of 3 to 3.5 feet bgs. Samples collected at 4 to 6 feet bgs (AA0393) and 8 to 10 feet bgs (AA0394) from this same borehole had no RGO exceedances. Bedrock was not encountered during drilling for collection of these samples. Groundwater was encountered at 6 feet bgs in the September 2000 boring A-393/394.

- ***Building 139.*** 4-ADNT, DNT, lead, and Aroclor 1260 were detected above RGOs in 1 of the 17 soil samples collected (Figure 1-14). This confirmation sample, AA0432, was collected at 2 to 3 feet bgs and is the only confirmation sample collected from Building Area 139. Screening soil samples were collected from the same location as AA0432 at depths of 2 to 3 feet bgs (AA0040), 4 to 6 feet bgs (AA0375), and 8 to 10 feet bgs (AA0376); no RGO exceedances were observed in these. It is noted that screening samples were not analyzed for lead or PCBs; therefore, contaminant depth is not known for Aroclor 1260 and lead. Aroclor 1260 was detected above both its RGO of 1 mg/kg and the Toxic Substances Control Act regulatory limit of 50 mg/kg. This soil would be classified as a bulk PCB remediation waste, per the regulatory requirements described in Section 2.4. Soil boring A-375/376 was advanced to 10 feet bgs in October 2000, and no groundwater or bedrock was encountered.

Process Line 4 Buildings. Five of the six TNT manufacturing buildings of process line 4 showed elevated concentrations of nitroaromatics in surface and/or subsurface soils. These were Building 141 (Mono House), Building 142 (Bi-Tri House), Building 143 (Fortifier House), Building 146 (Wash House), and Building 148 (Nail House).

- ***Building 141.*** Two or more nitroaromatic compounds (2A-4,6-DNT, 4-ADNT, 2,4-DNT 2,6-DNT, and 2,4,6-TNT) were detected above RGOs in 3 of the 17 soil samples collected for the RI (Figure 1-15). These exceedances were observed only in surface (0 to 1 foot bgs) and near-surface (1 to 2 feet bgs) soil. All three samples exhibiting exceedances were from the drowning tank area; samples collected at 4 to 6 feet bgs and 8 to 10 feet bgs in the vicinity of the drowning tank had no RGO exceedances. Thus, nitroaromatic contamination may extend to a depth of 4 feet bgs near the drowning tank. Bedrock and groundwater were not encountered during drilling activities conducted by IT in October 2000. Bedrock is estimated to be at a depth of 12 feet bgs.

- ***Building 142.*** Four nitroaromatic compounds (2,4,6-TNT, 2A4,6-DNT, 4-ADNT, and 2,6-DNT), lead, or PCB (Aroclor 1260) were detected above RGOs in 6 of 27 soil samples (Figure 1-16). Lead and Aroclor 1260 were detected in the confirmation surface soil sample (AA0427) at 0 to 1 foot bgs, but not in the subsurface confirmation sample collected from the same boring (AA0428) at 2 to 4 feet bgs. All RGO exceedances were within the top 3 feet of soil. October 2000 soil boring A-379/380 was advanced to 10 feet bgs and did not encounter bedrock. Groundwater was detected at 4 feet bgs.

- ***Building 143.*** Three nitroaromatic compounds (2,4,6-TNT, 2A-4,6-DNT, and 4-ADNT) were detected above RGOs in 1 of the 21 soil samples collected (Figure 1-17). This sample, AA0035, was a screening sample collected at 1.6 to 2.6 feet bgs. No RGO exceedances were found in screening samples collected from this same location in surface soil (AA0330) or at depth intervals of 4 to 6 feet bgs (AA0381) or 8 to 10 feet bgs (AA0382). Neither were RGO exceedances detected in a confirmation sample (AA0431) collected from this same location at 1.5 to 2.5 feet bgs. Nitroaromatic contamination may extend to a depth of 4 feet bgs. Bedrock was not encountered at this boring, but groundwater was detected in October 2000 at a depth of 7 feet bgs.

- ***Building 146.*** One or more of 4 nitroaromatic compounds (2,4,6-TNT, 2A-4,6-DNT, 4-ADNT, and 2,4-DNT) were detected above RGOs in 13 of the 34 soil samples collected (Figure 1-18). Contamination extends to a depth of at least 10 feet bgs, the greatest depth at which samples were collected. Groundwater was not encountered during drilling of bedrock monitoring well TNTA-BEDGW-001, which encountered bedrock at a depth of 55 feet. Monitoring well TNTA-BEDGW-001 was installed near the northwest corner of the former Wash House.

- ***Building 148.*** Three nitroaromatic compounds (2,4,6-TNT, 2A-4,6-DNT, and 4-ADNT) were detected above RGOs in 1of the 10 soil samples collected (Figure 1-19). This sample, AA0077, was collected at a depth interval of 0.7 to 1.7 feet bgs; a confirmation sample, AA0433, collected from this same location at 0.7 to 1.7 feet bgs exhibited no RGO exceedances. Nitroaromatic contamination extends to a depth of at least 1.7 feet bgs. Total depth of nitroaromatic contamination is not known because no sample was collected at a depth greater than 2 feet bgs.

1.5.1.2 Surface Water and Sediment

No COCs were identified for TNTA surface water or sediment, based on the results of the BHHRA.

1.5.2 TNTC

Findings of the current RI are summarized by medium and by TNT process line in the following sections.

1.5.2.1 Soil

As mentioned in Section 1.3, a total of 385 screening and 30 confirmation soil samples were collected from TNTC during the RI. The confirmation samples were collected from depth/location pairings at which screening samples were already taken. In some cases, one of the samples (e.g., screening sample) at a given depth/location was found to exceed an RGO but the other sample collected (e.g., confirmation sample) from this same depth/location pairing was not. Based on a review of the analytical data, it was determined that these differences are, in general, likely attributable to heterogeneity. For purposes of soil volume estimations, the higher-concentration sample at such depth/location pairings was assumed to be representative of COC concentrations at that location. Note that groundwater levels are presented in the following discussions to demarcate the transition from vadose zone to saturated soil. This information is used in Section 2.4 to calculate remedial soil volumes.

Process Line 8 Buildings. Four of the five TNT manufacturing buildings of process line 8 showed elevated concentrations of nitroaromatics, lead, PCBs, and/or PAHs in surface and/or subsurface soils. These were Building 682 (Bi-Tri House), Building 683 (Fortifier House), Building 686 (Wash House), and Building 689 (Acid and Fume Recovery).

- ***Building 682.*** Lead or one or more nitroaromatic compounds (2,4,6-TNT, 2-ADNT, 4-ADNT, 2,4-DNT, and 2,6-DNT [both as SVOCs]) were detected above RGOs in 9 of the 30 soil samples collected (Figure 1-20). RGO exceedances were exhibited in samples collected at depth intervals down to 2.5 feet bgs, with lead exceeding its RGO in 1 of 3 confirmation samples (ABO455 at 0.5 to 1.5 feet bgs). Nitroaromatics were also detected in a stone-lined drainage ditch north of the building. September 2000 soil boring C-369/370 encountered groundwater at 8 feet bgs, and groundwater was measured in October 2000 temporary piezometer GW-02 at 9.57 feet bgs. Bedrock was detected at a depth of 15 feet bgs in the boring for temporary piezometer GW-02.

- ***Building 683.*** Three or more nitroaromatic compounds (2,4,6-TNT, 2A-4,6-DNT, 4-ADNT, DNT, and 2,4-DNT and 2,6-DNT [both as SVOCs]) were detected above RGOs in 4 of the 10 soil samples collected (Figure 1-21). All of the samples were located in a boring near the drowning tank. Contamination extends to a depth of at least 10 feet bgs, the greatest depth at which soil samples were collected. Groundwater was encountered during drilling of borehole C-399/400 at a depth of 9 feet bgs, and bedrock was detected at a depth of 15 feet bgs during the drilling of temporary piezometer GW-08.

- ***Building 686.*** Nitroaromatics, lead, Aroclor 1260, and PAHs were detected above RGOs in 16 of the 34 soil samples collected (Figure 1-22). The lead RGO was exceeded in 1 of the 4 confirmation samples (surface soil sample AB0438), and the Aroclor 1260 concentrations exceeded the RGO in 2 of the 4 confirmation samples (surface soil samples AB0437 and AB0438). Nitroaromatics contamination was distributed throughout the area from the surface to depths of at least 4 feet bgs. Groundwater was encountered in September 2000 at 3 feet bgs during drilling of boring C-371/372. In October 1994, groundwater was encountered at 3.5 feet and bedrock was detected at 12.2 feet bgs in overburden monitoring well TNTC-MW06.

- ***Building 689.*** Two or more nitroaromatic compounds (2A-4,6-DNT, 4-ADNT, and DNT) and Aroclor 1260 were detected above RGOs in 3 of the 17 soil samples collected (Figure 1-23). Nitroaromatic contamination extends to a depth of at least 6 feet bgs. The total depth is not known, as soil samples were not taken below 6 feet bgs. Aroclor 1260 exceeded the RGO in 1 of 2 confirmation soil samples; the RGO exceedance was in surface soil sample AB0426, but the 4 to 6 foot bgs sample (AB0460) from the same location did not exceed the RGO. September 2000 soil boring C-3401/402 encountered groundwater at 8 feet bgs, and groundwater was measured in October 2000 temporary piezometer GW-02 at 9.6 feet bgs. Bedrock was detected at a depth of 15 feet bgs in the boring for temporary piezometer GW-02.

Process Line 9 Buildings. Three of the six TNT manufacturing buildings of process line 9 showed elevated concentrations of nitroaromatics, lead, and/or PAHs in surface and subsurface soils. These were Building 692 (Bi-Tri House), Building 693 (Fortifier House), and Building 696 (Wash House).

- ***Building 692.*** Two or more nitroaromatic compounds (2A-4,6-DNT, 4-ADNT, 2,4-DNT and 2-6-DNT [both as SVOCs], and 2,4,6-TNT) were detected above RGOs in 8 of the 22 soil samples collected (Figure 1-24). Nitroaromatic contamination extends to a depth of at least 6 feet bgs at the location of screening sample AB0405. RGO exceedances were not observed in the sample collected at 8 to 10 feet bgs (AB0406) from this same borehole nor in the confirmation sample collected at this same location from 4 to 6 feet bgs (AB0469). September 2000 soil boring C-405/406 encountered groundwater at 8 feet bgs, and groundwater was measured in October 2000 temporary piezometer GW-06 at depth of 9.50 feet bgs. Bedrock was detected at a depth of 15 feet bgs in the boring for temporary piezometer GW-06.

- ***Building 693.*** Nitroaromatic compounds (2A-4,6-DNT, 4-ADNT, and/or 2,4,6-TNT) were detected above RGOs in 2 of the 10 soil samples collected (Figure 1-25). Nitroaromatic contamination extends to a depth of at least 10 feet, but groundwater was encountered at a depth of 7 feet bgs in the September 2000 soil boring C-407/408 (temporary piezometer GW-07). Bedrock was not detected at a depth of 10 feet bgs in the boring. Note that human health risks associated with these exceedances are less than the OEPA risk management criteria (refer to Section 1.4.1.3).

- ***Building 696.*** Nitroaromatics, lead, and/or PAHs were detected above RGOs in 11 of the 35 soil samples collected (Figure 1-26). Contamination extends to a depth of at least 3 feet bgs, but the total depth of nitroaromatic contamination is not known. PAHs were observed at concentrations exceeding the RGO in 2 of the 4 confirmation samples (AB0445 at 0 to 1 foot bgs and AB0446 at 2 to 2.5 feet bgs). Groundwater and bedrock were not encountered during installation of the September 2000 boring C-373/374, drilled to a total depth of 10 feet bgs. Groundwater was not encountered in August 2001 temporary piezometer GW-18, but bedrock was detected at a depth of 12 feet bgs.

Process Line 10 Buildings. Three of the five TNT manufacturing buildings of process line 10 showed elevated concentrations of nitroaromatics in surface or subsurface soils. These were Building 602 (Bi-Tri House), Building 603 (Fortifier House), and Building 606 (Wash House).

- ***Building 602.*** 4-ADNT is the only COC detected above its RGO, in 1 of the 17 soil samples collected (Figure 1-27). It exceeded the RGO in screening sample AB0377, collected at 5 to 7 feet bgs. Nitroaromatics were not detected in the sample collected from this same boring at a depth of 8 to 10 feet bgs (AB0378), nor was 4-ADNT detected in a confirmation sample collected from this same location and depth (AB0465). Total depth of the nitroaromatic contamination is interpreted as extending to groundwater, which was encountered at a depth of 6 feet bgs in September 2000 boring C-377/378.

- ***Building 603.*** One or more nitroaromatic compounds (DNT, 2,4-DNT and 2,6-DNT [both as SVOCs], 2A-4,6-DNT, and 2,4,6-TNT) were detected above RGOs in 4 of the 11 soil samples collected, to depth intervals as great as 8 to 10 feet bgs (AB0464) (Figure 1-28). Groundwater was encountered at 8 feet bgs during drilling of September 2000 soil boring C-379/380. Groundwater was measured in temporary piezometer GW-04 at 6.9 feet bgs.

- ***Building 606.*** Two nitroaromatic compounds (2A-4,6-DNT and 4-ADNT) were detected above RGOs in 1 of the 17 soil samples collected (Figure 1-29). These exceedances were exhibited in sample AB0447, collected at a depth of 1 to 2 feet bgs. No deeper samples were collected at the location of AB0447. Groundwater was encountered during drilling of September 2000 soil boring C-381/382 (boring south of catch box) at a depth of 6 feet bgs. Groundwater was measured in August 2001 temporary piezometer GW-17 at 6.9 feet bgs. Bedrock was encountered in the temporary piezometer boring at a depth of 8 feet bgs.

Process Line 11 Buildings. Of the six TNT manufacturing buildings of process line 11, only Building 616 (Wash House) showed elevated concentrations of nitroaromatics in soils.

- ***Building 616.*** Three nitroaromatic compounds (2A-4,6-DNT, 4-ADNT, and 2,4,6-TNT) were detected above RGOs in 10 of the 43 soil samples at depths to 10 feet bgs, and PAH compounds were detected above RGOs in 1 of the 6 confirmation samples

(AB0432 at 0 to 1 foot bgs) (Figure 1-30). Nitroaromatics exceedances of RGOs were observed at depths up to 4 feet bgs. Groundwater was encountered during drilling of September 2000 soil boring C-361/362 at a depth of 8 feet bgs. Groundwater was measured in temporary piezometer GW-05 at a depth of 0.90 feet, and bedrock was encountered at a depth of 16.55 feet bgs.

Process Line 12 Buildings. Two buildings and the wastewater settling basins of process line 12 showed elevated concentrations of nitroaromatics, lead, and/or PCBs in surface and subsurface soils. These were Building 626 (Wash House), Building 629 (Acid and Fume Recovery), and Building 657 (Wastewater Settling Basins).

- ***Building 626.*** One nitroaromatic compound (2A-4,6-DNT) was detected above its RGO in 1 of the 18 soil samples collected (Figure 1-31). This screening sample, AB0074, was collected at a depth of 2.5 to 3.5 feet bgs. No nitroaromatics were detected in a second screening sample collected from the same depth and location (AB0431), and no deeper samples were collected at this location. Contamination is interpreted as extending to a depth of at least 3.5 feet bgs in this boring. Groundwater was encountered at 8 feet bgs in the September 2000 boring C-395/396. Probe refusal (bedrock) was encountered during drilling of temporary piezometer GW11 at a depth of 8.5 feet bgs. Note that human health risks associated with sample AB0074 are less than the OEPA risk management criteria (refer to Section 1.4.1.3).

- ***Building 629.*** Nitroaromatics were detected above RGOs in 8 of the 25 soil samples collected (Figure 1-32) to a depth of 10 feet bgs. Total PCBs were detected in 2 of 4 confirmation samples (AB0430 and AB0475, both collected at 2.5 to 3.5 feet bgs), and lead exceeded its RGO in 1 (AB0430) of 4 confirmation samples. Therefore, PCB and lead contamination extends to a depth of at least 3.5 feet bgs, and nitroaromatics contamination extends from the surface to depths of at least 10 feet bgs (bedrock). Groundwater was not encountered during drilling of soil boring C-363/364 nor during the installation of temporary piezometer GW-01. Probe refusal (bedrock) was encountered during drilling of the temporary piezometer at a depth of 10 feet bgs.

- ***Building 657.*** A total of 14 soil samples were collected from the Wastewater Settling Basins (Figure 1-33). PAHs were the only COCs that exceeded an RGO. This RGO exceedance was observed in the only confirmation sample, AB0468, collected at a depth of 3 to 5 feet bgs. Therefore, contamination extends to a depth of at least 5 feet bgs, but the total depth that exceeds RGOs is not known because only one confirmation sample was collected. Groundwater was not encountered in the September 2000 boring during sample collection, but probe refusal was obtained at a depth of 7 feet bgs.

1.5.2.2 Surface Water and Sediment

No COCs were identified for surface water at TNTA based on the results of the BHHRA. COCs were detected above RGOs in sediment at TNTC at only one sample location (Figure 1-34). 4-ADNT, 2A-4,6-DNT, and 2,4,6-TNT were detected above RGOs at sample location SD009.

2.0 Identification of Remedial Action Objectives at TNT Area A and TNT Area C

2.1 Introduction

This chapter identifies the RAOs for TNTA and TNTC, provides remediation volumes estimates based on the RAOs and analytical results, and identifies applicable or relevant and appropriate requirements (ARAR) associated with the chemicals, environmental media, and potential actions associated with the remediation of site materials. RAOs are cleanup objectives that are developed during the FFS and finalized in the record of decision to protect human health and the environment. They consist of medium-specific goals for protecting human health and the environment. RAOs provide the basis for the identification, detailed analysis, and selection of remedial alternatives.

RAOs developed for the protection of human health and the environment specify the following:

- COCs to be addressed
- Relevant exposure routes and receptors
- Chemical concentration limits specific to COCs, environmental media, and specific locations at the site, referred to as RGOs.

Separate RAOs were developed for TNTA and TNTC. The RAO for TNTA is:

- Remedial actions will be taken to prevent human exposure via any exposure route (ingestion, inhalation, or dermal contact) to total soil containing any of the COCs at concentrations that exceed TNTA RGOs.

The RAO for TNTC is:

- Remedial actions will be taken to prevent human exposure via any exposure route (ingestion, inhalation, or dermal contact) to total soil or sediment containing any of the COCs at concentrations that exceed TNTC RGOs.

Section 2.2 presents and describes the derivation of RGOs for TNTA and TNTC. Post-remediation ecological hazards, based on cleanup to RGOs, are evaluated in Section 2.3. The RGOs are used in Section 2.4 to provide estimations of the area and volume of contaminated media. Section 2.5 identifies action-specific ARARs associated with potential remedial alternatives.

2.2 *Remedial Goal Options*

RGOs are selected to address human health concerns based on chemical- and medium-specific ARARs, "to be considered" (TBC) criteria, and risk-based remediation criteria (RBRC); these terms are briefly described below:

- Chemical-and medium-specific ARARs – Enforceable regulatory chemical- and medium-specific concentrations. Note that ARARs are further defined in Section 2.4.

- TBCs – Nonenforceable chemical- and medium-specific guidance or advisories. One example is the USEPA (1998) average concentration of 400 mg/kg for lead used as a screening level for residential soil.

- RBRCs – Risk-based concentrations derived from the BHHRA exposure and toxicity assessments. These provide important perspective relating contaminant concentrations to specific risk levels. Because it is the desire of NASA to release the property for unrestricted use, RBRCs based on the more conservative exposure assumptions (i.e., residential use for soils; construction worker assumptions for TNTC sediments) were used in the FFS.

RGOs were developed for each COC in total soil at TNTA and in total soil and sediment at TNTC. The first step of RGO development was to perform a comprehensive search for any chemical-specific ARARs for COCs in soil and sediment. A legally enforceable ARAR was found to exist only for PCBs in soil (1 mg/kg); this ARAR was used as an RGO for combined Aroclor 1254 and Aroclor 1260. Section 2.5.3 discusses the pertinent PCB regulations and how they apply to remedial actions at TNTA and TNTC. The USEPA (1998) 400 mg/kg screening level for lead in soil, which is a TBC criterion, was adopted as the RGO for lead in TNTA and TNTC soils. The derivation of RGOs for other COCs is described in Section 2.2.1. All RGOs for TNTA and TNTC are provided in Sections 2.2.2 and 2.2.3, respectively.

Future residential land use was considered in the development of the RGOs, consistent with the desire of all stakeholders (NASA, OEPA, and the RAB) to release the property for unrestricted use, including potential residential development. Therefore, remediation of soil proposed in the FFS focuses on meeting these residential-based RGOs. The construction worker scenario represents the more conservative exposure scenario for TNTC sediment (refer to Section 2.2.3.2 and Appendix B) and is used in the FFS for sediment.

2.2.1 *Derivation of Risk-Based Remediation Concentrations*

The RBRCs selected as RGOs for nitroaromatics are COC-, receptor-, and medium-specific concentrations based on a cumulative target cancer risk level of 1E-5 and a cumulative target HI value of 1 for each target organ. The primary noncancer COCs identified in TNTA and TNTC are nitroaromatics, all of which have a common target organ, the erythrocyte. The only other COCs at TNTA and TNTC having recognized noncancer effects are lead and Aroclor 1254. Neither lead nor Aroclor 1254 has noncancer effects that are regarded as additive with those of the nitroaromatics; more details about assumptions regarding the additivity of hazard are provided in the BHHRA (IT, 2001b). The derivation of RBRCs incorporates all the exposure and toxicity assumptions and data used in the BHHRA.

A sum-of-ratios approach (SRA) was used to develop TNTA total soil RBRCs (Appendix B). The SRA separately considers cumulative cancer and noncancer effects of the COCs and provides the flexibility necessary so that the target cumulative risk values (i.e., ILCR = 1E-5, HI = 1) are divided among the COCs in appropriate proportions. The proportions are generally selected so that the remediation effort, costs, and/or time required to meet the RAO are minimized.

A detailed discussion of the SRA is provided in Appendix B. Briefly, in the SRA, chemical-specific concentrations are back-calculated using the output from the risk assessment, setting a target HI of 1 for noncarcinogens affecting the same target organ and a target ILCR of 1E-5 for carcinogens. The calculations are typically first made using the same relative proportions that were identified in the BHHRA as exposure point concentrations. These proportions may then be adjusted to accommodate site-specific concerns and minimize remediation.

Properly balancing the RBRCs is a critical component of the SRA. For example, it may be judged appropriate to adjust the RBRC upward for a given noncancer COC "A"; however, this adjustment decreases the remaining portion of the target HI for the other noncancer COCs affecting the same target organ as COC "A." Also, a given COC (e.g., TNT and the DNT isomers) may elicit both cancer and noncancer adverse effects. A determination must be made as to which type of effect is the "risk driver," cancer or noncancer, and whether a given concentration considered as a potential RBRC appreciably affects both cancer and noncancer risks. Simultaneous spatial evaluation of the analytical data is also necessary to select RBRCs that will help to minimize the remediation costs, efforts, and/or time expended to most effectively meet RAOs.

2.2.2 TNTA RGOs

RGOs for TNTA total soil were derived based on potential residential use. As mentioned in Section 2.2.1, the PCB ARAR of 1 mg/kg was selected as the RGO for combined Aroclors 1254 and 1260 for TNTA, and the TBC criterion of 400 mg/kg was selected as the RGO for lead. Note that Aroclor 1254 was not detected in TNTA total soil, but it is being treated as a COC because the ARAR-based RGO is for combined PCBs. Site-specific RBRCs were selected as RGOs for the remaining COCs, all of which are nitroaromatics (Table 2-1). The RGOs for TNTA differ somewhat but are comparable to the RGOs developed for TNTB. The following paragraphs briefly present the nitroaromatic RBRCs. Appendix B describes the derivation of the RBRCs for TNTA in greater detail.

Cancer Effects. 2,4-DNT, 2,6-DNT, TNT, and Aroclor 1260 are the only carcinogenic COCs identified for TNTA. All three of the nitroaromatic COCs elicit both cancer and noncancer effects. The cancer effects for the DNTs (combined ILCR of 3E-2) in the BHHRA exceed the OEPA target ILCR (1E-5) by a factor of nearly 3,000, whereas the noncancer effects for combined DNTs (hazard quotient [HQ] = 199) exceeds the OEPA noncancer target HI by a factor of 199. Therefore, cancer effects are clearly the risk-driving effects for 2,4-DNT and 2,6-DNT.

The ILCR for TNT in the BHHRA (3E-5) exceeds the OEPA target ILCR (1E-5) by a factor of approximately 3, whereas the noncancer HQ (8) exceeds the OEPA noncancer target HI by a factor of 8. This means that the noncancer effects of TNT more heavily influence human health risks than do its cancer effects, although the magnitude of the difference of noncancer versus cancer impact (with respect to the risk-based criteria of HI=1 and ILCR=1E-5) is not as great for TNT as it is for the DNT isomers. However, it is necessary to consider whether the contribution of TNT to cancer risk may be appreciable depending on the magnitude of the TNT RBRC selected based on noncancer effects.

A target ILCR of 1E-5 corresponds to a combined DNT RBRC of 7.5 mg/kg (Appendix B). A TNT RBRC of 8 mg/kg was selected based on noncancer effects as discussed under "Noncancer Effects" below. This TNT concentration corresponds to a de minimis ILCR of 5.6E-7; therefore, the DNT isomers are the only TNTA COCs quantitatively considered for cancer effects. A spatial evaluation was performed on all of the TNTA analytical results. This evaluation revealed that 2,4-DNT was far more prevalent than 2,6-DNT in the 0 to 7.5 mg/kg range. It was then determined that a 2,4-DNT RBRC of 6 mg/kg and a 2,6-DNT RBRC of 1.5 mg/kg (a combined total of 7.5 mg/kg) would most effectively help to minimize the remediation effort at TNTA.

Additionally, the cancer effects of Aroclor 1260 are additive with those of TNT and the DNT isomers. However, the sample with the maximum remaining Aroclor 1260 concentration would have an associated ILCR that is de minimis (refer to Appendix B). Even at the total PCBs ARAR of 1 mg/kg, the associated ILCR would be 3E-6; this risk level combined with a total

DNT concentration of 7.5 mg/kg (if the two concentrations were to occur in the same location) would round to 1E-5, the OEPA risk management criterion.

Noncancer Effects. Based on a review of site-specific TNTA analytical data, as well as confirmation samples collected during the remediation action performed at TNTB, it was determined that RBRCs should be selected to maximize the allowable residual concentrations of 2-ADNT and 4-ADNT. If all of the target HI (=1) was apportioned to the ADNT isomers, the combined ADNT RBRC would be 4.0 mg/kg; many TNTA samples exhibited combined ADNT concentrations ranging from 1 to 4 mg/kg. It was also determined from a spatial and quantitative evaluation of TNTA data, with the goal of minimizing the remediation effort necessary to meet the RAO, that an RBRC of 1.3 mg/kg for 2-ADNT, an RBRC of 1.7 mg/kg for 4-ADNT, and an RBRC of 8 mg/kg for TNT should be selected for TNTA soil. The RBRCs selected for 2-nitrotoluene (31 mg/kg) and 4-nitrotoluene (9 mg/kg) were likewise selected with the goal of minimizing the effort required to meet the RAO for TNTA; these values are associated with de minimis risk (i.e., HQ < 0.1). Combined, the HI for the noncancer COC RBRCs (1.0) meets the OEPA target HI. It is noted that the 2,4-DNT and 2,6-DNT RBRCs, selected on the basis of cancer effects, are regarded as de minimis with respect to noncancer effects (HQ values of 0.04 and 0.02, respectively).

Note on Isomer-Specific RBRCs. The TNTA RBRCs for the ADNT and DNT isomers are similar but are not the same as for TNTC (Section 2.2.3.1); caution should be taken that these values are not confused. Refer to the table below for clarification.

COC	TNTA RBRC (mg/kg)	TNTC RBRC (mg/kg)
2-ADNT	1.3	1.7
4-ADNT	1.7	1.3
2,4-DNT	6.0	6.5
2,6-DNT	1.5	1.0

2.2.3 TNTC RGOs

RGOs were derived for TNTC total soil and sediment separately and are presented in subsections 2.2.3.1 and 2.2.3.2, respectively.

2.2.3.1 Total Soil

RGOs for TNTC total soil were derived based on potential residential use. As mentioned in Section 2.2.1, the PCBs ARAR of 1 mg/kg was selected as the RGO for combined Aroclor 1254 and 1260 for TNTC, and the TBC criterion of 400 mg/kg (EPA, 1998) was selected as the RGO for lead. Also, at the direction of OEPA, an RGO of 1 mg/kg for the combined PAH COCs was selected. Site-specific RBRCs were selected as RGOs for the remaining COCs, all of which are nitroaromatics (Table 2-2). The RGOs for TNTC differ somewhat but are comparable to the RGOs previously developed for TNTB. The following paragraphs briefly present the nitroaromatic RBRCs. Appendix B describes the derivation of the RBRCs for TNTC in greater detail.

Cancer Effects. 2,4-DNT, 2,6-DNT, TNT, Aroclor 1254, and Aroclor 1260 are the carcinogenic COCs for TNTA total soil. As mentioned, an ARAR-based RGO was selected for the PCBs. All three of the nitroaromatic COCs and Aroclor 1254 elicit both cancer and noncancer effects. As discussed in Section 2.2.2, the noncancer effects of TNT are more dominant than are its cancer effects (i.e., with respect to a given concentration resulting in an exceedance of the OEPA risk criteria). Based on the noncancer effects of TNT (see discussion below under "Noncancer Effects"), an RBRC of 8 mg/kg was selected for TNT.

Because the TNT RBRC of 8 mg/kg results in a de minimis ILCR (i.e., <1E-6), the DNT isomers are the only TNTC nitroaromatic COCs quantitatively considered for cancer effects (refer to Appendix B). A target ILCR of 1E-5 corresponds to a combined DNT RBRC of 7.5 mg/kg. A spatial evaluation was performed on all of the TNTC analytical results. This evaluation revealed that 2,4-DNT was far more prevalent than 2,6-DNT in the 0 to 7.5 mg/kg range. It was then determined that a 2,4-DNT RBRC of 6.5 mg/kg and a 2,6-DNT RBRC of 1.0 mg/kg (total of 7.5 mg/kg) would most effectively help to minimize the remediation effort at TNTC.

Additionally, the cancer effects of Aroclors 1254 and 1260 are additive with those of TNT and the DNT isomers. However, the samples with the maximum remaining Aroclor 1254 and Aroclor 1260 concentrations would have associated ILCRs that are de minimis (refer to Appendix B). Even at the total PCBs ARAR of 1 mg/kg, the associated ILCR would be 3E-6; this risk level combined with a total DNT concentration of 7.5 mg/kg (if the two concentrations were to occur in the same location) would round to 1E-5, which does not exceed the OEPA risk management criterion.

Five PAHs were also identified as COCs. However, RBRCs were not developed for these for the following reasons: (1) PAHs were less prevalent than the nitroaromatic COCs, especially in subsurface soil; (2) PAHs are not known to have been used at the site other than presumably in paving materials, lubricants, and fuels for vehicles; (3) controlled vegetation burning may provide an ongoing source of PAHs in surficial soils (note that PAHs are more prevalent in TNTC surface soil than in TNTC subsurface soil); (4) naturally occurring petroliferous rock may be a natural source of PAHs in TNTC soil; (5) given the contribution of the DNT isomers to cancer risk associated with TNTC soils, the RBRCs for PAHs would have been less than the analytical reporting limits and could not be regarded as reliable quantifications.

Noncancer Effects. Based on a review of site-specific TNTC analytical data, as well as confirmation samples collected during the remediation action performed at TNTB, it was determined that RBRCs should be selected to maximize the allowable residual concentrations of 2-ADNT and 4-ADNT. If all of the target HI (=1) were apportioned to the ADNT isomers, the combined ADNT RBRC would be 4.0 mg/kg; many TNTC samples exhibited combined ADNT concentrations ranging from 1 to 4 mg/kg. It was also determined from a spatial and quantitative evaluation of TNTC data, with the goal of minimizing the remediation effort necessary to meet the RAO, that an RBRC of 1.7 mg/kg for 2-ADNT, an RBRC of 1.3 mg/kg for 4-ADNT, and an RBRC of 8 mg/kg for TNT should be selected for TNTC total soil RBRCs. Combined, the HI for the noncancer COC RBRCs (1.0) meets the OEPA target HI. It is noted that the 2,4-DNT and 2,6-DNT RBRCs, selected on the basis of cancer effects, are regarded as *de minimis* with respect to noncancer effects (HQ values of 0.04 and 0.01, respectively).

Note on Isomer-Specific RBRCs. The TNTC RBRCs for the ADNT and DNT isomers are similar but are not the same as for TNTA (Section 2.2.2); caution should be taken that these values are not confused. Refer to the table below for clarification.

COC	TNTA RBRC (mg/kg)	TNTC RBRC (mg/kg)
2-ADNT	1.3	1.7
4-ADNT	1.7	1.3
2,4-DNT	6.0	6.5
2,6-DNT	1.5	1.0

2.2.3.2 Sediment

A single sediment sample (AB1009) had high concentrations of 2-ADNT (11.2 mg/kg), 4-ADNT (12.8 mg/kg), and especially TNT (1,496 mg/kg). These concentrations resulted in sediment HI values for the resident (6) and construction worker (14) that exceeded the OEPA risk management criterion (HI = 1) (IT, 2001b). It is noted that, when rounded to one significant figure, the ILCR associated with this elevated TNT concentration equaled the upper limit of the OEPA cancer risk management range (i.e., 1E-5) for the resident and equaled the lower end of the OEPA cancer risk management range (i.e., 1E-6) for the construction worker. Therefore, the derivation of RGOs focuses on noncancer effects.

Noncancer RBRCs were derived for TNTC sediment using the SRA, as described in Appendix B. Separate RBRCs were derived for the construction worker and potential resident, assuming an HQ of 0.333 for each of the three COCs (Table 2-3). Because exposure to the construction worker was assumed to be more intense over a short period, the noncancer risks associated with the construction worker are estimated to be greater than for the resident, and the construction worker RBRCs are accordingly lower. For conservativeness, the construction worker RBRCs are proposed as RGOs for sediment:

- 2-ADNT – 5 mg/kg
- 4-ADNT – 5 mg/kg
- TNT – 41 mg/kg.

Concentrations in the 14 other sediment samples were much lower than these RGO levels. The second highest concentration of each sediment COC occurs in Sample AB1015 (2-ADNT – 3.25 mg/kg; 4-ADNT – 2.79 mg/kg; and TNT – 2.9 mg/kg). These concentrations result in HI values of 0.4 for the construction worker and 0.2 for the resident; associated cancer risks would be *de minimis*. Concentrations of these COCs in the other remaining sediment samples were much lower than in Sample AB1015 (TNT and combined ADNTs were each less than 0.8 mg/kg). Therefore, it was determined that existing concentrations of these COCs in TNTC sediment are unlikely to represent a human health risk except in the vicinity of Sample AB1009.

2.3 Residual Ecological Hazards

As mentioned in Section 1.4.2, EHQs estimated for TNTA and TNTC soils, sediment and surface water in the SLERA were found to be elevated (IT, 2001c). These estimates are associated with a considerable degree of uncertainty and are not, by themselves, appropriately definitive to recommend ecologically based RAOs. However, the SLERA suggests that proposed remediation based on human health-based RGOs for TNTA soils and TNTC soils and sediment be evaluated to determine whether the proposed action is either protective of the environment or significantly reduces EHQs. This section integrates the EHQs and the human health RGOs to provide a semiquantitative assessment of the reduction in potential ecological hazard effected by human health risk-based remediation. As mentioned in Section 2.2 regarding the BHHRA, only the confirmation soil samples were evaluated in the SLERA because the screening soil samples were not independently validated. Also, the screening samples were analyzed only for nitroaromatics; only one of the ecological "risk drivers," TNT, is a nitroaromatic. Therefore, only the confirmation samples were used in this residual risk reduction evaluation.

Tables 2-4 through 2-7 present estimated residual ecological hazards for chemicals found to be ecological "risk drivers" for at least one of the receptors evaluated for the respective environmental media. The receptor with the highest (i.e., "critical") EHQs value from the

SLERA for each medium is shown in the tables. Estimated post-remediation residual concentrations are based on the maximum detected concentration (or one-half the reporting limit if not detected) among the confirmation samples in areas not proposed for remediation; revised EHQ values were simply scaled as described in the footnotes to the tables. Using the estimated residual concentrations and scaled HQ estimation approach, the following reductions in HQ based on no-observed-adverse-effect level (NOAEL) values are observed (similar reductions may be observed for lowest-observed-adverse-effect level [LOAEL] values).

- TNTA surface soil – EHQ reductions range from a factor of 8 (lead) to a factor of 3,040 (TNT). If the HQ values from the SLERA are added together and compared to the sum of the estimated post-remediation HQ values, the overall HQ reduction is 24-fold. Note that different receptors (rabbit and wren) are included on Table 2-4, so the 24-fold reduction in EHQ does not refer to any particular receptor. Also, potential ecological hazards of different chemicals are not necessarily additive, so this overall 24-fold reduction in HQ does not connote a 24-fold reduction in ecological hazard but is included only for numerical comparisons. This last comment applies to each of the following bullets as well.

- TNTA total soil – EHQ reductions range from a factor of 1 (i.e., no reduction for calcium, which is not a human health COC) to a factor of 10,600 (TNT). If the HQ values for Aroclor 1260 are not considered (because the estimated residual Aroclor 1260 concentration [0.0768 mg/kg] is far less than the PCBs ARAR of 1 mg/kg), the estimated overall post-remediation reduction of the remaining summed HQ values is 5-fold.

- TNTC total soil – EHQ reductions range from a factor of 4 (lead) to a factor of 29,300 (TNT). If the EHQ values from the SLERA are added together and compared to the sum of the estimated post-remediation HQ values, the overall HQ reduction is 41-fold.

- TNTC sediment – EHQ reductions range from a factor of 1 (Aroclor 1260, selenium, and aluminum) to a factor of 517 (TNT). If the HQ values from the SLERA are added together and compared to the sum of the estimated post-remediation HQ values, the overall reduction is 9-fold. The exposure point concentrations for aluminum and selenium are less than background screening concentrations. If the contributions of aluminum and selenium are not considered in this comparison, then the estimated post-remediation reduction is 28-fold. Note that different receptors (mallard duck and raccoon) are included on Table 2-7, so the estimated 28-fold reduction in HQ does not refer to any particular receptor.

While some of the COCs are still estimated to have potential EHQs greater than a value of 1, this finding is not considered significant for the following reasons:

- Many of the estimated EHQs greater than 1 are due to detection limit issues. Further reduction in the human health RGOs to protect ecological receptors is not warranted, due to the fact that many of the RGOs are already near the analytical limit of detection (final column of Tables 2-4 through 2-7).

- Some of the estimated EHQs greater than 1 are actually due to metal concentrations near or below site-specific background concentrations. For example, background calcium in soil is 52,300 mg/kg, and residual levels of calcium are estimated to be 14,500 mg/kg for surface soil and 31,000 mg/kg for total soil at TNTA; background selenium in soil is 2 mg/kg, and the residual level of selenium in sediment is estimated to be 1.84 mg/kg at TNTC; background aluminum in soil is 15,500 mg/kg, and the residual level of aluminum in sediment is estimated to be 11,004 mg/kg at TNTC. Note: Because background sediment data were not available, background soil data were used as a surrogate (IT, 2001c).

- The estimated EHQs in Tables 2-4 through 2-7 incorporate additional safety factors, such as the use of an 8-fold modifying factor to account for species-to-species extrapolation and a conservative site-foraging factor of 100 percent. In reality, wildlife are not expected to spend 100 percent of their time at either TNTA or TNTC, and thus exposures to COCs would be reduced if more realistic values were selected for these parameters.

- EHQs are not measures of the probability that a wildlife receptor will develop a toxicological endpoint of concern, such as mortality or reproductive impairment. Additionally, EHQs in excess of 1 do not necessarily indicate that even a single individual of a species will demonstrate the associated effect endpoint. Thus, EHQs of 1 or lower are not necessarily a requirement to demonstrate acceptable ecological impacts.

- Bioaccumulation of COCs in the food chain was estimated using simple empirical models, and actual uptake is expected to be less than estimated. For example, uptake of Aroclor 1260 in earthworms from soil was estimated to be 27.3-fold but is likely much lower. Using a more realistic Aroclor 1260 uptake factor for earthworms would result in lower estimated exposures for earthworm-consuming wildlife, such as the wren, used in the ecological risk assessment (ERA).

In conclusion, given the reasons presented above, the proposed human health RGOs (Tables 2-1 through 2-3) are expected to result in residual COC soil and sediment concentrations that are protective of the environment. No additional aquatic RGOs are needed for surface water at TNTA or TNTC or sediment at TNTC because (1) there is very limited aquatic habitat at the sites and (2) the aquatic habitat that is present is of low quality and is not expected to support or attract fish or wildlife species.

2.4 *Area and Volume Estimates of Contaminated Media*

Identifying samples with COC concentrations above RGOs is the first step in determining area and volume estimates of contaminated media. Concentration data for the media of concern at TNTA and TNTC are shown in the shadowboxes on Figures 1-3 through 1-34. COC concentrations that exceed RGOs are shaded on the figures. There exists some uncertainty concerning the extent of contamination at locations where circumambient data at concentrations below RGOs are not available to completely delineate the boundaries of areas requiring remediation. At these locations the following rules were used to estimate remedial soil volumes:

- If the concentration of any COC at the lateral limit of the sampling data is greater than the RGO but less than 10 times the RGO, a 10-foot buffer was added to the lateral extent in that direction.

- If the concentration of any COC at the lateral limit of the sampling data is greater than 10 times the RGO, a 30-foot buffer was added to the lateral extent in that direction.

- If the concentration of any COC at the vertical limit of the sampling data is greater than the RGO but less than 10 times the RGO, a 5-foot buffer was added to the vertical extent.

- If the concentration of any COC at the vertical limit of the sampling data is greater than 10 times the RGO, the vertical extent was assumed to be the depth to the water table or bedrock, whichever is encountered first.

- If the concentration of lead on one side of a former building location is greater than the RGO, the extent of contamination was assumed to be a 10-foot wide strip around the perimeter of the foundation. This 10-foot-wide strip was assumed from surface to a depth of 2 to 3 feet, except in areas where contamination was specifically encountered (to which the above rules were applied).

Areas of nitroaromatic and PAH contamination exceeding RGOs are shown in red on the shadowbox figures, while lead and PCB contamination areas are shown in green.

The estimated areas and volumes of contaminated soil potentially requiring remediation at each building at TNTA and TNTC are shown on Tables 2-8 and 2-9, respectively. The volume of contaminated soil at TNTA that may require remediation is estimated to be 16,328 cubic yards. Of this total, 3,990 cubic yards (24 percent) might be classified as a hazardous waste upon excavation because the soil contains 2,4-DNT or lead at concentrations that exceed the "20 times rule." Section 2.5.1 describes how the "20 times rule" is used to classify contaminated soil for waste management. Additionally, another 119 cubic yards of soil with concentrations of total

PCBs greater than 50 mg/kg would be classified as a PCB remediation waste upon excavation. Section 2.5.3 presents an overview of the Toxic Substances Control Act (TSCA) regulations that govern the management of PCB wastes.

The volume of contaminated soil at TNTC that may require remediation is estimated to be 9,205 cubic yards. Of this total, 2,310 cubic yards (25 percent) might be classified as a hazardous waste upon excavation because the soil contains 2,4-DNT or lead at concentrations that exceed the "20 times rule."

In TNTC sediment, the concentrations of COCs were elevated above RGOs in only one sample, SD009 (Figure 1-34). This sample exceeded an RGO by more than an order of magnitude. It was assumed that soil would be removed in the vicinity of the sample for a total of 30 feet upstream, 30 feet downstream, 10 feet in width, and to a depth of 2 feet below sediment surface. Therefore, the volume of contaminated sediment potentially requiring remediation is estimated to be 44 cubic yards (Table 2-9). Based on the analytical data presented in Figure 1-31, the contaminated sediment would be classified as nonhazardous upon excavation.

It is important to note that there is significantly more analytical data for the nitroaromatic COCs than for lead, PAHs, or PCBs. As a result, there is a greater degree of uncertainty about the accuracy of the remedial volumes concerning these constituents.

2.5 ARARs Associated with Potential Remediation Activities

ARARs are defined in the USEPA CERCLA guidance document (USEPA, 1988) as follows:

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

- "Relevant and appropriate requirements" means those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.

A requirement may fall into one of these categories but not both. There is more discretion in the determination of relevant and appropriate requirements. It is possible that only a specific part or parts of a requirement will be considered relevant and appropriate in a given case. When the analysis results in a determination that a requirement is both relevant and appropriate, compliance with that requirement is mandatory to the same extent as for applicable requirements.

ARARs can be separated into three categories: chemical-specific, action-specific, and location-specific. Chemical-specific ARARs were addressed in Section 2.2.

Tables C-1 and C-2 in Appendix C present a list of location- and action-specific ARARs that were evaluated for their potential applicability to remedial areas and remedial actions under consideration at TNTA and TNTC. For each potential ARAR, the tables list a description of the regulatory requirement, the prerequisite that invokes the regulation, the federal and/or Ohio regulatory citation, and a determination on the applicability of the ARAR for the sites. No location-specific ARARs were determined to be applicable to the remediation of soil at TNTA and TNTC because areas of special significance (e.g., wetlands, sites containing cultural resources, habitats of endangered, threatened, or rare species) do not exist within the proposed remedial areas of TNTA and TNTC.

Several action-specific ARARs were determined to be applicable to remedial actions under consideration. Three of the more important action-specific ARARs are discussed in the following sections.

2.5.1 Toxicity Characteristic Leaching Procedure Limits

Samples of excavated soil will be analyzed using the toxicity characteristic leaching procedure (TCLP) test to determine if the generated waste exhibits a hazardous characteristic that would require it to be classified as a hazardous waste (40 Code of Federal Regulations [CFR] Part 261.24). Of the COCs present in soil at TNTA and TNTC, only 2,4-DNT and lead are on the TCLP list, at regulatory levels of 0.13 milligrams per liter (mg/L) and 5.0 mg/L (in TCLP extract), respectively. Because TCLP data are not available for soil at TNTA and TNTC, the total concentration data for 2,4-DNT and lead in soil were used to estimate the volume of soil that would be a hazardous waste upon excavation using the "20 times rule." The "20 times rule" calculates the minimum concentration of a hazardous constituent in a solid sample necessary to fail the TCLP test based on the assumption that 100 percent of the constituent leaches from the sample during the TCLP extraction procedure. The calculation is performed by multiplying the TCLP regulatory level for a constituent by 20, the volume ratio of TCLP extract to sample. The "20 times rule" concentrations for 2,4-DNT and lead in soil are 2.6 mg/kg and 100 mg/kg. These pseudo-regulatory levels were compared to 2,4-DNT and lead concentrations in soil to estimate the volumes of excavated soil that may have to be managed as a hazardous waste (Tables 2-8 and 2-9).

2.5.2 Land Disposal Restrictions

Land disposal restrictions (LDR) are applicable in the event that the excavated material is a hazardous waste (40 CFR 268.49). For hazardous wastes, the concentrations of underlying hazardous constituents (UHC) must be characterized to determine if the waste will require treatment prior to land disposal. Typically, the concentrations of UHCs in hazardous waste must not exceed the universal treatment standards (UTS) for the material to be land disposed without treatment. However, contaminated soil is a special case under the LDRs. Alternate treatment standards (ATS) have been created for contaminated soil because USEPA acknowledges that soil is a more difficult matrix to treat than the process wastes that the UTSs were originally created to address. The ATSs for contaminated soil allow the concentrations of UHCs to be up to 10 times the UTSs before treatment is required prior to land disposal. Nonmetal UHCs in contaminated soil or sediment that exceed the ATS must be treated to achieve a 90 percent reduction in concentration, capped at 10 times the UTS (40 CFR 268.49). For soil contaminated with metals, treatment must achieve a 90 percent reduction in constituent concentrations as measured in TCLP extract from the treated medium, capped at 10 times the UTS (40 CFR 268.49).

Tables 2-10 and 2-11 compare the MDCs of the COCs and other potential UHCs at TNTA and TNTC to the ATSs for contaminated soil. This comparison is used to determine if treatment of excavated material may be required prior to disposal. The MDCs of nonmetals are compared directly to the ATSs on the table, and the MDCs of metals are compared to 20 times the ATS. As shown in Table 2-11, the MDCs of lead, 2,4-DNT, and 2,6-DNT are greater than the applicable ATS, indicating that treatment may be required for some material excavated at TNTA. As shown in Table 2-10, the MDCs of chromium and lead are greater than the applicable ATSs at TNTC. To add some conservatism to the remedial cost estimates in this FFS, it is assumed that all soil identified in Tables 2-8 and 2-9 exceeding the "20 times rule" would require treatment to meet the ATSs. The LDRs do not apply to soil or sediment that is classified as nonhazardous based on TCLP test results.

2.5.3 PCB Waste Regulations

The management of solid waste contaminated with PCBs must comply with USEPA and OEPA regulations. Waste containing PCB concentrations greater than or equal to 50 parts per million (ppm) is defined by USEPA as a PCB remediation waste (40 CFR 761.3).

The USEPA provides for three different approaches to the management of PCB remediation waste: (1) self-implementing on-site cleanup and disposal, (2) performance-based disposal, and (3) risk-based disposal. Self-implementing on-site cleanup and disposal is a procedure the USEPA designed for a site of moderate size where there should be low residual environmental impact from remedial activities. The procedure may be less practical for larger or environmentally diverse sites. An advantage of the self-implementing cleanup for smaller site owners is that the USEPA has prescribed cleanup levels based on the future use of the site (i.e., high occupancy or low occupancy), so that a risk assessment is not required. In addition, due to the structured nature of a self-implementing cleanup, it may be conducted without prior written approval from the USEPA. The provisions of the self-implementing cleanup approach are not binding upon cleanups conducted under other authorities, such as actions conducted under Section 104 or Section 106 of CERCLA, or Section 3004(u) and (v) or Section 3008(h) of the Resource Conservation and Recovery Act (RCRA).

Under a performance-based disposal, the USEPA provides disposal options for management of PCB remediation waste once it is generated. Approved disposal options are identified in Table C-2 of Appendix C.

A risk-based disposal is one that does not follow the provisions of either the self-implementing or performance-based approach. A detailed application must be submitted to the USEPA documenting the cleanup plan for the site. Cleanup activities under a risk-based approach may not be conducted without prior written approval from the USEPA.

OEPA Regulation 3745-270-48 states that the total concentrations of all PCBs in hazardous waste must be reduced to the UTS of 10 mg/kg in order to comply with LDRs. Under the alternative LDR treatment standards for contaminated soil (OEPA 3745-270-49), concentrations of UHCs in soil are allowed to be 10 times the UTS. Therefore, contaminated soil with PCB concentrations less than or equal to 100 mg/kg does not require treatment prior to land disposal. Contaminated soil with PCB concentrations greater than 100 mg/kg must be treated to reduce the concentrations of PCBs in the soil by 90 percent, or to 100 mg/kg, whichever is higher.

If the total PCB concentration is below 50 mg/kg, then the soil is not regulated under the TCSA and can be disposed in a nonhazardous waste landfill. For example, the Port Clinton landfill can accept soil contaminated with PCBs up to a concentration of 25 mg/kg.

The highest PCB concentration in soil at TNTA is 69.8 mg/kg (Aroclor 1260). This concentration was detected at Building 139 (Figure 1-14). All other detections of PCBs in soil and sediment at TNTA and TNTC are below 25 mg/kg. Therefore, with the exception of the PCB-contaminated soil at Building 139 at TNTA, the soil and sediment would not be PCB remediation wastes (based on currently available data) and could be managed as a nonhazardous waste, unless classified as a hazardous waste for other reasons. All PCB concentrations in soil are below 100 mg/kg. Therefore, none of the PCB remediation waste would require treatment to comply with the LDRs.

3.0 Screening of Remedial Action Technologies

3.1 Introduction

This section discusses the screening of the technologies and process options used to assemble the remedial alternatives for soil and sediment at TNTA and TNTC. The steps involved in this screening are defined in *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA, 1988) and include:

- Identifying volumes or areas of contaminated media to which remedial actions might be applied, taking into account the RAOs and the chemical and physical characteristics of the site.
- Identifying and screening technology process options to eliminate those that cannot be implemented at the site.
- Assembling the representative technology process options into alternatives representing a range of treatment and disposal combinations, as appropriate (Chapter 4.0).

3.2 Identification of Soil Areas Requiring Remedial Action

A detailed discussion of the methodology of estimating the areas and volumes of contaminated soil and sediment that require remediation was provided in Section 2.4. The areas of soil and sediment that require remedial action are presented on Figures 1-3 through 1-19 for TNTA and on Figures 1-20 through 1-34 for TNTC. The estimated areas and volumes of soil and sediment requiring remedial action are presented in Table 2-8 for TNTA and Table 2-9 for TNTC.

It should be noted that it is difficult to accurately estimate remedial areas and volumes within TNTA and TNTC due to the extensive and extremely variable nature of the contaminant distribution at these sites. At the extreme, TNT can be present within the soil as a solid lump, or nugget. This variability is further demonstrated by comparing analytical results from screening and confirmation samples that are collocated. At a number of locations, concentration data from screening and confirmation samples present significantly different results. As will be discussed in the next section, this variability severely limits the applicability of some in situ technologies that are not particularly effective at sites where the contaminant distribution is highly nonuniform and unpredictable.

Despite the large number of soil samples collected at both sites, there are still locations where the lateral or vertical extent of contamination is not completely defined. The lack of circumambient data completely defining the extent of soil exceeding RGOs generates a significant degree of uncertainty in the volume estimates of contaminated soil requiring remedial action. The degree of uncertainty varies from one building area to another depending on the extent to which the contaminant data are bounded by nondetects. This uncertainty can be qualitatively evaluated by an inspection of the data in the shadowboxes on Figures 1-3 through 1-34.

In those areas where contamination has not been completely delineated, an assumption that contamination does not extend beyond the limits of the existing data would result in significantly underestimating the volume of contaminated soil. A relatively conservative approach was used at TNTB to estimate contaminated soil under similar circumstances, and that approach did not closely predict the actual volume of soil excavated to achieve RAOs. As a result, the rules used in this FFS (presented in Section 2.4) to estimate contaminated volumes beyond the limits of data in areas of uncertainty have been modified from those used at TNTB to increase the volume estimates. The difficulty in implementing any particular set of rules to extrapolate contaminant concentrations beyond existing data lies in the fact that the relationship (if one exists) between concentration data and contaminant distribution is not known. Therefore, any set of rules employed to estimate volume will be somewhat arbitrary and subject to error.

The screening of technology process options below will not be presented separately for TNTA and TNTC because the COCs at both sites are nearly identical and include the same classes of chemical compounds: nitroaromatic compounds, PCBs, lead, and PAHs.

3.3 Screening of Technology Process Options

Technology process options were chosen to represent a wide array of possible technologies that could be used in site remediation, such as bioremediation, physical process options, chemical process options, and institutional controls. In the following subsections, the technologies will be evaluated for their effectiveness in achieving RAOs, their implementability, and their relative cost. In Chapter 4.0 the most feasible technology options will be assembled into remedial alternatives.

3.3.1 Capping

3.3.1.1 Effectiveness

Capping was considered for this site because the contaminated medium is almost exclusively soil, with only a small area of contaminated sediment in TNTC. Caps are placed over contaminated soils to serve as a barrier to human and ecological receptors that may be exposed to the surface and subsurface soils. Also, a cap constructed with low-permeability materials would reduce the infiltration of precipitation through contaminated soils, thereby limiting the transport of contaminants to groundwater. Caps are effective in eliminating exposure to contaminated soil.

3.3.1.2 Implementability

Although the construction of caps over areas of contaminated soil is technically and administratively implementable at TNTA and TNTC, the numerous and discontinuous contaminated soil locations make capping less practical.

3.3.1.3 Cost

The costs associated with this option are moderate and involve site grading and construction of caps at various locations on the site. The operation and maintenance (O&M) costs are expected to be low.

3.3.1.4 Summary

Capping could be effective in achieving the RAOs at TNTA and TNTC, but the numerous and discontinuous contaminated soil locations make capping less practical. Therefore, it will not be included in any remedial alternatives.

3.3.2 Excavation

3.3.2.1 Effectiveness

This process could achieve the RAOs for soil by excavating the source of contamination. The excavation of contaminated materials would eliminate the contamination at the site, but it does not address the final disposition of the excavated material. Therefore, waste management of excavated materials will be required in order to meet the RAOs.

3.3.2.2 Implementability

Excavation of contaminated material is administratively and technically implementable at this site. This option involves using heavy equipment for effective removal of contaminated material from areas defined in Section 2.4.

3.3.2.3 Cost

The overall costs associated with this option would be low to moderate. The capital costs associated with this option depend upon the extent of contaminated material present at the site. There are no O&M costs associated with this option, because it is a one-time event.

3.3.2.4 Summary

Excavation can be effective in achieving RAOs for soil by removing contaminated soil present at TNTA and TNTC. This option is feasible and will be retained for inclusion in remedial action alternatives in Chapter 4.0.

3.3.3 On-Site and Off-Site Disposal

3.3.3.1 Effectiveness

On-site disposal would be an effective option for contaminated soil that had been treated to concentrations below RGOs. Off-site disposal would be an effective option for the management of treated and/or untreated soil that has been excavated from the site.

3.3.3.2 Implementability

This option is administratively and technically implementable at TNTA and TNTC. Nonhazardous and hazardous waste disposal facilities have been identified in the area.

3.3.3.3 Cost

The cost for on-site disposal of treated soil would be low. The cost for off-site disposal of contaminated soil would depend on the amount of soil excavated, and on the cost per ton charged by the off-site landfill for disposal of the waste, which in turn depends on the characteristics of the waste. The cost would be moderate if the contaminated soil is classified as nonhazardous waste and high if the contaminated soil is classified as hazardous waste.

3.3.3.4 Summary

On-site disposal would be the most cost-effective way to manage soil treated to concentrations below RGOs. Off-site disposal of contaminated soil is an effective and implementable process option to achieve RAOs for contaminated soil at TNTA and TNTC. The processes are retained for further development of alternatives in Chapter 4.0.

3.3.4 Ex Situ Chemical Stabilization

3.3.4.1 Effectiveness

Chemical stabilization is effective in immobilizing COCs in soil. Contaminated soil is excavated and then mixed with stabilizing agents in a batch mixer or pug mill. A treatability study would be required to determine mix recipe before full-scale implementation. Stabilization does not transform or remove the COCs from soil, it only hinders their environmental transport. Therefore, stabilization needs to be combined with other waste management options like off-site disposal in a nonhazardous waste landfill or capping of the stabilized soil. In this case, off-site disposal will be more appropriate, because of potential future residential land uses at TNTA and TNTC.

3.3.4.2 Implementability

This process is technically and administratively implementable at this site. A batch mixer or pug mill would be set up on site to mix the excavated soil with the stabilizing agents. Stabilized soil would then be transported off site to a nonhazardous waste landfill.

3.3.4.3 Cost

The cost associated with ex situ stabilization is moderate and depends on the amount of excavated material requiring treatment, the amount of stabilizing agents required, and labor costs associated with the implementation.

3.3.4.4 Summary

The feasibility of this process option warrants further development in Chapter 4.0.

3.3.5 In Situ Chemical Oxidation

3.3.5.1 Effectiveness

In situ chemical oxidation (ISCO) would be implemented by the application of an oxidizing chemical such as potassium permanganate to contaminated soil to convert the COCs into less toxic reaction products. The effectiveness of this technology hinges on the ability to uniformly deliver enough oxidizing reagent to contaminated areas within the subsurface to completely react with the contaminants of interest. It is unlikely, given the heterogeneous soil characteristics at these sites, that such a uniform delivery of chemical reagent could be achieved. The highly variable distribution of nitroaromatic compounds within subsurface soil at TNTA and TNTC (including the presence of TNT as crystalline nuggets) would make it impossible to effectively treat a large area of soil. Additionally, ISCO would not effectively treat lead-contaminated soil, and a secondary technology would be required to address this contaminant.

3.3.5.2 Implementability

The chemical oxidant would be delivered to the subsurface soil either by percolation or by direct injection. The amount of oxidant required is typically a function of the soil oxidant demand (SOD), as the chemical oxidant does not selectively oxidize only the nitroaromatic compounds. Naturally occurring chemicals in soil that are in reduced form (e.g., humic substances, ferrous iron) will also be oxidized and will add to the total oxidant demand. At most sites where ISCO is used, the SOD controls the mass of oxidant applied because the background SOD is usually significantly higher than the contaminant oxidant demand. However, this is likely not the case at TNTA and TNTC, due to the unpredictable occurrence of TNT as a large mass (nugget effect). Because the contaminant distribution is not predictable within the subsurface soil, oxidant demand would have to be based on both the background SOD and the maximum concentrations of nitroaromatic compounds detected in soil in order to ensure that all the soil is effectively treated. Under these conditions, sodium permanganate, which can be applied at higher aqueous concentrations than potassium permanganate, would likely be the most effective oxidant, given the nitroaromatic contaminants of interest and the high concentrations detected in soil at some locations. This situation would lead to the application of large amounts of concentrated sodium permanganate solution across the site.

The reaction products formed from the oxidation process are an additional concern. Manganese dioxide (MnO_2) is a byproduct of the reaction of sodium permanganate. Although MnO_2 is insoluble under oxidizing conditions, the introduction of large quantities of manganese into the subsurface is problematic and could potentially lead to manganese contamination of groundwater. In addition, the sodium (or potassium) permanganate would react with reduced metal species in soil converting them from an immobile to a more mobile state. For example, if trivalent chromium were present at the site as part of the natural soil matrix, introduction of sodium (or potassium) permanganate would oxidize trivalent chromium resulting in the formation of hexavalent chromium. The formation of hexavalent chromium is a major concern for chemical oxidation applications because of its higher mobility and toxicity compared to chromium in a reduced state. These metals issues could make regulatory acceptance of ISCO difficult.

3.3.5.3 Cost

The cost of treating contaminated soil using ISCO would be high. The cost mainly depends on the quantity of chemical oxidant needed. The required quantity of oxidant is driven by the concentrations of COCs in soil, cleanup levels that need to be achieved, and the SOD. For the reasons described in the previous two sections, the large amount of oxidant required to effectively treat the contaminated soil make this technology cost prohibitive.

3.3.5.4 Summary

ISCO cannot be implemented for treatment of nitroaromatic-contaminated soil at TNTA and TNTC in a cost-effective manner. Therefore, this technology option will be excluded from further consideration in the FFS.

3.3.6 Windrow Composting

3.3.6.1 Effectiveness

Windrow composting is an effective treatment process to achieve RAOs for nitroaromatic compounds and PAHs in soil at TNTA and TNTC. Organic compounds are biodegraded or biotransformed into less toxic products. Composting of explosives such as TNT and 2,4-DNT in soil has been successfully demonstrated. The primary advantage of composting is that the treated soil can be placed back on site as a soil cover or amendment and does not have to be managed off site as a waste material. The main drawbacks to composting are the significant increase in the volume of the media treated and the increased time and cost required to achieve RGOs in comparison to ex situ chemical stabilization. Because lead cannot be biodegraded into a less toxic substance, a second remedial technology or waste management approach would be required in those areas with lead contamination above the LDRs.

3.3.6.2 Implementability

This process is technically and administratively implementable at TNTA and TNTC. It requires a temporary building or an overhead cover structure to keep the compost from getting too wet during rain events. The amendments required for composting should be readily available from local sources. The time period required to achieve RAOs is longer for this technology than for some of the others previously mentioned.

3.3.6.3 Cost

The cost for composting the soil would be high. The main factors contributing to the capital cost are the construction of a cover structure and the purchase of composting amendments and operating labor. Also, the contaminated media must be excavated to implement the treatment. Operating costs can be more significant for windrow composting, depending upon the remedial duration required to achieve RGOs for the COCs in soil.

3.3.6.4 Summary

Composting of contaminated soil at TNTA and TNTC is a potentially feasible process option for attaining RGOs in site soil. Therefore, the process is retained for further development as a remedial alternative in Chapter 4.0.

4.0 Development and Detailed Analysis of Remedial Alternatives

4.1 Introduction

The goal of this chapter is to introduce, assess, and communicate the relative costs and benefits of the remedial alternatives selected for careful consideration. Chapter 5.0 provides the comparison and recommendation of a preferred alternative for the sites. The evaluation criteria for this analysis are provided by USEPA in *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (USEPA, 1988). These criteria are based upon the *National Oil and Hazardous Substances Pollution Contingency Plan* (NCP), Title 40 CFR, Section 300.430 (USEPA, 1990). The results of this analysis will likely be presented in the proposed plan and record of decision, or other public information documents, following the consideration of state and federal regulatory and community input.

The RI/FS guidance (USEPA, 1988) provides nine evaluation criteria for assessing alternatives within the context of a comprehensive FS. These criteria cover regulatory, technical, cost, institutional, and community considerations. Generally, the two threshold criteria are:

- Protection of human health and the environment
- Compliance with ARARs.

The five balancing criteria are:

- Long-term effectiveness and permanence
- Short-term effectiveness
- Reduction in toxicity, mobility, and volume
- Technical and administrative implementability
- Alternative cost including capital, O&M, and present value costs.

The final two criteria, which often are evaluated subsequent to the initial publication of the FS, are:

- State acceptance
- Community acceptance.

The first seven criteria will be fully evaluated in this FFS. The final two criteria will be discussed briefly in the FFS, as some unofficial public feedback on potential remedial options has already been obtained through preliminary presentations given at the regular public meetings of the PBOW RAB. The last two criteria will be officially evaluated through working-level discussions with state and federal regulators, as well as through the solicitation of community input from more formal public outreach activities. Once all of the FFS criteria have been adequately considered and a remedial alternative is recommended, the proposed removal action will be presented to OEPA and the public in an action memorandum. The action memorandum will be presented at a RAB meeting, where comments will be solicited from the public. Once approved, the action memorandum will be the basis for executing the interim removal action for soil at TNTA and TNTC.

The following five alternatives were selected for evaluation:

- Alternative 1 – No Action
- Alternative 2 –Excavation, Windrow Composting, and On-Site or Off-Site Disposal
- Alternative 3 – Excavation, Ex Situ Stabilization, and Off-Site Disposal
- Alternative 4 – Excavation and Off-Site Disposal
- Alternative 5 –Excavation, Windrow Composting, Ex Situ Stabilization, and On-Site or Off-Site Disposal.

4.2 Alternative 1 - No Action

4.2.1 Description

A no-action alternative is required by the NCP to be carried forward as a baseline for detailed comparison. Under this alternative, no remedial action or monitoring would be conducted for contaminated soil at the site. Thus, this alternative fails to meet the RAOs for soil or sediment at TNTA and TNTC.

4.2.2 Overall Protection of Human Health and the Environment

This alternative would not protect human health and may not protect the environment (refer to Section 1.5 for interpretation of SLERA results) because no action would be taken to reduce the concentrations of COCs in soil to meet OEPA risk management criteria or to prevent current or future receptors from exposure to COCs.

4.2.3 Compliance with ARARs

The no-action alternative would not comply with the chemical-specific ARAR for total PCBs in soil. Location- and action-specific ARARs are not applicable to this alternative because no remedial action would be taken.

4.2.4 Long-Term Effectiveness

This alternative would not result in any permanent reduction of risk to human health or the environment. No periodic review would take place to evaluate future site conditions.

4.2.5 Reduction of Toxicity, Mobility, or Volume

This alternative does not employ any remedial component that would permanently or significantly reduce the toxicity, mobility, or volume of contaminants in soil.

4.2.6 Short-Term Effectiveness

There are no short-term impacts from this alternative because no remedial action is taken.

4.2.7 Implementability

There are no technical or administrative implementation issues associated with this alternative.

4.2.8 Cost

There is no cost impact associated with this alternative.

4.2.9 State Acceptance

It is highly unlikely that OEPA would accept the no-action alternative to address soil contamination at TNTA and TNTC because this alternative does not protect human health.

4.2.10 Community Acceptance

It is highly unlikely that the community would accept the no-action alternative to address soil contamination at TNTA and TNTC because this alternative does not protect human health.

4.3 Alternative 2 – Excavation, Windrow Composting, and On-Site or Off-Site Disposal

4.3.1 Description

This alternative involves the excavation of contaminated soil within proposed remediation areas, windrow composting of soil contaminated with nitroaromatic compounds and PAHs, off-site disposal of soil with concentrations of lead above RGOs in a RCRA Subtitle C treatment, storage, and disposal facility (TSDF), off-site disposal of PCB-contaminated soil (≥ 50 mg/kg total PCBs) in a TSCA-approved TSDF, and surface placement of treated compost back on site.

Windrow composting has been used in the past to treat a variety of organic contaminants, including nitroaromatic compounds and PAHs. In particular, windrow composting has been used within the past 10 years at several sites to effectively treat nitroaromatic-contaminated soil that has been impacted by the production or handling of TNT-based munitions. The technology has been implemented on a full-scale basis to treat TNT-contaminated soil at the Umatilla Depot in Hermiston, Oregon; the Naval Surface Warfare Center in Crane, Indiana; the Joliet Army Ammunition Plant in Elwood, Illinois; and the U.S. Naval Submarine Base in Bangor, Washington.

Composting can be distinguished from other types of bioremediation processes by the use of bulking agents, such as wood chips and straw, to increase the porosity of the soil or sediment. Manure, yard wastes, and wood-processing wastes are often added to increase the amount of nutrients and readily degradable organic matter. Occasionally, other easily degradable carbon sources (e.g., molasses, acetate, glucose) are added to sustain microorganisms capable of degrading hazardous constituents. Inorganic fertilizers may be added to supplement available nutrients (USEPA, 1996).

Composting utilizes solid-, liquid- and gas-phase processes. The solid phase provides physical support for biofilm growth, a source of organic and inorganic nutrients, a sink for metabolic products, and thermal insulation. The liquid phase provides a matrix for the interchange of gases, nutrients, and metabolic products. The gas phase delivers oxygen and provides a sink for gaseous metabolic products, such as carbon dioxide and ammonia. The gas phase also serves as the primary heat sink, through evaporative cooling (USEPA, 1996).

The composting process is mediated by microbial populations that are classified as either mesophiles or thermophiles. Mesophilic microbes are those with an optimum temperature range of 25 to 40 degrees Celsius (°C). Thermophiles have an optimum temperature range of 40 to

60°C. Significant degradation of TNT has been reported within both temperature regimes, although slightly higher removals have been demonstrated under thermophilic conditions (Williams et al., 1992).

Composting can biologically degrade organic contaminants via aerobic, anaerobic, or a combination of anaerobic and aerobic processes. Research on TNT degradation using composting has shown that a combined anaerobic/aerobic process is the most effective in detoxifying TNT-contaminated soil. The first step in the biological degradation of TNT involves the reduction of one of the three aromatic nitro groups to an amino group through nitroso and hydroxylamino intermediates. Figure 4-1 shows the specific case of the reduction of an aromatic nitro group during the fermentation of glucose (Daun et al., 1998).

The sequential reduction of all three nitro groups, converting TNT to 2,4,6-triaminotoluene (TAT), can only be achieved under strict anaerobic conditions (Preuss et al., 1993). Figure 4-2 depicts the transformation processes that are involved in degradation of TNT in an anaerobic/aerobic composting system (Bruns-Nagel et al., 2000). Studies have shown that, in addition to the transformation of TNT to TAT, degradation of TNT may proceed through the condensation of amino-dinitrotoluenes to azoxy-tetranitrotoluenes (Achtnich et al., 1999).

Significant mineralization of TNT via composting has not been demonstrated. This may be explained by the rareness of polynitroaromatic compounds in nature and the resistance of the highly oxidized trinitro-substituted aromatic ring to oxidative microbial attack (Rieger and Knackmuss, 1995). However, TNT degradation and transformation products can be stabilized through interaction with organic and inorganic soil components. The reduction of TNT in the presence of clay and humic substances has been shown to significantly increase the removal rate of nitroaromatics from soil. The TNT metabolites hydoxyamino-dinitrotoluenes and TAT strongly bind to clay minerals and humic substances (Daun et al., 1998).

Three different types of interactions between TNT metabolites and soil are possible: physical sorption, sequestration, and covalent binding to soil organic matter. Only if TNT and its metabolites are bound through covalent linkages are they considered to be an integral part of the humus. When bound to humic materials in this manner, they are not considered to represent a potential future threat to the environment.

Composting studies using ^{14}C ring-labeled TNT have demonstrated significant binding of TNT transformation products to the humic substances (fulvic acid, humic acid, and humin) present in compost (Achtnich et al., 1999; Drzyzga et al., 1998; Bollag et al., 2002). The studies reported that the immobilized (unextractable) fraction of the ^{14}C-TNT ranged from 82 to 84 percent. All three studies used a combination anaerobic/aerobic treatment approach.

The nature of the bonding mechanism between TNT metabolites and the humic materials in the compost has been investigated using ^{15}N-nuclear magnetic resonance spectroscopy of ^{15}N-labeled TNT (Achtnich et al., 1999; Bruns-Nagel et al., 2000; Bollag et al., 2002). These studies found significant evidence of covalently bound ^{15}N. The Bruns-Nagel study found that the major portion (58 percent) of the ^{15}N was strongly bound to the humic fraction of the soil: 23 percent as heterocyclic structures, 15 percent covalently bonded, 15 percent as amino functions, and 2 percent as nitro functions.

The recent research has demonstrated that, after incorporation of the partially or fully reduced TNT into humic materials, the pollutant is practically indistinguishable from the soil organic matter. Furthermore, it can be assumed that mineralization of the bound residue would occur at a rate similar to that of the mineralization of the natural humus. Even if some covalently bound molecules are subsequently released and become bioavailable, this process should not occur to an extent that would cause toxic effects (Bollag et al., 2002).

Critical process parameters that impact the effectiveness of a composting process include porosity of the compost material, free air space, moisture content, particle size, temperature, carbon to nitrogen ratio, and pH. Bulking agents are typically added to the contaminated soil to increase the porosity of the composted material. Adequate porosity is needed to provide a conduit for air, water, and nutrients throughout the compost as well as to afford space for the growth of microbial communities. Compost bulk density typically ranges from 0.5 to 0.7 tons per cubic yard. Free air space is the portion of the porosity occupied by gas. Free air space is necessary for the maintenance of aerobic conditions within the compost. The gas/liquid ratio within the void space has a profound impact on the efficiency of the treatment process (Ro et al., 1998).

Proper moisture content is required for nutrient transport and maintenance of the microbial communities. Constructing a compost shelter or covering the piles with a water-impermeable fabric will prevent infiltrating rainfall from creating excessive moisture conditions within the compost. Adequate moisture levels can be maintained by periodically adding water to the compost to replace losses from evaporation. The recommended moisture content for composting is between 40 and 65 percent of saturation (USACE, 2002). The moisture content of the compost should be checked 2 to 3 times per week during treatment. The water usage in windrow composting is typically 1 gallon per cubic yard of compost per day. This results in an estimated water usage rate of 4,450 gallons per day for the proposed composting operation described later in this section.

Particle size is important because it affects the surface area available for microbial activity as well as the pore space available for oxygen and nutrient transport. A particle size from 1.3 to 5 centimeters is reported in the scientific literature to be optimum for composting (Forster and Wase, 1987), and USACE specifications recommend a particle size range of 2 to 10 centimeters (USACE, 2002). Larger particles reduce the surface area for microbial growth and may cause contaminants to become occluded such that they are not accessible for degradation. Wet clays, for example, can be difficult to mix with amendments and lumping can result. Lumping limits oxygen transfer rates and contaminant availability, resulting in incomplete treatment. Excavated soil is typically screened prior to mixing with amendments to remove large objects, and a shredder or crusher may be used to reduce the size of oversize material to facilitate treatment. Excavated material is typically screened down to 2 inches. Material between 2 and 6 inches can be crushed for treatment. Material larger than 6 inches is stockpiled for disposal. TNT is sometimes found as nodules in contaminated soil that can be difficult to treat via composting. Researchers at the Idaho National Engineering and Environmental Laboratory have used acetone to dissolve chunks of TNT. The resulting acetone/TNT slurry is then added back to the compost pile. The acetone is biodegradable and provides an additional carbon source for microbial growth.

The type of temperature control employed depends on the composting process used. The compost temperature in static piles and in-vessel composting is controlled by adjusting airflow through the compost. Compost temperature during windrow composting is controlled by the frequency of windrow turning and by minimizing the impact of climatic effects through sheltering or covering the compost. USACE specifications recommend that the compost temperature be maintained between 54 and 60°C for optimum treatment efficiency. Microbial activity is substantially reduced at temperatures above 71°C. Temperature control is particularly important in locations such as northern Ohio, where the impact of winter temperatures on the effectiveness of composting operations must be considered. Low ambient temperatures will impact the process if the amendments and/or soil become frozen prior to blending. The initial self-heating phase may be longer or may not occur if one or more of the components is at or near freezing. This problem can be overcome by staging amendments in large piles during cold weather or by using engineering controls such as a small heated amendment staging area to heat a 1 to 2 day supply of amendments prior to mixing. The temperature of the windrows should be monitored on a daily basis.

Compost microorganisms require adequate levels of carbon sources and other nutrients, including nitrogen, phosphorus, sulfur, and other trace minerals. Among these, carbon and nitrogen are usually the limiting substrates. Optimal carbon to nitrogen (C/N) ratios for different composting materials are reported to range from 20:1 to 40:1 (USACE, 2002), although a lower C/N ratio was effectively used during the composting project at Naval Surface Warfare Center in Crane, Indiana. If the C/N ratio is too low, nitrogen will be lost as ammonia, which may reach toxic levels and raise the compost pH.

The optimum pH for composting has been reported in the scientific literature to range from 6.0 to 8.5 (Fitzpatrick, 1993). At higher pH, nitrogen will be lost as ammonia and essential elements such as calcium and magnesium may not be available to microorganisms due to precipitation as insoluble metal hydroxides or carbonates. At lower pH, metals such as aluminum, copper, and zinc may be leached from minerals and may stop the composting process (Ro et al., 1998). USACE specifications recommend that the compost pH be maintained in the range of 5.5 to 9.0, and preferably within 6.5 to 8.5 (USACE, 2002).

Composting has typically been implemented using one of the three following processes: in-vessel composting, static pile composting, and windrow composting. In-vessel composting involves the placement of compost material in a large containment vessel equipped with a temperature-controlled aeration system. In-vessel systems may be equipped with a mechanism that periodically mixes the compost. In static pile composting, the material to be composted is formed into a pile and aerated by blowing air into the pile through perforated pipes. Static piles are not mechanically mixed, and the aeration system is used to control temperature. In windrow composting, the material to be composted is formed into long parallel rows. The rows are watered occasionally and are periodically turned to promote aeration and control temperature using a specialized piece of equipment called a windrow turner. Of the three types of composting processes, windrow composting has proven to be the most cost effective for soil remediation, due to its lower capital and operating costs. Therefore, windrow composting was selected as the representative composting technology for development in this FFS.

The windrow composting facility will be located within the area of contamination at either TNTA or TNTC. The selection of a site will be made during the remedial design (RD) phase of the project. The windrow composting treatment area will be constructed substantially in accordance with Section 02741A of the USACE specification, with a few modifications. The optimum size of the treatment facility is influenced by the trade-offs between fixed and variable project costs. Although assumptions concerning the size of the composting facility are used in this FFS to enable remediation costs to be estimated, the actual size of the treatment facility will be optimized during the RD. For this FFS, a preliminary optimization analysis was performed to assist in the preparation of a design basis. The optimization analysis evaluated the effect that the major cost elements (e.g., building size, equipment size, and operating labor) had on the overall cost of the project. The results of this analysis indicated that it is more cost effective to utilize large windrows and more than one treatment building to reduce the project duration, thereby decreasing costs from operating labor.

The preliminary design basis proposes that the treatment area will consist of two 72-foot wide by 400-foot long temporary fabric structures in which the windrows will be formed. The temporary structures will have a compacted earthen base. The windrow dimensions will be 7 feet high by 20 feet wide by 330 feet long. Each treatment building will house 2 parallel windrows, with aisles approximately 10 feet wide between and around the windrows. A 35-foot long open area beyond the ends of the windrows will allow the windrow turner to turn around inside the treatment building. A large door will be constructed on each end of the building to allow the windrow turner to move between buildings.

Stockpiles of contaminated material, oversize material, treated compost, and amendment storage will be located outside of the fabric structures. Liners and covers will be provided for stockpiled materials and amendments as required by the Section 02741A of the USACE specifications. The treatment area, material stockpiles, and amendment storage areas will be surrounded by an earthen berm designed to prevent run-on from a 25-year flood and run-off from a design storm equal to a 25-year, 24-hour rainfall event (4 inches of storm water). The total estimated volume of contaminated soil and sediment from TNTA and TNTC is 25,533 cubic yards (consolidated basis). Once this soil is excavated, the total volume of unconsolidated material is estimated to be 33,193 cubic yards (30 percent swell). It is assumed that the bermed area will be large enough to accommodate the volume of contaminated soil from either TNTA or TNTC, but not both at the same time.

Contact water will be transferred from collection sumps within the containment area to a lined retention pond. The contact water retention pond will be designed to contain 130 percent of the combined volume of the design storm event plus the maximum reuse water required. Water in the retention pond will be pumped to a storage tank to be reused for moisture control in the composting process to the extent possible. Excess water above that required for the composting process will be treated as necessary to comply with discharge criteria. The actual discharge terminus (publicly owned treatment works or direct discharge to surface water) will be determined during the RD.

Due to some uncertainty in the extent of contaminated soil at the sites within TNTA and TNTC, it is proposed that a pre-excavation soil investigation be conducted to more definitively target remediation areas and provide a more complete characterization of all COC (e.g., lead, PAHs, and PCBs). In addition to better defining the total volume of soil to be treated, the additional sampling and analysis will also better delineate areas where lead concentrations are sufficiently high that the soil should be segregated for off-site treatment and disposal. After this work is completed, soil within the remediation areas will be excavated and screened to remove oversize material and reduce particle size to increase the efficiency of the composting process. The excavated soil will be trucked to the composting treatment area for screening. The screened soil will be stockpiled at the compost facility for treatment or disposal. Soil adhering to the oversize material will be removed so that the oversize material can be returned to the excavation. Any oversize material not appropriate for use as backfill will be disposed off site at an approved disposal facility.

Amendments will be brought to the facility as needed so that large amounts of amendments are not required to be stored on site. This minimizes the cost of amendment storage as well as odor problems associated with manure, as the odor increases with storage duration. The amendments will be premixed in a tub grinder and discharged along the windrow footprints in the treatment building. Contaminated soil will be added to the premixed amendments, and the compost materials will be mixed with the windrow turner.

It is assumed that the compost will consist of 25 percent by volume (74.7 percent by weight) contaminated soil, 72 percent by volume (19.6 percent by weight) straw, and 3 percent by volume (5.7 percent by weight) chicken manure. The composition of the compost is based on the treatment mix used at the Naval Surface Warfare Center in Crane, Indiana. The actual compost mix used at PBOW will be based on the cost of amendments readily available in the surrounding area and the results of a composting optimization study conducted on contaminated soil from TNTA and TNTC. Based on the compost recipe stated above, the bulk density of the blended compost mixture would be approximately 760 pounds per cubic yard (lb/cy). Therefore, each linear foot of windrow will contain 0.84 cy (1,854 lb) of soil. The total volume of soil treated in a windrow would be 278 cy, with a total capacity of 1,112 cy of soil per treatment cycle in both buildings. A treatment cycle for each batch is assumed to require 3 weeks, 2 weeks for treatment and 1 week for curing and analytical testing. If additional time for post-treatment curing is required, the windrow will be moved outside the treatment building and covered with plastic sheeting. The treatment cycles for windrows will be staggered so that the windrows do not complete the treatment cycle at the same time.

The compost will be turned periodically with the windrow turner to mechanically aerate the material. After the compost is turned, microorganisms within the pile aerobically degrade organic compounds until the available oxygen within the pile is utilized. Beyond this point, further contaminant degradation is achieved through an anaerobic process. The periodic turning of the compost pile permits the composting process to alternate between aerobic and anaerobic treatment phases. This is the most effective approach to the biological degradation of nitroaromatic explosives.

Precompliance testing of the compost will consist of sampling the compost immediately after formation and at the completion of treatment. Immunoassay or colorimetric analyses may be utilized for the detection of some nitroaromatic contaminants during precompliance testing if this proves to be more cost effective than fixed-based laboratory analyses. For the purpose of estimating cost, it is assumed that one precompliance sample (pre- and post-treatment) will be collected for analysis for every 50 cubic yards of compost. The precompliance sample that is submitted for analysis from each sampling station will actually be a composite of several samples that traverse the width and depth of the windrow.

If the precompliance results indicate that cleanup levels have been achieved, compliance samples would then be collected to confirm the results of the definitive analyses used for precompliance testing. For cost estimating purposes in this FFS, it assumed that one compliance sample would be collected for every 150 cubic yards of treated compost. The compliance sample would be a composite of several samples collected within the sampling station that traverse the width and depth of the windrow. The actual sampling and analytical strategy employed during remediation would be subject to negotiation between the OEPA and the USACE.

The soil data from TNTA and TNTC indicate that lead and PCB concentrations in soil within some areas may exceed levels that would be acceptable for return to the site after composting. Although composting will not effectively treat these contaminants, the concentrations of these chemicals would nevertheless be reduced in the final treated compost. The blending that occurs during the addition and mixing of amendments and the periodic turning of the windrows would serve to level out to some degree the concentrations of these chemicals throughout the treated compost. At this time, it is difficult to accurately estimate the volume of lead- and PCB-contaminated soil that may need to be managed using an alternate remedial approach because the amount of analytical data available for lead and PCBs is not as extensive as that for nitroaromatic compounds. The data currently available indicates that the volumes of soil with elevated lead and PCB concentrations are relatively small compared to the total volume of soil requiring remediation.

For cost estimating purposes in this FS, it is assumed that soil with lead concentrations greater than 1.33 times the LDR (1.33 x 150 = 200 mg/kg) would be segregated from the remaining excavated soil prior to composting. A lead concentration of 150 mg/kg is used because the LDRs limit the concentration of metals in contaminated soil to 10 times the UTS (40 CFR 268.49). The UTS for lead is 0.75 mg/L by TCLP (40 CFR 268.48). Using the "20 times rule" as a conservative estimate of the UTS on a total mass basis, the maximum allowable lead concentration in soil under the LDRs would be 150 mg/kg (0.75 ppm x 20 x 10). A concentration limit with a factor of 1.33 times the LDR is used because the contaminated soil is estimated to constitute approximately 75 percent by weight of the compost mixture once amendments are added to the soil.

The segregated lead-contaminated soil would be disposed off site as a hazardous waste at a Subtitle C TSDF. Likewise, soil contaminated with PCBs at a concentration above 50 mg/kg would be segregated from other excavated soil prior to composting. The PCB-contaminated soil would be disposed off site as a PCB remediation waste at a Subtitle C TSDF. For cost estimating purposes, it is assumed that hazardous waste or PCB remediation waste will be disposed of at an EQ Environmental, Inc. TSDF in Belleville, Michigan.

Treated compost that meets the cleanup goals would be trucked back to the area of contamination and spread on the ground surface to assist in the revegetation of the excavated areas after they are backfilled with clean soil. The compost would not be suitable for use as structural backfill because it lacks sufficient compressive strength. Because the compost cannot be used as backfill and the volume of the compost is greater than the volume of the contaminated soil originally excavated from the contaminated areas, locations within PBOW outside the areas of contamination may need to be identified for the surface placement of the excess treated compost (in excess of that required to cover excavated areas). Remediation areas within TNT Manufacturing Area B and the Red Water Pond Areas might be suitable as additional surface disposal locations for treated compost.

4.3.2 Overall Protection of Human Health and the Environment

Alternative 2 will protect human health by excavating contaminated soil with concentrations of COC above the RGOs. Ecological receptors may also benefit, in that removal of the most highly contaminated soil will lower the EHQs calculated for various receptors in the ecological risk assessment. Although the soil removal will mitigate the migration of soil contaminants to groundwater, it is unclear at the present time if the current soil RGOs will provide adequate protection for groundwater. This evaluation cannot be performed until the future area-specific and downgradient groundwater investigations are completed. As a result, additional remedial actions for soil may be required in the future.

The alternative provides adequate protection against the potential hazards of contaminants in excavated soil through the combination of treatment and waste management technologies. Once the contaminated soil is excavated, the soil will be biologically treated via windrow composting to reduce the concentrations of nitroaromatic compounds and PAHs to levels acceptable for placement back on site (RGOs). Any soil that cannot be treated to RGOs will be disposed of off site at an OEPA-approved TSDF.

4.3.3 Compliance with ARARs

The alternative will comply with the chemical-specific ARAR for total PCBs in soil. The location- and action-specific ARARs were considered for Alternative 2 are presented in Appendix A. None of the location-specific ARARs presented in Table A-1 were identified as applicable for this remedial alternative. The alternative will comply with all action-specific ARARs, in particular the regulations that deal with the identification, storage, and disposal of hazardous waste.

4.3.4 Long-Term Effectiveness

The long-term effectiveness of Alternative 2 is achieved through the removal and treatment of soil contaminated with COC at concentrations above the RGOs. As previously discussed, the alternative will be effective in protecting potential human receptors from direct exposure to COC in soil. The alternative may also benefit ecological receptors by significantly reducing the EHQs associated with soil contamination at the sites. The removal and treatment of the most highly contaminated soil will also reduce the mass transport of soil contaminants to groundwater, although the ultimate effectiveness of the alternative in protecting groundwater cannot be adequately evaluated at this time. This issue will be addressed after additional data are collected during the future area-specific and downgradient groundwater investigations.

The alternative will not require the maintenance of any long-term controls at the site to manage residual risk from direct exposure to soil.

4.3.5 Reduction of Toxicity, Mobility, or Volume

Alternative 2 would satisfy the statutory preference for selecting remedial actions that employ treatment technologies that permanently and significantly reduce the toxicity, mobility, or volume of hazardous substances as their principal element. The excavation and treatment of contaminated soils by windrow composting would reduce the toxicity and mobility of nitroaromatic compounds and PAHs in soil through a combination of biological degradation and immobilization via covalent binding with humic substances in the compost.

Under this alternative, 24,797 cubic yards of nitroaromatic-contaminated soil (consolidated basis) would be treated and placed back on site at TNTA and TNTC; 617 cubic yards of lead-contaminated soil (consolidated basis) would be disposed of in a Subtitle C TSDF (treatment may be required at the TSDF to comply with land disposal restrictions); 119 cubic yards of PCB-contaminated soil (consolidated basis) would be disposed of off site in a TSCA-approved TSDF. Although composting would reduce the concentrations of PCBs in soil, the treatment efficiencies are not high enough for the process to achieve RGOs for soil classified as a PCB remediation waste (>50 mg/kg total PCBs). Tables 2-8 and 2-9 provide a detailed breakdown of excavated soil volumes on a site-by-site basis.

4.3.6 Short-Term Effectiveness

The implementation of Alternative 2 does not present any significant health threats to the community. The excavation and treatment of contaminated soils would be performed within the confines of PBOW at a sufficient distance from the property boundaries that the nearby community should not be affected. The composting process would be managed to minimize the generation of dust or nuisance odors during remediation. Proper decontamination and waste transportation practices will be followed to prevent the spread of contamination when equipment or waste materials leave the site.

Alternative 2 does not present site workers with any unusual health or safety concerns for a remediation project. A hazard evaluation will be performed prior to the commencement of the removal action and a health and safety plan will be followed during site activities to ensure that risks to workers are minimized. Remediation workers would be supplied with any protective gear required to conduct operations in a safe manner. The temporary enclosure under which composting operations are performed will be designed to ensure that adequate airflow exists to provide a safe environment for remediation workers.

Environmental impacts during remediation will be mitigated primarily through measures designed to ensure that contamination is not spread during remedial activities. These measures include such as dust controls during excavation and treatment, decontamination procedures for equipment and personnel, and storm water run-off and run-on controls. Storm water controls would include actions such as: erection of an enclosure over the compost treatment area, covering piles of contaminated soil and amendments to prevent run-off, berming the treatment and staging areas to control run-on and run-off, constructing a contact water basin to collect and reuse storm water, and providing wastewater treatment equipment to treat storm water that cannot be reused in the treatment process (if required to comply with discharge criteria).

It is estimated that 41 to 47 months would be required to complete remedial activities under Alternative 2 at both TNTA and TNTC in one field event, from the initiation of work plans to backfilling excavated areas and disposal of treatment residuals. If the two sites were remediated in two separate field events, the estimated remedial duration would be 30 to 36 months for TNTA and 22 to 28 months for TNTC. The combined time period for both sites is less than the sum of the individual time intervals for each site because the combined time period accounts for efficiencies in executing remedial tasks concurrently. Tables 4-1, 4-2, and 4-9 provide additional detail on the individual work elements involved in the execution of this alternative.

4.3.7 Implementability

A composting optimization study would be completed prior to the initiation of site activities. This study would evaluate the cost and availability of various amendments that could be obtained locally for use in the treatment process and, based on this evaluation, determine the most cost-effective compost mixture to treat the soil.

Windrow composting is a reliable technology, as it has been implemented at a number of remediation sites to treat soil contaminated with nitroaromatic explosives, PAHs, and other chemicals, such as pesticides. Composting technology has also been widely used in the treatment of agricultural wastes and the management of treatment residuals from municipal wastewater treatment plants. As a result, a number of contractors are experienced in implementing the technology, and equipment is readily available. Composting amendments should be readily available in the surrounding agricultural areas.

Treatment equipment may be either leased or purchased, depending upon the relative economics of each option. It is recommended that composting equipment be purchased, as it will be required on site for a period of time that would make it economically advantageous to purchase rather than lease. The composting equipment could also be used on other projects that involve treatment of soil contaminated with nitroaromatic explosives, PAHs, or pesticides, thus spreading these costs across multiple projects. Additionally, it is recommended that the USACE purchase (rather than lease) a fabric enclosure to cover the windrows during treatment. This type of structure could be disassembled and reused at other sites.

Compliance sampling of the sidewall and bottom areas of the excavation and analysis of the soil samples for COC can be used to monitor the effectiveness of excavation in removing soil contaminated above RGOs.

The effectiveness of the composting process is monitored by periodic sampling and analysis of the compost during and after the treatment process. Immunoassay or colorimetric analytical methods may be utilized during precompliance testing to lower analytical costs, although field test kits may not be available for all the nitroaromatic COCs. Standard fixed-base laboratory analyses would be used for final compliance sampling after treatment is complete for each batch of compost. The treatment process could be extended for any composted material that fails compliance testing. Alternatively, the compost could be disposed of off site at an approved TSDF if the compliance results of the treated compost are significantly elevated above the RGOs such that further biological treatment would not be cost-effective.

The alternative does nothing to preclude additional remedial action for soil if it is later determined that this is required to protect groundwater.

Alternative 2 does not present any unusual regulatory requirements that would compromise the administrative feasibility of the remedial approach. OEPA would need to approve the disposal facility used for any waste materials managed off site.

4.3.8 Cost

The detailed cost evaluations for the implementation of Alternative 2 for TNTA and TNTC are presented in Tables 4-1 and 4-2. The estimated capital cost for Alternative 2 is $7.7 million for TNTA and $5.4 million for TNTC. These costs are calculated assuming that the temporary treatment structure and the major items of capital equipment are purchased rather than leased. This is the more economical approach, given the duration of time estimated to complete remediation at each site.

The total capital cost to implement Alternative 2 at both TNTA and TNTC during one remediation event is $11.0 million. A detailed cost evaluation for the two sites combined is presented in Table 4-9. This combined cost is less than the sum of the individual costs for TNTA and TNTC because it accounts for the economies of scale in completing both projects at one time. In order for the cost estimate for each area to be complete and independent, the estimate must account for the purchase of all structures and equipment. Therefore, the sum of the individual alternatives for TNTA and TNTC would double these costs.

Appendix B provides supporting calculations used to estimate remedial costs. A contingency of 30 percent has been added to the cost estimates for both sites to account for uncertainty in the estimated volume of soil requiring remediation and to provide an allowance for cost elements that are not identifiable at the present time. Due to the relatively short time frame over which the remedial alternative would be completed, all costs associated with its implementation are classified as capital costs. Accordingly, there are no O&M costs for this alternative, and the present value cost is equivalent to the capital cost.

4.3.9 State Acceptance

This criterion will be evaluated in the action memorandum for the removal action, after a public meeting has been conducted and the public comment period has concluded.

4.3.10 Community Acceptance

The RAB for PBOW holds periodic meetings at which the USACE and NASA provide updates on the progress of environmental restoration and solicit questions and comments from the public. During several of these meetings, potential remedial options for cleanup of TNT-contaminated soil at TNTA, TNTB, and TNTC at PBOW have been presented and discussed. It should be noted that some members of the RAB have expressed a clear preference for windrow composting over chemical stabilization and/or direct disposal for the management of nitroaromatic contaminants in soil.

This criterion will be evaluated in more detail in the action memorandum for the removal action, after a public meeting has been conducted and the public comment period has concluded.

4.4 Alternative 3 – Excavation, Ex Situ Stabilization, and Off-Site Disposal

4.4.1 Description

Alternative 3 combines excavation, ex situ stabilization, and off-site disposal in order to achieve the RAOs for soil at TNTA and TNTC. The proposed approach is to excavate all the areas in which the concentrations of COCs in soil exceed the RGOs defined in Chapter 2.0. The total estimated volume of contaminated soil and sediment from TNTA and TNTC is 25,533 cubic yards (consolidated basis). Once this soil is excavated, the total volume of unconsolidated material is estimated to be 33,193 cubic yards (30 percent swell).

Due to some uncertainty in the extent of contaminated soil at the sites within TNTA and TNTC, it is proposed that a pre-excavation soil investigation be conducted to more definitively target remediation areas and provide a more complete characterization of all COC (e.g., lead, PAHs, and PCBs). In addition to better defining the total volume of soil to be treated, the additional sampling and analysis will also better delineate areas where lead concentrations are sufficiently high that the soil should be segregated for off-site treatment and disposal. After this work is completed, soil within the remediation areas will be excavated and screened to remove oversize material and reduce particle size to increase the efficiency of the stabilization process. The excavated soil will be trucked to the treatment area for screening. The screened soil will be stockpiled at the treatment facility for chemical stabilization or disposal. Soil adhering to the oversize material will be removed so that the oversize material can be returned to the excavation. Any oversize material not appropriate for use as backfill will be disposed off site at an approved disposal facility.

As described earlier, the number of COCs exceeding RGOs and their concentration ranges vary from area to area within TNTA and TNTC. Therefore, following excavation of the contaminated soil, representative soil samples from each area would be analyzed using the TCLP test. Based on existing soil data from TNTA and TNTC, the unconsolidated volume of excavated soil that may be classified as a characteristic hazardous waste due to 2,4-DNT and lead concentrations is estimated at 6,180 cubic yards (consolidated basis). This volume is 25 percent of the total excavated soil. Another 119 cubic yards of consolidated soil from Building 139 at TNTA may be classified as a PCB remediation waste because PCBs have been detected at concentrations greater than 50 mg/kg.

Section 2.5.1 summarizes the applicable regulations used to determine if the excavated soil is a hazardous waste. Soil that passes the TCLP tests may be disposed in a nonhazardous waste landfill. Under this alternative, any soil classified as hazardous waste would be stabilized on site to achieve nonhazardous waste classification prior to land disposal in a Subtitle D industrial waste landfill. It is estimated that, of the 25,533 cubic yards of soil and sediment that would be excavated under this approach, 19,234 cubic yards (consolidated basis) would be shipped untreated for disposal at a nonhazardous waste landfill, while the remaining 6,180 cubic yards would require stabilization prior to disposal at a nonhazardous soil waste landfill. The 119 cubic yards of PCB remediation waste would be shipped to a hazardous waste landfill for treatment and disposal. For cost estimating purposes, it is assumed that all nonhazardous soil will be disposed of at the Erie County Landfill. It is assumed that hazardous waste or PCB remediation waste will be disposed of at an EQ Environmental, Inc. TSDF in Belleville, Michigan.

Chemical stabilization would be used to treat the excavated soil classified as a hazardous waste. A stabilization treatability/optimization study would be completed prior to full-scale implementation to identify the most cost-effective stabilization agents for the COCs in soil. The treatability study would also specify the stabilization mix recipe (mass ratio of reagents to soil) for the range of contaminant concentrations that are anticipated, based on the soil data. For cost estimating purposes in this FFS, it is assumed that activated carbon and portland cement would be used to stabilize the contaminated soil. Activated carbon is used to bind the nitroaromatic contaminants that could otherwise be difficult to stabilize due to their water solubility. The assumed mass ratios of carbon to soil and cement to soil in the stabilization mix are 0.02 (2 lbs carbon per 100 lbs soil) and 0.08 (8 lbs cement per 100 lbs soil), respectively. These ratios are considered to be conservative, and the actual amount of activated carbon and cement required could be less.

During full-scale remediation, the stabilization reagents would be mixed with the soil ex situ to stabilize the chemical contaminants, thereby decreasing the mobility of the COCs in the stabilized waste matrix. The stabilizing agents are mixed with the excavated soil in a 10-cubic-yard trailer-mounted batch mixing system. This size system is typically used for small to moderate volumes of contaminated soil. Larger projects would utilize a pug mill operating in a continuous mixing mode. A representative sample of the stabilized soil would be taken for every 150 cubic yards of soil treated. The samples would be tested for hazardous characteristics using the TCLP test. If the soil tests nonhazardous and complies with the LDR requirements, it would be disposed in a nonhazardous waste landfill. If the soil tests hazardous or does not comply with LDR requirements, it would be reprocessed until it complies with regulatory requirements for nonhazardous disposal.

It is important to understand that stabilization does not reduce the concentrations or transform the COCs in the soil; it only alters the physical availability of contaminants. Therefore, it is not recommended that the stabilized soil be used as fill material for a site to be released for unrestricted use. Instead, the stabilized soil would be disposed of in a nonhazardous waste landfill.

4.4.2 Overall Protection of Human Health and the Environment

Alternative 3 would protect human health by excavating contaminated soil with concentrations of COCs above the RGOs. Ecological receptors may also benefit, in that removal of the most contaminated soil would result in lowering EHQs calculated for various receptors in the SLERA. Although the soil removal would mitigate the migration of soil contaminants to groundwater, it is unclear at the present time whether the current soil RGOs will provide adequate protection for groundwater. This evaluation cannot be performed until the future area-specific and downgradient groundwater investigations are completed. As a result, additional remedial actions for soil may be required in the future.

The alternative provides adequate protection against the potential hazards of contaminants in excavated soil through the combination of treatment and waste management technologies. Once the contaminated soil is excavated, soil classified as hazardous based on TCLP testing would be chemically stabilized to render it nonhazardous. The stabilized soil and nonhazardous untreated soil would then be disposed of in a Subtitle D landfill approved by OEPA to accept industrial waste. Contaminated soil classified as a PCB remediation waste would be disposed of at a TSCA-approved TSDF.

4.4.3 Compliance with ARARs

The alternative would comply with the chemical-specific ARAR for total PCBs in soil. The location- and action-specific ARARs that were considered for Alternative 3 are presented in Appendix A. None of the location-specific ARARs (Table A-1) were identified as applicable for this remedial alternative. The remedial alternative would comply with all the action-specific ARARs (Table A-2), in particular the regulations that deal with the identification, storage, and disposal of hazardous waste.

4.4.4 Long-Term Effectiveness

The long-term effectiveness of Alternative 3 is achieved through the removal and treatment of soil contaminated with COCs at concentrations above the RGOs. As previously discussed, the alternative would be effective in protecting potential receptors from direct exposure to COCs in soil. The removal and treatment of the most highly contaminated soil would also reduce the mass transport of soil contaminants to groundwater, although the ultimate effectiveness of the alternative in protecting groundwater cannot be adequately evaluated at this time. This issue will be addressed after additional data are collected during the future area-specific and downgradient groundwater investigations. Soil that is highly contaminated with nitroaromatic compounds may be difficult to stabilize effectively. A portion of the most contaminated soil might require treatment offsite using a different treatment technology (i.e., incineration).

The alternative will not require the maintenance of any long-term controls at the site to manage residual risk from direct exposure to soil.

4.4.5 Reduction of Toxicity, Mobility, or Volume

Alternative 3 would not comply with the statutory preference for selecting remedial actions that employ treatment technologies that permanently and significantly reduce the toxicity, mobility, or volume of hazardous substances as their principal element. The treatment of contaminated soils by chemical stabilization would reduce the mobility of nitroaromatic compounds and lead in soil. However, it should be noted that most of the contaminated soil (77 percent) would not be treated prior to disposal.

Under this alternative, 6,180 cubic yards of stabilized soil would be disposed of in a Subtitle D landfill; 19,234 cubic yards of nonhazardous soil would be disposed of, untreated, at a Subtitle D landfill; 119 cubic yards of PCB-contaminated soil would be disposed of off site in a TSCA-approved TSDF.

4.4.6 Short-Term Effectiveness

The implementation of Alternative 3 would not present any significant health threats to the community. The excavation and treatment of contaminated soils would be performed within the confines of PBOW at a sufficient distance from the property boundaries that the nearby community should not be affected. The stabilization process would be managed to minimize the generation of dust and volatile emissions during remediation. Proper decontamination and waste transportation practices will be followed to prevent the spread of contamination when equipment or waste materials leave the site.

Alternative 3 does not present site workers with any unusual health or safety concerns for a remediation project. A hazard evaluation will be performed prior to the commencement of the removal action and a health and safety plan will be followed during site activities to ensure that risks to workers are minimized. Remediation workers would be supplied with any protective gear required to conduct operations in a safe manner.

Environmental impacts during remediation will be mitigated primarily through measures designed to ensure that contamination is not spread during remedial activities. These measures include dust controls during excavation and treatment, decontamination procedures for equipment and personnel, and storm water run-off and run-on controls. Storm water controls would include actions such as covering piles of contaminated soil to prevent run-off, berming the treatment and staging areas to control run-on and run-off, construction of a contact water basin to collect and reuse storm water, and providing wastewater treatment equipment to treat storm water that cannot be reused in the treatment process, if required to comply with discharge criteria.

It is estimated that 20 to 26 months would be required to complete remedial activities under Alternative 3 in one field event, from the initiation of work plans to backfilling excavated areas and disposal of treatment residuals. If the two sites were remediated in two separate field events, the estimated remedial duration would be 16 to 22 months for TNTA and 13 to 19 months for

TNTC. The combined time period for both sites is less than the sum of the individual time intervals for each site because the combined time period accounts for efficiencies in executing remedial tasks concurrently. Tables 4-3, 4-4, and 4-10 provide additional detail on the individual work elements involved in the execution of this alternative.

4.4.7 Implementability

A stabilization treatability/optimization study is recommended prior to full-scale implementation to determine the appropriate ratio of stabilization chemicals to soil over the range of contaminant concentrations anticipated.

Chemical stabilization has been used at numerous sites to immobilize contaminants in soil both as an in situ and ex situ technology. As a result, a number of contractors are experienced in implementing this technology, and equipment and materials are readily available.

Compliance sampling of the sidewall and bottom areas of the excavation and analysis of the soil samples for COCs can be used to monitor the effectiveness of excavation in removing soil contaminated above RGOs.

The stabilization process is monitored after treatment is complete by TCLP testing to demonstrate that the leachable concentrations of contaminants in samples of the stabilized matrix are below the maximum levels permissible in the land disposal restrictions. The compressive strength of the stabilized material is also typically tested to ensure it is suitable as structural backfill. If the stabilized soil does not pass the TCLP test, the soil could be reprocessed.

The alternative does nothing to preclude additional remedial action for soil if it is later determined that this is required to protect groundwater.

Alternative 3 does not present any unusual regulatory requirements that would compromise the administrative feasibility of the remedial approach. OEPA would have to approve the disposal facility used for any waste materials managed off site.

4.4.8 Cost

The detailed cost evaluations for the implementation of Alternative 3 for TNTA and TNTC are presented in Tables 4-3 and 4-4. The estimated capital cost for Alternative 3 is $4.7 million for TNTA and $3.1 million for TNTC.

The total capital cost to implement Alternative 3 at both TNTA and TNTC during one remediation event is $7.1 million. A detailed cost evaluation for the two sites combined is presented in Table 4-10. This combined cost is less than the sum of the individual costs for TNTA and TNTC because it accounts for the economies of scale in completing both projects at one time.

Appendix B provides supporting calculations used to estimate remedial costs. A contingency of 30 percent has been added to the cost estimates for both sites to account for uncertainty in the estimated volume of soil requiring remediation and to provide an allowance for cost elements that are not identifiable at the present time. Due to the relatively short time frame over which the remedial alternative would be completed, all costs associated with its implementation are classified as capital costs. Accordingly, there are no O&M costs for this alternative, and the present value cost is equivalent to the capital cost.

4.4.9 State Acceptance

This criterion will be evaluated in the action memorandum for the removal action, after a public meeting has been conducted and the public comment period has concluded.

4.4.10 Community Acceptance

The RAB for PBOW holds periodic meetings at which the USACE and NASA provide updates on the progress of environmental restoration and solicit questions and comments from the public. During several of these meetings, potential remedial options for cleanup of TNT-contaminated soil at TNTA, TNTB, and TNTC at PBOW have been presented and discussed. It should be noted that some members of the RAB have expressed a clear preference for windrow composting over chemical stabilization for the treatment of nitroaromatic contaminants in soil. RAB members have also expressed a concern about remedial alternatives that involved a significant degree of off-site management of waste materials, particularly at local landfills.

This criterion will be evaluated in more detail in the action memorandum for the removal action, after a public meeting has been conducted and the public comment period has concluded.

4.5 Alternative 4 – Excavation and Off-Site Treatment/Disposal

4.5.1 Description

Alternative 4 combines excavation and off-site treatment and disposal in order to achieve the RAOs for soil at TNTA and TNTC. No on-site treatment will be performed under Alternative 4. The proposed approach is to excavate all the areas in which the concentrations of the COCs in soil exceed the RGOs defined in Chapter 2.0. The total estimated volume of contaminated soil and sediment from TNTA and TNTC is 25,533 cubic yards. Once this soil is excavated, the total volume of unconsolidated material is estimated to be 33,193 cubic yards (30 percent swell).

Due to some uncertainty in the extent of contaminated soil at the sites within TNTA and TNTC, it is proposed that a pre-excavation soil investigation be conducted to more definitively target remediation areas and provide a more complete characterization of all COC (e.g., lead, PAHs, and PCBs). In addition to better defining the total volume of soil to be treated, the additional sampling and analysis will also better delineate areas where lead concentrations are sufficiently high that the soil should be segregated for off-site metals treatment. After this work is completed, soil within the remediation areas will be excavated and screened to remove oversize material. The excavated soil will be trucked to the staging area for screening. The screened soil will be stockpiled at the staging area for subsequent off-site disposal. Soil adhering to the oversize material will be removed so that the oversize material can be returned to the excavation. Any oversize material not appropriate for use as backfill will be disposed off site along with the rest of the contaminated soil.

Following excavation of the contaminated soil, representative soil samples from each area would be analyzed using the TCLP test. Based on existing soil data from TNTA and TNTC, the unconsolidated volume of excavated soil that may be classified as a characteristic hazardous waste due to 2,4-DNT and lead concentrations is estimated at 6,180 cubic yards. Another 119 cubic yards of unconsolidated soil from Building 139 at TNTA may be classified as a PCB remediation waste because PCBs have been detected at concentrations greater than 50 mg/kg. The combined volume of RCRA hazardous and PCB remediation waste is estimated to be 25 percent of the total excavated soil.

Section 2.5.1 summarizes the applicable regulations used to determine if the excavated soil is a hazardous waste. Soil that passes the TCLP tests can be disposed in a nonhazardous landfill. Therefore, it is estimated that, of the 25,533 cubic yards of soil and sediment that would be excavated under this approach, 19,234 cubic yards could be shipped for disposal at a Subtitle D industrial (nonhazardous) waste landfill. The remaining 6,180 cubic yards would be manifested and shipped for disposal at an off-site Subtitle C TSDF. The TSDF would treat any waste material that does not comply with the LDR treatment standards prior to disposal. For cost estimating purposes, it is assumed that all nonhazardous waste will be disposed of at the Erie County Landfill. It is assumed that hazardous waste or PCB remediation waste will be disposed of at an EQ Environmental, Inc. TSDF in Belleville, Michigan.

4.5.2 Overall Protection of Human Health and the Environment

Alternative 3 would protect human health by excavating contaminated soil with concentrations of COCs above the RGOs. Ecological receptors may also benefit, in that removal of the most contaminated soil will result in lowering the EHQs calculated for various receptors in the ecological risk assessment. Although the soil removal would mitigate the migration of soil contaminants to groundwater, it is unclear at the present time whether the current soil RGOs will provide adequate protection for groundwater. This evaluation cannot be performed until the future area-specific and downgradient groundwater investigations are completed. As a result, additional remedial actions for soil may be required in the future.

The alternative provides adequate protection against the potential hazards of contaminants in excavated soil by disposing of the contaminated soil in a disposal facility designed, constructed, and maintained to permanently manage such waste materials. Once the contaminated soil is excavated, soil classified as hazardous based on TCLP testing will be disposed of in a RCRA Subtitle C TSDF. Nonhazardous soil would be disposed of in a Subtitle D landfill approved by OEPA to accept industrial waste. Contaminated soil classified as a PCB remediation waste would be disposed of at a TSCA-approved TSDF.

4.5.3 Compliance with ARARs

This alternative would comply with the chemical-specific ARAR for total PCBs in soil. The location- and action-specific ARARs that were considered for Alternative 4 are presented in Appendix A. None of the location-specific ARARs (Table A-1) were identified as applicable for this alternative. The remedial alternative would comply with all the action-specific ARARs (Table A-2), in particular the regulations that deal with the identification, storage, and disposal of hazardous waste.

4.5.4 Long-Term Effectiveness

The long-term effectiveness of Alternative 4 is achieved through the removal of contaminated soil with COCs at concentrations above RGOs. As previously discussed, the alternative would be effective in protecting potential receptors from direct exposure to COCs in soil. The removal of the most highly contaminated soil would also reduce the mass transport of soil contaminants to groundwater, although the ultimate effectiveness of the alternative in protecting groundwater cannot be adequately evaluated at this time. This issue will be addressed after additional data one collected during the future area-specific and downgradient groundwater investigations.

The alternative would not require the maintenance of any long-term controls at the site to manage residual risk from direct exposure to soil.

4.5.5 *Reduction of Toxicity, Mobility, or Volume*

Although Alternative 4 would reduce the mass and volume of contaminated media remaining at the site, no net reductions in contaminant mass would be achieved unless a process such as incineration is performed at the TSDF, because COCs are transferred from one location to another. As a result, Alternative 4 would not comply with the statutory preference for selecting remedial actions that employ treatment technologies that permanently and significantly reduce the toxicity, mobility, or volume of hazardous substances as their principal element. However, transferring waste material from an uncontrolled disposal site to a managed disposal facility that is designed and constructed to prevent the release of contaminants to the environment would restrict the mobility of COC in excavated soil.

4.5.6 *Short-Term Effectiveness*

The implementation of Alternative 4 would not present any significant health threats to the community. The excavation of contaminated soils would be performed within the confines of PBOW at a sufficient distance from the property boundaries that the nearby community should not be affected. Proper decontamination and waste transportation practices would be followed to prevent the spread of contamination when equipment or waste materials leave the site.

Alternative 4 does not present site workers with any unusual health or safety concerns for a remediation project. A hazard evaluation will be performed prior to the commencement of the removal action, and a health and safety plan will be followed during site activities to ensure that risks to workers are minimized. Remediation workers would be supplied with any protective gear required to conduct operations in a safe manner.

Environmental impacts during remediation would be mitigated primarily through measures designed to ensure that contamination is not spread during remedial activities. This includes measures such as dust controls during excavation, decontamination procedures for equipment and personnel, and storm water run-off and run-on controls. Storm water controls would include actions such as covering piles of contaminated soil to prevent run-off, berming the staging areas to control run-on and run-off, construction of a contact water basin to collect storm water, and providing wastewater treatment equipment to treat storm water if required to comply with discharge criteria.

It is estimated that 16 to 22 months would be required to complete remedial activities under Alternative 4 in one field event, from the initiation of work plans to disposal of contaminated soil and backfilling excavated areas. If the two sites were remediated in two separate field events, the estimated remedial duration would be 12 to 18 months for TNTA and 10 to 16 months for TNTC. The combined time period for both sites is less than the sum of the individual time intervals for each site because the combined time period accounts for efficiencies in executing remedial tasks concurrently. Tables 4-5, 4-6, and 4-11 provide additional detail on the individual work elements involved in the execution of this alternative.

4.5.7 Implementability

This alternative is technically and administratively implementable.

Compliance sampling of the sidewall and bottom areas of the excavation and analysis of the soil samples for COCs can be used to monitor the effectiveness of excavation in removing soil contaminated above RGOs.

The alternative does nothing to preclude additional remedial action for soil if it is later determined that this is required to protect groundwater.

Alternative 4 does not present any unusual regulatory requirements that would compromise the administrative feasibility of the remedial approach. OEPA would have to approve the disposal facility used for any waste materials managed off site.

4.5.8 Cost

The detailed cost evaluations associated with the implementation of Alternative 4 for TNTA and TNTC are presented in Tables 4-5 and 4-6. The estimated capital cost for Alternative 4 is $4.9 million for TNTA and $3.1 million for TNTC. The total capital cost to implement Alternative 4 at both TNTA and TNTC during one remediation event is $7.7 million. A detailed cost evaluation for the two sites combined is presented in Table 4-11. This combined cost is less than the sum of the individual costs for TNTA and TNTC because it accounts for the economies of scale in completing both projects at one time. The contingency capital cost allowance for Alternative 4 is 30 percent. This contingency accounts for the uncertainty in the estimated volume of soil requiring remediation and an allowance for unidentified cost elements not incorporated in the estimate. There are no long-term O&M costs associated with this alternative. Therefore, the present value of this alternative is the same as its capital cost.

4.5.9 State Acceptance

This criterion will be evaluated in the action memorandum for the removal action, after a public meeting has been conducted and the public comment period has concluded.

4.5.10 Community Acceptance

The RAB for PBOW holds periodic meetings at which the USACE and NASA provide updates on the progress of environmental restoration and solicit questions and comments from the public. During several of these meetings, potential remedial options for cleanup of TNT-contaminated soil at TNTA, TNTB, and TNTC at PBOW have been presented and discussed. It should be noted that some members of the RAB have expressed a clear preference for windrow composting over other technologies that do not permanently reduce the mass of nitroaromatic contaminants in soil. RAB members have expressed a concern about remedial alternatives that involved a significant degree of off-site management of waste materials, particularly at local landfills.

This criterion will be evaluated in more detail in the action memorandum for the removal action, after a public meeting has been conducted and the public comment period has concluded.

4.6 Alternative 5 – Excavation, Windrow Composting, Chemical Stabilization, and On-Site/Off-Site Disposal

4.6.1 Description

This alternative involves the excavation of contaminated soil within proposed remediation areas, windrow composting of soil contaminated with nitroaromatic compounds and PAHs at concentrations above RGOs, chemical stabilization of soil contaminated with lead above the RGO, off-site disposal of PCB-contaminated soil (≥50 mg/kg total PCBs) in a TSCA-approved TSDF, off-site disposal of lead-stabilized soil as a nonhazardous waste in a Subtitle D landfill, and surface placement of treated compost back on-site. This alternative is similar to Alternative 2, with the exception that lead-contaminated soil under Alternative 2 would be disposed of off site as a hazardous waste in a RCRA Subtitle C TSDF. Lead-contaminated soil under Alternative 5 would be chemically stabilized and disposed of as a nonhazardous waste. For cost estimating purposes, it is assumed that all nonhazardous waste (lead-stabilized and nonhazardous soil) will be disposed of at the Erie County Landfill. It is assumed that PCB remediation waste will be disposed of at an EQ Environmental, Inc. TSDF in Belleville, Michigan.

Detailed descriptions of windrow composting and chemical stabilization technologies are presented under the description of Alternatives 2 and 3 in Sections 4.3.1 and 4.4.1, respectively.

4.6.2 Overall Protection of Human Health and the Environment

Alternative 5 would protect human health by excavating contaminated soil with concentrations of COCs above the RGOs. Ecological receptors may also benefit, in that removal of the most contaminated soil would result in lowering the EHQs calculated for various receptors in the ecological risk assessment. Although the soil removal will mitigate the migration of soil contaminants to groundwater, it is unclear at the present time whether the current soil RGOs will provide adequate protection for groundwater. This evaluation cannot be performed until the future area-specific and downgradient groundwater investigations are completed. As a result, additional remedial actions for soil may be required in the future.

The alternative provides adequate protection against the potential hazards of contaminants in excavated soil through the combination of treatment and waste management technologies. Once the contaminated soil is excavated, the soil contaminated with elevated levels of nitroaromatic compounds and PAHs is biologically treated via windrow composting to reduce the concentrations of nitroaromatic compounds to levels acceptable for placement back on site (RGOs). Soil with lead concentrations above RGOs would be chemically stabilized and disposed of off site as a nonhazardous waste in a Subtitle D landfill. Soil with PCB concentrations at 50 mg/kg or greater would be disposed of offsite as a PCB remediation waste in a TSCA-approved TSDF.

4.6.3 Compliance with ARARs

The alternative would comply with the chemical-specific ARAR for total PCBs in soil. The location- and action-specific ARARs that were considered for Alternative 5 are presented in Appendix A. None of the location-specific ARARs were identified as applicable for this remedial alternative. The alternative would comply with all action-specific ARARs, in particular the regulations that deal with the identification, storage, and disposal of hazardous waste.

4.6.4 Long-Term Effectiveness

The long-term effectiveness of Alternative 5 is achieved through the removal and treatment of soil contaminated with COCs at concentrations above the RGOs. As previously discussed, the alternative would be effective in protecting potential receptors from direct exposure to COCs in soil. The ultimate effectiveness of the alternative in preventing indirect exposures that may be caused by the migration of soil contaminants to groundwater cannot be adequately evaluated at this time. This issue will be addressed after the future area-specific and downgradient groundwater investigations are completed.

The alternative would not require the maintenance of any long-term controls at the site to manage residual risk from direct exposure to soil.

4.6.5 *Reduction of Toxicity, Mobility, or Volume*

Alternative 5 would comply with the statutory preference for selecting remedial actions that employ treatment technologies that permanently and significantly reduce the toxicity, mobility, or volume of hazardous substances as their principal element. The treatment of contaminated soils by windrow composting would reduce the toxicity and mobility of nitroaromatic compounds and PAHs in soil through a combination of biological degradation and immobilization via covalent binding with humic substances in the compost. Treatment of lead-contaminated soil using chemical stabilization reduces the mobility of lead in the treated soil.

Under this alternative, 24,797 cubic yards of nitroaromatic- and PAH-contaminated soil would be treated and placed back on site; 617 cubic yards of lead-contaminated soil would be treated and disposed of in a Subtitle D landfill; and 119 cubic yards of PCB-contaminated soil would be disposed of off site in a TSCA-approved TSDF.

4.6.6 *Short-Term Effectiveness*

The implementation of Alternative 5 would not present any significant health threats to the community. The excavation and treatment of contaminated soils would be performed within the confines of PBOW at a sufficient distance from the property boundaries that the nearby community should not be affected. The composting and stabilization processes would be managed to minimize the generation of dust or nuisance odors during remediation. Proper decontamination and waste transportation practices will be followed to prevent the spread of contamination when equipment or waste materials leave the site.

Alternative 5 does not present site workers with any unusual health or safety concerns. A hazard evaluation will be performed prior to the commencement of the removal action, and a health and safety plan will be followed during site activities to ensure that risks to workers are minimized. Remediation workers would be supplied with any protective gear required to conduct operations in a safe manner. The temporary enclosure under which composting operations are performed would be designed to ensure that adequate airflow exists to provide a safe environment for remediation workers.

Environmental impacts during remediation will be mitigated primarily through measures designed to ensure that contamination is not spread during remedial activities. This includes measures such as dust controls during excavation and treatment, decontamination procedures for equipment and personnel, and storm water run-off and run-on controls. Storm water controls would include actions such as erection of an enclosure over the windrows area, covering piles of contaminated soil and amendments to prevent run-off, berming the treatment and staging areas to control run-on and run-off, construction of a contact water basin to collect and reuse storm water, and providing wastewater treatment equipment to treat storm water that cannot be reused in the treatment process, if required to comply with discharge criteria.

It is estimated that 42 to 48 months would be required to complete remedial activities under Alternative 5 in one field event, from the initiation of work plans to backfilling excavated areas and disposal of treatment residuals. If the two sites were remediated in two separate field events, the estimated remedial duration would be 12 to 18 months for TNTA and 10 to 16 months for TNTC. The combined time period for both sites is less than the sum of the individual time intervals for each site because the combined time period accounts for efficiencies in executing remedial tasks concurrently. Tables 4-7, 4-8, and 4-12 provide additional detail on the individual work elements involved in the execution of this alternative.

4.6.7 Implementability

A composting treatability/optimization study would be completed prior to the initiation of site activities. This study would evaluate the cost and availability of various amendments that could be obtained locally for use in the treatment process and, based on this evaluation, determine the most cost-effective compost mixture to treat the soil. A bench-scale stabilization treatability/optimization study is recommended prior to full-scale implementation to determine the appropriate ratio of stabilization chemicals to soil over the range of lead concentrations anticipated.

Windrow composting is a reliable technology, as it has been implemented at a number of remediation sites to treat soil contaminated with nitroaromatic explosives, PAHs, and other chemicals, such as pesticides. Composting technology has also been widely used in the treatment of agricultural wastes and the management of treatment residuals from municipal wastewater treatment plants. Chemical stabilization has been used at numerous sites to immobilize lead in soil both as an in situ and ex situ technology. As a result, a number of contractors are experienced in implementing these technologies, and equipment is readily available. Composting amendments should be readily available in the surrounding agricultural areas.

Treatment equipment may be either leased or purchased, depending upon the relative economics of each option. It is recommended that the composting equipment be purchased, as it would be required on site for a period of time that may make it economically advantageous to purchase rather than lease. The composting equipment could also be used on other projects that involve treatment of soil contaminated with nitroaromatic explosives, PAHs, or pesticides, thus spreading these costs across multiple projects. Additionally, it is recommended that the USACE purchase (rather than lease) a fabric enclosure to cover the windrows during treatment. This type of structure can be disassembled and reused at other sites. The economics of purchasing stabilization equipment are not as attractive due to the shorter duration the equipment will be needed on site, unless its purchase can be justified through use on multiple projects.

Compliance sampling of the sidewall and bottom areas of the excavation and analysis of the soil samples for COCs can be used to monitor the effectiveness of excavation in removing soil contaminated above RGOs.

The effectiveness of the composting process is easily monitored by periodic sampling and analysis of the compost during and after the treatment process. Immunoassay or colorimetric analytical methods may be utilized during precompliance testing to lower analytical costs, although field test kits may not be available for all the nitroaromatic COCs. Standard fixed-base laboratory analyses would be used for final compliance sampling after treatment is complete for each batch of compost. The composting treatment process could be extended for any composted material that fails compliance testing. Alternatively, the compost could be chemically stabilized and/or disposed of off site at an approved TSDF if the compliance results of the treated compost are significantly elevated above the RGOs such that further biological treatment would not be cost-effective.

The stabilization process is monitored after treatment is complete by TCLP testing to demonstrate that the leachable concentrations of lead in samples of the stabilized matrix are below the maximum levels permissible in the land disposal restrictions. The compressive strength of the stabilized material is also typically tested to ensure it is suitable as structural backfill. If the stabilized soil does not pass the TCLP test, the soil could be reprocessed.

The alternative does nothing to preclude additional remedial action for soil if it is later determined that this is required to protect groundwater.

Alternative 5 does not present any unusual regulatory requirements that would compromise the administrative feasibility of the remedial approach. OEPA would have to approve the disposal facility used for any waste materials managed off site.

4.6.8 Cost

The detailed cost evaluations for the implementation of Alternative 5 for TNTA and TNTC are presented in Tables 4-7 and 4-8. The estimated capital cost for Alternative 5 is $7.8 million for TNTA and $5.5 million for TNTC.

The total capital cost to implement Alternative 5 at both TNTA and TNTC during one remediation event is $11.1 million. A detailed cost evaluation for the two sites combined is presented in Table 4-12. This combined cost is less than the sum of the individual costs for TNTA and TNTC because it accounts for the economies of scale in completing both projects at one time. In order for the cost estimate for each area to be complete and independent, the estimate must account for the purchase of all structures and equipment. Therefore, the sum of the individual alternatives for TNTA and TNTC would double count these costs.

Appendix B provides supporting calculations used to estimate remedial costs. A contingency of 20 percent has been added to the cost estimates for both sites to account for uncertainty in the estimated volume of soil requiring remediation and to provide an allowance for cost elements that are not identifiable at the present time. Due to the relatively short time frame over which the remedial alternative would be completed, all costs associated with its implementation are classified as capital costs. Accordingly, there are no O&M costs for this alternative, and the present value cost is equivalent to the capital cost.

4.6.9 State Acceptance

This criterion will be evaluated in the action memorandum for the removal action, after a public meeting has been conducted and the public comment period has concluded.

4.6.10 Community Acceptance

The RAB for PBOW holds periodic meetings at which the USACE and NASA provide updates on the progress of environmental restoration and solicit questions and comments from the public. During several of these meetings, potential remedial options for cleanup of TNT-contaminated soil at TNTA, TNTB, and TNTC at PBOW have been presented and discussed. It should be noted that some members of the RAB have expressed a clear preference for windrow composting over chemical stabilization for the treatment of nitroaromatic contaminants in soil.

This criterion will be evaluated in more detail in the action memorandum for the removal action, after a public meeting has been conducted and the public comment period has concluded.

5.0 Comparative Analysis of Remedial Alternatives

This chapter provides a comparative analysis of all five alternatives developed in Chapter 4.0. The comparison will be based on the evaluation criteria and the overall feasibility of the alternatives in achieving RAOs for contaminated soil at TNTA and TNTC. A summary of this comparative analysis is presented in Table 5-1 for TNTA and Table 5-2 for TNTC.

5.1 Protection of Human Health and the Environment

All of the alternatives, with the exception of Alternative 1, would permanently treat/remove contaminated soil, thereby reducing cancer and noncancer human health risks to within the respective OEPA risk management ranges. Alternatives 2 through 5 may also benefit ecological receptors by significantly reducing the EHQs associated with soil contamination at the sites. Alternatives 2 through 5 may provide a corollary benefit to long-term groundwater and surface water quality by removing or mitigating the most significant source areas that contribute to contamination in these media. Alternative 1 does not employ removal, containment, or treatment response actions that would mitigate the impact of source areas on receptors or other environmental media.

5.2 Compliance with ARARs

All of the alternatives, with the exception of Alternative 1, would comply with the chemical-, location-, and action-specific ARARs. Alternative 1 would not comply with the chemical-specific ARAR for total PCBs in soil. Location- and action-specific ARARs are not applicable for Alternative 1 because no action would be taken.

5.3 Long-Term Effectiveness and Permanence

All of the alternatives, with the exception of Alternative 1, would reduce the magnitude of residual risk at the sites to levels within the risk management range. No long-term controls would be required at the sites for Alternatives 2 though 5.

5.4 Reduction of the Toxicity, Mobility, or Volume of Contamination

Alternatives 2 and 5 would satisfy the statutory preference for selecting remedial actions that employ treatment technologies that permanently and significantly reduce the toxicity, mobility, or volume of hazardous substances as their principal element. Alternatives 5 and 2 would treat the vast majority of the contaminated soil excavated at TNTA and TNTC (99.5 and 97.1 percent, respectively). In contrast, Alternative 3 would treat only 24 percent of the contaminated soil excavated from TNTA and TNTC. Alternative 4 would not employ any on-site treatment, although off-site treatment of some contaminated soil would be required to comply with LDR requirements prior to disposal.

The composting component of Alternatives 2 and 5 provides essentially irreversible treatment by coupling biodegradation and transformation processes to reduce the toxicity and mobility of soil contaminants. Alternative 3 employs chemical stabilization to reduce the mobility of contaminants. While chemical stabilization is not an irreversible process, the combination of stabilization and off-site disposal at an industrial landfill should prevent the contaminants in the treated soil from leaching back into the environment. Although Alternative 4 would remove contamination from the site, it would not result in any reduction of contaminant mass. The disposal of excavated soil in an appropriate TSDF would minimize the potential for contaminants to leach into the environment. Alternative 1 would have no effect on the toxicity, volume, or mobility of soil contamination.

5.5 Short-Term Effectiveness

Alternatives 2 through 5 would all provide adequate safeguards for site workers and the community during remediation. Only small volumes of contaminated soil excavated under Alternatives 2 and 5 would require off-site management. All the contaminated soil excavated under Alternatives 3 and 4 would require off-site management. Short-term effectiveness is not relevant to Alternative 1 because no action would be taken. No threatened or endangered animal or plant species will be significantly affected or destroyed by remedial actions at TNTA and TNTC. In the event threatened and/or endangered plant species are later discovered in the proposed remediation areas, care will be taken to minimize disturbance. There will be short-term disturbances to ecological habitat as a result of the proposed remediation; however, the re-establishment of vegetative cover following the action will allow displaced species to recolonize these disturbed areas.

Remedial durations for TNTA and TNTC are presented in Tables 5-1 and 5-2. These remedial time frames do not reflect the efficiencies realized when conducting remedial action for TNTA and TNTC in one event. A complete analysis of the remedial duration of each alternative, for each individual site and for both sites combined, is presented in Table 5-3. The following time frames presented in this paragraph are for TNTA and TNTC combined. Alternative 4 would be completed within the shortest period of time, requiring approximately 16 to 22 months. Alternative 3 would take 20 to 26 months to complete. Alternative 2 would require 41 to 47 months to complete, and Alternative 5 would require the longest period of time to complete, at 42 to 48 months.

5.6 Implementability

All of the technologies in these alternatives are well developed and have been implemented on a full-scale basis on numerous projects. Equipment, technical specialists, and materials are available for all the alternatives. The effectiveness of the alternatives can be monitored by sampling and analysis. All of the alternatives would require the approval of OEPA for disposal of material off site. None of the alternatives would preclude additional actions if the technologies are not completely effective.

5.7 Cost

Alternative 1 is the lowest cost alternative. Alternative 3 has the lowest cost of the alternatives that employ some sort of remedial action. Chemical stabilization of the hazardous fraction of the excavated soil allows all soil (expect PCB-remediation waste) to be disposed off site as a nonhazardous waste. The cost to stabilize the soil is less than the differential between hazardous and nonhazardous waste disposal costs. Alternative 4 is the second lowest cost alternative. Alternatives 2 and 5 are the two highest cost alternatives. Alternative 2 is slightly lower in cost than Alternative 5 because there is not enough lead-contaminated soil at concentrations high enough for the increased costs of chemical stabilization to offset the cost for disposal as a hazardous waste.

Remedial costs for TNTA and TNTC are presented in Tables 5-1 and 5-2. These costs do not reflect the economies of scale realized when conducting remedial action for TNTA and TNTC in one event. Table 5-4 compares the individual costs for remedial action at TNTA and TNTC with the combined cost for executing these actions together. The table shows that significant cost savings can be realized with Alternatives 2 and 5 when remediation is conducted concurrently.

5.8 State Acceptance

This criterion will be evaluated in an action memorandum for TNTA and TNTC after receiving regulatory review comments on this FFS.

5.9 Community Acceptance

This criterion will be evaluated in an action memorandum for TNTA and TNTC after a public meeting is held. Preliminary comments from some members of the RAB indicate a preference for alternatives that include windrow composting as a component of the remedy. RAB members have also expressed a concern about remedial alternatives that involved a significant degree of off-site management of waste materials (particularly at local landfills), as would occur under Alternatives 3 and 4.

5.10 Recommendations

The comparative analyses presented in Tables 5-1 and 5-2 indicate that Alternative 2: Excavation, Windrow Composting, On-Site and Off-Site Disposal should be selected as the recommended remedial alternative for both TNTA and TNTC. The alternative meets the threshold criteria of protection of human health and the environment and complies with ARARs.

Alternative 2 is selected over Alternatives 3 and 4 because it utilizes on-site treatment to a high degree, satisfying the statutory preference for alternatives that reduce the toxicity, mobility, or volume of contamination through treatment. The composting technology used in Alternative 2 results in an irreversible humification of the nitroaromatic and PAH contaminants in soil, while chemical stabilization does not destroy the contaminants and the process may be reversible under the right conditions. Soil with very elevated concentrations of nitroaromatic compounds may be difficult to successfully stabilize. Additionally, preliminary comments from some members of the RAB indicate a strong preference for composting over other technologies discussed.

Alternative 2 is selected over Alternative 5 because it is more cost effective to chemically stabilize the small volume of lead-contaminated soil at an off-site TSDF than at an on-site batch treatment plant. This approach also precludes the disposal of contaminated soil at local municipal landfills, because the soil shipped off site must be treated to meet LDR requirements prior to disposal.

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TABLES

Table 1-1

Summary of Total Hazard and Total Cancer Risk by Source Medium
TNT Area A, Former Plum Brook Ordnance Works
Sandusky, Ohio

	Groundskeeper	Indoor Worker	Construction Worker	On-Site Resident	Adult Hunter	Child Venison Consumer
Source Medium	Total HI	Total HI	Total HI	Total HI	Total HI	Total HI
Surface Soil	6.45E-01	2.76E-01	NA	NA	3.30E-02	NA
Total Soil	NA	NA	6.04E+01	2.19E+02	NA	NA
Surface Water	NA	NA	5.93E-02	2.93E-02	NA	NA
Sediment	NA	NA	NA	NA	NA	NA
Total across all media	**6.45E-01**	**2.76E-01**	**6.05E+01**	**2.19E+02**	**3.30E-02**	**NA**

	Groundskeeper	Indoor Worker	Construction Worker	On-Site Resident			Adult Hunter	Child Venison Consumer
Source Medium	Total ILCR	Total ILCR	Total ILCR	Adult ILCR	Child ILCR	Total ILCR	Total ILCR	Total ILCR
Surface Soil	6.08E-06	2.71E-06	NA	NA	NA	NA	4.46E-07	2.34E-08
Total Soil	NA	NA	3.51E-04	1.06E-02	1.53E-02	2.59E-02	NA	NA
Surface Water	NA	NA	5.13E-09	6.76E-08	3.04E-08	9.79E-08	NA	NA
Sediment	NA	NA	6.46E-08	2.38E-07	4.63E-10	2.38E-07	NA	NA
Total across all media	**6.08E-06**	**2.71E-06**	**3.51E-04**	**1.06E-02**	**1.53E-02**	**2.59E-02**	**4.46E-07**	**2.34E-08**

HI - Hazard index.
ILCR - Incremental lifetime cancer risk.
NA - Not applicable.

Table 1-2

Summary by Building Area of Total Cancer Risk and Noncancer Hazard[a] TNT Area A, Former Plum Brook Ordnance Works Sandusky, Ohio

Former Building Number	Total Soil Receptors: Construction Worker HI	Construction Worker ILCR	On-Site Resident HI	On-Site Resident ILCR Adult	On-Site Resident ILCR Child	On-Site Resident ILCR Total
111[b]	2.85E-02	2.04E-08	9.90E-02	5.94E-07	8.94E-07	1.49E-06
112	5.34E-01	9.32E-08	1.85E+00	2.62E-06	4.10E-06	6.72E-06
116[b]	6.98E-04	1.36E-08	2.54E-03	4.72E-07	5.60E-07	1.03E-06
119[c]	4.06E+00	1.96E-06	1.42E+01	5.84E-05	8.54E-05	1.44E-04
126	2.33E+00	2.65E-07	8.07E+00	8.98E-06	1.10E-05	2.00E-05
129[b]	NA	2.39E-09	NA	6.35E-08	1.06E-07	1.69E-07
131	1.64E+00	4.34E-07	5.71E+00	1.32E-05	1.89E-05	3.21E-05
136	NA	3.26E-08	NA	1.17E-06	1.31E-06	2.49E-06
139[c]	1.88E-01	3.89E-06	6.52E-01	1.04E-04	1.73E-04	2.77E-04
141	7.75E-01	1.69E-07	2.68E+00	5.22E-06	7.30E-06	1.25E-05
142[b,c]	3.60E-01	1.57E-07	1.24E+00	4.30E-06	6.92E-06	1.12E-05
143[b]	6.71E-02	8.39E-08	2.32E-01	2.93E-06	3.43E-06	6.36E-06
146	8.04E+00	5.03E-07	2.78E+01	1.73E-05	2.08E-05	3.81E-05
148[b]	7.70E-02	2.40E-08	2.67E-01	6.85E-07	1.06E-06	1.74E-06
182	7.00E-02	5.02E-07	2.55E-01	1.52E-05	2.19E-05	3.71E-05
185	1.68E-03	1.02E-08	6.12E-03	3.10E-07	4.44E-07	7.54E-07
192	1.20E+01	5.93E-05	4.38E+01	1.80E-03	2.59E-03	4.39E-03
195	5.69E+01	3.47E-04	2.07E+02	1.05E-02	1.51E-02	2.57E-02

[a]Based on the results of the BHHRA (IT Corporation, 2001b). Note that only confirmation samples were evaluated in the BHHRA.

[b] At least one remedial goal option was exceeded in at least one screening sample, and noncancer or cancer risk associated with that sample exceeded OEPA risk management criteria. Therefore, the area is proposed for remediation.

[c]Additionally, area proposed for remediation of lead.

Shading indicates areas with noncancer or cancer risks greater than OEPA risk management criteria (i.e., HI > 1 and/or ILCR > 1E-5).

BHHRA - Baseline human health risk assessment.

HI - Hazard Index.

ILCR - Incremental Lifetime Cancer Risk.

NA - Not applicable.

OEPA = Ohio Environmental Protection Agency.

Table 1-3

Summary of Total Hazard and Total Cancer Risk from Chemicals of Concern
TNT Area C, Former Plum Brook Ordnance Works
Sandusky, Ohio

Source Medium	Groundskeeper Total HI	Indoor Worker Total HI	Construction Worker Total HI	On-Site Resident Total HI	Adult Hunter Total HI	Child Venison Consumer Total HI
Surface Soil	9.54E+01	4.08E+01	NA	NA	4.88E+00	NA
Total Soil	NA	NA	3.60E+02	1.24E+03	NA	NA
Surface Water	NA	NA	1.59E-01	7.84E-02	NA	NA
Sediment	NA	NA	1.37E+01	5.60E+00	NA	NA
Total across all media	**9.54E+01**	**4.08E+01**	**3.74E+02**	**1.25E+03**	**4.88E+00**	**NA**

	Groundskeeper	Indoor Worker	Construction Worker	On-Site Resident			Adult Hunter	Child Venison Consumer
Source Medium	Total ILCR	Total ILCR	Total ILCR	Adult ILCR	Child ILCR	Total ILCR	Total ILCR	Total ILCR
Surface Soil	5.43E-04	2.32E-04	NA	NA	NA	NA	3.39E-05	2.09E-07
Total Soil	NA	NA	5.01E-05	1.57E-03	1.91E-03	3.48E-03	NA	NA
Surface Water	NA	NA	1.77E-08	2.33E-07	1.05E-07	3.38E-07	NA	NA
Sediment	NA	NA	1.36E-06	5.51E-06	6.65E-06	1.22E-05	NA	NA
Total across all media	**5.43E-04**	**2.32E-04**	**5.15E-05**	**1.57E-03**	**1.92E-03**	**3.49E-03**	**3.39E-05**	**2.09E-07**

HI - Hazard index
ILCR - Incremental lifetime cancer risk
NA - Not applicable

Table 1-4

Summary by Building Area of Total Cancer Risk and Noncancer Hazard[a] TNT Area C, Former Plum Brook Ordnance Works Sandusky, Ohio

Former Building Number	Total Soil Receptors: Construction Worker HI	Construction Worker ILCR	On-Site Resident HI	On-Site Resident ILCR Adult	On-Site Resident ILCR Child	On-Site Resident ILCR Total
602[b]	4.56E-02	2.10E-08	1.71E-01	5.64E-07	9.32E-07	1.50E-06
603	9.77E-01	2.92E-07	3.38E+00	8.94E-06	1.27E-05	2.16E-05
606	8.45E-01	2.29E-08	2.82E+00	7.56E-07	9.54E-07	1.71E-06
611	NA	1.20E-09	NA	3.19E-08	5.32E-08	8.51E-08
616	1.99E+01	2.22E-06	6.87E+01	7.64E-05	9.18E-05	1.68E-04
626[c]	2.48E-01	2.64E-08	8.56E-01	8.81E-07	1.09E-06	1.97E-06
629[d]	1.10E+00	4.59E-06	3.95E+00	1.39E-04	2.00E-04	3.39E-04
657[e]	NA	1.40E-07	NA	4.90E-06	5.69E-06	1.06E-05
681	6.96E-02	2.71E-08	2.41E-01	8.62E-07	1.16E-06	2.02E-06
682[d]	3.56E+02	3.85E-05	1.23E+03	1.33E-03	1.59E-03	2.92E-03
683	4.77E+00	5.82E-06	1.66E+01	1.78E-04	2.53E-04	4.31E-04
686[d]	4.52E+01	7.02E-06	1.56E+02	2.44E-04	2.89E-04	5.33E-04
689	4.21E+00	1.39E-06	1.46E+01	4.87E-05	5.67E-05	1.05E-04
692	9.85E+00	1.15E-06	3.41E+01	3.84E-05	4.84E-05	8.68E-05
693[f]	3.23E-01	1.11E-08	1.12E+00	3.61E-07	4.69E-07	8.30E-07
696[d]	8.91E+00	7.91E-06	2.91E+01	1.33E-04	1.53E-04	2.86E-04

[a]Based on the results of the BHHRA for TNT A&C (IT Corporation, 2001b). Note that only confirmation samples were evaluated in the BHHRA.

[b]At least one RGO was exceeded in at least one screening sample, and noncancer or cancer risks associated with that sample exceeded OEPA risk management criteria. Therefore, the area is proposed for remediation.

[c]Marginal exceedance of RGO in a confirmation sample. Estimated risks are less than OEPA risk management criteria. Area is proposed for remediation, but a specific risk management decision is recommended before remediation activities at TNT C are commenced.

[d]Additionally, area proposed for remediation of lead.

[e]Marginal exceedance of RGO for polynuclear aromatic hydrocarbons. Area is proposed for remediation.

[f]Marginal exceedance of RGO in confirmation and screening samples. Estimated risks are less than OEPA risk management criteria. Area is proposed for remediation, but a specific risk management decision is recommended before remediation activities at TNT C are commenced.

Shading indicates areas with noncancer or cancer risks greater than OEPA risk management criteria (i.e., HI > 1 and/or ILCR > 1E-5).

BHHRA - Baseline human health risk assessment.

HI - Hazard Index

ILCR - Incremental Lifetime Cancer Risk

NA - Not applicable

OEPA - Ohio Environmental Protection Agency.

RGO - Remedial goal objective.

Table 2-1

Proposed RGOs for TNTA Total Soil COCs
Former Plum Brook Ordnance Works, Sandusky, Ohio

COC	Proposed RGO (mg/kg)	Basis	HQ	ILCR
2-Amino-4,6-Dinitrotoluene	1.3	RBRC	0.3	NA
4-Amino-2,6-Dinitrotoluene	1.7	RBRC	0.4	NA
2,4,6-Trinitrotoluene	8.0	RBRC	0.2	6E-7[a]
2-Nitrotoluene	31	RBRC	0.04	NA
4-Nitrotoluene	9	RBRC	0.01	NA
2,4-Dinitrotoluene	6.0	RBRC	0.04[b]	8E-6
2,6-Dinitrotoluene	1.5	RBRC	0.02[b]	2E-6
Aroclor 1260	1.0	ARAR[c]	NA	3E-6 (5E-8)[d]
Lead	400	TBC[e]	NA	NA
Total HI/ILCR			1.0	1.0E-5 (1.3E-5)[f]

[a] RGO derived on the basis of noncancer effects; cancer risk is de minimis (<1E-6).
[b] RGO derived on the basis of carcinogenicity; noncancer effects are de minimis (HQ<0.1).
[c] 40 CFR 761.3
[d] Value shown in parentheses is the ILCR for the highest detected concentration among the areas not proposed for remediation based on the nitroaromatic RGOs; this value is *de minimis* (i.e., <1E-6).
[e] EPA Soil screening value for average lead concentration.
[f] Value outside of parentheses is for nitroaromatics and the maximum detected concentration among the remaining samples for residual PCBs; value shown in parentheses is the total ILCR assuming the combined Aroclor 1254 and 1260 concentration is equal to the RGO.

ARAR - Applicable or reasonable and appropriate requirement.
COC - Chemical of concern.
HQ - Hazard quotient.
ILCR - Incremental lifetime cancer risk.
mg/kg - Milligrams per kilogram.
NA - Not applicable.
RBRC - Risk-based remediation concentration.
RGO - Remedial goal option.
TBC - To be considered criterion.

Table 2-2

Proposed RGOs for TNTC Total Soil COCs
Former Plum Brook Ordnance Works, Sandusky, Ohio

COC	Proposed RGO (mg/kg)	Basis	HQ	ILCR
2-Amino-4,6-Dinitrotoluene	1.7	RBRC	0.4	NA
4-Amino-2,6-Dinitrotoluene	1.3	RBRC	0.3	NA
2,4,6-Trinitrotoluene	8.0	RBRC	0.2	6E-7[a]
2,4-Dinitrotoluene	6.5	RBRC	0.04[b]	9E-6
2,6-Dinitrotoluene	1.0	RBRC	0.01[b]	1E-6
Aroclor 1260[c]	1.0	ARAR[d]	NA	3E-6 (5E-7)[e]
Aroclor 1254[c]	1.0	ARAR[d]	0.6 (0.1)[f]	3E-6 (6E-7)[g]
PAHs	1.0	TBC[h]	NA	NA[i]
Lead	400	TBC[j]	NA	NA
Total HI/ILCR			1.0[k]	1.0E-5 (1.3E-5)[l]

[a] RGO derived on the basis of noncancer effects; cancer risk is de minimis (<1E-6).
[b] RGO derived on the basis of carcinogenicity; noncancer effects are de minimis (HQ<0.1).
[c] ARAR value of 1.0 mg/kg is for combined Aroclor 1254 and 1260 concentrations.
[d] 40 CFR 761.3
[e] Value shown in parentheses is the ILCR for the highest detected concentration (0.15 mg/kg) among the areas not proposed for remediation based on the nitroaromatic RGOs; this value is *de minimis* (i.e., <1E-6).
[f] HQ value shown in parentheses is for the highest detected concentration (0.176 mg/kg) among the areas not proposed for remediation based on the nitroaromatic RGOs.
[g] ILCR value shown in parentheses is for the highest detected concentration (0.176 mg/kg) among the areas not proposed for remediation based on the nitroaromatic RGOs; this value is *de minimis* (i.e., <1E-6).
[h] OEPA policy for combined carcinogenic PAHs.
[i] Although carcinogenic, the ILCR would be based on the specific combination of PAHs present in a given sample.
[j] EPA Soil screening value for average lead concentration.
[k] Total HI reflects the additive effects of the nitroaromatics. The effects of Aroclor 1254 are not regarded as additive with those of the nitoraromatics, so its HQ is not added into the HI for nitroaromatic effects.
[l] Value outside of parentheses is for nitroaromatics and the maximum detected concentration among the remaining samples for residual PCBs; value shown in parentheses is the total ILCR assuming the combined Aroclor 1254 and 1260 concentration is equal to the RGO.

ARAR - Applicable or reasonable and appropriate requirement.
COC - Chemical of concern.
HQ - Hazard quotient.
ILCR - Incremental lifetime cancer risk.
mg/kg - Milligrams per kilogram.
NA - Not applicable.
PAH - Polynuclear aromatic hydrocarbon.
RBRC - Risk-based remediation concentration.
RGO - Remedial goal option.
TBC - To be considered criterion.

Table 2-3

Proposed RGOs for TNTC Sediment COCs
Former Plum Brook Ordnance Works, Sandusky, Ohio

COC	RBRC Based on Resident (mg/kg)	RBRC Based on Construction Worker (mg/kg)	Proposed RGO (mg/kg)	HQ of Proposed RGO[a]	ILCR of Proposed RGO[a]
2-Amino-4,6-Dinitrotoluene	12.1	5.0	5.0	0.3	NA
4-Amino-2,6-Dinitrotoluene	12.1	5.0	5.0	0.3	NA
2,4,6-Trinitrotoluene	101	41	41	0.3	9E-7[b]
Total HI/ILCR				1.0	9E-7

[a] Based on the construction worker scenario.
[b] RGO derived on the basis of noncancer effects; cancer risk is de minimis (<1E-6).

COC - Chemical of concern.
HQ - Hazard quotient.
ILCR - Incremental lifetime cancer risk.
mg/kg - Milligrams per kilogram.
NA - Not applicable.
RBRC - Risk-based remediation concentration.
RGO - Remedial goal option.

Table 2-4

Ecological Implications of Human Health Soil RGOs on Surface Soil Receptors
Feasibility Study
TNT Area A, Former Plum Brook Ordnance Works
Sandusky, Ohio

Chemical[a]	Human Health RGO (mg/kg)	Expected Residual Conc.[b] (mg/kg)	Critical Ecological NOAEL Hazard Quotient (and receptor)[c]		EPC for Critical[d] Ecological Receptor (mg/kg)	Scaled[e] Ecological NOAEL Hazard Quotient Using Expected Residual Conc.	Estimated Reduction in Ecological Hazard[f]	Lowest Reported Detection Limit[d] (mg/kg)
2,4,6-trinitrotoluene	8	0.05	134	rabbit	152	0.04	3040	0.1
Aroclor 1260	1	0.014	873	wren	2.48	5	177	0.08
Calcium	NA	14,500	109	wren	125,000	13	9	NA
Lead	400	69.5	338	wren	564	42	8	NA

Chemical[a]	Human Health RGO (mg/kg)	Expected Residual Conc.[b] (mg/kg)	Critical Ecological LOAEL Hazard Quotient (and receptor)		EPC for Critical[d] Ecological Receptor (mg/kg)	Scaled[e] Ecological LOEAL Hazard Quotient Using Expected Residual Conc.	Estimated Ecological Hazard Reduction Factor[f]	Lowest Reported Detection Limit[d] (mg/kg)
2,4,6-trinitrotoluene	8	0.05	27	rabbit	152	0.009	3040	0.1
Aroclor 1260	1	0.014	87	wren	2.48	0.5	177	0.08
Calcium	NA	14,500	22	wren	125,000	3	9	NA
Lead	400	69.5	34	wren	564	4	8	NA

[a] Chemicals shown are those having the highest ecological HQ values in the Remedial Investigation Report Ecological Risk Assessment (ERA) (IT, 2001c). Human health COC are bolded.

[b] Residual concentrations in surface soil were estimated by removing the soil samples from the ecological data base that were within the proposed excavation footprint and recalculating the exposure point concentration following the methodology used in the ERA. Value shown for each chemical except 2,4,6-trinitrotoluene (TNT) is the remaining maximum detected concentration; value shown for TNT is 0.5 X the maximum reporting limit. Dilution from clean backfill was not considered in estimating the residual concentrations.

[c] Value and corresponding receptor shown are for the highest HQ value among receptors evaluated in the ERA.

[d] Value shown is from the ERA.

[e] Estimated using the following scaling relationship:

Scaled HQ = Residual Conc. x (pre-remediation HQ/pre-remediation EPC).

Note that calculations were performed using unrounded HQ values, but that the resultant scaled quotients are rounded to one significant figure.

[f] Estimated by dividing pre-remediation EPC by expected residual concentration (note that HQs are linear with concentration). Ecological hazard reduction factors are rounded to the nearest whole number.

Notes:

COC = chemical of concern
Conc. = Concentration
EPC = exposure point concentration (original EPC used in ERA for surface soil exposure)
ERA = Ecological Risk Assessment
HQ = ecological hazard quotient from ERA.
LOAEL = lowest-observed-adverse-effect level
mg/kg = milligram per kilogram
NA = not applicable
NOAEL = no-observed-adverse-effect level
RGO = remedial goal option.
TNT = 2,4,6-trinitrotoluene

Table 2-5

Ecological Implications of Human Health Soil RGOs on Total Soil Receptors
Feasibility Study
TNT Area A, Former Plum Brook Ordnance Works
Sandusky, Ohio

Chemical[a]	Human Health RGO (mg/kg)	Expected Residual Conc.[b] (mg/kg)	Critical Ecological NOAEL Hazard Quotient (and receptor)[c]		EPC for Critical[d] Ecological Receptor (mg/kg)	Scaled[e] Ecological NOAEL Hazard Quotient Using Expected Residual Conc.	Estimated Reduction in Ecological Hazard[f]	Lowest Reported Detection Limit[d] (mg/kg)
2,4,6-trinitrotoluene	8	0.05	45	shrew	530	0.004	10600	0.1
Aroclor 1260	1	0.0768	743	shrew	0.132	432	2	0.08
Calcium	NA	31,000	25	shrew	40,000	19	1	NA
Lead	400	69.5	32	shrew	624	3.6	9	NA

Chemical[a]	Human Health RGO (mg/kg)	Expected Residual Conc.[b] (mg/kg)	Critical Ecological NOAEL Hazard Quotient (and receptor)[c]		EPC for Critical[d] Ecological Receptor (mg/kg)	Scaled[e] Ecological NOAEL Hazard Quotient Using Expected Residual Conc.	Estimated Reduction in Ecological Hazard[f]	Lowest Reported Detection Limit[d] (mg/kg)
2,4,6-trinitrotoluene	8	0.05	9	shrew	530	0.0008	10600	0.1
Aroclor 1260	1	0.0768	74	shrew	0.132	43	2	0.08
Calcium	NA	31,000	5	shrew	40,000	4	1	NA
Lead	400	69.5	3	shrew	624	0.3	9	NA

[a] Chemicals shown are those having the highest ecological HQ values in the Remedial Investigation Report Ecological Risk Assessment (ERA) (IT, 2001c). Human health COC are bolded.

[b] Residual concentrations in total soil were estimated by removing the soil samples from the ecological data base that were within the proposed excavation footprint and recalculating the exposure point concentration following the methodology used in the ERA. Value shown for each chemical except 2,4,6-trinitrotoluene (TNT) is the remaining maximum detected concentration; value shown for TNT is 0.5 X the maximum reporting limit. Dilution from clean backfill was not considered in estimating the residual concentrations.

[c] Value and corresponding receptor shown are for the highest HQ value among receptors evaluated in the ERA.

[d] Value shown is from the ERA.

[e] Estimated using the following scaling relationship:

Scaled HQ = Residual Conc. x (pre-remediation HQ/pre-remediation EPC).

Note that calculations were performed using unrounded HQ values, but that the resultant scaled quotients are rounded to one significant figure.

[f] Estimated by dividing pre-remediation EPC by expected residual concentration (note that HQs are linear with concentration). Ecological hazard reduction factors are rounded to the nearest whole number.

Notes:

COC = chemical of concern
Conc. = Concentration
EPC = exposure point concentration (original EPC used in ERA for surface soil exposure)
ERA = Ecological Risk Assessment
HQ = ecological hazard quotient from ERA.
LOAEL = lowest-observed-adverse-effect level
mg/kg = milligram per kilogram
NA = not applicable
NOAEL = no-observed-adverse-effect level
RGO = remedial goal option.

Table 2-6

Ecological Implications of Human Health Soil RGOs on Total Soil Receptors
Feasibility Study
TNT Area C, Former Plum Brook Ordnance Works
Sandusky, Ohio

Chemical[a]	Human Health RGO (mg/kg)	Expected Residual Conc.[b] (mg/kg)	Critical Ecological NOAEL Hazard Quotient (and receptor)[c]		EPC for Critical[d] Ecological Receptor (mg/kg)	Scaled[e] Ecological NOAEL Hazard Quotient Using Expected Residual Conc.	Estimated Reduction in Ecological Hazard[f]	Lowest Reported Detection Limit[d] (mg/kg)
2,4,6-trinitrotoluene	8	1.41	4,120	shrew	41,300	0.1	29291	0.1
Aroclor 1260	1	0.15	1,420	shrew	1.71	125	11	0.08
Lead	400	134	45	shrew	578	10	4	NA

Chemical[a]	Human Health RGO (mg/kg)	Expected Residual Conc.[b] (mg/kg)	Critical Ecological NOAEL Hazard Quotient (and receptor)[c]		EPC for Critical[d] Ecological Receptor (mg/kg)	Scaled[e] Ecological NOAEL Hazard Quotient Using Expected Residual Conc.	Estimated Reduction in Ecological Hazard[f]	Lowest Reported Detection Limit[d] (mg/kg)
2,4,6-trinitrotoluene	8	1.41	823	shrew	41,300	0.03	29291	0.1
Aroclor 1260	1	0.15	142	shrew	1.71	12	11	0.08
Lead	400	134	5	shrew	578	1	4	NA

[a] Chemicals shown are those having the highest ecological HQ values in the Remedial Investigation Report Ecological Risk Assessment (ERA) (IT, 2001c). All chemicals shown are human health COC.

[b] Residual concentrations in total soil were estimated by removing the soil samples from the ecological data base that were within the proposed excavation footprint and recalculating the exposure point concentration following the methodology used in the ERA. Value shown for each chemical except 2,4,6-trinitrotoluene (TNT) is the remaining maximum detected concentration; value shown for TNT is 0.5 X the maximum reporting limit. Dilution from clean backfill was not considered in estimating the residual concentrations.

[c] Value and corresponding receptor shown are for the highest HQ value among receptors evaluated in the ERA.

[d] Value shown is from the ERA.

[e] Estimated using the following scaling relationship:

Scaled HQ = Residual Conc. x (pre-remediation HQ/pre-remediation EPC).

Note that calculations were performed using unrounded HQ values, but that the resultant scaled quotients are rounded to one significant figure.

[f] Estimated by dividing pre-remediation EPC by expected residual concentration (note that HQs are linear with concentration). Ecological hazard reduction factors are rounded to the nearest whole number.

Notes:
COC = chemical of concern
Conc. = Concentration
EPC = exposure point concentration (original EPC used in ERA for surface soil exposure)
ERA = Ecological Risk Assessment
HQ = ecological hazard quotient from ERA.
LOAEL = lowest-observed-adverse-effect level
mg/kg = milligram per kilogram
NA = not applicable
NOAEL = no-observed-adverse-effect level
RGO = remedial goal option.

Table 2-7

Ecological Implications of Human Health Sediment RGOs on Sediment Receptors
Feasibility Study
TNT Area C, Former Plum Brook Ordnance Works
Sandusky, Ohio

Chemical[a]	Human Health RGO (mg/kg)	Expected Residual Conc.[b] (mg/kg)	Critical Ecological NOAEL Hazard Quotient (and receptor) [c]		EPC for Critical [d] Ecological Receptor (mg/kg)	Scaled [e] Ecological NOAEL Hazard Quotient Using Expected Residual Conc.	Estimated Reduction in Ecological Hazard [f]	Lowest Reported Detection Limit [d] (mg/kg)
2-amino-4,6-dinitrotoluene	3.6	3.25	42	mallard	12.8	11	4	0.0833
4-amino-2,6-dinitrotoluene	3.6	2.79	37	mallard	11.2	9	4	0.0833
2,4,6-trinitrotoluene	30	2.9	2,240	mallard	1,500	4	517	0.0833
Aroclor 1260	NA	0.71	67	raccoon	0.77	62	1	0.084
Selenium	NA	1.84	119	raccoon	1.77	124	1	1.19
Aluminum	NA	11,000	82	raccoon	11,000	82	1	NA

Chemical[a]	Human Health RGO (mg/kg)	Expected Residual Conc.[b] (mg/kg)	Critical Ecological NOAEL Hazard Quotient (and receptor) [c]		EPC for Critical [d] Ecological Receptor (mg/kg)	Scaled [e] Ecological NOAEL Hazard Quotient Using Expected Residual Conc.	Estimated Reduction in Ecological Hazard [f]	Lowest Reported Detection Limit [d] (mg/kg)
2-amino-4,6-dinitrotoluene	3.6	3.25	2	mallard	12.8	0.4	4	0.0833
4-amino-2,6-dinitrotoluene	3.6	2.79	2	mallard	11.2	0.4	4	0.0833
2,4,6-trinitrotoluene	30	2.9	169	raccoon	1,500	0.3	517	0.0833
Aroclor 1260	NA	0.71	7	raccoon	0.77	6	1	0.084
Selenium	NA	1.84	79	raccoon	1.77	82	1	1.19
Aluminum	NA	11,000	8	raccoon	11,000	8	1	NA

[a] Chemicals shown are those having the highest ecological HQ values in the Remedial Investigation Report Ecological Risk Assessment (ERA) (IT, 2001c). Human health COC are bolded.

[b] Residual concentrations in sediment were estimated by removing the sediment samples from the ecological data base that were within the proposed excavation footprint and recalculating the exposure point concentration following the methodology used in the ERA. Value shown for each chemical except 2,4,6-trinitrotoluene (TNT) is the remaining maximum detected concentration; value shown for TNT is 0.5 X the maximum reporting limit. Dilution from clean backfill was not considered in estimating the residual concentrations.

[c] Value and corresponding receptor shown are for the highest HQ value among receptors evaluated in the ERA.

[d] Value shown is from the ERA.

[e] Estimated using the following scaling relationship:

Scaled HQ = Residual Conc. x (pre-remediation HQ/pre-remediation EPC)

Note that calculations were performed using unrounded HQ values, but that the resultant scaled quotients are rounded to one significant figure.

[f] Estimated by dividing pre-remediation EPC by expected residual concentration (note that HQs are linear with concentration). Ecological hazard reduction factors are rounded to the nearest whole number.

Notes:
COC = chemical of concern
Conc. = Concentration
EPC = exposure point concentration (original EPC used in ERA for surface soil exposure)
ERA = Ecological Risk Assessment
HQ = ecological hazard quotient from ERA.
LOAEL = lowest-observed-adverse-effect level
mg/kg = milligram per kilogram
NA = not applicable

Table 2-8

Area and Volume of Contaminated Soil Requiring Remediation
Feasibility Study
TNT Area A, Former Plum Brook Ordnance Works
Sandusky, Ohio

Building No.	Building Name	Area No.	Area (ft^2)	Perimeter (feet)	Depth (feet)	Volume (yd^3)	Volume Hazardous Waste 2,4-DNT[a] (yd^3)	Volume Hazardous Waste Lead[b] (yd^3)	Total Volume Hazardous Waste (yd^3)	Volume PCB Waste[c] (yd^3)	Figure No.
112	Bi-Tri House	I	4444	268	9.5	1564	30	15	45	0	1-7
116	Wash House-Line 1	I	400	80	15	222	0	0	0	0	1-8
119	Acid & Fume Recovery	I	5376	374	9	1792	1792	187	1792	0	
		II	1854	231	4	275	0	0	0	0	
		Total	7230	605		2067	1792	187	1792	0	1-9
126	Wash House-Line 2	I	3600	240	11	1467	0	0	0	0	
		II	4505	347	8	1335	0	0	0	0	
		Total	8105	587		2802	0	0	0	0	1-10
129	Acid & Fume Recovery	I	400	80	7	104	52	0	52	0	1-11
131	Mono House	I	3600	240	13	1733	578	267	578	0	1-12
133	Fortifier House	I	400	80	6	89	0	0	0	0	1-13
139[b]	Acid & Fume Recovery	I	400	0	8	119	119	119	119	119	
		II	2835	316	4	420	0	0	0	0	
		Total	3235	316		539	119	119	119	119	1-14
141	Mono House	I	515	90	4	76	38	76	76	0	1-15
142	Bi-Tri House	I	1740	149	4	258	30	30	30	0	
		II	547	79	2	41	0	0	0	0	
		Total	2287	228		299	30	30	30	0	1-16
143	Fortifier House	I	266	64	4	39	0	0	0	0	1-17
146	Wash House-Line 4	I	7744	360	15	4302	143	0	143	0	1-18
148	Nailing House	I	296	60	7	77	0	0	0	0	1-19
182	Graining House	I	3600	240	7	933	533	0	533	0	1-3
192	DNT Sweating/Graining House	I	3102	214	4	460	460	0	460	0	1-4
195	DNT Nitrating	I	3600	240	7	933	117	0	117	0	1-5
111	Mono House	I	400	80	6	89	30	15	45	0	1-6
Total			**49624**	**3832**		**16328**	**3922**	**708**	**3990**	**119**	
								217		119	

Notes:
[shaded] = Estimated volume of soil that cannot be effectively composted to attain RGOs

[a] Volume of soil with conc. of 2,4-DNT > 2.4 mg/kg (20X TCLP limit) .

[b] Volume of soil with conc. of lead > 200 mg/kg (150 mg/kg x 1.33 blending factor for composting). Factor of 1.33 is used because soil is projected to be approximately 75 weight percent of compost mixture. Therefore, lead in soil up to 200 mg/kg would be below the LDR limit after composting.

[c] Volume of soil with total PCBs > 50 mg/kg is classified as a bulk PCB remediation waste.

Table 2-9

Area and Volume of Contaminated Soil and Sediment Requiring Remediation
Feasibility Study
TNT Area C, Former Plum Brook Ordnance Works
Sandusky, Ohio

Building No.	Building Name	Area No.	Area (ft^2)	Perimeter (feet)	Depth (feet)	Total Volume (yd^3)	Volume Hazardous Waste 2,4-DNT[a] (yd^3)	Volume Hazardous Waste Lead[b] (yd^3)	Total Volume Hazardous Waste (yd^3)	Volume PCB Waste[c] (yd^3)	Figure No.
602	Bi-Tri House	I	400	80	6	89	0	0	0	0	1-27
603	Fortifier House	I	400	80	8	119	45	0	45	0	1-28
606	Wash House-Line 10	I	400	80	7	104	0	0	0	0	1-29
616	Wash House-Line 11	I	1619	200	8	480	0	59	59	0	1-30
626	Wash House-Line 12	I	400	80	8	119	0	0	0	0	1-31
629	Acid & Fume Recovery	I	3600	240	10	1333	667	74	667	0	1-32
657	Wastewater Settling Basins	I	400	80	7	104	0	0	0	0	1-33
682	Bi-Tri House	I	3644	280	4	540	270	59	270	0	
		II	763	232	5	141	71	0	71	0	
		II	2885	316	8	855	0	0	0	0	
		Total	7292	828		1536	341	59	341	0	1-20
683	Fortifier House	I	3600	240	9	1200	720	0	720	0	1-21
686	Wash House-Line 8	I	8277	455	4	1226	0	59	59	0	1-22
689	Acid & Fume Recovery	I	400	80	8	119	119	60	119	0	1-23
692	Bi-Tri House	I	2851	254	8	845	211	0	211	0	1-24
693	Fortifier House	I	567	96	7	147	0	0	0	0	1-25
696	Wash House-Line 9	I	3301	392	12	1467	0	89	89	0	
		II	1476	90	5	273	0	0	0	0	
		Total	4777	482		1740	0	89	89	0	1-26
NA	Drainage Ditch north of Bld 616	I	600	140	2	44	0	0	0	0	1-34
Total			**35583**	**3415**		**9205**	**2103**	**400**	**2310**	**0**	
								400			

Notes:

[shaded] = Estimated volume of soil that cannot be effectively composted to attain RGOs

[a] Volume of soil with conc. of 2,4-DNT > 2.4 mg/kg (20X TCLP limit) .

[b] Volume of soil with conc. of Pb > 200 mg/kg (150 mg/kg x 1.33 blending factor for composting). Factor of 1.33 is used because soil is projected approximately 75 weight percent of compost mixture. Therefore, lead in soil up to 200 mg/kg would be below the LDR limit after composting.

[c] Volume of soil with total PCBs > 50 mg/kg is classified as a bulk PCB remediation waste.

Table 2-10

Comparison of Alternate Treatment Standards for Soil to Maximum Detected Concentrations
TNT Area A, Former Plum Brook Ordnance Works
Sandusky, Ohio

Chemical[a]	UTS[b]	ATS (mg/kg)	20 x ATS	MDC [c] (mg/kg)	Does MDC exceed 10 x UTS ?[d]
Inorganics					
Lead	0.75 mg/L	7.5	150	11900	**Yes**
Nitroaromatics					
2-Amino-4,6-dinitrotoluene	NA	NA	NA	33.6	NA
4-Amino-2,6-dinitrotoluene	NA	NA	NA	16	NA
2-Nitrotoluene	NA	NA	NA	582	NA
4-Nitrotoluene	NA	NA	NA	484	NA
2,4,6-Trinitrotoluene	NA	NA	NA	530	NA
2,4-Dinitrotoluene	140 mg/kg	1400	NA	8910	**Yes**
2,6-Dintrotoluene	28 mg/kg	280	NA	10274	**Yes**
PCBs					
Aroclor-1260 [e]	10 mg/kg	100	NA	69.8	No
Semivolatile Organic Compounds					
Benzo(a)pyrene	3.4 mg/kg	34	NA	0.218	No

COC - Chemicals of Concern
MDC - Maximum detected concentration
NA - Not Applicable (No UTS established)
PCBs - Polychlorinated Biphenyls
UTS - Universal Treatment Standard
ATS - Alternate Treatment Standard for contaminated soil = 10 times the UTS

Notes:

[a] Chemicals selected for screening are the COC in addition to inorganic constituents detected at elevated concentrations with respect to background concentrations.

[b] The universal treatment standards are defined in 40 CFR 268.48 Table UTS.

[c] The maximum detected concentration is the greater of the highest detected concentration for surface and subsurface soil values shown on Tables 2-13 and 2-14 of BHHRA (IT, 2001b).

[d] If the MDC in contaminated soil (classified as a hazardous waste) exceeds the UTS, a 90% reduction in total concentration capped by 10 x UTS is required to prior to land disposal (40 CFR 268.48).

[e] The UTS is for total PCBs.

Table 2-11

Comparison of Alternate Treatment Standards for Soil to Maximum Detected Concentrations
TNT Area C, Former Plum Brook Ordnance Works
Sandusky, Ohio

Chemicals [a]	UTS [b]	ATS (mg/kg)	20 x ATS (mg/kg)	MDC [c] (mg/kg)	MDC exceed 20 x ATS?[d]
Inorganics					
Chromium	0.6 mg/L	6.0	120	202	**Yes**
Lead	0.75 mg/L	7.5	150	934	**Yes**
Nitroaromatics					
2-Amino-4,6-dinitrotoluene	NA			38	NA
4-Amino-2,6-dinitrotoluene	NA			14.6	NA
2,4,6-Trinitrotoluene	NA			41621	NA
2,4-Dinitrotoluene	140 mg/kg	1400		275	No
2,6-Dinitrotoluene	28 mg/kg	280		65.5	No
PCBs					
Aroclor 1254 [e]	10 mg/kg	100		0.97	No
Aroclor 1260 [e]	10 mg/kg	100		4.9	No
Semivolatile Organic Compounds					
Benzo(a)anthracene	3.4 mg/kg	34		11.1	No
Benzo(a)pyrene	3.4 mg/kg	34		8.2	No
Benzo(b)fluoranthene	6.8 mg/kg	68		10.2	No
Dibenz(a,h)anthracene	8.2 mg/kg	82		1.4	No
Indeno(1,2,3-cd)pyrene	3.4 mg/kg	34		3.6	No

COC - Chemicals of Concern
MDC - Maximum detected concentration
NA - Not Applicable (No UTS established)
PCBs - Polychlorinated Biphenyls
UTS - Universal Treatment Standard
ATS - Alternate Ttreatment Standard for contaminated soil = 10 times the UTS

Notes:

[a] Chemicals selected for screening are the COC in addition to inorganic constituents detected at elevated concentrations with respect to background concentrations.

[b] The universal treatment standards are defined in 40 CFR 268.48 Table UTS.

[c] The maximum detected concentration is the greater of the highest detected concentration for surface and subsurface soil values shown on Tables 2-13 and 2-14 of BHHRA (IT, 2001b).

[d] If the MDC in contaminated soil (classified as a hazardous waste) exceeds the UTS, a 90% reduction in total concentration capped by 10 x UTS is required to prior to land disposal (40 CFR 268.48).

[e] The UTS is for total PCBs

Table 4-1
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

Alternative 2
Excavation/Composting/Off-Site and On-Site Disposal
Cost Estimate

Site: TNT Area A
Plum Brook Ordnance Works
Date: 9/11/2003

Scope:
1. Perform bench-scale treatability study, prepare composting work plan, H&S plan, materials list, and procurement.
2. Mobilize equipment and personnel.
3. Conduct pre-remediation soil sampling to better delineate the lateral and vertical extent of contamination.
4. Prepare site for remedial activity.
5. Excavate contaminated soil and perform confirmatory sampling.
6. Treatment of soil contaminated with nitroaromatic compounds via windrow composting.
7. Off-site disposal of lead- and PCB-contaminated soil that cannot be effectively treated via composting.
8. Backfill excavation with clean soil and spread treated compost across site.
9. Demobilize equipment and personnel.

1.0 Bench-Scale Study, Work Plan, Health and Safety Plan, Materials List, and Procurement

Includes:

1. Perform bench-scale treatability study to define most cost-effective compost mix formula. Results will be used to generate the design work plan.
2. Labor to generate RA work plan, engineering specifications, and Health and Safety Plan
3. Procure equipment and materials

Service/Materials	Unit	Unit Cost		Subtotal	
Bench-Scale Study	1	$20,000.00	/ea	$20,000.00	
Contractor Labor:					
Senior Engineer (E-12)	40	$97.00	/hr.	$3,880.00	
Task Manager (E-8)	80	$62.00	/hr.	$4,960.00	
Geologist (E-8)	40	$62.00	/hr.	$2,480.00	
Project Engineer (E-6)	160	$50.00	/hr.	$8,000.00	
Health and Safety (E-8)	40	$62.00	/hr.	$2,480.00	
Procurement Specialist (E-6)	80	$56.00	/hr.	$4,480.00	
Drafting (E-6)	40	$50.00	/hr.	$2,000.00	
Document Repro (Draft and Final)	2	$1,000.00	/ea	$2,000.00	
				Subtotal	**$50,280.00**

Table 4-1
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

2.0 Mobilization/Demobilization of Equipment and Personnel

Includes:

1. Mobilize equipment and personnel
2. Contractor field crew consists of a site superintendent, geolgist, and field technician.
3. Four 2-day trips for 2 contractor personnel for pre-remediation coordination.

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent (E-8)	24	$60.00	/hr	$1,440.00	
QA (Sampling) Coordinator	24	$40.00	/hr	$960.00	
H&S Coordinator	16	$50.00	/hr	$800.00	
Geologist	2	$480.00	/day	$960.00	
Subcontractor Labor:					
Excavator Operator	2	$340.91	/day	$681.83	
Equipment Operator	2	$326.98	/day	$653.95	
Dozer Operator	2	$326.98	/day	$653.95	
Loader Operator	2	$312.00	/day	$624.00	
Loader Operator	2	$312.00	/day	$624.00	
Laborers	2	$288.00	/day	$576.00	
Truck Drivers	12	$262.00	/day	$3,144.00	
Equipment:					
Excavator	2	$704.00	/day	$1,408.00	
1 cy Front Wheel Loader	2	$280.86	/day	$561.72	
3 cy Front Wheel Loader	2	$485.22	/day	$970.44	
Windrow Turner	2	$1,000.00	/mob	$2,000.00	
D-6H Dozer	2	$630.70	/day	$1,261.40	
Dump Trucks	12	$428.00	/day	$5,136.00	
Travel for contractor crew:					
Perdiem	40	$38.00	/day	$1,520.00	
Lodging	40	$80.00	/day	$3,200.00	
Rental Car	18	$40.00	/day	$720.00	
Airfare	24	$600.00	/ea	$14,400.00	
				Subtotal	**$42,295.00**

Table 4-1
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

3.0 Pre-Remediation Soil Sampling

Includes:
1. Hydropunch soil sampling
2. Analysis of soil samples for chemicals of concern.

Assumptions:

1. Perimeter of proposed remediation area (ft) =	3832
2. Distance between boring locations =	40
3. No. of borings =	96
4. Average depth of boring (ft) =	10
5. No. of samples collected per boring =	3
6. Total no. of samples collected =	288
7. No. of borings advanced per day =	10

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor:					
Field Geologist	10	$480.00	/day	$4,800.00	
Subcontractor:					
Mob/Demob	1	$2,000.00	/ea	$2,000.00	
Hydropunch Borings	960	$15.00	/ft	$14,400.00	
Equipment Decon	96	$90.00	/ea	$8,640.00	
Materials:					
Field Supplies	96	$20.00	/bor.	$1,920.00	
Field Instruments	2	$400.00	/wk	$800.00	
Analytical:					
NACs (8330)	288	$158.00	/ea	$45,504.00	
Lead	288	$24.00	/ea	$6,912.00	
PAHs (8270C)	288	$160.00	/ea	$46,080.00	
PCBs	288	$83.00	/ea	$23,904.00	
Shipping	77	$40.00	/ea	$3,072.00	
Equipment:					
P/U Truck	10	$52.00	/day	$520.00	
Travel for Contractor Crew:					
Perdiem	10	$38.00	/day	$380.00	
Lodging	10	$80.00	/day	$800.00	
				Subtotal	**$159,732.00**

Table 4-1
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

4.0 Site Preparation

Includes:
1. Clear remedial areas and treatment area = 5 acres
2. Construct 12" soil berm around treatment areas (400 ft x 500 ft area = 1800 ft).
3. Excavate soil for contact water retension pond.
4. Construct 6-inch reinforced concrete slab for treatment area.

Assumptions:

1. Volume of soil removed for contact water retention pond =	3,288
2. Excavator: hydraulic backhoe, 1 cy bucket	
3. Excavator output (cy/day) =	600
4. Days to excavate soil =	7
5. Volume of containment berm (cy) =	133
6. No. of contractor field crew =	2
7. Area of concrete treatment slab (160 ft x 420 ft) (sf) =	67200

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor:					
Site Superintendent	320	$60.00	/hr	$19,200.00	
QA Coordinator	320	$40.00	/hr	$12,800.00	
Subcontractor:					
Surveying	1	$24,000.00	/site	$24,000.00	
Site Clearing	7	$2,300.00	/acre	$16,100.00	
Excavator Operator	7	$258.80	/day	$1,811.60	
Concrete Slab	67200	$4.39	/sf	$295,008.00	
Equipment:					
Excavator	7	$704.00	/day	$4,928.00	
Materials:					
Earthen containment berm	133	$6.00	/cy	$798.00	
Travel for Field Crew:					
Per Diem	112	$38.00	/day	$4,256.00	
Lodging	112	$80.00	/day	$8,960.00	
Rental Car	56	$40.00	/day	$2,240.00	
				Subtotal	**$390,102.00**

5.0 Excavation of Contaminated Soil

Includes:
1. Excavation of soil with contaminants exceeding RGOs
2. Screen oversize material
3. Collect confirmatory samples to determine extent of excavation
4. Staging and characterizing waste stream

Assumptions and Calculations:

1. Cubic yards of consolidated soil excavated =	16328
2. Swell factor for soil upon excavation =	1.3
3. Cubic yards of unconsolidated soil =	21226
4. Density of unconsolidated soil (tons/cy) =	1.1
5. Mass of unconsolidated soil (tons) =	23349
6. Capacity of screening plant (tons/hr) =	100
7. Excavator: hydraulic backhoe, 1 cy bucket	
8. Excavator output (cy/day) =	600
9. Days to excavate soil =	43
10. Dump truck capacity (cy) =	12
11. Dump truck haul distance (mi.) =	0.5
12. Dump truck output (cy/day) =	250
13. No. of required dump trucks per day =	2
14. Soil sample collected for waste characterization / cy =	150
15. No. of soil samples collected for waste characterization =	142
16. Number of contractor field crew =	3
17. Number of subcontractor excavation crew =	4
18. Number of subcontractor screening crew =	3
19. Airfare included under mobilization	
20. Lineal foot of excavation per confirmation sample =	20
21. Resampling factor for confirmation sampling =	1.1
22. No.of confirmatory samples from excavated area =	347
23. Subcontractor markup on equipment =	1.25
24. Subcontractor markup on labor =	1.31
25. Excavation area (ft^2) =	49624
26. Cost multiplier for 1-week turnaround on analytical data =	1.25
27. Fraction of excavation work performed in Level C PPE =	0.10
28. Labor productivity factor for Level C work =	0.67
29. Days excavation crew in Level C =	5
30. Days screening crew in Level C =	4
31. Perimeter of excavation area (ft) =	3832
32. Excavation area (sf) =	49624
33. Volume of pit water requiring POTW disposal (gal) =	20000

Service/Materials	Unit	Unit Cost		Subtotal
Contractor Labor:				
Site Superintendent (E-8)	344	$60.00	/hr	$20,640.00
QA (Sampling) Coordinator	344	$40.00	/hr	$13,760.00
H&S Coordinator	344	$50.00	/hr	$17,200.00
Chemist (home office)	86	$51.00	/hr	$4,386.00
Subcontractor:				
Excavator Operator	43	$340.91	/day	$14,659.32
Equipment Operator	35	$326.98	/day	$11,444.16
Loader Operator	35	$312.00	/day	$10,920.00
Laborers	78	$288.00	/day	$22,464.00
Truck Drivers	129	$262.00	/day	$33,798.00
Road Repair	1	$50,000.00	/site	$50,000.00
PBOW Security	43	$120.00	/day	$5,160.00
Equipment:				
Excavator	43	$704.00	/day	$30,272.00
100-ton/hr Screening Plant	7	$1,800.00	/wk	$12,600.00
Radial Stacking Conveyor	7	$1,222.00	/wk	$8,554.00
1 cy Front Wheel Loader	35	$280.86	/day	$9,830.10
Dump Truck	86	$428.00	/day	$36,808.00
3000 gal. Water Truck	43	$402.00	/day	$17,286.00
150 gpm Pump	2	$2,439.00	/ea.	$4,878.00
300 gpm Pump	2	$3,749.00	/ea.	$7,498.00
7-ft Diameter Sand Filter	1	$22,310.00	/ea.	$22,310.00
200-gpm GAC Adsorber (6000#-disp.)	1	$14,217.00	/ea.	$14,217.00
20000 gal Steel Water Tank	1	$14,618.00	/ea.	$14,618.00

Table 4-1
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

5.0 Excavation of Contaminated Soil (continued)					
Analytical:					
TCLP Extraction	142	$12.88	/ea	$1,828.25	
SVOCs (8270C)	489	$300.00	/ea	$146,700.00	
NACs (8330)	489	$197.50	/ea	$96,577.50	
Lead	489	$30.00	/ea	$14,670.00	
PCBs	489	$103.75	/ea	$50,733.75	
NAC field analyses	347	$40.00	/ea	$13,880.00	
Lead field analyses	2	$4,200.00	/mo.	$8,400.00	
Shipping	130	$40.00	/ea	$5,216.00	
Materials & Services:					
Office Trailer	4	$500.00	/mo.	$2,000.00	
Level D PPE	245	$10.00	/day	$2,450.00	
Level C PPE	32	$35.00	/day	$1,120.00	
PID rental	2	$974.00	/mo.	$1,948.00	
CGI rental	2	$380.00	/mo.	$760.00	
Pit Water Disposal	20	$1.62	/kgal	$32.40	
Travel for Field Crew:					
Perdiem	568	$38.00	/day	$21,584.00	
Lodging	568	$80.00	/day	$45,440.00	
Rental Car	230	$40.00	/day	$9,200.00	
				Subtotal	**$805,842.00**

6.0 Windrow Composting of Contaminated of Soil

Includes:
1. Purchase and erection of treatment building
2. Purchase of composting equipment
3. Procurement and installation of contact water treatment equipment
4. Purchase of stockpile & amendment storage liners and covers
5. Procurement & stockpiling of composting amendments
6. Mix and compost soil and amendments
7. Pre-compliance testing: after compost formation & at end of treatment.
8. Pre-compliance testing using definitive field analysis for NAC
9. Compliance sampling for NAC, metals, PAHs, PCBs

Assumptions:

1. Volume of consolidated soil to be treated (cy) =	15992
2. Volume of unconsolidated soil to be treated (cy) =	20790
3. Compost treatment duration (months) =	14
4. Capacity of windrow turner (tons/hr) =	3,200
5. Operating life of flails (hrs) =	25
6. No. of flails on windrow turner =	172
7. Volume of compost in treatment building (cy) =	4,448
8. Bulk density of compost (tons/cy) =	0.379
9. Bermed work area (sf) =	200,000
10. Contaminated soil stockpile area (sf) =	62,370
11. Treated soil stockpile area (sf) =	6,672
12. Height of stockpiles (ft) =	9
13. Manure storage area (sf) =	192
14. Capacity of contact water treatment system (gpm) =	200
15. Loading rate of multimedia filter (gpm/sf) =	5
16. Diameter of multimedia filter (ft) =	7
17. Volume of bulking amendment (cy) =	59947
18. Volume of agricultural waste amendment (cy) =	2425
19. Total volume of compost (cy) =	83133
20. Shrinkage factor for compost =	0.60
21. Compost volume per pre-compliance sample collected (cy) =	50
22. Compost volume per compliance sample collected (cy) =	150
23. Markup on materials =	1.1
24. Subcontractor markup on equipment =	1.25
25. Subcontractor markup on labor =	1.31
26. Cost multiplier for 1-week turnaround on analytical costs =	1.25
27. Salvage factor for major equipment at end of project =	0.50
28. Number of contractor field crew =	2
29. Number of subcontractor field crew =	3

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent	308	$480.00	/day	$147,840.00	
QA (Sampling) Coordinator	308	$320.00	/day	$98,560.00	
Subcontractor Labor:					
Equipment Operator	308	$326.98	/day	$100,708.61	
Equipment Operator	308	$326.98	/day	$100,708.61	
Equipment Operator	308	$326.98	/day	$100,708.61	
PBOW Security	56	$120.00	/day	$6,720.00	
Equipment:					
Windrow Turner (7' x 20')	1	$156,250.00	/ea	$156,250.00	less salvage
75 cy/hr Tub Grinder	1	$26,225.00	/ea	$26,225.00	less salvage
Bobcat	1	$16,000.00	/ea	$16,000.00	less salvage
P/U Truck	1	$20,000.00	/ea	$20,000.00	

Table 4-1
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

6.0 Windrow Composting of Contaminated of Soil (continued)						
Materials:						
Office Trailer	28	$500.00	/mo.	$14,000.00		
Erect Treatment Building	2	$35,080.00	/ea	$70,160.00		
Building Foundation & Accessories	2	$14,132.00	/ea	$28,264.00		
Treatment Building	2	$130,866.00	/ea	$261,732.00		
Treatment Building Lighting	2	$10,460.00	/ea	$20,920.00		
Dismantle Treatment Building	2	$33,500.00	/ea	$67,000.00		
Repl. Flails for Windrow Turner	3096	$9.50	/ea	$29,412.00		
40-mil Liner for Stockpiles	72494	$1.58	/sf	$114,830.65		
10-mil Cover for Stockpiles	69795	$0.83	/sf	$57,580.88		
40-mil Liner for Manure	202	$1.58	/sf	$319.33		
10-mil Cover for Manure	606	$0.83	/sf	$499.95		
Straw	59947	$13.56	/cy	$812,611.56		
Manure	2425	$14.97	/cy	$36,309.53		
Water	1775	$9.40	/kgal	$16,682.67		
Level D PPE	924	$10.00	/day	$9,240.00		
PID rental	14	$974.00	/mo.	$13,636.00		
CGI rental	14	$380.00	/mo.	$5,320.00		
Analytical:						
Pre-Compliance Sampling:						
NAC field analyses	3325	$40.00	/ea	$133,012.80		
Compliance Testing:						
SVOCs (8270C)	333	$300.00	/ea	$99,759.60		
NACs (8330)	333	$197.50	/ea	$65,675.07		
Lead	333	$30.00	/ea	$9,975.96		
PCBs	333	$103.75	/ea	$34,500.20		
Travel for Field Crew:						
Per Diem	2156	$38.00	/day	$81,928.00		
Lodging	2156	$30.00	/day	$64,680.00	long-term stay	
Rental Car	431	$40.00	/day	$17,240.00		
				Subtotal		**$2,839,011.00**

Table 4-1
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

7.0 Off-Site Disposal

Includes:
1. Dispose of stabilized soil and non-hazardous soil (not stabilized) at a nonhazardous waste
2. Dispose of PCB waste at a TSCA approved landfill

Assumptions and Calculations:

1. Consolidated volume of D008 soil for haz disposal (cy) =	217	
2. Consolidated volume of D030 soil for haz disposal (cy) =	0	
3. Consolidated volume of PCB soil for haz disposal (cy) =	119	
4. Consolidated volume of soil for non-haz disposal (cy) =	0	
5. Non-haz waste transportation cost ($/ton) =	6	
6. Non-haz waste disposal costs ($/ton) =	31	Erie County Landfill
7. Non-haz waste regulatory fees ($/ton) =	0	included in disposal
8. Haz waste transportation cost ($/ton) =	35	
9. D008 Haz waste disposal cost ($/ton) =	75	EO Environmental
10. D030 Haz waste disposal cost ($/ton) =	150	EO Environmental
11. PCB Haz waste disposal cost ($/ton) =	75	EO Environmental
12. Haz waste regulatory fees ($/ton) =	10	
13. No. of contractor field crew =	2	
14. No. of subcontractor field crew =	2	
14. Output of front-end loader (cy/day) =	550	
15. No. of field days =	1	

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent (E-8)	8	$60.00	/hr	$480.00	
QA Coordinator	8	$40.00	/hr	$320.00	
Subcontractor Labor:					
Front End Loader Operator	1	$346.00	/day	$346.00	
Oiler	1	$293.00	/day	$293.00	
PBOW Security	1	$120.00	/day	$120.00	
Materials:					
Level D PPE	2	$10.00	/day	$20.00	
Equipment:					
1 cy Front Wheel Loader	1	$280.86	/day	$280.86	
Disposal Costs:					
Transportation (Non-Haz Waste)	0	$6.00	/ton	$0.00	
Disposal Cost (Non-Haz waste)	0	$31.00	/ton	$0.00	
Transportation (Haz Waste)	480	$35.00	/ton	$16,799.54	
Disposal Cost (D008 haz waste)	310	$85.00	/ton	$26,334.44	
Disposal Cost (D030 haz waste)	0	$160.00	/ton	$0.00	
Disposal Cost (PCB haz waste)	170	$85.00	/ton	$14,464.45	
Travel for field crew:					
Lodging	4	$80.00	/day	$320.00	
Perdiem	4	$38.00	/day	$152.00	
Rental Car	2	$40.00	/day	$80.00	
				Subtotal	**$60,010.00**

Table 4-1
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

8.0 On-Site Compost Disposal / Backfill Excavation with Clean Soil

Includes:
1. Backfill excavated areas with clean backfill.
2. Load treated compost, truck to site, spread compost across site with dozer
3. Confirmation testing under contaminated soil stockpiles.
4. Prepare site close-out report.

Assumptions and Calculations:

1. Volume of consolidated soil excavated (cy) =	16328
2. Compaction factor =	1.15
3. Volume of soil required for backfill (cy) =	18777
4. Cost of clean backfill soil delivered to site ($/cy) =	12
6. Field days required to backfill soil =	34
7. No. of contractor field crew =	2
8. No. of subcontractor backfill field crew =	1
9. No. of compost loading field crew =	7
10. No. of compost spreading field crew =	2
8. No. of confirmatory samples from clean backfill =	2
9. Total volume of compost before treatment (cy) =	83133
10. Shrinkage factor for treated compost =	0.60
11. Volume of compost after treatment (cy) =	49880
12. Loader output (cy/day) =	1575
13. Days to load treated compost =	48
14. Dump truck capacity (cy) =	12
15. Dump truck haul distance (mi.) =	0.5
16. Dump truck output (cy/day) =	250
17. No. of dump trucks per day =	6
18. Dozer (D-6H) capacity (cy/hr) =	90
19. Days to spread treated compost =	70
20. Subcontractor markup on equipment =	1.25
21. Subcontractor markup on labor =	1.31
22. Area of contaminated soil stockpile (sf) =	62370
23. Area per confirmation sample (sf) =	400
24. No. of confirmation samples under soil stockpile =	156

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent	560	$60.00	/hr	$33,600.00	
QA Coordinator	560	$40.00	/hr	$22,400.00	
Site Close-Out Report	1	$20,000.00	/ea	$20,000.00	
Subcontractor Labor:					
Front End Loader Operator	34	$312.00	/day	$10,608.00	
Front End Loader Operator	48	$312.00	/day	$14,976.00	
Dump Truck Drivers	288	$262.00	/day	$75,456.00	
Dozer Operator	70	$326.98	/day	$22,888.32	
Laborer/Oiler	70	$279.29	/day	$19,550.44	
PBOW Security	34	$120.00	/day	$4,080.00	
Equipment:					
1 cy Front End Loader	34	$280.86	/day	$9,549.24	
3 cy Front End Loader	48	$485.22	/day	$23,290.56	
Dump Trucks	288	$428.00	/day	$123,264.00	
D-6H Dozer	70	$630.70	/day	$44,149.00	
Material:					
Backfill	18777	$12.00	/cy	$225,326.40	delivered to site
PID rental	7	$974.00	/mo.	$6,818.00	
CGI rental	7	$380.00	/mo.	$2,660.00	
Level D PPE	510	$10.00	/day	$5,100.00	
Analytical:					
RCRA Metals	2	$105.00	/ea	$210.00	
NACs (8330)	158	$158.00	/ea	$24,964.00	
SVOCs	2	$230.00	/ea	$460.00	
Lead	156	$24.00	/ea	$3,744.00	
PAHs (8270C)	156	$160.00	/ea	$24,960.00	
PCBs	156	$83.00	/ea	$12,948.00	
Shipping	42	$40.00	/ea	$1,680.00	

Table 4-1
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

8.0 On-Site Compost Disposal / Backfill Excavation with Clean Soil (continued)					
Travel for field crew:					
	Lodging	910	$80.00 /day	$72,800.00	
	Perdiem	910	$38.00 /day	$34,580.00	
	Rental Car	311	$40.00 /day	$12,440.00	
Subcontract:					
	Reseeding	218	$56.84 /msf	$12,391.00	
				Subtotal	**$864,893.00**
9.0 Overall Cost					
				Total Capital Cost	**$5,212,165.00**
				Contingency (30%)	**$1,563,650.00**
				PM Multiplier (7.5%)	**$390,912.00**
				Fee/Profit (10%)	**$521,217.00**
				Total Cost	**$7,688,000.00**

*This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

Table 4-2
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

Alternative 2
Excavation/Composting/Off-Site and On-Site Disposal
Cost Estimate

Site: TNT Area C
Plum Brook Ordnance Works
Date: 9/11/2003

Scope:

1. Perform bench-scale treatability study, prepare composting work plan, H&S plan, materials list, and procurement.
2. Mobilize equipment and personnel.
3. Conduct pre-remediation soil sampling to better delineate the lateral and vertical extent of contamination.
4. Prepare site for remedial activity.
5. Excavate contaminated soil and perform confirmatory sampling.
6. Treatment of soil contaminated with nitroaromatic compounds via windrow composting.
7. Off-site disposal of lead- and PCB-contaminated soil that cannot be effectively treated via composting.
8. Backfill excavation with clean soil and spread treated compost across site.
9. Demobilize equipment and personnel.

1.0 Bench-Scale Study, Work Plan, Health and Safety Plan, Materials List, and Procurement

Includes:

1. Perform bench-scale treatability study to define most cost-effective compost mix formula. Results will be used to generate the design work plan.
2. Labor to generate work plan, engineering specifications, and Health and Safety Plan
3. Procure equipment and materials

Service/Materials	Unit	Unit Cost		Subtotal	
Bench-Scale Study	1	$20,000.00	/ea	$20,000.00	
Contractor Labor:					
Senior Engineer (E-12)	40	$97.00	/hr.	$3,880.00	
Task Manager (E-8)	80	$62.00	/hr.	$4,960.00	
Geologist (E-8)	40	$62.00	/hr.	$2,480.00	
Project Engineer (E-6)	160	$50.00	/hr.	$8,000.00	
Health and Safety (E-8)	40	$62.00	/hr.	$2,480.00	
Procurement Specialist (E-6)	80	$56.00	/hr.	$4,480.00	
Drafting (E-6)	40	$50.00	/hr.	$2,000.00	
Document Repro (Draft and Final)	2	$1,000.00	/ea	$2,000.00	
				Subtotal	**$50,280.00**

Table 4-2
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

2.0 Mobilization/Demobilization of Equipment and Personnel

Includes:

1. Mobilize equipment and personnel
2. Contractor field crew consists of a site superintendent, geolgist, and field technician.
3. Four 2-day trips for 2 contractor personnel for pre-remediation coordination.

Service/Materials	Unit	Unit Cost		Subtotal	
Labor:					
Site Superintendent (E-8)	24	$60.00	/hr	$1,440.00	
QA (Sampling) Coordinator	24	$40.00	/hr	$960.00	
H&S Coordinator	16	$50.00	/hr	$800.00	
Geologist	2	$480.00	/day	$960.00	
Subcontractor Labor:					
Excavator Operator	2	$340.91	/day	$681.83	
Equipment Operator	2	$326.98	/day	$653.95	
Dozer Operator	2	$326.98	/day	$653.95	
Loader Operator	2	$312.00	/day	$624.00	
Loader Operator	2	$312.00	/day	$624.00	
Laborers	2	$288.00	/day	$576.00	
Truck Drivers	12	$262.00	/day	$3,144.00	
Equipment:					
Excavator	2	$704.00	/day	$1,408.00	
1 cy Front Wheel Loader	2	$280.86	/day	$561.72	
3 cy Front Wheel Loader	2	$485.22	/day	$970.44	
Windrow Turner	2	$1,000.00	/mob	$2,000.00	
D-6H Dozer	2	$630.70	/day	$1,261.40	
Dump Trucks	12	$428.00	/day	$5,136.00	
Travel for contractor crew:					
Perdiem	40	$38.00	/day	$1,520.00	
Lodging	40	$80.00	/day	$3,200.00	
Rental Car	18	$40.00	/day	$720.00	
Airfare	24	$600.00	/ea	$14,400.00	
				Subtotal	**$42,295.00**

Table 4-2
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

3.0 Pre-Remediation Soil Sampling

Includes:
1. Hydropunch soil sampling
2. Analysis of soil samples for chemicals of concern.

Assumptions:

1. Perimeter of proposed remediation area (ft) =	3415
2. Distance between boring locations =	40
3. No. of borings =	85
4. Average depth of boring (ft) =	10
5. No. of samples collected per boring =	3
6. Total no. of samples collected =	255
7. No. of borings advanced per day =	10

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor:					
Field Geologist	9	$480.00	/day	$4,320.00	
Subcontractor:					
Mob/Demob	1	$2,000.00	/ea	$2,000.00	
Hydropunch Borings	850	$15.00	/ft	$12,750.00	
Equipment Decon	85	$90.00	/ea	$7,650.00	
Materials:					
Field Supplies	85	$20.00	/bor.	$1,700.00	
Field Instruments	2	$400.00	/wk	$800.00	
Analytical:					
NACs (8330)	255	$158.00	/ea	$40,290.00	
Lead	255	$24.00	/ea	$6,120.00	
PAHs (8270C)	255	$160.00	/ea	$40,800.00	
PCBs	255	$83.00	/ea	$21,165.00	
Shipping	68	$40.00	/ea	$2,720.00	
Equipment:					
P/U Truck	9	$52.00	/day	$468.00	
Travel for Contractor Crew:					
Perdiem	9	$38.00	/day	$342.00	
Lodging	9	$80.00	/day	$720.00	
				Subtotal	**$141,845.00**

Table 4-2
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

4.0 Site Preparation

Includes:
1. Clear remedial areas and treatment area = 5 acres
2. Construct 12" soil berm around treatment areas (400 ft x 500 ft area = 1800 ft).
3. Excavate soil for contact water retension pond.
4. Construct 6-inch reinforced concrete slab for treatment area.

Assumptions:

1. Volume of soil removed for contact water retention pond =	3,288
2. Excavator: hydraulic backhoe, 1 cy bucket	
3. Excavator output (cy/day) =	600
4. Days to excavate soil =	7
5. Volume of containment berm (cy) =	133
6. No. of contractorfield crew =	2
7. Area of concrete treatment slab (160 ft x 420 ft) (sf) =	67200

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor:					
Site Superintendent	320	$60.00	/hr	$19,200.00	
QA Coordinator	320	$40.00	/hr	$12,800.00	
Subcontractor:					
Surveying	1	$24,000.00	/site	$24,000.00	
Site Clearing	7	$2,300.00	/acre	$16,100.00	
Excavator Operator	7	$258.80	/day	$1,811.60	
Concrete Slab	67200	$4.39	/sf	$295,008.00	
Equipment:					
Excavator	7	$704.00	/day	$4,928.00	
Materials:					
Earthen containment berm	133	$6.00	/cy	$798.00	
Travel for Field Crew:					
Per Diem	112	$38.00	/day	$4,256.00	
Lodging	112	$80.00	/day	$8,960.00	
Rental Car	56	$40.00	/day	$2,240.00	
				Subtotal	**$390,102.00**

Table 4-2
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

5.0 Excavation of Contaminated Soil

Includes:
1. Excavation of soil with contaminants exceeding RGOs
2. Screen oversize material
3. Collect confirmatory samples to determine extent of excavation
4. Staging and characterizing waste stream

Assumptions and Calculations:

1. Cubic yards of consolidated soil excavated =	9205
2. Swell factor for soil upon excavation =	1.3
3. Cubic yards of unconsolidated soil =	11967
4. Density of unconsolidated soil (tons/cy) =	1.1
5. Mass of unconsolidated soil (tons) =	13163
6. Capacity of screening plant (tons/hr) =	100
7. Excavator: hydraulic backhoe, 1 cy bucket	
8. Excavator output (cy/day) =	600
9. Days to excavate soil =	24
10. Dump truck capacity (cy) =	12
11. Dump truck haul distance (mi.) =	0.5
12. Dump truck output (cy/day) =	250
13. No. of required dump trucks per day =	2
14. Soil sample collected for waste characterization / cy =	150
15. No. of soil samples collected for waste characterization =	80
16. Number of contractor field crew =	3
17. Number of subcontractor excavation crew =	4
18. Number of subcontractor screening crew =	3
19. Airfare included under mobilization	
20. Lineal foot of excavation per confirmation sample =	20
21. Resampling factor for confirmation sampling =	1.1
22. No.of confirmatory samples from excavated area =	286
23. Subcontractor markup on equipment =	1.25
24. Subcontractor markup on labor =	1.31
25. Excavation area (ft^2) =	35583
26. Cost multiplier for 1-week turnaround on analytical data =	1.25
27. Fraction of excavation work performed in Level C PPE =	0.10
28. Labor productivity factor for Level C work =	0.67
29. Days excavation crew in Level C =	3
30. Days screening crew in Level C =	2
31. Perimeter of excavation area (ft) =	3415
32. Excavation area (sf) =	35583
33. Volume of pit water requiring POTW disposal (gal) =	20000

Service/Materials	Unit	Unit Cost		Subtotal
Contractor Labor:				
Site Superintendent (E-8)	192	$60.00	/hr	$11,520.00
QA (Sampling) Coordinator	192	$40.00	/hr	$7,680.00
H&S Coordinator	192	$50.00	/hr	$9,600.00
Chemist (home office)	48	$51.00	/hr	$2,448.00
Subcontractor:				
Excavator Operator	24	$340.91	/day	$8,181.95
Equipment Operator	20	$326.98	/day	$6,539.52
Loader Operator	20	$312.00	/day	$6,240.00
Laborers	44	$288.00	/day	$12,672.00
Truck Drivers	72	$262.00	/day	$18,864.00
Road Repair	1	$50,000.00	/site	$50,000.00

Table 4-2
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

5.0 Excavation of Contaminated Soil (continued)						
Equipment:						
Excavator	24	$704.00	/day	$16,896.00		
100-ton/hr Screening Plant	4	$1,800.00	/wk	$7,200.00		
Radial Stacking Conveyor	4	$1,222.00	/wk	$4,888.00		
1 cy Front Wheel Loader	20	$280.86	/day	$5,617.20		
Dump Truck	48	$428.00	/day	$20,544.00		
3000 gal. Water Truck	24	$402.00	/day	$9,648.00		
150 gpm Pump	2	$2,439.00	/ea.	$4,878.00		
300 gpm Pump	2	$3,749.00	/ea.	$7,498.00		
7-ft Diameter Sand Filter	1	$22,310.00	/ea.	$22,310.00		
200-gpm GAC Adsorber (6000#-disp.)	1	$14,217.00	/ea.	$14,217.00		
20000 gal Steel Water Tank	1	$14,618.00	/ea.	$14,618.00		
Analytical:						
TCLP Extraction	80	$12.88	/ea	$1,030.00		
SVOCs (8270C)	366	$300.00	/ea	$109,800.00		
NACs (8330)	366	$197.50	/ea	$72,285.00		
Lead	366	$30.00	/ea	$10,980.00		
PCBs	366	$103.75	/ea	$37,972.50		
NAC field analyses	286	$40.00	/ea	$11,440.00		
Lead field analyses	2	$4,200.00	/mo.	$8,400.00		
Shipping	98	$40.00	/ea	$3,904.00		
Materials & Services:						
Office Trailer	4	$500.00	/mo.	$2,000.00		
Level D PPE	138	$10.00	/day	$1,380.00		
Level C PPE	18	$35.00	/day	$630.00		
PID rental	2	$974.00	/mo.	$1,948.00		
CGI rental	2	$380.00	/mo.	$760.00		
Pit Water Disposal	20	$1.62	/kgal	$32.40		
Travel for Contractor Crew:						
Perdiem	319	$38.00	/day	$12,122.00		
Lodging	319	$80.00	/day	$25,520.00		
Rental Car	129	$40.00	/day	$5,160.00		
					Subtotal	**$567,424.00**

Table 4-2
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

6.0 Windrow Composting of Contaminated of Soil

Includes:

1. Purchase and erection of treatment building
2. Purchase of composting equipment
3. Procurement and installation of contact water treatment equipment
4. Purchase of stockpile & amendment storage liners and covers
5. Procurement & stockpiling of composting amendments
6. Mix and compost soil and amendments
7. Pre-compliance testing: after compost formation & at end of treatment.
8. Pre-compliance testing using definitive field analysis for NAC
9. Compliance sampling for NAC, metals, PAHs, PCBs

Assumptions:

1. Volume of consolidated soil to be treated (cy) =	8805
2. Volume of unconsolidated soil to be treated (cy) =	11446
3. Compost treatment duration (months) =	8
4. Capacity of windrow turner (tons/hr) =	3,200
5. Operating life of flails (hrs) =	25
6. No. of flails on windrow turner =	172
7. Volume of compost in treatment building (cy) =	4,448
8. Bulk density of compost (tons/cy) =	0.379
9. Bermed work area (sf) =	200,000
10. Contaminated soil stockpile area (sf) =	34,338
11. Treated soil stockpile area (sf) =	6,672
12. Height of stockpiles (ft) =	9
13. Manure storage area (sf) =	192
14. Capacity of contact water treatment system (gpm) =	200
15. Loading rate of multimedia filter (gpm/sf) =	5
16. Diameter of multimedia filter (ft) =	7
17. Volume of bulking amendment (cy) =	33003
18. Volume of agricultural waste amendment (cy) =	1335
19. Total volume of compost before treatment (cy) =	45773
20. Shrinkage factor for compost =	0.60
21. Compost volume per pre-compliance sample collected (cy) =	50
22. Compost volume per compliance sample collected (cy) =	150
23. Markup on materials =	1.1
24. Subcontractor markup on equipment =	1.25
25. Subcontractor markup on labor =	1.31
26. Cost multiplier for 1-week turnaround on analytical data =	1.25
27. Factor for salvage value of major capital equipment =	0.50
28. Number of contractor field crew =	2
29. Number of subcontractor field crew =	3

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent	176	$480.00	/day	$84,480.00	
QA (Sampling) Coordinator	176	$320.00	/day	$56,320.00	
Subcontractor Labor:					
Equipment Operator	176	$326.98	/day	$57,547.78	
Equipment Operator	176	$326.98	/day	$57,547.78	
Equipment Operator	176	$326.98	/day	$57,547.78	
PBOW Security	32	$120.00	/day	$3,840.00	
Equipment:					
Windrow Turner (7' x 20')	1	$156,250.00	/ea.	$156,250.00	less salvage
75 cy/hr Tub Grinder	1	$26,225.00	/ea.	$26,225.00	less salvage
Bobcat	1	$16,000.00	/ea.	$16,000.00	less salvage
P/U Truck	1	$20,000.00	/ea.	$20,000.00	

Table 4-2
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

6.0 Windrow Composting of Contaminated of Soil (continued)						
Materials:						
Office Trailer	16	$500.00	/mo.	$8,000.00		
Erect Treatment Building	2	$35,080.00	/ea	$70,160.00		
Building Foundation & Accessories	2	$14,132.00	/ea	$28,264.00		
Treatment Building	2	$130,866.00	/ea	$261,732.00		
Treatment Building Lighting	2	$10,460.00	/ea	$20,920.00		
Dismantle Treatment Building	2	$33,500.00	/ea	$67,000.00		
Repl. Flails for Windrow Turner	1892	$9.50	/ea	$17,974.00		
40-mil Liner for Stockpiles	43061	$1.58	/sf	$68,207.83		
10-mil Cover for Stockpiles	41763	$0.83	/sf	$34,454.48		
40-mil Liner for Manure	202	$1.58	/sf	$319.33		
10-mil Cover for Manure	606	$0.83	/sf	$499.95		
Straw	33003	$13.56	/cy	$447,372.17		
Manure	1335	$14.97	/cy	$19,988.96		
Water	1027	$9.40	/kgal	$9,658.39		
Level D PPE	528	$10.00	/day	$5,280.00		
PID rental	8	$974.00	/mo.	$7,792.00		
CGI rental	8	$380.00	/mo.	$3,040.00		
Analytical:						
Pre-Compliance Sampling:						
NAC field analyses	1831	$40.00	/ea	$73,236.80		
Compliance Sampling:						
SVOCs (8270C)	183	$300.00	/ea	$54,927.60		
NACs (8330)	183	$197.50	/ea	$36,160.67		
Lead	183	$30.00	/ea	$5,492.76		
PCBs	183	$103.75	/ea	$18,995.80		
Travel for Field Crew:						
Per Diem	1232	$38.00	/day	$46,816.00		
Lodging	1232	$30.00	/day	$36,960.00	long-term stay	
Rental Car	246	$40.00	/day	$9,840.00		
					Subtotal	**$1,888,851.00**

Table 4-2
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

7.0 Off-Site Disposal

Includes:
1. Dispose of stabilized soil and non-hazardous soil (not stabilized) at a nonhazardous waste
2. Dispose of PCB waste at a TSCA approved landfill

Assumptions and Calculations:

1. Consolidated volume of D008 soil for haz disposal (cy) =	400	
2. Consolidated volume of D030 soil for haz disposal (cy) =	0	
3. Consolidated volume of PCB soil for haz disposal (cy) =	0	
4. Consolidated volume of soil for non-haz disposal (cy) =	0	
5. Non-haz waste transportation cost ($/ton) =	6	
6. Non-haz waste disposal costs ($/ton) =	31	Erie County Landfill
7. Non-haz waste regulatory fees ($/ton) =	0	included in disposal
8. Haz waste transportation cost ($/ton) =	35	
9. D008 Haz waste disposal cost ($/ton) =	75	EO Environmental
10. D030 Haz waste disposal cost ($/ton) =	150	EO Environmental
11. PCB Haz waste disposal cost ($/ton) =	75	EO Environmental
12. Haz waste regulatory fees ($/ton) =	10	
13. No. of contractor field crew =	2	
14. No. of subcontractor field crew =	2	
14. Output of front-end loader (cy/day) =	550	
15. No. of field days =	1	

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent (E-8)	8	$60.00	/hr	$480.00	
QA Coordinator	8	$40.00	/hr	$320.00	
Subcontractor Labor:					
Front End Loader Operator	1	$346.00	/day	$346.00	
Oiler	1	$293.00	/day	$293.00	
PBOW Security	1	$120.00	/day	$120.00	
Materials:					
Level D PPE	2	$10.00	/day	$20.00	
Equipment:					
1 cy Front Wheel Loader	1	$280.86	/day	$280.86	
Disposal Costs:					
Transportation (Non-Haz Waste)	0	$6.00	/ton	$0.00	
Disposal Cost (Non-Haz waste)	0	$31.00	/ton	$0.00	
Transportation (Haz Waste)	572	$35.00	/ton	$20,020.46	
Disposal Cost (D008 haz waste)	572	$85.00	/ton	$48,621.11	
Disposal Cost (D030 haz waste)	0	$160.00	/ton	$0.00	
Disposal Cost (PCB haz waste)	0	$85.00	/ton	$0.00	
Travel for field crew:					
Lodging	4	$80.00	/day	$320.00	
Perdiem	4	$38.00	/day	$152.00	
Rental Car	2	$40.00	/day	$80.00	
				Subtotal	**$71,053.00**

Table 4-2
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

8.0 On-Site Compost Disposal / Backfill Excavation with Clean Soil

Includes:
1. Backfill excavated areas with clean backfill.
2. Load treated compost, truck to site, spread compost across site with dozer
3. Confirmation testing under contaminated soil stockpiles.
4. Prepare site close-out report.

Assumptions and Calculations:

1. Volume of consolidated soil excavated (cy) =	9205
2. Compaction factor =	1.15
3. Volume of soil required for backfill (cy) =	10586
4. Cost of clean backfill soil delivered to site ($/cy) =	12
6. Field days required to backfill soil =	19
7. No. of contractor field crew =	2
8. No. of subcontractor backfill field crew =	1
9. No. of compost loading field crew =	7
10. No. of compost spreading field crew =	2
8. No. of confirmatory samples from clean backfill =	2
9. Total volume of compost before treatment (cy) =	45773
10. Shrinkage factor for treated compost =	0.60
11. Volume of compost after treatment (cy) =	27464
12. Loader output (cy/day) =	1575
13. Days to load treated compost =	26
14. Dump truck capacity (cy) =	12
15. Dump truck haul distance (mi.) =	0.5
16. Dump truck output (cy/day) =	250
17. No. of dump trucks per day =	6
18. Dozer (D-6H) capacity (cy/hr) =	90
19. Days to spread treated compost =	39
20. Subcontractor markup on equipment =	1.25
21. Subcontractor markup on labor =	1.31
22. Area of contaminated soil stockpile (sf) =	34338
23. Area per confirmation sample (sf) =	400
24. No. of confirmation samples under soil stockpile =	86

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent	312	$60.00	/hr	$18,720.00	
QA Coordinator	312	$40.00	/hr	$12,480.00	
Site Close-Out Report	1	$20,000.00	/ea	$20,000.00	
Subcontractor Labor:					
Front End Loader Operator	19	$312.00	/day	$5,928.00	
Front End Loader Operator	26	$312.00	/day	$8,112.00	
Dump Truck Drivers	156	$262.00	/day	$40,872.00	
Dozer Operator	39	$326.98	/day	$12,752.06	
Laborer/Oiler	39	$279.29	/day	$10,892.39	
PBOW Security	19	$120.00	/day	$2,280.00	
Equipment:					
1 cy Front End Loader	19	$280.86	/day	$5,336.42	
3 cy Front End Loader	26	$485.22	/day	$12,615.82	
Dump Trucks	156	$428.00	/day	$66,768.00	
D-6H Dozer	39	$630.70	/day	$24,597.30	
Material:					
Backfill	10586	$12.00	/cy	$127,029.00	delivered to site
PID rental	4	$974.00	/mo.	$3,896.00	
CGI rental	4	$380.00	/mo.	$1,520.00	
Level D PPE	279	$10.00	/day	$2,790.00	

Table 4-2
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

8.0 On-Site Compost Disposal / Backfill Excavation with Clean Soil					
Analytical:					
	RCRA Metals	2	$105.00 /ea	$210.00	
	NACs (8330)	88	$158.00 /ea	$13,904.00	
	SVOCs	2	$230.00 /ea	$460.00	
	Lead	86	$24.00 /ea	$2,064.00	
	PAHs (8270C)	86	$160.00 /ea	$13,760.00	
	PCBs	86	$83.00 /ea	$7,138.00	
	Shipping	23	$40.00 /ea	$920.00	
Travel for field crew:					
	Lodging	500	$80.00 /day	$40,000.00	
	Perdiem	500	$38.00 /day	$19,000.00	
	Rental Car	172	$40.00 /day	$6,880.00	
Subcontract:					
	Reseeding	218	$56.84 /msf	$12,391.00	
				Subtotal	**$493,316.00**
9.0 Overall Cost					
				Total Capital Cost	**$3,645,166.00**
				Contingency (30%)	**$1,093,550.00**
				PM Multiplier (7.5%)	**$273,387.00**
				Fee/Profit (10%)	**$364,517.00**
				Total Cost	**$5,377,000.00**

*This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

Table 4-3
Alternative 3 - Excavation, Ex-Situ Stabilization, and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

Alternative 3
Excavation/Stabilization/Off-Site Disposal Cost Estimate

Site: TNT Area A
Plum Brook Ordnance Works
Date: 9/11/2003

Scope:
1. Perform bench-scale treatability study, prepare stabilization work plan, H&S plan, materials list, and procurement
2. Mobilize equipment and personnel
3. Conduct pre-remediation soil sampling to better delineate the lateral and vertical extent of contamination.
4. Prepare site for remedial activity.
5. Excavate contaminated soil and perform confirmatory sampling
6. Chemically stabilize soil classified as a hazardous waste based on TCLP testing.
7. Dispose of stabilized soil and untreated non-hazardous soil in a Subtitle D landfill. Dispose of PCB remediation waste in a TSCA landfill.
8. Backfill excavated areas
9. Demobilize equipment and personnel

1.0 Bench-Scale Study, Work Plan, Health and Safety Plan, Materials List, and Procurement

Includes:

1. Perform bench-scale treatability study to test the effectiveness of stabilizing the nitroaromatics and determine stabilization amendments. Results will be used to generate the design work plan.
2. Labor to generate work plan, engineering specifications, and Health and Safety Plan
3. Procure equipment and materials

Service/Materials	Unit	Unit Cost		Subtotal	
Bench-Scale Study	1	$15,000.00	/ea	$15,000.00	
Contractor Labor:					
Senior Engineer (E-12)	40	$97.00	/hr.	$3,880.00	
Task Manager (E-8)	80	$62.00	/hr.	$4,960.00	
Geologist (E-8)	40	$62.00	/hr.	$2,480.00	
Project Engineer (E-6)	160	$50.00	/hr.	$8,000.00	
Health and Safety (E-8)	40	$62.00	/hr.	$2,480.00	
Procurement Specialist (E-6)	80	$56.00	/hr.	$4,480.00	
Drafting (E-6)	40	$50.00	/hr.	$2,000.00	
Document Repro (Draft and Final)	2	$1,000.00	/ea	$2,000.00	
				Subtotal	**$45,280.00**

Table 4-3
Alternative 3 - Excavation, Ex-Situ Stabilization, and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

2.0 Mobilization/Demobilization of Equipment and Personnel

Includes:
1. Mobilize equipment and personnel
2. Contractor field crew consists of a site superintendent, geologist, and a field technician.
3. Four 2-day trips for 2 contractor personnel for pre-remediation coordination.

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent (E-8)	24	$60.00	/hr	$1,440.00	
QA (Sampling) Coordinator	24	$40.00	/hr	$960.00	
H&S Coordinator	16	$50.00	/hr	$800.00	
Field Geologist	2	$480.00	/day	$960.00	
Subcontractor Labor:					
Excavator Operator	2	$340.91	/day	$681.83	
Equipment Operator	2	$326.98	/day	$653.95	
Equipment Operator	2	$326.98	/day	$653.95	
Loader Operator	2	$312.00	/day	$624.00	
Loader Operator	2	$312.00	/day	$624.00	
Laborers	2	$288.00	/day	$576.00	
Truck Drivers	6	$262.00	/day	$1,572.00	
Equipment:					
Excavator	2	$704.00	/day	$1,408.00	
1 cy Front Wheel Loader	2	$280.86	/day	$561.72	
10-cy Mixing System	2	$975.00	/ea	$1,950.00	
Screening Plant	2	$1,000.00	/ea	$2,000.00	
Radial Conveyor	2	$500.00	/ea	$1,000.00	
Dump Truck	6	$428.00	/day	$2,568.00	
Travel for contractor crew:					
Perdiem	34	$38.00	/day	$1,292.00	
Lodging	34	$80.00	/day	$2,720.00	
Rental Car	18	$40.00	/day	$720.00	
Airfare	21	$600.00	/ea	$12,600.00	
				Subtotal	**$36,365.45**

Table 4-3
Alternative 3 - Excavation, Ex-Situ Stabilization, and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

3.0 Pre-Remediation Soil Sampling

Includes:
1. Hydropunch soil sampling
2. Analysis of soil samples for chemicals of concern.

Assumptions:

1. Perimeter of proposed remediation area (ft) =	3832
2. Distance between boring locations =	40
3. No. of borings =	96
4. Average depth of boring (ft) =	10
5. No. of samples collected per boring =	3
6. Total no. of samples collected =	288
7. No. of borings advanced per day =	10

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor:					
Field Geologist	10	$480.00	/day	$4,800.00	
Subcontractor:					
Mob/Demob	1	$2,000.00	/ea	$2,000.00	
Hydropunch Borings	960	$15.00	/ft	$14,400.00	
Equipment Decon	96	$90.00	/ea	$8,640.00	
Materials:					
Field Supplies	96	$20.00	/bor.	$1,920.00	
Field Instruments	2	$400.00	/wk	$800.00	
Analytical:					
NACs (8330)	288	$158.00	/ea	$45,504.00	
Lead	288	$24.00	/ea	$6,912.00	
PAHs (8270C)	288	$160.00	/ea	$46,080.00	
PCBs	288	$83.00	/ea	$23,904.00	
Shipping	77	$40.00	/ea	$3,080.00	
Equipment:					
P/U Truck	10	$52.00	/day	$520.00	
Travel for Contractor Crew:					
Perdiem	10	$38.00	/day	$380.00	
Lodging	10	$80.00	/day	$800.00	
				Subtotal	**$159,740.00**

Table 4-3
Alternative 3 - Excavation, Ex-Situ Stabilization, and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

4.0 Site Preparation

Includes:
1. Clear remedial areas and treatment area = 5 acres
2. Construct 12" soil berm around treatment areas (500 ft x 300 ft area = 1600 ft).
3. Excavate soil for contact water retension pond.
4. Construct 6-inch reinforced concrete slab for treatment area.

Assumptions:

1. Volume of soil removed for contact water retention pond =	2,923
2. Excavator: hydraulic backhoe, 1 cy bucket	
3. Excavator output (cy/day) =	600
4. Days to excavate soil =	6
5. Volume of containment berm (cy) =	74
6. No. of contractor field crew =	2
7. Area of concrete treatment slab (150 ft x 150 ft) (sf) =	22500

Service/Materials	Unit	Unit Cost	Subtotal	
Contractor:				
Site Superintendent	240	$60.00 /hr	$14,400.00	
QA Coordinator	240	$40.00 /hr	$9,600.00	
Subcontractor:				
Surveying	1	$24,000.00 /site	$24,000.00	
Site Clearing	5	$2,300.00 /acre	$11,500.00	
Excavator Operator	6	$340.91 /day	$2,045.49	
Concrete Slab	22500	$4.39 /sf	$98,775.00	
Equipment:				
Excavator	6	$704.00 /day	$4,224.00	
Materials:				
Earthen containment berm	74	$6.00 /cy	$444.00	
Travel for Field Crew:				
Per Diem	84	$38.00 /day	$3,192.00	
Lodging	84	$80.00 /day	$6,720.00	
Rental Car	42	$40.00 /day	$1,680.00	
			Subtotal	**$176,580.00**

5.0 Excavation of Contaminated Soil

Includes:
1. Excavation of soil with contaminants exceeding RGOs
2. Screen oversize material
3. Collect confirmatory sampling to determine extent of excavation
4. Staging and characterizing waste stream

Assumptions and Calculations:

1. Cubic yards of consolidated soil excavated =	16328
2. Swell factor for soil upon excavation =	1.3
3. Cubic yards of unconsolidated soil =	21226
4. Density of unconsolidated soil (tons/cy) =	1.1
5. Mass of unconsolidated soil (tons) =	23349
6. Capacity of screening plant (tons/hr) =	100
7. Excavator: hydraulic backhoe, 1 cy bucket ($/day) =	$704
8. Excavator output (cy/day) =	600
9. Days to excavate soil =	43
10. Dump truck capacity (cy) =	12
11. Dump truck haul distance (mi.) =	0.5
12. Dump truck output (cy/day) =	250
13. No. of required dump trucks per day =	2
14. Soil sample collected for waste characterization / cy =	150
15. No. of soil samples collected for waste characterization =	142
16. Number of contractor field crew =	3
17. Number of subcontractor excavation crew =	4
18. Number of subcontractor screening crew =	3
19. Airfare included under mobilization	
20. Lineal foot of excavation per confirmation sample =	20
21. Resampling factor for confirmation sampling =	1.1
22. No.of confirmatory samples from excavated area =	347
23. Subcontractor markup on equipment =	1.25
24. Subcontractor markup on labor =	1.31
25. Excavation area (ft^2) =	49624
26. Cost multiplier for 1-week turnaround on analytical data =	1.25
27. Fraction of excavation work performed in Level C PPE =	0.10
28. Labor productivity factor for Level C work =	0.67
29. Days excavation crew in Level C =	5
30. Days screening crew in Level C =	4
31. Perimeter of excavation area (ft) =	3832
32. Excavation area (sf) =	49624
33. Volume of pit water requiring POTW disposal (gal) =	20000

Service/Materials	Unit	Unit Cost		Subtotal
Contractor Labor:				
Site Superintendent (E-8)	344	$60.00	/hr	$20,640.00
QA (Sampling) Coordinator	344	$40.00	/hr	$13,760.00
H&S Coordinator	344	$50.00	/hr	$17,200.00
Chemist (home office)	86	$51.00	/hr	$4,386.00
Subcontractor:				
Excavator Operator	43	$340.91	/day	$14,659.32
Equipment Operator	35	$326.98	/day	$11,444.16
Loader Operator	35	$312.00	/day	$10,920.00
Laborers	78	$288.00	/day	$22,464.00
Truck Drivers	129	$262.00	/day	$33,798.00
Road Repair	1	$50,000.00	/site	$50,000.00

Table 4-3
Alternative 3 - Excavation, Ex-Situ Stabilization, and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

5.0 Excavation of Contaminated Soil (continued)					
Equipment:					
Excavator	43	$704.00	/day	$30,272.00	
100-ton/hr Screening Plant	7	$1,800.00	/wk	$12,600.00	
Radial Stacking Conveyor	7	$1,222.00	/wk	$8,554.00	
1 cy Front Wheel Loader	35	$280.86	/day	$9,830.10	
12-cy Dump Truck	86	$428.00	/day	$36,808.00	
3000 gal. Water Truck	43	$402.00	/day	$17,286.00	
150 gpm Pump	2	$2,439.00	/ea.	$4,878.00	
300 gpm Pump	2	$3,749.00	/ea.	$7,498.00	
7-ft Diameter Sand Filter	1	$22,310.00	/ea.	$22,310.00	
200-gpm GAC Adsorber (6000#-disp.)	1	$14,217.00	/ea.	$14,217.00	
20000 gal Steel Water Tank	1	$14,618.00	/ea.	$14,618.00	
Analytical:					
TCLP Extraction	142	$12.88	/ea	$1,828.25	
Lead	489	$300.00	/ea	$146,700.00	
SVOCs (8270C)	489	$197.50	/ea	$96,577.50	
NACs (8330)	489	$30.00	/ea	$14,670.00	
PCBs	489	$103.75	/ea	$50,733.75	
NAC field analyses	347	$40.00	/ea	$13,880.00	
Lead field analyses	2	$4,200.00	/mo.	$8,400.00	
Shipping	130	$40.00	/ea	$5,216.00	
Materials & Services:					
Office Trailer	6	$500.00	/mo.	$3,000.00	
Level D PPE	245	$10.00	/day	$2,450.00	
Level C PPE	32	$35.00	/day	$1,120.00	
PID rental	3	$974.00	/mo.	$2,922.00	
CGI rental	3	$380.00	/mo.	$1,140.00	
Pit Water Disposal	20	$1.62	/kgal	$32.40	
Travel for Contractor Crew:					
Perdiem	568	$38.00	/day	$21,584.00	
Lodging	568	$80.00	/day	$45,440.00	
Rental Car	230	$40.00	/day	$9,200.00	
				Subtotal	**$803,036.00**

Table 4-3
Alternative 3 - Excavation, Ex-Situ Stabilization, and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

6.0 Chemical Stabilization of Hazardous Soil

Includes:

1. Stabilization of hazardous soil using cement and activated carbon

Assumptions and Calculations:

1. Volume of consolidated haz. soil to be stabilized =	3871
2. Swell factor for soil upon excavation =	1.3
3. Cubic yards of unconsolidated soil =	5032
4. Density of soil (ton/cy) =	1.1
5. Tons of hazardous soil that needs to be stabilized =	5535
6. Mass ratio of carbon to soil =	0.02
7. Mass ratio of portland cement to soil =	0.08
8. Carbon cost ($/ton)=	2000
9. Cement cost ($/ton)=	105
10. Carbon required for stabilization (tons) =	111
11. Cement required for stabilization (tons) =	443
12. No. of contractor field crew =	2
13. Stabilization batch cycle time (min) =	15
14. Time required to stabilize soil (days) =	18
15. Swell upon stabilization =	1.132
16. Volume of stabilized soil (cy) =	5696
17. Soil sample collected for waste characterization / cy =	150
18. No. of soil samples collected =	38
19. Subcontractor markup on labor =	1.72
20. Contractor markup on labor =	1.60
21. Subcontractor markup on equipment =	1.25
22. Subcontractor markup on labor =	1.31
23. Contaminated soil stockpile area (sf) =	15096
24. Treated soil stockpile area (sf) =	900
25. Height of stockpiles (ft) =	9.0
26. Width of soil stockpiles (ft) =	60
27. No. of subcontractor field crew =	4
28. Equipment setup/teardown (days) =	10

Service/Materials	Unit	Unit Cost		Subtotal
Contractor Labor:				
Site Superintendent	28	$480.00	/day	$13,440.00
QA (Sampling) Coordinator	28	$320.00	/day	$8,960.00
Subcontractor Labor:				
Wheel Loader Operator	28	$312.00	/day	$8,736.00
Process Equipment Operator	28	$314.40	/day	$8,803.20
Process Equipment Operator	28	$314.40	/day	$8,803.20
Laborer	28	$270.00	/day	$7,560.00
PBOW Security	28	$120.00	/day	$3,360.00
Equipment:				
1 cy Front Wheel Loader	28	$280.86	/day	$7,864.08
10-cy Mixing System	2	$6,250.00	/mo	$12,500.00
Belt Feeder for Mixing Stystem	2	$728.00	/mo	$1,456.00
Stabilization Ancilliary Equipment	2	$557.00	/mo	$1,114.00
Dust Collecton System	2	$530.00	/mo	$1,060.00
Radial Stacking Conveyor	2	$3,605.00	/mo	$7,210.00
Materials:				
Office Trailer	4	$500.00	/mo.	$2,000.00
Carbon	111	$2,000.00	/ton	$222,000.00
Cement	443	$105.00	/ton	$46,515.00
40-mil Liner for Soil Stockpiles	15996	$1.58	/sf	$25,338.00
10-mil Cover for Soil Stockpiles	22955	$0.83	/sf	$18,938.00
Water	46	$9.40	/kgpd	$435.00
Level D PPE	112	$10.00	/day	$1,120.00
PID rental	2	$974.00	/mo.	$1,948.00
CGI rental	2	$380.00	/mo.	$760.00

Table 4-3
Alternative 3 - Excavation, Ex-Situ Stabilization, and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

6.0 Chemical Stabilization of Hazardous Soil (continued)				
Analytical:				
TCLP Extraction	38	$10.30 /ea	$391.00	
Lead	38	$24.00 /ea	$912.00	
SVOCs (8270C)	38	$240.00 /ea	$9,120.00	
NACs (8330)	38	$158.00 /ea	$6,004.00	
PCBs	38	$83.00 /ea	$3,154.00	
Unconfined Compresive Strength	38	$130.00 /ea	$4,940.00	
Shipping	5	$40.00 /ea	$203.00	
Travel for contractor crew:				
Lodging	549	$80.00 /day	$43,920.00	
Perdiem	549	$38.00 /day	$20,862.00	
Rental Car	78	$40.00 /day	$3,120.00	
			Subtotal	**$502,546.00**

Table 4-3
Alternative 3 - Excavation, Ex-Situ Stabilization, and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

7.0 Off-Site Disposal

Includes:
1. Dispose of stabilized soil and non-hazardous soil (not stabilized) at a nonhazardous waste
2. Dispose of PCB waste at a TSCA approved landfill

Assumptions and Calculations:

1. Cubic yards of soil not requiring stabilization =	16040	
2. Tons of soil not requiring stabilization =	17644	
3. Tons of stabilized soil =	6642	
4. Tons of soil for non-haz waste landfill disposal =	24286	
5. Unconsolidated volume of PCB waste for disposal (cy) =	155	
6. Tons of soil for haz waste landfill disposal =	170	
7. Non-haz waste transportation cost ($/ton) =	6	
8. Non-haz waste disposal costs ($/ton) =	31	Erie County Landfill
9. Non-haz waste regulatory fees ($/ton) =	0	included in disposal
10. Haz waste transportation cost ($/ton) =	35	
11. D008 Haz waste disposal cost ($/ton) =	75	EO Environmental
12. D030 Haz waste disposal cost ($/ton) =	150	EO Environmental
13. PCB Haz waste disposal cost ($/ton) =	75	EO Environmental
14. Haz waste regulatory fees ($/ton) =	10	
15. No. of contractor field crew =	2	
14. No. of subcontractor field crew =	2	
16. Output of front-end loader (cy/day) =	550	
17. No. of field days =	37	-

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent (E-8)	296	$60.00	/hr	$17,760.00	
QA Coordinator	296	$40.00	/hr	$11,840.00	
Subcontractor Labor:					
Front End Loader Operator	37	$312.00	/day	$11,544.00	
Laborer	37	$293.00	/day	$10,841.00	
PBOW Security	37	$120.00	/day	$4,440.00	
Materials:					
Level D PPE	74	$10.00	/day	$740.00	
Equipment:					
1 cy Front End Loader	37	$280.86	/day	$10,391.82	
Disposal Costs:					
Transportation (Non-Haz Waste)	24286	$6.00	/ton	$145,716.12	
Disposal Cost (Non-Haz waste)	24286	$31.00	/ton	$752,866.60	
Transportation (Haz Waste)	170	$35.00	/ton	$5,955.95	
Disposal Cost (D008 haz waste)	0	$85.00	/ton	$0.00	
Disposal Cost (D030 haz waste)	0	$160.00	/ton	$0.00	
Disposal Cost (PCB haz waste)	170	$85.00	/ton	$14,464.45	
Travel for field crew:					
Lodging	207	$80.00	/day	$16,560.00	
Perdiem	207	$38.00	/day	$7,866.00	
Rental Car	104	$40.00	/day	$4,160.00	
				Subtotal	**$1,015,146.00**

Table 4-3
Alternative 3 - Excavation, Ex-Situ Stabilization, and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

8.0 Backfill Excavation with Clean Soil

Includes:
1. Backfill excavated areas with clean backfill (confirm soil is clean by sampling)
2. Confirmation testing under contaminated soil stockpiles.
3. Prepare site close-out report.

Assumptions and Calculations:

1. Volume of consolidated soil excavated (cy) =	16328
2. Compaction factor =	1.15
3. Volume of soil required for backfill (cy) =	18777
4. Cost of clean backfill soil delivered to site ($/cy) =	12
5. Field days required to backfill soil =	34
6. No. of contractor field crew =	2
8. No. of subcontractor backfill field crew =	2
7. No. of confirmatory samples from backfill =	2
8. Subcontractor markup on equipment =	1.25
9. Subcontractor markup on labor =	1.31
10. Area of contaminated soil stockpile (sf) =	62370
11. Area per confirmation sample (sf) =	400
12. No. of confirmation samples under soil stockpile =	156

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent (E-8)	272	$60.00	/hr	$16,320.00	
QA Coordinator	272	$40.00	/hr	$10,880.00	
Site Close-Out Report	1	$20,000.00	/ea	$20,000.00	
Subcontractor Labor:					
Front End Loader Operator	34	$312.00	/day	$10,608.00	
Laborer/Oiler	34	$279.29	/day	$9,495.93	
PBOW Security	34	$120.00	/day	$4,080.00	
Equipment:					
1 cy Front End Loader	34	$280.86	/day	$9,549.24	
Material:					
Backfill	18777	$12.00	/cy	$225,326.40	delivered to site
PID rental	2	$974.00	/mo.	$1,948.00	
CGI rental	2	$380.00	/mo.	$760.00	
Level D PPE	68	$10.00	/day	$680.00	
Analytical:					
RCRA Metals	2	$105.00	/ea	$210.00	
NACs (8330)	158	$158.00	/ea	$24,964.00	
SVOCs	2	$230.00	/ea	$460.00	
Lead	156	$24.00	/ea	$3,744.00	
PAHs (8270C)	156	$160.00	/ea	$24,960.00	
PCBs	156	$83.00	/ea	$12,948.00	
Shipping	42	$40.00	/ea	$1,680.00	
Travel for field crew:					
Lodging	190	$80.00	/day	$15,200.00	
Perdiem	190	$38.00	/day	$7,220.00	
Rental Car	95	$40.00	/day	$3,800.00	
Subcontract:					
Reseeding	218	$56.84	/msf	$12,391.00	
				Subtotal	**$417,225.00**

9.0 Overall Cost

Total Capital Cost	**$3,155,918.45**
Contingency (30%)	**$946,776.00**
PM Multiplier (7.5%)	**$236,694.00**
Fee/Profit (10%)	**$315,592.00**
Total Cost	**$4,655,000.00**

*This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

Table 4-4
Alternative 3 - Excavation, Ex-Situ Stabilization, and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

Alternative 3
Excavation/Stabilization/Off-Site Disposal Cost Estimate

Site: TNT Area C
Plum Brook Ordnance Works
Date: 9/11/2003

Scope:
1. Perform bench-scale treatability study, prepare stabilization work plan, H&S plan, materials list, and procurement
2. Mobilize equipment and personnel
3. Conduct pre-remediation soil sampling to better delineate the lateral and vertical extent of contamination.
4. Prepare site for remedial activity.
5. Excavate contaminated soil and perform confirmatory sampling
6. Chemically stabilize soil classified as a hazardous waste based on TCLP testing.
7. Dispose of stabilized soil and untreated non-hazardous soil in a Subtitle D landfill. Dispose of PCB remediation waste in a TSCA landfill.
8. Backfill excavated areas
9. Demobilize equipment and personnel

1.0 Bench-Scale Study, Work Plan, Health and Safety Plan, Materials List, and Procurement

Includes:

1. Perform bench-scale treatability study to test the effectiveness of stabilizing the nitroaromatics and determine stabilization amendments. Results will be used to generate the design work plan.
2. Labor to generate work plan, engineering specifications, and Health and Safety Plan
3. Procure equipment and materials

Service/Materials	Unit	Unit Cost		Subtotal	
Bench-Scale Study	1	$15,000.00	/ea	$15,000.00	
Contractor Labor:					
Senior Engineer (E-12)	40	$97.00	/hr.	$3,880.00	
Task Manager (E-8)	80	$62.00	/hr.	$4,960.00	
Geologist (E-8)	40	$62.00	/hr.	$2,480.00	
Project Engineer (E-6)	160	$50.00	/hr.	$8,000.00	
Health and Safety (E-8)	40	$62.00	/hr.	$2,480.00	
Procurement Specialist (E-6)	80	$56.00	/hr.	$4,480.00	
Drafting (E-6)	40	$50.00	/hr.	$2,000.00	
Document Repro (Draft and Final)	2	$1,000.00	/ea	$2,000.00	
				Subtotal	**$45,280.00**

Table 4-4
Alternative 3 - Excavation, Ex-Situ Stabilization, and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

2.0 Mobilization/Demobilization of Equipment and Personnel

Includes:

1. Mobilize equipment and personnel
2. Contractor field crew consists of a site superintendent, geologist, and a field technician.
3. Four 2-day trips for 2 contractor personnel for pre-remediation coordination.

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent (E-8)	24	$60.00	/hr	$1,440.00	
QA (Sampling) Coordinator	24	$40.00	/hr	$960.00	
H&S Coordinator	16	$50.00	/hr	$800.00	
Field Geologist	2	$480.00	/day	$960.00	
Subcontractor Labor:					
Excavator Operator	2	$340.91	/day	$681.83	
Equipment Operator	2	$326.98	/day	$653.95	
Equipment Operator	2	$326.98	/day	$653.95	
Loader Operator	2	$312.00	/day	$624.00	
Loader Operator	2	$312.00	/day	$624.00	
Laborers	2	$288.00	/day	$576.00	
Truck Drivers	6	$262.00	/day	$1,572.00	
Equipment:					
Excavator	2	$704.00	/day	$1,408.00	
1 cy Front Wheel Loader	2	$280.86	/day	$561.72	
10-cy Mixing System	2	$975.00	/ea	$1,950.00	
Screening Plant	2	$1,000.00	/ea	$2,000.00	
Radial Conveyor	2	$500.00	/ea	$1,000.00	
Dump Truck	6	$428.00	/day	$2,568.00	
Travel for contractor crew:					
Perdiem	34	$38.00	/day	$1,292.00	
Lodging	34	$80.00	/day	$2,720.00	
Rental Car	18	$40.00	/day	$720.00	
Airfare	21	$600.00	/ea	$12,600.00	
				Subtotal	**$36,365.45**

Table 4-4
Alternative 3 - Excavation, Ex-Situ Stabilization, and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

3.0 Pre-Remediation Soil Sampling

Includes:
1. Hydropunch soil sampling
2. Analysis of soil samples for chemicals of concern.

Assumptions:

1. Perimeter of proposed remediation area (ft) =	3415
2. Distance between boring locations =	40
3. No. of borings =	86
4. Average depth of boring (ft) =	10
5. No. of samples collected per boring =	3
6. Total no. of samples collected =	258
7. No. of borings advanced per day =	10

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor:					
Field Geologist	9	$480.00	/day	$4,320.00	
Subcontractor:					
Mob/Demob	1	$2,000.00	/ea	$2,000.00	
Hydropunch Borings	860	$15.00	/ft	$12,900.00	
Equipment Decon	86	$90.00	/ea	$7,740.00	
Materials:					
Field Supplies	86	$20.00	/bor.	$1,720.00	
Field Instruments	2	$400.00	/wk	$800.00	
Analytical:					
NACs (8330)	258	$158.00	/ea	$40,764.00	
Lead	258	$24.00	/ea	$6,192.00	
PAHs (8270C)	258	$160.00	/ea	$41,280.00	
PCBs	258	$83.00	/ea	$21,414.00	
Shipping	69	$40.00	/ea	$2,760.00	
Equipment:					
P/U Truck	9	$52.00	/day	$468.00	
Travel for Contractor Crew:					
Perdiem	9	$38.00	/day	$342.00	
Lodging	9	$80.00	/day	$720.00	
				Subtotal	**$143,420.00**

Table 4-4
Alternative 3 - Excavation, Ex-Situ Stabilization, and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

4.0 Site Preparation

Includes:
1. Clear remedial areas and treatment area = 5 acres
2. Construct 12" soil berm around treatment areas (500 ft x 300 ft area = 1600 ft).
3. Excavate soil for contact water retension pond.
4. Construct 6-inch reinforced concrete slab for treatment area.

Assumptions:

1. Volume of soil removed for contact water retention pond =	2,923
2. Excavator: hydraulic backhoe, 1 cy bucket	
3. Excavator output (cy/day) =	600
4. Days to excavate soil =	6
5. Volume of containment berm (cy) =	74
6. No. of contractor field crew =	2
7. Area of concrete treatment slab (150 ft x 150 ft) (sf) =	22500

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor:					
Site Superintendent	240	$60.00	/hr	$14,400.00	
QA Coordinator	240	$40.00	/hr	$9,600.00	
Subcontractor:					
Surveying	1	$24,000.00	/site	$24,000.00	
Site Clearing	5	$2,300.00	/acre	$11,500.00	
Excavator Operator	6	$340.91	/day	$2,045.49	
Concrete Slab	22500	$4.39	/sf	$98,775.00	
Equipment:					
Excavator	6	$704.00	/day	$4,224.00	
Materials:					
Earthen containment berm	74	$6.00	/cy	$444.00	
Travel for Field Crew:					
Per Diem	84	$38.00	/day	$3,192.00	
Lodging	84	$80.00	/day	$6,720.00	
Rental Car	42	$40.00	/day	$1,680.00	
				Subtotal	**$176,580.00**

Table 4-4
Alternative 3 - Excavation, Ex-Situ Stabilization, and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

5.0 Excavation of Contaminated Soil

Includes:
1. Excavation of soil with contaminants exceeding RGOs
2. Screen oversize material
3. Collect confirmatory sampling to determine extent of excavation
4. Staging and characterizing waste stream

Assumptions and Calculations:

1. Cubic yards of consolidated soil excavated =	9205
2. Swell factor for soil upon excavation =	1.3
3. Cubic yards of unconsolidated soil =	11967
4. Density of unconsolidated soil (tons/cy) =	1.1
5. Mass of unconsolidated soil (tons) =	13163
6. Capacity of screening plant (tons/hr) =	100
7. Excavator: hydraulic backhoe, 1 cy bucket ($/day) =	$704
8. Excavator output (cy/day) =	600
9. Days to excavate soil =	24
10. Dump truck capacity (cy) =	12
11. Dump truck haul distance (mi.) =	0.5
12. Dump truck output (cy/day) =	250
13. No. of required dump trucks per day =	2
14. Soil sample collected for waste characterization / cy =	150
15. No. of soil samples collected for waste characterization =	80
16. Number of contractor field crew =	3
17. Number of subcontractor excavation crew =	4
18. Number of subcontractor screening crew =	3
19. Airfare included under mobilization	
20. Lineal foot of excavation per confirmation sample =	20
21. Resampling factor for confirmation sampling =	1.1
22. No.of confirmatory samples from excavated area =	286
23. Subcontractor markup on equipment =	1.25
24. Subcontractor markup on labor =	1.31
25. Excavation area (ft^2) =	35583
26. Cost multiplier for 1-week turnaround on analytical data =	1.25
27. Fraction of excavation work performed in Level C PPE =	0.10
28. Labor productivity factor for Level C work =	0.67
29. Days excavation crew in Level C =	3
30. Days screening crew in Level C =	2
31. Perimeter of excavation area (ft) =	3415
32. Excavation area (sf) =	35583
33. Volume of pit water requiring POTW disposal (gal) =	20000

Service/Materials	Unit	Unit Cost		Subtotal
Contractor Labor:				
Site Superintendent (E-8)	192	$60.00	/hr	$11,520.00
QA (Sampling) Coordinator	192	$40.00	/hr	$7,680.00
H&S Coordinator	192	$50.00	/hr	$9,600.00
Chemist (home office)	48	$51.00	/hr	$2,448.00
Subcontractor:				
Excavator Operator	24	$340.91	/day	$8,181.95
Equipment Operator	20	$326.98	/day	$6,539.52
Loader Operator	20	$312.00	/day	$6,240.00
Laborers	44	$288.00	/day	$12,672.00
Truck Drivers	72	$262.00	/day	$18,864.00
Road Repair	1	$50,000.00	/site	$50,000.00

Table 4-4
Alternative 3 - Excavation, Ex-Situ Stabilization, and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

5.0 Excavation of Contaminated Soil (continued)					
Equipment:					
Excavator	24	$704.00	/day	$16,896.00	
100-ton/hr Screening Plant	4	$1,800.00	/wk	$7,200.00	
Radial Stacking Conveyor	4	$1,222.00	/wk	$4,888.00	
1 cy Front Wheel Loader	20	$280.86	/day	$5,617.20	
12-cy Dump Truck	48	$428.00	/day	$20,544.00	
3000 gal. Water Truck	24	$402.00	/day	$9,648.00	
150 gpm Pump	2	$2,439.00	/ea.	$4,878.00	
300 gpm Pump	2	$3,749.00	/ea.	$7,498.00	
7-ft Diameter Sand Filter	1	$22,310.00	/ea.	$22,310.00	
200-gpm GAC Adsorber (6000#-disp.)	1	$14,217.00	/ea.	$14,217.00	
20000 gal Steel Water Tank	1	$14,618.00	/ea.	$14,618.00	
Analytical:					
TCLP Extraction	80	$12.88	/ea	$1,030.00	
Lead	366	$300.00	/ea	$109,800.00	
SVOCs (8270C)	366	$197.50	/ea	$72,285.00	
NACs (8330)	366	$30.00	/ea	$10,980.00	
PCBs	366	$103.75	/ea	$37,972.50	
NAC field analyses	286	$40.00	/ea	$11,440.00	
Lead field analyses	2	$4,200.00	/mo.	$8,400.00	
Shipping	98	$40.00	/ea	$3,904.00	
Materials & Services:					
Office Trailer	4	$500.00	/mo.	$2,000.00	
Level D PPE	138	$10.00	/day	$1,380.00	
Level C PPE	18	$35.00	/day	$630.00	
PID rental	2	$974.00	/mo.	$1,948.00	
CGI rental	2	$380.00	/mo.	$760.00	
Pit Water Disposal	20	$1.62	/kgal	$32.40	
Travel for Contractor Crew:					
Perdiem	319	$38.00	/day	$12,122.00	
Lodging	319	$80.00	/day	$25,520.00	
Rental Car	129	$40.00	/day	$5,160.00	
				Subtotal	**$567,424.00**

Table 4-4
Alternative 3 - Excavation, Ex-Situ Stabilization, and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

6.0 Chemical Stabilization of Hazardous Soil

Includes:

1. Stabilization of hazardous soil using cement and activated carbon

Assumptions and Calculations:

1. Volume of consolidated haz. soil to be stabilized =	2310
2. Swell factor for soil upon excavation =	1.3
3. Cubic yards of unconsolidated soil =	3003
4. Density of soil (ton/cy) =	1.1
5. Tons of hazardous soil that needs to be stabilized =	3303
6. Mass ratio of carbon to soil =	0.02
7. Mass ratio of portland cement to soil =	0.08
8. Carbon cost ($/ton)=	2000
9. Cement cost ($/ton)=	105
10. Carbon required for stabilization (tons) =	66
11. Cement required for stabilization (tons) =	264
12. No. of contractor field crew =	2
13. Stabilization batch cycle time (min) =	15
14. Time required to stabilize soil (days) =	11
15. Swell upon stabilization =	1.132
16. Volume of stabilized soil (cy) =	3399
17. Soil sample collected for waste characterization / cy =	150
18. Subcontractor profit =	0.12
19. Subcontractor markup on labor =	1.72
20. Contractor markup on labor =	1.60
21. Subcontractor markup on equipment =	1.25
22. Subcontractor markup on labor =	1.31
23. Contaminated soil stockpile area (sf) =	9009
24. Treated soil stockpile area (sf) =	900
25. Height of stockpiles (ft) =	9.0
26. Width of soil stockpiles (ft) =	60
27. No. of subcontractor field crew =	4
28. Equipment setup/teardown (days) =	10

Service/Materials	Unit	Unit Cost		Subtotal
Contractor Labor:				
Site Superintendent	21	$480.00	/day	$10,080.00
QA (Sampling) Coordinator	21	$320.00	/day	$6,720.00
Subcontractor Labor:				
Wheel Loader Operator	21	$312.00	/day	$6,552.00
Process Equipment Operator	21	$314.40	/day	$6,602.40
Process Equipment Operator	21	$314.40	/day	$6,602.40
Laborer	21	$270.00	/day	$5,670.00
PBOW Security	21	$120.00	/day	$2,520.00
Equipment:				
1 cy Front Wheel Loader	21	$280.86	/day	$5,898.06
10-cy Mixing System	1	$6,250.00	/mo	$6,250.00
Belt Feeder for Mixing Stystem	1	$728.00	/mo	$728.00
Stabilization Ancilliary Equipment	1	$557.00	/mo	$557.00
Dust Collecton System	1	$530.00	/mo	$530.00
Radial Stacking Conveyor	1	$3,605.00	/mo	$3,605.00
Materials:				
Office Trailer	2	$500.00	/mo.	$1,000.00
Carbon	66	$2,000.00	/ton	$132,000.00
Cement	264	$105.00	/ton	$27,720.00
40-mil Liner for Soil Stockpiles	9909	$1.58	/sf	$15,695.86
10-mil Cover for Soil Stockpiles	15042	$0.83	/sf	$12,409.65
Water	28	$9.40	/kgpd	$260.10
Level D PPE	84	$10.00	/day	$840.00
PID rental	1	$974.00	/mo.	$974.00
CGI rental	1	$380.00	/mo.	$380.00

Table 4-4
Alternative 3 - Excavation, Ex-Situ Stabilization, and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

6.0 Chemical Stabilization of Hazardous Soil (continued)				
Analytical:				
TCLP Extraction	23	$10.30 /ea	$237.00	
Lead	23	$24.00 /ea	$552.00	
SVOCs (8270C)	23	$240.00 /ea	$5,520.00	
NACs (8330)	23	$158.00 /ea	$3,634.00	
PCBs	23	$83.00 /ea	$1,909.00	
Unconfined Compresive Strength	23	$130.00 /ea	$2,990.00	
Shipping	3	$40.00 /ea	$123.00	
Travel for field crew:				
Lodging	412	$80.00 /day	$32,960.00	
Perdiem	412	$38.00 /day	$15,656.00	
Rental Car	59	$40.00 /day	$2,360.00	
			Subtotal	**$319,535.00**

Table 4-4
Alternative 3 - Excavation, Ex-Situ Stabilization, and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

7.0 Off-Site Disposal

Includes:
1. Dispose of stabilized soil and non-hazardous soil (not stabilized) at a nonhazardous waste
2. Dispose of PCB waste at a TSCA approved landfill

Assumptions and Calculations:

1. Cubic yards of soil not requiring stabilization =	8964	
2. Tons of soil not requiring stabilization =	9860	
3. Tons of stabilized soil =	3964	
4. Tons of soil for non-haz waste landfill disposal =	13824	
5. Unconsolidated volume of PCB waste for disposal (cy) =	0	
6. Tons of soil for haz waste landfill disposal =	0	
7. Non-haz waste transportation cost ($/ton) =	6	
8. Non-haz waste disposal costs ($/ton) =	31	Erie County Landfill
9. Non-haz waste regulatory fees ($/ton) =	0	included in disposal
10. Haz waste transportation cost ($/ton) =	35	
11. D008 Haz waste disposal cost ($/ton) =	75	EO Environmental
12. D030 Haz waste disposal cost ($/ton) =	150	EO Environmental
13. PCB Haz waste disposal cost ($/ton) =	75	EO Environmental
14. Haz waste regulatory fees ($/ton) =	10	
15. No. of contractor field crew =	2	
14. No. of subcontractor field crew =	2	
16. Output of front-end loader (cy/day) =	550	
17. No. of field days =	21	

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent (E-8)	168	$60.00	/hr	$10,080.00	
QA Coordinator	168	$40.00	/hr	$6,720.00	
Subcontractor Labor:					
Front End Loader Operator	21	$312.00	/day	$6,552.00	
Laborer	21	$293.00	/day	$6,153.00	
PBOW Security	21	$120.00	/day	$2,520.00	
Materials:					
Level D PPE	42	$10.00	/day	$420.00	
Equipment:					
1 cy Front End Loader	21	$280.86	/day	$5,898.06	
Disposal Costs:					
Transportation (Non-Haz Waste)	13824	$6.00	/ton	$82,944.85	
Disposal Cost (Non-Haz waste)	13824	$31.00	/ton	$428,548.40	
Transportation (Haz Waste)	0	$35.00	/ton	$0.00	
Disposal Cost (D008 haz waste)	0	$85.00	/ton	$0.00	
Disposal Cost (D030 haz waste)	0	$160.00	/ton	$0.00	
Disposal Cost (PCB haz waste)	0	$85.00	/ton	$0.00	
Travel for field crew:					
Lodging	118	$80.00	/day	$9,440.00	
Perdiem	118	$38.00	/day	$4,484.00	
Rental Car	59	$40.00	/day	$2,360.00	
				Subtotal	**$566,120.00**

Table 4-4
Alternative 3 - Excavation, Ex-Situ Stabilization, and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

8.0 Backfill Excavation with Clean Soil

Includes:
1. Backfill excavated areas with clean backfill (confirm soil is clean by sampling)
2. Confirmation testing under contaminated soil stockpiles.
3. Prepare site close-out report.

Assumptions and Calculations:

1. Volume of consolidated soil excavated (cy) =	9205
2. Compaction factor =	1.15
3. Volume of soil required for backfill (cy) =	10586
4. Cost of clean backfill soil delivered to site ($/cy) =	12
5. Field days required to backfill soil =	19
6. No. of contractor field crew =	2
8. No. of subcontractor backfill field crew =	2
7. No. of confirmatory samples from backfill =	2
8. Subcontractor markup on equipment =	1.25
9. Subcontractor markup on labor =	1.31
10. Area of contaminated soil stockpile (sf) =	34338
11. Area per confirmation sample (sf) =	400
12. No. of confirmation samples under soil stockpile =	86

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent (E-8)	152	$60.00	/hr	$9,120.00	
QA Coordinator	152	$40.00	/hr	$6,080.00	
Site Close-Out Report	1	$20,000.00	/ea	$20,000.00	
Subcontractor Labor:					
Front End Loader Operator	19	$312.00	/day	$5,928.00	
Laborer/Oiler	19	$279.29	/day	$5,306.55	
PBOW Security	19	$120.00	/day	$2,280.00	
Equipment:					
1 cy Front End Loader	19	$280.86	/day	$5,336.34	
Material:					
Backfill	10586	$12.00	/cy	$127,029.00	delivered to site
PID rental	1	$974.00	/mo.	$974.00	
CGI rental	1	$380.00	/mo.	$380.00	
Level D PPE	38	$10.00	/day	$380.00	
Analytical:					
RCRA Metals	2	$105.00	/ea	$210.00	
NACs (8330)	88	$158.00	/ea	$13,904.00	
SVOCs	2	$230.00	/ea	$460.00	
Lead	86	$24.00	/ea	$2,064.00	
PAHs (8270C)	86	$160.00	/ea	$13,760.00	
PCBs	86	$83.00	/ea	$7,138.00	
Shipping	23	$40.00	/ea	$920.00	
Travel for field crew:					
Lodging	106	$80.00	/day	$8,480.00	
Perdiem	106	$38.00	/day	$4,028.00	
Rental Car	53	$40.00	/day	$2,120.00	
Subcontract:					
Reseeding	218	$56.84	/msf	$12,391.00	
				Subtotal	**$248,289.00**

9.0 Overall Cost

Total Capital Cost	**$2,103,013.45**
Contingency (30%)	**$630,904.00**
PM Multiplier (7.5%)	**$157,726.00**
Fee/Profit (10%)	**$210,301.00**
Total Cost	**$3,102,000.00**

*This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

Table 4-5
Alternative 4 - Excavation and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

Alternative 4
Excavation/Off-Site Disposal Cost Estimate

Site: TNT Area A
Plum Brook Ordnance Works
Date: 9/11/2003

Scope:
1. Perform bench-scale treatability study, prepare stabilization work plan, H&S plan, materials list, and procurement
2. Mobilize equipment and personnel
3. Conduct pre-remediation soil sampling to better delineate the lateral and vertical extent of contamination.
4. Prepare site for remedial activity.
5. Excavate contaminated soil and perform confirmatory sampling
6. Dispose of untreated non-hazardous soil in a Subtitle D landfill. Dispose of untreated hazardous soil in a Subtitle C landfill. Dispose of PCB remediation waste in a TSCA landfill.
7. Backfill excavated areas
8. Demobilize equipment and personnel

1.0 Work Plan. Health and Safety Plan. Materials List. and Procurement

Includes:
1. Labor to generate work plan, engineering specifications, and Health and Safety Plan
2. Procure equipment and materials

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Senior Engineer (E-12)	40	$97.00	/hr.	$3,880.00	
Task Manager (E-8)	80	$62.00	/hr.	$4,960.00	
Geologist (E-8)	40	$62.00	/hr.	$2,480.00	
Project Engineer (E-6)	160	$50.00	/hr.	$8,000.00	
Health and Safety (E-8)	40	$62.00	/hr.	$2,480.00	
Procurement Specialist (E-6)	80	$56.00	/hr.	$4,480.00	
Drafting (E-6)	40	$50.00	/hr.	$2,000.00	
Document Repro (Draft and Final)	2	$1,000.00	/ea	$2,000.00	
				Subtotal	**$30,280.00**

2.0 Mobilization of Equipment and Personnel

Includes:
1. Mobilize equipment and personnel
2. Contractor field crew consists of a site superintendent, geologist, and a field technician.
3. Four 2-day trips for 2 contractor personnel for pre-remediation coordination.

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent (E-8)	24	$60.00	/hr	$1,440.00	
QA (Sampling) Coordinator	24	$40.00	/hr	$960.00	
H&S Coordinator	16	$50.00	/hr	$800.00	
Field Geologist	2	$480.00	/day	$960.00	
Subcontractor Labor:					
Excavator Operator	2	$340.91	/day	$681.83	
Equipment Operator	2	$326.98	/day	$653.95	
Loader Operator	2	$312.00	/day	$624.00	
Laborers	2	$288.00	/day	$576.00	
Truck Drivers	6	$262.00	/day	$1,572.00	
Equipment:					
Excavator	2	$704.00	/day	$1,408.00	
1 cy Front Wheel Loader	2	$280.86	/day	$561.72	
Screening Plant	2	$1,000.00	/ea	$2,000.00	
Radial Conveyor	2	$500.00	/ea	$1,000.00	
Dump Truck	6	$428.00	/day	$2,568.00	
Travel for contractor crew:					
Perdiem	30	$38.00	/day	$1,140.00	
Lodging	30	$80.00	/day	$2,400.00	
Rental Car	16	$40.00	/day	$640.00	
Airfare	19	$600.00	/ea	$11,400.00	
				Subtotal	**$31,385.50**

Table 4-5
Alternative 4 - Excavation and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

3.0 Pre-Remediation Soil Sampling

Includes:
1. Hydropunch soil sampling
2. Analysis of soil samples for chemicals of concern.

Assumptions:

1. Perimeter of proposed remediation area (ft) =	3832
2. Distance between boring locations =	40
3. No. of borings =	96
4. Average depth of boring (ft) =	10
5. No. of samples collected per boring =	3
6. Total no. of samples collected =	288
7. No. of borings advanced per day =	10

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor:					
Field Geologist	10	$480.00	/day	$4,800.00	
Subcontractor:					
Mob/Demob	1	$2,000.00	/ea	$2,000.00	
Hydropunch Borings	960	$15.00	/ft	$14,400.00	
Equipment Decon	96	$90.00	/ea	$8,640.00	
Materials:					
Field Supplies	96	$20.00	/bor.	$1,920.00	
Field Instruments	2	$400.00	/wk	$800.00	
Analytical:					
NACs (8330)	288	$158.00	/ea	$45,504.00	
Lead	288	$24.00	/ea	$6,912.00	
PAHs (8270C)	288	$160.00	/ea	$46,080.00	
PCBs	288	$83.00	/ea	$23,904.00	
Shipping	77	$40.00	/ea	$3,080.00	
Equipment:					
P/U Truck	10	$52.00	/day	$520.00	
Travel for Contractor Crew:					
Perdiem	10	$38.00	/day	$380.00	
Lodging	10	$80.00	/day	$800.00	
				Subtotal	**$159,740.00**

Table 4-5
Alternative 4 - Excavation and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

4.0 Site Preparation

Includes:
1. Clear remedial areas and treatment area = 5 acres
2. Construct 12" soil berm around staging areas (200 ft x 250 ft area = 900 ft).
3. Excavate soil for contact water retension pond.

Assumptions:

1. Volume of soil removed for contact water retention pond =	1,644
2. Excavator: hydraulic backhoe, 1 cy bucket	
3. Excavator output (cy/day) =	600
4. Days to excavate soil =	4
5. Volume of containment berm (cy) =	74
6. No. of contractor field crew =	2

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor:					
Site Superintendent	80	$60.00	/hr	$4,800.00	
QA Coordinator	80	$40.00	/hr	$3,200.00	
Subcontractor:					
Surveying	1	$24,000.00	/site	$24,000.00	
Site Clearing	4	$2,300.00	/acre	$9,200.00	
Excavator Operator	4	$340.91	/day	$1,363.66	
Equipment:					
Excavator	4	$704.00	/day	$2,816.00	
Materials:					
Earthen containment berm	74	$6.00	/cy	$444.00	
Travel for Field Crew:					
Per Diem	28	$38.00	/day	$1,064.00	
Lodging	28	$80.00	/day	$2,240.00	
Rental Car	14	$40.00	/day	$560.00	
				Subtotal	**$49,688.00**

Table 4-5
Alternative 4 - Excavation and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

5.0 Excavation of Contaminated Soil

Includes:
1. Excavation of soil with contaminants exceeding RGOs
2. Screen oversize material
3. Collect confirmatory sampling to determine extent of excavation
4. Staging and characterizing waste stream

Assumptions and Calculations:

1. Cubic yards of consolidated soil excavated =	16328
2. Swell factor for soil upon excavation =	1.3
3. Cubic yards of unconsolidated soil =	21226
4. Density of unconsolidated soil (tons/cy) =	1.1
5. Mass of unconsolidated soil (tons) =	23349
6. Capacity of screening plant (tons/hr) =	100
7. Excavator: hydraulic backhoe, 1 cy bucket ($/day) =	$704
8. Excavator output (cy/day) =	600
9. Days to excavate soil =	43
10. Dump truck capacity (cy) =	12
11. Dump truck haul distance (mi.) =	0.5
12. Dump truck output (cy/day) =	250
13. No. of required dump trucks per day =	2
14. Soil sample collected for waste characterization / cy =	150
15. No. of soil samples collected for waste characterization =	142
16. Number of contractor field crew =	3
17. Number of subcontractor excavation crew =	4
18. Number of subcontractor screening crew =	3
19. Airfare included under mobilization	
20. Lineal foot of excavation per confirmation sample =	20
21. Resampling factor for confirmation sampling =	1.1
22. No.of confirmatory samples from excavated area =	347
23. Subcontractor markup on equipment =	1.25
24. Subcontractor markup on labor =	1.31
25. Excavation area (ft^2) =	49624
26. Cost multiplier for 1-week turnaround on analytical data =	1.25
27. Fraction of excavation work performed in Level C PPE =	0.10
28. Labor productivity factor for Level C work =	0.67
29. Days excavation crew in Level C =	5
30. Days screening crew in Level C =	4
31. Perimeter of excavation area (ft) =	3832
32. Excavation area (sf) =	49624
33. Volume of pit water requiring POTW disposal (gal) =	20000

Service/Materials	Unit	Unit Cost		Subtotal
Contractor Labor:				
Site Superintendent (E-8)	344	$60.00	/hr	$20,640.00
QA (Sampling) Coordinator	344	$40.00	/hr	$13,760.00
H&S Coordinator	344	$50.00	/hr	$17,200.00
Chemist (home office)	86	$51.00	/hr	$4,386.00
Subcontractor:				
Excavator Operator	43	$340.91	/day	$14,659.32
Equipment Operator	35	$326.98	/day	$11,444.16
Loader Operator	35	$312.00	/day	$10,920.00
Laborers	78	$288.00	/day	$22,464.00
Truck Drivers	129	$262.00	/day	$33,798.00
Road Repair	1	$50,000.00	/site	$50,000.00
Equipment:				
Excavator	43	$704.00	/day	$30,272.00
100-ton/hr Screening Plant	7	$1,800.00	/wk	$12,600.00
Radial Stacking Conveyor	7	$1,222.00	/wk	$8,554.00
1 cy Front Wheel Loader	35	$280.86	/day	$9,830.10
12-cy Dump Truck	86	$428.00	/day	$36,808.00
3000 gal. Water Truck	43	$402.00	/day	$17,286.00
150 gpm Pump	2	$2,439.00	/ea.	$4,878.00
300 gpm Pump	2	$3,749.00	/ea.	$7,498.00
7-ft Diameter Sand Filter	1	$22,310.00	/ea.	$22,310.00
200-gpm GAC Adsorber (6000#-disp.)	1	$14,217.00	/ea.	$14,217.00
20000 gal Steel Water Tank	1	$14,618.00	/ea.	$14,618.00

Table 4-5
Alternative 4 - Excavation and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

5.0 Excavation of Contaminated Soil (continued)					
Analytical:					
TCLP Extraction	142	$12.88	/ea	$1,828.25	
Lead	489	$300.00	/ea	$146,700.00	
SVOCs (8270C)	489	$197.50	/ea	$96,577.50	
NACs (8330)	489	$30.00	/ea	$14,670.00	
PCBs	489	$103.75	/ea	$50,733.75	
NAC field analyses	347	$40.00	/ea	$13,880.00	
Lead field analyses	2	$4,200.00	/mo.	$8,400.00	
Shipping	130	$40.00	/ea	$5,216.00	
Materials & Services:					
Office Trailer	6	$500.00	/mo.	$3,000.00	
Level D PPE	245	$10.00	/day	$2,450.00	
Level C PPE	32	$35.00	/day	$1,120.00	
PID rental	3	$974.00	/mo.	$2,922.00	
CGI rental	3	$380.00	/mo.	$1,140.00	
Pit Water Disposal	20	$1.62	/kgal	$32.40	
Travel for Contractor Crew:					
Perdiem	568	$38.00	/day	$21,584.00	
Lodging	568	$80.00	/day	$45,440.00	
Rental Car	230	$40.00	/day	$9,200.00	
				Subtotal	**$803,036.00**

Table 4-5
Alternative 4 - Excavation and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

6.0 Off-Site Disposal

Includes:
1. Dispose of non-hazardous soil at a nonhazardous waste landfill.
2. Dispose of hazardous soil at a RCRA Subtitle C TSDF.
3. Dispose of PCB waste at a TSCA approved landfill.

Assumptions and Calculations:

1. Volume of consolidated, non-hazardous soil (cy) =	12338	
2. Volume of unconsolidated, non-hazardous soil (cy) =	16040	
3. Tons of non-hazardous soil for disposal =	17644	
4. Consolidated volume of D008 soil for haz disposal (cy) =	68	no D030 waste comingled
5. Consolidated volume of D030 soil for haz disposal (cy) =	3803	
6. Consolidated volume of PCB soil for haz disposal (cy) =	119	
7. Total volume of unconsolidated hazardous soil (cy) =	5186	
8. Non-haz waste transportation cost ($/ton) =	6	
9. Non-haz waste disposal costs ($/ton) =	31	Erie County Landfill
10. Non-haz waste regulatory fees ($/ton) =	0	included in disposal
11. Haz waste transportation cost ($/ton) =	35	
12. D008 Haz waste disposal cost ($/ton) =	75	
13. D030 Haz waste disposal cost ($/ton) =	150	
14. PCB Haz waste disposal cost ($/ton) =	75	
15. Haz waste regulatory fees ($/ton) =	10	
16. No. of contractor field crew =	2	
14. No. of subcontractor field crew =	2	
17. Output of front-end loader (cy/day) =	550	
18. No. of field days =	39	

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent (E-8)	312	$60.00	/hr	$18,720.00	
QA Coordinator	312	$40.00	/hr	$12,480.00	
Subcontractor Labor:					
Front End Loader Operator	39	$312.00	/day	$12,168.00	
Laborer	39	$293.00	/day	$11,427.00	
PBOW Security	39	$120.00	/day	$4,680.00	
Materials:					
Level D PPE	78	$10.00	/day	$780.00	
Equipment:					
1 cy Front End Loader	39	$280.86	/day	$10,953.54	
Disposal Costs:					
Transportation (Non-Haz Waste)	17644	$6.00	/ton	$105,864.12	
Disposal Cost (Non-Haz waste)	17644	$31.00	/ton	$546,964.60	
Transportation (Haz Waste)	5705	$35.00	/ton	$199,675.00	
Disposal Cost (D008 haz waste)	97	$85.00	/ton	$8,245.00	
Disposal Cost (D030 haz waste)	5438	$160.00	/ton	$870,080.00	
Disposal Cost (PCB haz waste)	170	$85.00	/ton	$14,450.00	
Travel for field crew:					
Lodging	218	$80.00	/day	$17,440.00	
Perdiem	218	$38.00	/day	$8,284.00	
Rental Car	109	$40.00	/day	$4,360.00	
				Subtotal	**$1,846,571.00**

Table 4-5
Alternative 4 - Excavation and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

7.0 Backfill Excavation with Clean Soil

Includes:
1. Backfill excavated areas with clean backfill (confirm soil is clean by sampling)
2. Confirmation testing under contaminated soil stockpiles.
3. Prepare site close-out report.

Assumptions and Calculations:

1. Volume of consolidated soil excavated (cy) =	16328
2. Compaction factor =	1.15
3. Volume of soil required for backfill (cy) =	18777
4. Cost of clean backfill soil delivered to site ($/cy) =	12
5. Field days required to backfill soil =	34
6. No. of contractor field crew =	2
8. No. of subcontractor backfill field crew =	2
7. No. of confirmatory samples from backfill =	2
8. Subcontractor markup on equipment =	1.25
9. Subcontractor markup on labor =	1.31
10. Area of contaminated soil stockpile (sf) =	62370
11. Area per confirmation sample (sf) =	400
12. No. of confirmation samples under soil stockpile =	156

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent (E-8)	272	$60.00	/hr	$16,320.00	
QA Coordinator	272	$40.00	/hr	$10,880.00	
Site Close-Out Report	1	$20,000.00	/ea	$20,000.00	
Subcontractor Labor:					
Front End Loader Operator	34	$312.00	/day	$10,608.00	
Laborer/Oiler	34	$279.29	/day	$9,495.93	
PBOW Security	34	$120.00	/day	$4,080.00	
Equipment:					
1 cy Front End Loader	34	$280.86	/day	$9,549.24	
Material:					
Backfill	18777	$12.00	/cy	$225,326.40	delivered to site
PID rental	2	$974.00	/mo.	$1,948.00	
CGI rental	2	$380.00	/mo.	$760.00	
Level D PPE	68	$10.00	/day	$680.00	
Analytical:					
RCRA Metals	2	$105.00	/ea	$210.00	
NACs (8330)	158	$158.00	/ea	$24,964.00	
SVOCs	2	$230.00	/ea	$460.00	
Lead	156	$24.00	/ea	$3,744.00	
PAHs (8270C)	156	$160.00	/ea	$24,960.00	
PCBs	156	$83.00	/ea	$12,948.00	
Shipping	42	$40.00	/ea	$1,680.00	
Travel for field crew:					
Lodging	190	$80.00	/day	$15,200.00	
Perdiem	190	$38.00	/day	$7,220.00	
Rental Car	95	$40.00	/day	$3,800.00	
Subcontract:					
Reseeding	218	$56.84	/msf	$12,391.00	
				Subtotal	**$417,225.00**

8.0 Overall Cost

Total Capital Cost	**$3,337,925.50**
Contingency (30%)	**$1,001,378.00**
PM Multiplier (7.5%)	**$250,344.00**
Fee/Profit (10%)	**$333,793.00**
Total Cost	**$4,923,000.00**

*This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

Table 4-6
Alternative 4 - Excavation and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

Alternative 4
Excavation/Off-Site Disposal Cost Estimate

Site: TNT Area C
Plum Brook Ordnance Works
Date: 9/11/2003

Scope:
1. Perform bench-scale treatability study, prepare stabilization work plan, H&S plan, materials list, and procurement
2. Mobilize equipment and personnel
3. Conduct pre-remediation soil sampling to better delineate the lateral and vertical extent of contamination.
4. Prepare site for remedial activity.
5. Excavate contaminated soil and perform confirmatory sampling
6. Dispose of untreated non-hazardous soil in a Subtitle D landfill. Dispose of untreated hazardous soil in a Subtitle C landfill. Dispose of PCB remediation waste in a TSCA landfill.
7. Backfill excavated areas
8. Demobilize equipment and personnel

1.0 Work Plan, Health and Safety Plan, Materials List, and Procurement

Includes:
1. Labor to generate work plan, engineering specifications, and Health and Safety Plan
2. Procure equipment and materials

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Senior Engineer (E-12)	40	$97.00	/hr.	$3,880.00	
Task Manager (E-8)	80	$62.00	/hr.	$4,960.00	
Geologist (E-8)	40	$62.00	/hr.	$2,480.00	
Project Engineer (E-6)	160	$50.00	/hr.	$8,000.00	
Health and Safety (E-8)	40	$62.00	/hr.	$2,480.00	
Procurement Specialist (E-6)	80	$56.00	/hr.	$4,480.00	
Drafting (E-6)	40	$50.00	/hr.	$2,000.00	
Document Repro (Draft and Final)	2	$1,000.00	/ea	$2,000.00	
				Subtotal	**$30,280.00**

2.0 Mobilization/Demobilization of Equipment and Personnel

Includes:
1. Mobilize equipment and personnel
2. Contractor field crew consists of a site superintendent, geologist, and a field technician.
3. Four 2-day trips for 2 contractor personnel for pre-remediation coordination.

Service/Materials	Unit	Unit Cost		Subtotal	
Labor:					
Site Superintendent (E-8)	24	$60.00	/hr	$1,440.00	
QA (Sampling) Coordinator	24	$40.00	/hr	$960.00	
H&S Coordinator	16	$50.00	/hr	$800.00	
Field Geologist	2	$480.00	/day	$960.00	
Subcontractor Labor:					
Excavator Operator	2	$340.91	/day	$681.83	
Equipment Operator	2	$326.98	/day	$653.95	
Loader Operator	2	$312.00	/day	$624.00	
Laborers	2	$288.00	/day	$576.00	
Truck Drivers	6	$262.00	/day	$1,572.00	
Equipment:					
Excavator	2	$704.00	/day	$1,408.00	
1 cy Front Wheel Loader	2	$280.86	/day	$561.72	
Screening Plant	2	$1,000.00	/ea	$2,000.00	
Radial Conveyor	2	$500.00	/ea	$1,000.00	
Dump Truck	6	$428.00	/day	$2,568.00	
Travel for contractor crew:					
Perdiem	30	$38.00	/day	$1,140.00	
Lodging	30	$80.00	/day	$2,400.00	
Rental Car	16	$40.00	/day	$640.00	
Airfare	19	$600.00	/ea	$11,400.00	
				Subtotal	**$31,385.50**

Table 4-6
Alternative 4 - Excavation and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

3.0 Pre-Remediation Soil Sampling

Includes:
1. Hydropunch soil sampling
2. Analysis of soil samples for chemicals of concern.

Assumptions:

1. Perimeter of proposed remediation area (ft) =	3415
2. Distance between boring locations =	40
3. No. of borings =	86
4. Average depth of boring (ft) =	10
5. No. of samples collected per boring =	3
6. Total no. of samples collected =	258
7. No. of borings advanced per day =	10

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor:					
Field Geologist	9	$480.00	/day	$4,320.00	
Subcontractor:					
Mob/Demob	1	$2,000.00	/ea	$2,000.00	
Hydropunch Borings	860	$15.00	/ft	$12,900.00	
Equipment Decon	86	$90.00	/ea	$7,740.00	
Materials:					
Field Supplies	86	$20.00	/bor.	$1,720.00	
Field Instruments	2	$400.00	/wk	$800.00	
Analytical:					
NACs (8330)	258	$158.00	/ea	$40,764.00	
Lead	258	$24.00	/ea	$6,192.00	
PAHs (8270C)	258	$160.00	/ea	$41,280.00	
PCBs	258	$83.00	/ea	$21,414.00	
Shipping	69	$40.00	/ea	$2,760.00	
Equipment:					
P/U Truck	9	$52.00	/day	$468.00	
Travel for Contractor Crew:					
Perdiem	9	$38.00	/day	$342.00	
Lodging	9	$80.00	/day	$720.00	
				Subtotal	**$143,420.00**

Table 4-6
Alternative 4 - Excavation and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

4.0 Site Preparation

Includes:
1. Clear remedial areas and treatment area = 5 acres
2. Construct 12" soil berm around staging areas (200 ft x 250 ft area = 900 ft).
3. Excavate soil for contact water retension pond.

Assumptions:

1. Volume of soil removed for contact water retention pond =	1,644
2. Excavator: hydraulic backhoe, 1 cy bucket	
3. Excavator output (cy/day) =	600
4. Days to excavate soil =	4
5. Volume of containment berm (cy) =	74
6. No. of contractor field crew =	2

Service/Materials	Unit	Unit Cost	Subtotal	
Contractor:				
Site Superintendent	80	$60.00 /hr	$4,800.00	
QA Coordinator	80	$40.00 /hr	$3,200.00	
Subcontractor:				
Surveying	1	$24,000.00 /site	$24,000.00	
Site Clearing	4	$2,300.00 /acre	$9,200.00	
Excavator Operator	4	$340.91 /day	$1,363.66	
Equipment:				
Excavator	4	$704.00 /day	$2,816.00	
Materials:				
Earthen containment berm	74	$6.00 /cy	$444.00	
Travel for Field Crew:				
Per Diem	28	$38.00 /day	$1,064.00	
Lodging	28	$80.00 /day	$2,240.00	
Rental Car	14	$40.00 /day	$560.00	
			Subtotal	**$49,688.00**

Table 4-6
Alternative 4 - Excavation and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

5.0 Excavation of Contaminated Soil

Includes:
1. Excavation of soil with contaminants exceeding RGOs
2. Screen oversize material
3. Collect confirmatory sampling to determine extent of excavation
4. Staging and characterizing waste stream

Assumptions and Calculations:

1. Cubic yards of consolidated soil excavated =	9205
2. Swell factor for soil upon excavation =	1.3
3. Cubic yards of unconsolidated soil =	11967
4. Density of unconsolidated soil (tons/cy) =	1.1
5. Mass of unconsolidated soil (tons) =	13163
6. Capacity of screening plant (tons/hr) =	100
7. Excavator: hydraulic backhoe, 1 cy bucket ($/day) =	$704
8. Excavator output (cy/day) =	600
9. Days to excavate soil =	24
10. Dump truck capacity (cy) =	12
11. Dump truck haul distance (mi.) =	0.5
12. Dump truck output (cy/day) =	250
13. No. of required dump trucks per day =	2
14. Soil sample collected for waste characterization / cy =	150
15. No. of soil samples collected for waste characterization =	80
16. Number of contractor field crew =	3
17. Number of subcontractor excavation crew =	4
18. Number of subcontractor screening crew =	3
19. Airfare included under mobilization	
20. Lineal foot of excavation per confirmation sample =	20
21. Resampling factor for confirmation sampling =	1.1
22. No.of confirmatory samples from excavated area =	286
23. Subcontractor markup on equipment =	1.25
24. Subcontractor markup on labor =	1.31
25. Excavation area (ft^2) =	35583
26. Cost multiplier for 1-week turnaround on analytical data =	1.25
27. Fraction of excavation work performed in Level C PPE =	0.10
28. Labor productivity factor for Level C work =	0.67
29. Days excavation crew in Level C =	3
30. Days screening crew in Level C =	2
31. Perimeter of excavation area (ft) =	3415
32. Excavation area (sf) =	35583
33. Volume of pit water requiring POTW disposal (gal) =	20000

Service/Materials	Unit	Unit Cost		Subtotal
Contractor Labor:				
Site Superintendent (E-8)	192	$60.00	/hr	$11,520.00
QA (Sampling) Coordinator	192	$40.00	/hr	$7,680.00
H&S Coordinator	192	$50.00	/hr	$9,600.00
Chemist (home office)	48	$51.00	/hr	$2,448.00
Subcontractor:				
Excavator Operator	24	$340.91	/day	$8,181.95
Equipment Operator	20	$326.98	/day	$6,539.52
Loader Operator	20	$312.00	/day	$6,240.00
Laborers	44	$288.00	/day	$12,672.00
Truck Drivers	72	$262.00	/day	$18,864.00
Road Repair	1	$50,000.00	/site	$50,000.00
Equipment:				
Excavator	24	$704.00	/day	$16,896.00
100-ton/hr Screening Plant	4	$1,800.00	/wk	$7,200.00
Radial Stacking Conveyor	4	$1,222.00	/wk	$4,888.00
1 cy Front Wheel Loader	20	$280.86	/day	$5,617.20
12-cy Dump Truck	48	$428.00	/day	$20,544.00
3000 gal. Water Truck	24	$402.00	/day	$9,648.00
150 gpm Pump	2	$2,439.00	/ea.	$4,878.00
300 gpm Pump	2	$3,749.00	/ea.	$7,498.00
7-ft Diameter Sand Filter	1	$22,310.00	/ea.	$22,310.00
200-gpm GAC Adsorber (6000#-disp.)	1	$14,217.00	/ea.	$14,217.00
20000 gal Steel Water Tank	1	$14,618.00	/ea.	$14,618.00

Table 4-6
Alternative 4 - Excavation and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

5.0 Excavation of Contaminated Soil (continued)					
Analytical:					
TCLP Extraction	80	$12.88	/ea	$1,030.00	
Lead	366	$300.00	/ea	$109,800.00	
SVOCs (8270C)	366	$197.50	/ea	$72,285.00	
NACs (8330)	366	$30.00	/ea	$10,980.00	
PCBs	366	$103.75	/ea	$37,972.50	
NAC field analyses	286	$40.00	/ea	$11,440.00	
Lead field analyses	2	$4,200.00	/mo.	$8,400.00	
Shipping	98	$40.00	/ea	$3,904.00	
Materials:					
Office Trailer	4	$500.00	/mo.	$2,000.00	
Level D PPE	138	$10.00	/day	$1,380.00	
Level C PPE	18	$35.00	/day	$630.00	
PID rental	2	$974.00	/mo.	$1,948.00	
CGI rental	2	$380.00	/mo.	$760.00	
Pit Water Disposal	20	$1.62	/kgal	$32.40	
Travel for Contractor Crew:					
Perdiem	319	$38.00	/day	$12,122.00	
Lodging	319	$80.00	/day	$25,520.00	
Rental Car	129	$40.00	/day	$5,160.00	
				Subtotal	**$567,424.00**

Table 4-6
Alternative 4 - Excavation and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

6.0 Off-Site Disposal

Includes:

1. Dispose of non-hazardous soil at a nonhazardous waste landfill.
2. Dispose of hazardous soil at a RCRA Subtitle C TSDF.
3. Dispose of PCB waste at a TSCA approved landfill.

Assumptions and Calculations:

1. Volume of consolidated, non-hazardous soil (cy) =	6895	
2. Volume of unconsolidated, non-hazardous soil (cy) =	8964	
3. Tons of non-hazardous soil for disposal =	9860	
4. Consolidated volume of D008 soil for haz disposal (cy) =	207	
5. Consolidated volume of D030 soil for haz disposal (cy) =	2103	
6. Consolidated volume of PCB soil for haz disposal (cy) =	0	
7. Total volume of unconsolidated hazardous soil (cy) =	3003	
8. Non-haz waste transportation cost ($/ton) =	6	
9. Non-haz waste disposal costs ($/ton) =	31	Erie County Landfill
10. Non-haz waste regulatory fees ($/ton) =	0	included in disposal
11. Haz waste transportation cost ($/ton) =	35	
12. D008 Haz waste disposal cost ($/ton) =	75	EO Environmental
13. D030 Haz waste disposal cost ($/ton) =	150	EO Environmental
14. PCB Haz waste disposal cost ($/ton) =	75	EO Environmental
15. Haz waste regulatory fees ($/ton) =	10	
16. No. of contractor field crew =	2	
14. No. of subcontractor field crew =	2	
17. Output of front-end loader (cy/day) =	550	
18. No. of field days =	22	

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent (E-8)	176	$60.00	/hr	$10,560.00	
QA Coordinator	176	$40.00	/hr	$7,040.00	
Subcontractor Labor:					
Front End Loader Operator	22	$312.00	/day	$6,864.00	
Laborer	22	$293.00	/day	$6,446.00	
PBOW Security	22	$120.00	/day	$2,640.00	
Materials:					
Level D PPE	44	$10.00	/day	$440.00	
Equipment:					
1 cy Front End Loader	22	$280.86	/day	$6,178.92	
Disposal Costs:					
Transportation (Non-Haz Waste)	9860	$6.00	/ton	$59,160.85	
Disposal Cost (Non-Haz waste)	9860	$31.00	/ton	$305,664.40	
Transportation (Haz Waste)	3303	$35.00	/ton	$115,605.00	
Disposal Cost (D008 haz waste)	296	$85.00	/ton	$25,160.00	
Disposal Cost (D030 haz waste)	3007	$160.00	/ton	$481,120.00	
Disposal Cost (PCB haz waste)	0	$85.00	/ton	$0.00	
Travel for field crew:					
Lodging	123	$80.00	/day	$9,840.00	
Perdiem	123	$38.00	/day	$4,674.00	
Rental Car	62	$40.00	/day	$2,480.00	
				Subtotal	**$1,043,873.00**

Table 4-6
Alternative 4 - Excavation and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

7.0 Backfill Excavation with Clean Soil

Includes:

1. Backfill excavated areas with clean backfill (confirm soil is clean by sampling)
2. Confirmation testing under contaminated soil stockpiles.
3. Prepare site close-out report.

Assumptions and Calculations:

1. Volume of consolidated soil excavated (cy) =	9205
2. Compaction factor =	1.15
3. Volume of soil required for backfill (cy) =	10586
4. Cost of clean backfill soil delivered to site ($/cy) =	12
5. Field days required to backfill soil =	19
6. No. of contractor field crew =	2
8. No. of subcontractor backfill field crew =	2
7. No. of confirmatory samples from backfill =	2
8. Subcontractor markup on equipment =	1.25
9. Subcontractor markup on labor =	1.31
10. Area of contaminated soil stockpile (sf) =	34338
11. Area per confirmation sample (sf) =	400
12. No. of confirmation samples under soil stockpile =	86

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent (E-8)	152	$60.00	/hr	$9,120.00	
QA Coordinator	152	$40.00	/hr	$6,080.00	
Site Close-Out Report	1	$20,000.00	/ea	$20,000.00	
Subcontractor Labor:					
Front End Loader Operator	19	$312.00	/day	$5,928.00	
Laborer/Oiler	19	$279.29	/day	$5,306.55	
PBOW Security	19	$120.00	/day	$2,280.00	
Equipment:					
1 cy Front End Loader	19	$280.86	/day	$5,336.34	
Material:					
Backfill	10586	$12.00	/cy	$127,029.00	delivered to site
PID rental	1	$974.00	/mo.	$974.00	
CGI rental	1	$380.00	/mo.	$380.00	
Level D PPE	38	$10.00	/day	$380.00	
Analytical:					
RCRA Metals	2	$105.00	/ea	$210.00	
NACs (8330)	88	$158.00	/ea	$13,904.00	
SVOCs	2	$230.00	/ea	$460.00	
Lead	86	$24.00	/ea	$2,064.00	
PAHs (8270C)	86	$160.00	/ea	$13,760.00	
PCBs	86	$83.00	/ea	$7,138.00	
Shipping	23	$40.00	/ea	$920.00	
Travel for field crew:					
Lodging	106	$80.00	/day	$8,480.00	
Perdiem	106	$38.00	/day	$4,028.00	
Rental Car	53	$40.00	/day	$2,120.00	
Subcontract:					
Reseeding	218	$56.84	/msf	$12,391.00	
				Subtotal	**$248,289.00**

8.0 Overall Cost

Total Capital Cost	**$2,114,359.50**
Contingency (30%)	**$634,308.00**
PM Multiplier (7.5%)	**$158,577.00**
Fee/Profit (10%)	**$211,436.00**
Total Cost	**$3,119,000.00**

*This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

Table 4-7
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

Alternative 5
Excavation/Composting/Stabilization/Off-Site and On-Site Disposal Cost Estimate

Site: TNT Area A
Plum Brook Ordnance Works
Date: 9/11/2003

Scope:

1. Perform bench-scale treatability studies to test the effectiveness of windrow composting and chemical stabilization for treating chemical of concern in soil, prepare remedial work plan, H&S plan, materials list, and procurement.
2. Mobilize equipment and personnel
3. Conduct pre-remediation soil sampling to better delineate the lateral and vertical extent of contamination.
4. Prepare site for remedial activity.
5. Excavate contaminated soil and perform confirmatory sampling.
6. Treatment of soil contaminated with nitroaromatic compounds via windrow composting.
7. Chemically stabilize Pb-contaminated soil that cannot be effectively treated using windrow composting..
8. Off-site disposal of stabilized soil and PCB remediation waste..
9. Backfill excavation with clean soil and spread treated compost across site.
10. Demobilize equipment and personnel.

1.0 Bench-Scale Study, Work Plan, Health and Safety Plan, Materials List, and Procurement

Includes:

1. Perform bench-scale treatability study to (1) define most cost-effective compost mix formula and (2) determine the optimum chemical additives and mix ratio for chemical stabilization. Results will be used to generate the design work plan.
2. Labor to generate work plan, engineering specifications, and Health and Safety Plan
3. Procure equipment and materials

Service/Materials	Unit	Unit Cost		Subtotal	
Composting Treatability Study	1	$20,000.00	/ea	$20,000.00	
Stabilization Treatability Study	1	$15,000.00	/ea	$15,000.00	
Contractor Labor:					
Senior Engineer (E-12)	80	$97.00	/hr.	$7,760.00	
Task Manager (E-8)	160	$62.00	/hr.	$9,920.00	
Geologist (E-8)	40	$62.00	/hr.	$2,480.00	
Project Engineer (E-6)	320	$50.00	/hr.	$16,000.00	
Health and Safety (E-8)	80	$62.00	/hr.	$4,960.00	
Procurement Specialist (E-6)	160	$56.00	/hr.	$8,960.00	
Drafting (E-6)	80	$50.00	/hr.	$4,000.00	
Document Repro (Draft and Final)	2	$1,000.00	/ea	$2,000.00	
				Subtotal	**$91,080.00**

Table 4-7
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

2.0 Mobilization/Demobilization of Equipment and Personnel

Includes:
1. Mobilize equipment and personnel
2. Contractor field crew consists of site superintendent, geologist, and a field technicians
3. Four 2-day trips for 2 contractor personnel for pre-remediation coordination.

Service/Materials	Unit	Unit Cost		Subtotal	
Labor:					
Site Superintendent (E-8)	24	$60.00	/hr	$1,440.00	
QA (Sampling) Coordinator	24	$40.00	/hr	$960.00	
H&S Coordinator	16	$50.00	/hr	$800.00	
Field Geologist	2	$480.00	/day	$960.00	
Subcontractor Labor:					
Excavator Operator	2	$340.91	/day	$681.83	
Equipment Operator	2	$326.98	/day	$653.95	
Equipment Operator	2	$326.98	/day	$653.95	
Dozer Operator	2	$326.98	/day	$653.95	
Loader Operator	2	$312.00	/day	$624.00	
Loader Operator	2	$312.00	/day	$624.00	
Laborers	2	$288.00	/day	$576.00	
Truck Drivers	12	$262.00	/day	$3,144.00	
Equipment:					
Excavator	2	$704.00	/day	$1,408.00	
1 cy Front Wheel Loader	2	$280.86	/day	$561.72	
3 cy Front Wheel Loader	2	$485.22	/day	$970.44	
Windrow Turner	2	$1,000.00	/mob	$2,000.00	
10-cy Mixing System	2	$975.00	/ea	$1,950.00	
Screening Plant	2	$1,000.00	/ea	$2,000.00	
Radial Conveyor	2	$500.00	/ea	$1,000.00	
D-6H Dozer	2	$630.70	/day	$1,261.40	
Dump Trucks	12	$428.00	/day	$5,136.00	
Travel for contractor crew:					
Perdiem	42	$38.00	/day	$1,596.00	
Lodging	42	$80.00	/day	$3,360.00	
Rental Car	20	$40.00	/day	$800.00	
Airfare	25	$600.00	/ea	$15,000.00	
				Subtotal	**$48,815.00**

Table 4-7
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

3.0 Pre-Remediation Soil Sampling

Includes:
1. Hydropunch soil sampling
2. Analysis of soil samples for chemicals of concern.

Assumptions:

1. Perimeter of proposed remediation area (ft) =	3832
2. Distance between boring locations =	40
3. No. of borings =	96
4. Average depth of boring (ft) =	10
5. No. of samples collected per boring =	3
6. Total no. of samples collected =	288
7. No. of borings advanced per day =	10

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor:					
Field Geologist	10	$480.00	/day	$4,800.00	
Subcontractor:					
Mob/Demob	1	$2,000.00	/ea	$2,000.00	
Hydropunch Borings	960	$15.00	/ft	$14,400.00	
Equipment Decon	96	$90.00	/ea	$8,640.00	
Materials:					
Field Supplies	96	$20.00	/bor.	$1,920.00	
Field Instruments	2	$400.00	/wk	$800.00	
Analytical:					
NACs (8330)	288	$158.00	/ea	$45,504.00	
Lead	288	$24.00	/ea	$6,912.00	
PAHs (8270C)	288	$160.00	/ea	$46,080.00	
PCBs	288	$83.00	/ea	$23,904.00	
Shipping	77	$40.00	/ea	$3,072.00	
Equipment:					
P/U Truck	10	$52.00	/day	$520.00	
Travel for Contractor Crew:					
Perdiem	10	$38.00	/day	$380.00	
Lodging	10	$80.00	/day	$800.00	
				Subtotal	**$159,732.00**

Table 4-7
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

4.0 Site Preparation

Includes:
1. Clear remedial areas and treatment area = 5 acres
2. Construct 12" soil berm around treatment areas (400 ft x 500 ft area = 1800 ft).
3. Excavate soil for contact water retension pond.
4. Construct 6-inch reinforced concrete slab for treatment area.

Assumptions:

1. Volume of soil removed for contact water retention pond =	3,288
2. Excavator: hydraulic backhoe, 1 cy bucket	
3. Excavator output (cy/day) =	600
4. Days to excavate soil =	7
5. Volume of containment berm (cy) =	106
6. No. of contractor field crew =	2
7. Area of concrete treatment slab (160 ft x 420 ft) (sf) =	67200

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor:					
Site Superintendent	320	$60.00	/hr	$19,200.00	
QA Coordinator	320	$40.00	/hr	$12,800.00	
Subcontractor:					
Surveying	1	$24,000.00	/site	$24,000.00	
Site Clearing	7	$2,300.00	/acre	$16,100.00	
Excavator Operator	7	$258.80	/day	$1,811.60	
Concrete Slab	67200	$4.39	/sf	$295,008.00	
Equipment:					
Excavator	7	$704.00	/day	$4,928.00	
Materials:					
Earthen containment berm	106	$6.00	/cy	$636.00	
Travel for Field Crew:					
Per Diem	112	$38.00	/day	$4,256.00	
Lodging	112	$80.00	/day	$8,960.00	
Rental Car	56	$40.00	/day	$2,240.00	
				Subtotal	**$389,940.00**

Table 4-7
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

5.0 Excavation of Contaminated Soil

Includes:
1. Excavation of soil with contaminants exceeding RGOs
2. Screen oversize material
2. Collect confirmatory samples to determine extent of excavation
3. Staging and characterizing waste stream

Assumptions and Calculations:

1. Cubic yards of consolidated soil excavated =	16328
2. Swell factor for soil upon excavation =	1.3
3. Cubic yards of unconsolidated soil =	21226
4. Density of unconsolidated soil (tons/cy) =	1.1
5. Mass of unconsolidated soil (tons) =	23349
6. Capacity of screening plant (tons/hr) =	100
7. Excavator: hydraulic backhoe, 1 cy bucket ($/day) =	602
8. Excavator output (cy/day) =	600
9. Days to excavate soil =	43
10. Dump truck capacity (cy) =	12
11. Dump truck haul distance (mi.) =	0.5
12. Dump truck output (cy/day) =	250
13. No. of required dump trucks per day =	2
14. Soil sample collected for waste characterization / cy =	150
15. No. of soil samples collected for waste characterization =	142
16. Number of contractor field crew =	3
17. Number of subcontractor excavation crew =	4
18. Number of subcontractor screening crew =	3
19. Airfare included under mobilization	
20. Lineal foot of excavation per confirmation sample =	20
21. Resampling factor for confirmation sampling =	1.1
22. No.of confirmatory samples from excavated area =	347
23. Subcontractor markup on equipment =	1.25
24. Subcontractor markup on labor =	1.31
25. Excavation area (ft^2) =	49624
26. Cost multiplier for 1-week turnaround on analytical data =	1.25
27. Fraction of excavation work performed in Level C PPE =	0.10
28. Labor productivity factor for Level C work =	0.67
29. Days excavation crew in Level C =	5
30. Days screening crew in Level C =	4
31. Perimeter of excavation area (ft) =	3832
32. Excavation area (sf) =	49624
33. Volume of pit water requiring POTW disposal (gal) =	20000

Service/Materials	Unit	Unit Cost		Subtotal
Contractor Labor:				
Site Superintendent (E-8)	344	$60.00	/hr	$20,640.00
QA (Sampling) Coordinator	344	$40.00	/hr	$13,760.00
H&S Coordinator	344	$50.00	/hr	$17,200.00
Chemist (home office)	86	$51.00	/hr	$4,386.00
Subcontractor:				
Excavator Operator	43	$340.91	/day	$14,659.32
Equipment Operator	35	$326.98	/day	$11,444.16
Loader Operator	35	$312.00	/day	$10,920.00
Laborers	78	$288.00	/day	$22,464.00
Truck Drivers	129	$262.00	/day	$33,798.00
Road Repair	1	$50,000.00	/site	$50,000.00
Equipment:				
Excavator	43	$704.00	/day	$30,272.00
100-ton/hr Screening Plant	7	$1,800.00	/wk	$12,600.00
Radial Stacking Conveyor	7	$1,222.00	/wk	$8,554.00
1 cy Front Wheel Loader	35	$280.86	/day	$9,830.10
Dump Truck	86	$428.00	/day	$36,808.00
3000 gal. Water Truck	43	$402.00	/day	$17,286.00
150 gpm Pump	2	$2,439.00	/ea.	$4,878.00
300 gpm Pump	2	$3,749.00	/ea.	$7,498.00
7-ft Diameter Sand Filter	1	$22,310.00	/ea.	$22,310.00
200-gpm GAC Adsorber (6000#-disp.)	1	$14,217.00	/ea.	$14,217.00
20000 gal Steel Water Tank	1	$14,618.00	/ea.	$14,618.00

Table 4-7
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

5.0 Excavation of Contaminated Soil (continued)					
Analytical:					
TCLP Extraction	142	$12.88	/ea	$1,828.25	
SVOCs (8270C)	489	$300.00	/ea	$146,700.00	
NACs (8330)	489	$197.50	/ea	$96,577.50	
Lead	489	$30.00	/ea	$14,670.00	
PCBs	489	$103.75	/ea	$50,733.75	
NAC field analyses	347	$40.00	/ea	$13,880.00	
Lead field analyses	2	$4,200.00	/mo.	$8,400.00	
Shipping	130	$40.00	/ea	$5,216.00	
Materials & Services:					
Office Trailer	6	$500.00	/mo.	$3,000.00	
Level D PPE	245	$10.00	/day	$2,450.00	
Level C PPE	32	$35.00	/day	$1,120.00	
PID rental	3	$974.00	/mo.	$2,922.00	
Pit Water Disposal	20	$1.62	/kgal	$32.40	
Travel for Contractor Crew:					
Perdiem	568	$38.00	/day	$21,584.00	
Lodging	568	$80.00	/day	$45,440.00	
Rental Car	230	$40.00	/day	$9,200.00	
				Subtotal	**$801,896.00**

Table 4-7
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

6.0 Winrow Composting of Contaminated of Soil

Includes:
1. Purchase and erection of treatment building
2. Purchase composting equipment
3. Procurement and installation of contact water treatment equipment
4. Purchase of stockpile & amendment storage liners and covers
5. Procurement & stockpiling of composting amendments
6. Mix and compost soil and amendments
7. Pre-compliance testing: after compost formation & at end of treatment.
8. Compliance sampling for NAC, metals, PAHs, PCBs

Assumptions:

1. Volume of consolidated soil to be treated (cy) =	15992
2. Volume of unconsolidated soil to be treated (cy) =	20790
3. Compost treatment duration (months) =	14
4. Capacity of windrow turner (tons/hr) =	3,200
5. Operating life of flails (hrs) =	25
6. No. of flails on windrow turner =	172
7. Volume of compost in treatment building (cy) =	4,448
8. Bulk density of compost (tons/cy) =	0.379
9. Bermed work area (sf) =	200,000
10. Contaminated soil stockpile area (sf) =	62,370
11. Treated soil stockpile area (sf) =	6,672
12. Height of stockpiles (ft) =	9
13. Manure storage area (sf) =	192
14. Capacity of contact water treatment system (gpm) =	200
15. Loading rate of multimedia filter (gpm/sf) =	5
16. Diameter of multimedia filter (ft) =	7
17. Volume of bulking amendment (cy) =	59947
18. Volume of agricultural waste amendment (cy) =	2425
19. Total volume of compost before treatment (cy) =	83133
20. Shrinkage factor for compost =	0.60
21. Compost volume per pre-compliance sample collected (cy) =	50
22. Compost volume per compliance sample collected (cy) =	150
23. Markup on materials =	1.10
24. Subcontractor markup on equipment =	1.25
25. Subcontractor markup on labor =	1.31
26. Cost multiplier for 1-week turnaround on analytical data =	1.25
27. Salvage factor for major equipment at end of project =	0.50
28. Number of contractor field crew =	2
29. Number of subcontractor field crew =	3

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent	308	$480.00	/day	$147,840.00	
QA (Sampling) Coordinator	308	$320.00	/day	$98,560.00	
Subcontractor Labor:					
Equipment Operator	308	$326.98	/day	$100,708.61	
Equipment Operator	308	$326.98	/day	$100,708.61	
Equipment Operator	308	$326.98	/day	$100,708.61	
PBOW Security	56	$120.00	/day	$6,720.00	
Equipment:					
Windrow Turner (7' x 20')	1	$156,250.00	/ea.	$156,250.00	less salvage
75 cy/hr Tub Grinder	1	$26,225.00	/ea	$26,225.00	less salvage
Bobcat	1	$16,000.00	/ea.	$16,000.00	less salvage
P/U Truck	1	$20,000.00	/ea.	$20,000.00	

Table 4-7
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

6.0 Winrow Composting of Contaminated of Soil						
Materials:						
Office Trailer	28	$500.00	/mo.	$14,000.00		
Erect Treatment Building	2	$35,080.00	/ea	$70,160.00		
Building Foundation & Accessories	2	$14,132.00	/ea	$28,264.00		
Treatment Building	2	$130,866.00	/ea	$261,732.00		
Treatment Building Lighting	2	$10,460.00	/ea	$20,920.00		
Dismantle Treatment Building	2	$33,500.00	/ea	$67,000.00		
Repl. Flails for Windrow Turner	3096	$9.50	/ea	$29,412.00		
40-mil Liner for Soil Stockpiles	72494	$1.58	/sf	$114,830.65		
10-mil Cover for Soil Stockpiles	69795	$0.83	/sf	$57,580.88		
40-mil Liner for Manure	202	$1.58	/sf	$319.33		
10-mil Cover for Manure	606	$0.83	/sf	$499.95		
Straw	59947	$13.56	/cy	$812,611.56		
Manure	2425	$14.97	/cy	$36,309.53		
Water	1775	$9.40	/kgal	$16,682.67		
Level D PPE	924	$10.00	/day	$9,240.00		
PID rental	14	$974.00	/mo.	$13,636.00		
CGI rental	14	$380.00	/mo.	$5,320.00		
Analytical:						
Pre-Compliance Sampling:						
NAC field analyses	3325	$40.00	/ea	$133,012.80		
Compliance Sampling:						
SVOCs (8270C)	333	$300.00	/ea	$99,759.60		
NACs (8330)	333	$197.50	/ea	$65,675.07		
Lead	333	$30.00	/ea	$9,975.96		
PCBs	333	$103.75	/ea	$34,500.20		
Travel for Field Crew:						
Per Diem	2156	$38.00	/day	$81,928.00		
Lodging	2156	$30.00	/day	$64,680.00	long-term stay	
Rental Car	431	$40.00	/day	$17,240.00		
				Subtotal		**$2,839,011.00**

Table 4-7
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

7.0 Stabilization of Pb-Contaminated Soil

Includes:

1. Stabilization of hazardous soil using cement and activated carbon

Assumptions and Calculations:

1. Volume of consolidated haz. soil to be stabilized =	217
2. Swell factor for soil upon excavation =	1.3
3. Cubic yards of unconsolidated soil =	282
4. Density of soil (ton/cy) =	1.1
5. Tons of hazardous soil that needs to be stabilized =	310
6. Bulk density of portland cement (tons/cy) =	1.27
7. Bulk density of activated carbon (tons/cy) =	1.31
8. Mix ratio of carbon to soil =	0.02
9. Mix ratio of portland cement to soil =	0.08
10. Carbon cost ($/ton)=	2000
11. Cement cost ($/ton)=	105
12. Carbon required for stabilization (tons) =	6
13. Cement required for stabilization (tons) =	25
14. No. of contractor field crew =	2
15. Stabilization batch cycle time (min) =	15
16. Field days required to stabilize soil =	1
17. Swell upon stabilization =	1.132
18. Soil sample collected for waste characterization / cy =	150
19. No. of soil samples collected =	2
20. Tons of stabilized soil =	372
21. Volume of stabilized soil (cy) =	319
22. Subcontractor markup on equipment =	1.25
23. Subcontractor markup on labor =	1.31
24. Number of subcontractor field crew =	4
25. Equipment setup/teardown (days) =	10

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent	11	$480.00	/day	$5,280.00	
QA (Sampling) Coordinator	11	$320.00	/day	$3,520.00	
Subcontractor Labor:					
Wheel Loader Operator	11	$238.00	/day	$2,618.00	
Process Equipment Operator	11	$240.00	/day	$2,640.00	
Process Equipment Operator	11	$240.00	/day	$2,640.00	
Laborer	11	$270.00	/day	$2,970.00	
PBOW Security	11	$120.00	/day	$1,320.00	
Equipment:					
1 cy Front Wheel Loader	11	$280.86	/day	$3,089.46	
10-cy Mixing System	1	$6,250.00	/mo	$6,250.00	
Belt Feeder for Mixing Stystem	1	$728.00	/mo	$728.00	
Stabilization Ancilliary Equipment	1	$557.00	/mo	$557.00	
Dust Collecton System	1	$530.00	/mo	$530.00	
Radial Stacking Conveyor	1	$3,605.00	/mo	$3,605.00	
Materials:					
Office Trailer	2	$500.00	/mo.	$1,000.00	
Carbon	6	$2,000.00	/ton	$12,000.00	
Cement	25	$105.00	/ton	$2,625.00	
Water	3	$9.40	/kgpd	$24.68	
Level D PPE	44	$10.00	/day	$440.00	
PID rental	1	$974.00	/mo.	$974.00	
CGI rental	1	$380.00	/mo.	$380.00	
Analytical:					
TCLP Extraction	2	$10.30	/ea	$21.00	
Lead	2	$24.00	/ea	$48.00	
SVOCs (8270C)	2	$240.00	/ea	$480.00	
NACs (8330)	2	$158.00	/ea	$316.00	
PCBs	2	$83.00	/ea	$166.00	
Unconfined Compresive Strength	2	$130.00	/ea	$260.00	
Shipping	1	$40.00	/ea	$40.00	
Travel for field crew:					
Lodging	92	$80.00	/day	$7,360.00	
Perdiem	92	$38.00	/day	$3,496.00	
Rental Car	31	$40.00	/day	$1,240.00	
				Subtotal	**$66,618.00**

Table 4-7
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

8.0 Off-Site Disposal

Includes:
1. Dispose of stabilized soil at a nonhazardous waste landfill
2. Dispose of PCB waste at a TSCA approved landfill

Assumptions and Calculations:

1. Tons of stabilized soil =	372	
2. Tons of soil for non-haz waste landfill disposal =	372	
3. Volume of consolidated soil for haz waste disposal (cy) =	119	
4. Volume of unconsolidated soil for haz waste disposal (cy) =	155	
5. Tons of soil for haz waste landfill disposal =	171	
6. Non-haz waste transportation cost ($/ton) =	6	
7. Non-haz waste disposal costs ($/ton) =	31	Erie County Landfill
8. Non-haz waste regulatory fees ($/ton) =	0	included in disposal
9. Haz waste transportation cost ($/ton) =	35	
10. D008 Haz waste disposal cost ($/ton) =	75	EO Environmental
11. D030 Haz waste disposal cost ($/ton) =	150	EO Environmental
12. PCB Haz waste disposal cost ($/ton) =	75	EO Environmental
13. Haz waste regulatory fees ($/ton) =	10	
14. No. of contractor field crew =	2	
14. No. of subcontractor field crew =	2	
15. Output of front-end loader (cy/day) =	550	
16. No. of field days =	1	
17. Subcontractor markup on equipment =	1.25	
18. Subcontractor markup on labor =	1.31	

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent (E-8)	8	$60.00	/hr	$480.00	
QA Coordinator	8	$40.00	/hr	$320.00	
Subcontractor Labor:					
Front End Loader Operator	1	$312.00	/day	$312.00	
Laborer/Oiler	1	$279.29	/day	$279.29	
PBOW Security	1	$120.00	/day	$120.00	
Materials:					
Level D PPE	2	$10.00	/day	$20.00	
Equipment:					
1 cy Front Wheel Loader	1	$280.86	/day	$280.86	
Disposal Costs:					
Transportation (Non-Haz Waste)	372	$6.00	/ton	$2,232.00	
Disposal Cost (Non-Haz waste)	372	$31.00	/ton	$11,532.00	
Transportation (Haz Waste)	171	$35.00	/ton	$5,967.50	
Disposal Cost (D008 haz waste)	0	$85.00	/ton	$0.00	
Disposal Cost (D030 haz waste)	0	$160.00	/ton	$0.00	
Disposal Cost (PCB haz waste)	171	$85.00	/ton	$14,492.50	
Travel for field crew:					
Lodging	4	$80.00	/day	$320.00	
Perdiem	4	$38.00	/day	$152.00	
Rental Car	2	$40.00	/day	$80.00	
				Subtotal	**$36,588.00**

Table 4-7
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

9.0 On-Site Compost Disposal / Backfill Excavation with Clean Soil

Includes:
1. Backfill excavated areas with clean backfill.
2. Load treated compost, truck to site, spread compost with dozer
3. Confirmation testing under contaminated soil stockpiles.
4. Prepare site close-out report.

Assumptions and Calculations:

1. Volume of consolidated soil excavated (cy) =	16328
2. Compaction factor =	1.15
3. Volume of soil required for backfill (cy) =	18777
4. Cost of clean backfill soil delivered to site ($/cy) =	12
6. Field days required to backfill soil =	34
7. No. of contractor field crew =	2
8. No. of subcontractor backfill field crew =	1
9. No. of compost loading field crew =	7
10. No. of compost spreading field crew =	2
8. No. of confirmatory samples from clean backfill =	2
9. Total volume of compost before treatment (cy) =	83133
10. Shrinkage factor for treated compost =	0.60
11. Volume of compost after treatment (cy) =	49880
12. Loader output (cy/day) =	1575
13. Days to load treated compost =	48
14. Dump truck capacity (cy) =	12
15. Dump truck haul distance (mi.) =	0.5
16. Dump truck output (cy/day) =	250
17. No. of dump trucks per day =	6
18. Dozer (D-6H) capacity (cy/hr) =	90
19. Days to spread treated compost =	70
20. Subcontractor markup on equipment =	1.25
21. Subcontractor markup on labor =	1.31
22. Area of contaminated soil stockpile (sf) =	62370
23. Area per confirmation sample (sf) =	400
24. No. of confirmation samples under soil stockpile =	156

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent	560	$60.00	/hr	$33,600.00	
QA Coordinator	560	$40.00	/hr	$22,400.00	
Site Close-Out Report	1	$20,000.00	/ea	$20,000.00	
Subcontractor Labor:					
Front End Loader Operator	34	$312.00	/day	$10,608.00	
Front End Loader Operator	48	$312.00	/day	$14,976.00	
Dump Truck Drivers	288	$262.00	/day	$75,456.00	
Dozer Operator	70	$326.98	/day	$22,888.32	
Laborer/Oiler	70	$279.29	/day	$19,550.44	
PBOW Security	34	$120.00	/day	$4,080.00	
Equipment:					
1 cy Front End Loader	34	$280.86	/day	$9,549.24	
3 cy Front End Loader	48	$485.22	/day	$23,290.56	
Dump Trucks	288	$428.00	/day	$123,264.00	
D-6H Dozer	70	$630.70	/day	$44,149.00	
Material:					
Clean Backfill	18777	$12.00	/cy	$225,326.40	delivered to site
PID rental	7	$974.00	/mo.	$6,818.00	
CGI rental	7	$380.00	/mo.	$2,660.00	
Level D PPE	510	$10.00	/day	$5,100.00	
Analytical:					
RCRA Metals	2	$105.00	/ea	$210.00	
NACs (8330)	158	$158.00	/ea	$24,964.00	
SVOCs	2	$230.00	/ea	$460.00	
Lead	156	$24.00	/ea	$3,744.00	
PAHs (8270C)	156	$160.00	/ea	$24,960.00	
PCBs	156	$83.00	/ea	$12,948.00	
Shipping	42	$40.00	/ea	$1,680.00	

Table 4-7
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

9.0 On-Site Compost Disposal / Backfill Excavation with Clean Soil					
Travel for field crew:					
	Lodging	910	$80.00 /day	$72,800.00	
	Perdiem	910	$38.00 /day	$34,580.00	
	Rental Car	311	$40.00 /day	$12,440.00	
Subcontract:					
	Reseeding	218	$56.84 /msf	$12,391.00	
				Subtotal	**$864,893.00**
10.0 Overall Cost					
				Total Capital Cost	**$5,298,573.00**
				Contingency (30%)	**$1,589,572.00**
				PM Multiplier (7.5%)	**$397,393.00**
				Fee/Profit (10%)	**$529,857.00**
				Total Cost	**$7,815,000.00**

*This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

Table 4-8
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

Alternative 5 Excavation/Composting/Stabilization/Off-Site and On-Site Disposal Cost Estimate	Site: TNT Area C Plum Brook Ordnance Works Date: 9/11/2003

Scope:
1. Perform bench-scale treatability studies to test the effectiveness of windrow composting and chemical stabilization for treating chemical of concern in soil, prepare remedial work plan, H&S plan, materials list, and procurement.
2. Mobilize equipment and personnel
3. Conduct pre-remediation soil sampling to better delineate the lateral and vertical extent of contamination.
4. Prepare site for remedial activity.
5. Excavate contaminated soil and perform confirmatory sampling.
6. Treatment of soil contaminated with nitroaromatic compounds via windrow composting.
7. Chemically stabilize Pb-contaminated soil that cannot be effectively treated using windrow composting..
8. Off-site disposal of stabilized soil and PCB remediation waste..
9. Backfill excavation with clean soil and spread treated compost across site.
10. Demobilize equipment and personnel.

1.0 Bench-Scale Study, Work Plan, Health and Safety Plan, Materials List, and Procurement

Includes:
1. Perform bench-scale treatability study to (1) define most cost-effective compost mix formula and (2) determine the optimum chemical additives and mix ratio for chemical stabilization. Results will be used to generate the design work plan.
2. Labor to generate work plan, engineering specifications, and Health and Safety Plan
3. Procure equipment and materials

Service/Materials	Unit	Unit Cost		Subtotal	
Composting Treatability Study	1	$20,000.00	/ea	$20,000.00	
Stabilization Treatability Study	1	$15,000.00	/ea	$15,000.00	
Contractor Labor:					
Senior Engineer (E-12)	80	$97.00	/hr.	$7,760.00	
Task Manager (E-8)	160	$62.00	/hr.	$9,920.00	
Geologist (E-8)	40	$62.00	/hr.	$2,480.00	
Project Engineer (E-6)	320	$50.00	/hr.	$16,000.00	
Health and Safety (E-8)	80	$62.00	/hr.	$4,960.00	
Procurement Specialist (E-6)	160	$56.00	/hr.	$8,960.00	
Drafting (E-6)	80	$50.00	/hr.	$4,000.00	
Document Repro (Draft and Final)	2	$1,000.00	/ea	$2,000.00	
				Subtotal	**$91,080.00**

Table 4-8
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

2.0 Mobilization of Equipment and Personnel

Includes:
1. Mobilize equipment and personnel
2. Contractor field crew consists of site superintendent, geologist, and a field technicians
3. Four 2-day trips for 2 contractor personnel for pre-remediation coordination.

Service/Materials	Unit	Unit Cost		Subtotal	
Labor:					
Site Superintendent (E-8)	24	$60.00	/hr	$1,440.00	
QA (Sampling) Coordinator	24	$40.00	/hr	$960.00	
H&S Coordinator	16	$50.00	/hr	$800.00	
Field Geologist	2	$480.00	/day	$960.00	
Subcontractor Labor:					
Excavator Operator	2	$340.91	/day	$681.83	
Equipment Operator	2	$326.98	/day	$653.95	
Equipment Operator	2	$326.98	/day	$653.95	
Dozer Operator	2	$326.98	/day	$653.95	
Loader Operator	2	$312.00	/day	$624.00	
Loader Operator	2	$312.00	/day	$624.00	
Laborers	2	$288.00	/day	$576.00	
Truck Drivers	12	$262.00	/day	$3,144.00	
Equipment:					
Excavator	2	$704.00	/day	$1,408.00	
1 cy Front Wheel Loader	2	$280.86	/day	$561.72	
3 cy Front Wheel Loader	2	$485.22	/day	$970.44	
Windrow Turner	2	$1,000.00	/mob	$2,000.00	
10-cy Mixing System	2	$975.00	/ea	$1,950.00	
Screening Plant	2	$1,000.00	/ea	$2,000.00	
Radial Conveyor	2	$500.00	/ea	$1,000.00	
D-6H Dozer	2	$630.70	/day	$1,261.40	
Dump Trucks	12	$428.00	/day	$5,136.00	
Travel for contractor crew:					
Perdiem	42	$38.00	/day	$1,596.00	
Lodging	42	$80.00	/day	$3,360.00	
Rental Car	20	$40.00	/day	$800.00	
Airfare	25	$600.00	/ea	$15,000.00	
				Subtotal	**$48,815.00**

Table 4-8
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

3.0 Pre-Remediation Soil Sampling

Includes:
1. Hydropunch soil sampling
2. Analysis of soil samples for chemicals of concern.

Assumptions:

1. Perimeter of proposed remediation area (ft) =	3415
2. Distance between boring locations =	40
3. No. of borings =	85
4. Average depth of boring (ft) =	10
5. No. of samples collected per boring =	3
6. Total no. of samples collected =	255
7. No. of borings advanced per day =	10

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor:					
Field Geologist	9	$480.00	/day	$4,320.00	
Subcontractor:					
Mob/Demob	1	$2,000.00	/ea	$2,000.00	
Hydropunch Borings	850	$15.00	/ft	$12,750.00	
Equipment Decon	85	$90.00	/ea	$7,650.00	
Materials:					
Field Supplies	85	$20.00	/bor.	$1,700.00	
Field Instruments	2	$400.00	/wk	$800.00	
Analytical:					
NACs (8330)	255	$158.00	/ea	$40,290.00	
Lead	255	$24.00	/ea	$6,120.00	
PAHs (8270C)	255	$160.00	/ea	$40,800.00	
PCBs	255	$83.00	/ea	$21,165.00	
Shipping	68	$40.00	/ea	$2,720.00	
Equipment:					
P/U Truck	9	$52.00	/day	$468.00	
Travel for Contractor Crew:					
Perdiem	9	$38.00	/day	$342.00	
Lodging	9	$80.00	/day	$720.00	
				Subtotal	**$141,845.00**

Table 4-8
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

4.0 Site Preparation

Includes:
1. Clear remedial areas and treatment area = 5 acres
2. Construct 12" soil berm around treatment areas (400 ft x 500 ft area = 1800 ft).
3. Excavate soil for contact water retension pond.
4. Construct 6-inch reinforced concrete slab for treatment area.

Assumptions:

1. Volume of soil removed for contact water retention pond =	3,288
2. Excavator: hydraulic backhoe, 1 cy bucket	
3. Excavator output (cy/day) =	600
4. Days to excavate soil =	7
5. Volume of containment berm (cy) =	106
6. No. of contractor field crew =	2
7. Area of concrete treatment slab (160 ft x 420 ft) (sf) =	67200

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor:					
Site Superintendent	320	$60.00	/hr	$19,200.00	
QA Coordinator	320	$40.00	/hr	$12,800.00	
Subcontractor:					
Surveying	1	$24,000.00	/site	$24,000.00	
Site Clearing	7	$2,300.00	/acre	$16,100.00	
Excavator Operator	7	$258.80	/day	$1,811.60	
Concrete Slab	67200	$4.39	/sf	$295,008.00	
Equipment:					
Excavator	7	$704.00	/day	$4,928.00	
Materials:					
Earthen containment berm	106	$6.00	/cy	$636.00	
Travel for Field Crew:					
Per Diem	112	$38.00	/day	$4,256.00	
Lodging	112	$80.00	/day	$8,960.00	
Rental Car	56	$40.00	/day	$2,240.00	
				Subtotal	**$389,940.00**

Table 4-8
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

5.0 Excavation of Contaminated Soil

Includes:
1. Excavation of soil with contaminants exceeding RGOs
2. Screen oversize material
2. Collect confirmatory samples to determine extent of excavation
3. Staging and characterizing waste stream

Assumptions and Calculations:

1. Cubic yards of consolidated soil excavated =	9205
2. Swell factor for soil upon excavation =	1.3
3. Cubic yards of unconsolidated soil =	11967
4. Density of unconsolidated soil (tons/cy) =	1.1
5. Mass of unconsolidated soil (tons) =	13163
6. Capacity of screening plant (tons/hr) =	100
7. Excavator: hydraulic backhoe, 1 cy bucket	
8. Excavator output (cy/day) =	600
9. Days to excavate soil =	24
10. Dump truck capacity (cy) =	12
11. Dump truck haul distance (mi.) =	0.5
12. Dump truck output (cy/day) =	250
13. No. of required dump trucks per day =	2
14. Soil sample collected for waste characterization / cy =	150
15. Soil sample collected for waste characterization / cy =	80
16. Number of contractor field crew =	3
17. Number of subcontractor excavation crew =	4
18. Number of subcontractor screening crew =	3
19. Airfare included under mobilization	
20. Lineal foot of excavation per confirmation sample =	20
21. Resampling factor for confirmation sampling =	1.1
22. Collect confirmatory samples from excavated area =	286
23. Subcontractor markup on equipment =	1.25
24. Subcontractor markup on labor =	1.31
25. Excavation area (ft^2) =	35583
26. Cost multiplier for 1-week turnaround on analytical data =	1.25
27. Fraction of excavation work performed in Level C PPE =	0.10
28. Labor productivity factor for Level C work =	0.67
29. Days excavation crew in Level C =	3
30. Days screening crew in Level C =	2
31. Perimeter of excavation area (ft) =	3415
32. Excavation area (sf) =	35583
33. Volume of pit water requiring POTW disposal (gal) =	20000

Service/Materials	Unit	Unit Cost		Subtotal
Contractor Labor:				
Site Superintendent (E-8)	192	$60.00	/hr	$11,520.00
QA (Sampling) Coordinator	192	$40.00	/hr	$7,680.00
H&S Coordinator	192	$50.00	/hr	$9,600.00
Chemist (home office)	48	$51.00	/hr	$2,448.00
Subcontractor:				
Excavator Operator	24	$340.91	/day	$8,181.95
Equipment Operator	20	$326.98	/day	$6,539.52
Loader Operator	20	$312.00	/day	$6,240.00
Laborers	44	$288.00	/day	$12,672.00
Truck Drivers	72	$262.00	/day	$18,864.00
Road Repair	1	$50,000.00	/site	$50,000.00
Equipment:				
Excavator	24	$704.00	/day	$16,896.00
100-ton/hr Screening Plant	4	$1,800.00	/wk	$7,200.00
Radial Stacking Conveyor	4	$1,222.00	/wk	$4,888.00
1 cy Front Wheel Loader	20	$280.86	/day	$5,617.20
Dump Truck	48	$428.00	/day	$20,544.00
3000 gal. Water Truck	24	$402.00	/day	$9,648.00
150 gpm Pump	2	$2,439.00	/ea.	$4,878.00
300 gpm Pump	2	$3,749.00	/ea.	$7,498.00
7-ft Diameter Sand Filter	1	$22,310.00	/ea.	$22,310.00
200-gpm GAC Adsorber (6000#-disp.)	1	$14,217.00	/ea.	$14,217.00
20000 gal Steel Water Tank	1	$14,618.00	/ea.	$14,618.00

Table 4-8
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

5.0 Excavation of Contaminated Soil (continued)					
Analytical:					
TCLP Extraction	80	$12.88	/ea	$1,030.00	
SVOCs (8270C)	366	$300.00	/ea	$109,800.00	
NACs (8330)	366	$197.50	/ea	$72,285.00	
Lead	366	$30.00	/ea	$10,980.00	
PCBs	366	$103.75	/ea	$37,972.50	
NAC field analyses	286	$40.00	/ea	$11,440.00	
Lead field analyses	2	$4,200.00	/mo.	$8,400.00	
Shipping	98	$40.00	/ea	$3,904.00	
Materials & Services:					
Office Trailer	4	$500.00	/mo.	$2,000.00	
Level D PPE	138	$10.00	/day	$1,380.00	
Level C PPE	18	$35.00	/day	$630.00	
PID rental	2	$974.00	/mo.	$1,948.00	
CGI rental	2	$380.00	/mo.	$760.00	
Pit Water Disposal	20	$1.62	/kgal	$32.40	
Travel for Contractor Crew:					
Perdiem	319	$38.00	/day	$12,122.00	
Lodging	319	$80.00	/day	$25,520.00	
Rental Car	129	$40.00	/day	$5,160.00	
				Subtotal	**$567,424.00**

Table 4-8
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

6.0 Winrow Composting of Contaminated of Soil

Includes:
1. Purchase and erection of treatment building
2. Lease/purchase composting equipment
3. Procurement and installation of contact water treatment equipment
4. Purchase of stockpile & amendment storage liners and covers
5. Procurement & stockpiling of composting amendments
6. Mix and compost soil and amendments
7. Pre-compliance testing: after compost formation & at end of treatment.
8. Compliance sampling for NAC, metals, PAHs, PCBs

Assumptions:

1. Volume of consolidated soil to be treated (cy) =	8805
2. Volume of unconsolidated soil to be treated (cy) =	11446
3. Compost treatment duration (months) =	8
4. Capacity of windrow turner (tons/hr) =	3,200
5. Operating life of flails (hrs) =	25
6. No. of flails on windrow turner =	172
7. Volume of compost in treatment building (cy) =	4,448
8. Bulk density of compost (tons/cy) =	0.379
9. Bermed work area (sf) =	200,000
10. Contaminated soil stockpile area (sf) =	34,338
11. Treated soil stockpile area (sf) =	6,672
12. Height of stockpiles (ft) =	9
13. Manure storage area (sf) =	192
14. Capacity of contact water treatment system (gpm) =	200
15. Loading rate of multimedia filter (gpm/sf) =	5
16. Diameter of multimedia filter (ft) =	7
17. Volume of bulking amendment (cy) =	33003
18. Volume of agricultural waste amendment (cy) =	1335
19. Total volume of compost before treatment (cy) =	45773
20. Shrinkage factor for compost =	0.60
21. Compost volume per pre-compliance sample collected (cy) =	50
22. Compost volume per compliance sample collected (cy) =	150
23. Markup on materials =	1.10
24. Subcontractor markup on equipment =	1.25
25. Subcontractor markup on labor =	1.31
26. Cost multiplier for 1-week turnaround on analytical data =	1.25
27. Salvage factor for major equipment at end of project =	0.50
28. Number of contractor field crew =	2
29. Number of subcontractor field crew =	3

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent	176	$480.00	/day	$84,480.00	
QA (Sampling) Coordinator	176	$320.00	/day	$56,320.00	
Subcontractor Labor:					
Equipment Operator	176	$326.98	/day	$57,547.78	
Equipment Operator	176	$326.98	/day	$57,547.78	
Equipment Operator	176	$326.98	/day	$57,547.78	
PBOW Security	32	$120.00	/day	$3,840.00	
Equipment:					
Windrow Turner (7' x 20')	1	$156,250.00	/ea.	$156,250.00	less salvage
75 cy/hr Tub Grinder	1	$26,225.00	/ea.	$26,225.00	less salvage
Bobcat	1	$16,000.00	/ea.	$16,000.00	less salvage
P/U Truck	1	$20,000.00	/ea.	$20,000.00	less salvage

Table 4-8
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

6.0 Winrow Composting of Contaminated of Soil (continued)						
Materials:						
Office Trailer	16	$500.00	/mo.	$8,000.00		
Erect Treatment Building	2	$35,080.00	/ea	$70,160.00		
Building Foundation & Accessories	2	$14,132.00	/ea	$28,264.00		
Treatment Building	2	$130,866.00	/ea	$261,732.00		
Treatment Building Lighting	2	$10,460.00	/ea	$20,920.00		
Dismantle Treatment Building	2	$33,500.00	/ea	$67,000.00		
Repl. Flails for Windrow Turner	1892	$9.50	/ea	$17,974.00		
40-mil Liner for Stockpiles	43061	$1.58	/sf	$68,207.83		
10-mil Cover for Stockpiles	41763	$0.83	/sf	$34,454.48		
40-mil Liner for Manure	202	$1.58	/sf	$319.33		
10-mil Cover for Manure	606	$0.83	/sf	$499.95		
Straw	33003	$13.56	/cy	$447,372.17		
Manure	1335	$14.97	/cy	$19,988.96		
Water	1027	$9.40	/kgal	$9,658.39		
Level D PPE	528	$10.00	/day	$5,280.00		
PID rental	8	$974.00	/mo.	$7,792.00		
CGI rental	8	$380.00	/mo.	$3,040.00		
Analytical:						
Pre-Compliance Sampling:						
NAC field analyses	1831	$40.00	/ea	$73,236.80		
Compliance Sampling:						
SVOCs (8270C)	183	$300.00	/ea	$54,927.60		
NACs (8330)	183	$197.50	/ea	$36,160.67		
Lead	183	$30.00	/ea	$5,492.76		
PCBs	183	$103.75	/ea	$18,995.80		
Travel for Field Crew:						
Per Diem	1232	$38.00	/day	$46,816.00		
Lodging	1232	$30.00	/day	$36,960.00	long-term stay	
Rental Car	246	$40.00	/day	$9,840.00		
				Subtotal		**$1,888,851.00**

Table 4-8
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

7.0 Stabilization of Pb-Contaminated Soil

Includes:

1. Stabilization of hazardous soil using cement and activated carbon

Assumptions and Calculations:

1. Volume of consolidated haz. soil to be stabilized =	400
2. Swell factor for soil upon excavation =	1.3
3. Cubic yards of unconsolidated soil =	520
4. Density of soil (ton/cy) =	1.1
5. Tons of hazardous soil that needs to be stabilized =	572
6. Bulk density of portland cement (tons/cy) =	1.27
7. Bulk density of activated carbon (tons/cy) =	1.31
8. Mix ratio of carbon to soil =	0.02
9. Mix ratio of portland cement to soil =	0.08
10. Carbon cost ($/ton)=	2000
11. Cement cost ($/ton)=	105
12. Carbon required for stabilization (tons) =	11
13. Cement required for stabilization (tons) =	46
14. No. of contractor field crew =	2
15. Stabilization batch cycle time (min) =	15
16. Field days required to stabilize soil =	2
17. Swell upon stabilization =	1.132
18. Soil sample collected for waste characterization / cy =	150
19. No. of soil samples collected =	4
20. Tons of stabilized soil =	686
21. Volume of stabilized soil (cy) =	589
22. Subcontractor markup on equipment =	1.25
23. Subcontractor markup on labor =	1.31
24. Number of subcontractor field crew =	4
28. Equipment setup/teardown (days) =	10

Service/Materials	Unit	Unit Cost		Subtotal		
Contractor Labor:						
Site Superintendent	12	$480.00	/day	$5,760.00	includes setup	
QA (Sampling) Coordinator	12	$320.00	/day	$3,840.00		
Subcontractor Labor:						
Wheel Loader Operator	12	$238.00	/day	$2,856.00		
Process Equipment Operator	12	$240.00	/day	$2,880.00		
Process Equipment Operator	12	$240.00	/day	$2,880.00		
Laborer	12	$270.00	/day	$3,240.00		
PBOW Security	12	$120.00	/day	$1,440.00		
Equipment:						
1 cy Front Wheel Loader	12	$280.86	/day	$3,370.32		
10-cy Mixing System	1	$6,250.00	/mo	$6,250.00		
Belt Feeder for Mixing Stystem	1	$728.00	/mo	$728.00		
Stabilization Ancilliary Equipment	1	$557.00	/mo	$557.00		
Dust Collecton System	1	$530.00	/mo	$530.00		
Radial Stacking Conveyor	1	$3,605.00	/mo	$3,605.00		
Materials:						
Carbon	11	$2,000.00	/ton	$22,000.00		
Cement	46	$105.00	/ton	$4,830.00		
Water	5	$9.40	/kgpd	$45.56		
Level D PPE	48	$10.00	/day	$480.00		
PID rental	1	$974.00	/mo.	$974.00		
CGI rental	1	$380.00	/mo.	$380.00		
Analytical:						
TCLP Extraction	4	$10.30	/ea	$41.00		
Lead	4	$24.00	/ea	$96.00		
SVOCs (8270C)	4	$240.00	/ea	$960.00		
NACs (8330)	4	$158.00	/ea	$632.00		
PCBs	4	$83.00	/ea	$332.00		
Unconfined Compresive Strength	4	$130.00	/ea	$520.00		
Shipping	1	$40.00	/ea	$40.00		
Travel for field crew:						
Lodging	101	$80.00	/day	$8,080.00		
Perdiem	101	$38.00	/day	$3,838.00		
Rental Car	34	$40.00	/day	$1,360.00		
				Subtotal		**$82,545.00**

Table 4-8
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

8.0 Off-Site Disposal

Includes:
1. Dispose of stabilized soil at a nonhazardous waste landfill
2. Dispose of PCB waste at a TSCA approved landfill

Assumptions and Calculations:

1. Tons of stabilized soil =	686	
2. Tons of soil for non-haz waste landfill disposal =	686	
3. Volume of consolidated soil for haz waste disposal (cy) =	0	
4. Volume of unconsolidated soil for haz waste disposal (cy) =	0	
5. Tons of soil for haz waste landfill disposal =	0	
6. Non-haz waste transportation cost ($/ton) =	6	
7. Non-haz waste disposal costs ($/ton) =	31	Erie County Landfill
8. Non-haz waste regulatory fees ($/ton) =	0	included in disposal
9. Haz waste transportation cost ($/ton) =	35	
10. D008 Haz waste disposal cost ($/ton) =	75	EO Environmental
11. D030 Haz waste disposal cost ($/ton) =	150	EO Environmental
12. PCB Haz waste disposal cost ($/ton) =	75	EO Environmental
13. Haz waste regulatory fees ($/ton) =	10	
14. No. of contractor field crew =	2	
14. No. of subcontractor field crew =	2	
15. Output of front-end loader (cy/day) =	550	
16. No. of field days =	1	
17. Subcontractor markup on equipment =	1.25	
18. Subcontractor markup on labor =	1.31	

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent (E-8)	8	$60.00	/hr	$480.00	
QA Coordinator	8	$40.00	/hr	$320.00	
Subcontractor Labor:					
Front End Loader Operator	1	$312.00	/day	$312.00	
Laborer/Oiler	1	$279.29	/day	$279.29	
PBOW Security	1	$120.00	/day	$120.00	
Materials:					
Level D PPE	2	$10.00	/day	$20.00	
Equipment:					
1 cy Front Wheel Loader	1	$280.86	/day	$280.86	
Disposal Costs:					
Transportation (Non-Haz Waste)	686	$6.00	/ton	$4,116.00	
Disposal Cost (Non-Haz waste)	686	$31.00	/ton	$21,266.00	
Transportation (Haz Waste)	0	$35.00	/ton	$0.00	
Disposal Cost (D008 haz waste)	0	$85.00	/ton	$0.00	
Disposal Cost (D030 haz waste)	0	$160.00	/ton	$0.00	
Disposal Cost (PCB haz waste)	0	$85.00	/ton	$0.00	
Travel for field crew:					
Lodging	4	$80.00	/day	$320.00	
Perdiem	4	$38.00	/day	$152.00	
Rental Car	2	$40.00	/day	$80.00	
				Subtotal	**$27,746.00**

Table 4-8
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

9.0 On-Site Compost Disposal / Backfill Excavation with Clean Soil

Includes:
1. Backfill excavated areas with clean backfill.
2. Load treated compost, truck to site, spread compost with dozer
3. Confirmation testing under contaminated soil stockpiles.
4. Prepare site close-out report.

Assumptions and Calculations:

1. Volume of consolidated soil excavated (cy) =	9205
2. Compaction factor =	1.15
3. Volume of soil required for backfill (cy) =	10586
4. Cost of clean backfill soil delivered to site ($/cy) =	12
6. Field days required to backfill soil =	19
7. No. of contractor field crew =	2
8. No. of subcontractor backfill field crew =	1
9. No. of compost loading field crew =	7
10. No. of compost spreading field crew =	2
8. No. of confirmatory samples from clean backfill =	2
9. Total volume of compost before treatment (cy) =	45773
10. Shrinkage factor for treated compost =	0.60
11. Volume of compost after treatment (cy) =	27464
12. Loader output (cy/day) =	1575
13. Days to load treated compost =	26
14. Dump truck capacity (cy) =	12
15. Dump truck haul distance (mi.) =	0.5
16. Dump truck output (cy/day) =	250
17. No. of dump trucks per day =	6
18. Dozer (D-6H) capacity (cy/hr) =	90
19. Days to spread treated compost =	39
20. Subcontractor markup on equipment =	1.25
21. Subcontractor markup on labor =	1.31
22. Area of contaminated soil stockpile (sf) =	34338
23. Area per confirmation sample (sf) =	400
24. No. of confirmation samples under soil stockpile =	86

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent	312	$60.00	/hr	$18,720.00	
QA Coordinator	312	$40.00	/hr	$12,480.00	
Site Close-Out Report	1	$20,000.00	/ea	$20,000.00	
Subcontractor Labor:					
Front End Loader Operator	19	$312.00	/day	$5,928.00	
Front End Loader Operator	26	$312.00	/day	$8,112.00	
Dump Truck Drivers	156	$262.00	/day	$40,872.00	
Dozer Operator	39	$326.98	/day	$12,752.06	
Laborer/Oiler	39	$279.29	/day	$10,892.39	
PBOW Security	19	$120.00	/day	$2,280.00	
Equipment:					
1 cy Front End Loader	19	$280.86	/day	$5,336.34	
3 cy Front End Loader	26	$485.22	/day	$12,615.72	
Dump Trucks	156	$428.00	/day	$66,768.00	
D-6H Dozer	39	$630.70	/day	$24,597.30	
Material:					
Clean Backfill	10586	$12.00	/cy	$127,029.00	delivered to site
PID rental	4	$974.00	/mo.	$3,896.00	
CGI rental	4	$380.00	/mo.	$1,520.00	
Level D PPE	279	$10.00	/day	$2,790.00	
Analytical:					
RCRA Metals	2	$105.00	/ea	$210.00	
NACs (8330)	88	$158.00	/ea	$13,904.00	
SVOCs	2	$230.00	/ea	$460.00	
Lead	86	$24.00	/ea	$2,064.00	
PAHs (8270C)	86	$160.00	/ea	$13,760.00	
PCBs	86	$83.00	/ea	$7,138.00	
Shipping	23	$40.00	/ea	$920.00	

Table 4-8
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

9.0 On-Site Compost Disposal / Backfill Excavation with Clean Soil (continued)					
Travel for field crew:					
	Lodging	500	$80.00 /day	$40,000.00	
	Perdiem	500	$38.00 /day	$19,000.00	
	Rental Car	172	$40.00 /day	$6,880.00	
Subcontract:					
	Reseeding	218	$56.84 /msf	$12,391.00	
				Subtotal	**$493,316.00**
10.0 Overall Cost					
				Total Capital Cost	**$3,731,562.00**
				Contingency (30%)	**$1,119,469.00**
				PM Multiplier (7.5%)	**$279,867.00**
				Fee/Profit (10%)	**$373,156.00**
				Total Cost	**$5,504,000.00**

*This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

Table 4-9
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

Alternative 2 Excavation/Composting/Off-Site and On-Site Disposal Cost Estimate	Site: TNT Area A & C Plum Brook Ordnance Works Date: 9/11/2003

Scope:

1. Perform bench-scale treatability study, prepare composting work plan, H&S plan, materials list, and procurement.
2. Mobilize equipment and personnel.
3. Conduct pre-remediation soil sampling to better delineate the lateral and vertical extent of contamination.
4. Prepare site for remedial activity.
5. Excavate contaminated soil and perform confirmatory sampling.
6. Treatment of soil contaminated with nitroaromatic compounds via windrow composting.
7. Off-site disposal of lead- and PCB-contaminated soil that cannot be effectively treated via composting.
8. Backfill excavation with clean soil and spread treated compost across site.
9. Demobilize equipment and personnel.

1.0 Bench-Scale Study, Work Plan, Health and Safety Plan, Materials List, and Procurement

Includes:

1. Perform bench-scale treatability study to define most cost-effective compost mix formula. Results will be used to generate the design work plan.
2. Labor to generate work plan, engineering specifications, and Health and Safety Plan
3. Procure equipment and materials

Service/Materials	Unit	Unit Cost		Subtotal	
Bench-Scale Study	1	$20,000.00	/ea	$20,000.00	
Contractor Labor:					
Senior Engineer (E-12)	40	$97.00	/hr.	$3,880.00	
Task Manager (E-8)	80	$62.00	/hr.	$4,960.00	
Geologist (E-8)	40	$62.00	/hr.	$2,480.00	
Project Engineer (E-6)	160	$50.00	/hr.	$8,000.00	
Health and Safety (E-8)	40	$62.00	/hr.	$2,480.00	
Procurement Specialist (E-6)	80	$56.00	/hr.	$4,480.00	
Drafting (E-6)	40	$50.00	/hr.	$2,000.00	
Document Repro (Draft and Final)	2	$1,000.00	/ea	$2,000.00	
				Subtotal	**$50,280.00**

Table 4-9
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

2.0 Mobilization/Demobilization of Equipment and Personnel

Includes:
1. Mobilize equipment and personnel (2 events for subcontractor).
2. Contractor field crew consists of a site superintendent, geolgist, and field technician.
3. Four 2-day trips for 2 contractor personnel for pre-remediation coordination.

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent (E-8)	24	$60.00	/hr	$1,440.00	
QA (Sampling) Coordinator	24	$40.00	/hr	$960.00	
H&S Coordinator	16	$50.00	/hr	$800.00	
Geologist	2	$480.00	/day	$960.00	
Subcontractor Labor:					
Excavator Operator	2	$340.91	/day	$681.83	
Equipment Operator	2	$326.98	/day	$653.95	
Dozer Operator	2	$326.98	/day	$653.95	
Loader Operator	2	$312.00	/day	$624.00	
Loader Operator	2	$312.00	/day	$624.00	
Laborers	2	$288.00	/day	$576.00	
Truck Drivers	12	$262.00	/day	$3,144.00	
Equipment:					
Excavator	2	$704.00	/day	$1,408.00	
1 cy Front Wheel Loader	2	$280.86	/day	$561.72	
3 cy Front Wheel Loader	2	$485.22	/day	$970.44	
Windrow Turner	2	$1,000.00	/mob	$2,000.00	
D-6H Dozer	2	$630.70	/day	$1,261.40	
Dump Trucks	12	$428.00	/day	$5,136.00	
Travel for contractor crew:					
Perdiem	40	$38.00	/day	$1,520.00	
Lodging	40	$80.00	/day	$3,200.00	
Rental Car	18	$40.00	/day	$720.00	
Airfare	24	$600.00	/ea	$14,400.00	
				Subtotal	**$42,295.00**

Table 4-9
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

3.0 Pre-Remediation Soil Sampling

Includes:
1. Hydropunch soil sampling
2. Analysis of soil samples for chemicals of concern.

Assumptions:

1. Perimeter of proposed remediation area (ft) =	7247
2. Distance between boring locations =	40
3. No. of borings =	182
4. Average depth of boring (ft) =	10
5. No. of samples collected per boring =	3
6. Total no. of samples collected =	546
7. No. of borings advanced per day =	10

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor:					
Field Geologist	19	$480.00	/day	$9,120.00	
Subcontractor:					
Mob/Demob	1	$2,000.00	/ea	$2,000.00	
Hydropunch Borings	1820	$15.00	/ft	$27,300.00	
Equipment Decon	182	$90.00	/ea	$16,380.00	
Materials:					
Field Supplies	182	$20.00	/bor.	$3,640.00	
Field Instruments	4	$400.00	/wk	$1,600.00	
Analytical:					
NACs (8330)	546	$158.00	/ea	$86,268.00	
Lead	546	$24.00	/ea	$13,104.00	
PAHs (8270C)	546	$160.00	/ea	$87,360.00	
PCBs	546	$83.00	/ea	$45,318.00	
Shipping	146	$40.00	/ea	$5,840.00	
Equipment:					
P/U Truck	19	$52.00	/day	$988.00	
Travel for Contractor Crew:					
Perdiem	19	$38.00	/day	$722.00	
Lodging	19	$80.00	/day	$1,520.00	
				Subtotal	**$301,160.00**

Table 4-9
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

4.0 Site Preparation

Includes:
1. Clear remedial areas and treatment area = 8 acres
2. Construct 12" soil berm around treatment areas (400 ft x 500 ft area = 1800 ft).
3. Excavate soil for contact water retension pond.
4. Construct 6-inch reinforced concrete slab for treatment area.

Assumptions:

1. Volume of soil removed for contact water retention pond =	3,288
2. Excavator: hydraulic backhoe, 1 cy bucket	
3. Excavator output (cy/day) =	600
4. Days to excavate soil =	7
5. Volume of containment berm (cy) =	133
6. No. of contractor field crew =	2
7. Area of concrete treatment slab (160 ft x 420 ft) (sf) =	67200

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor:					
Site Superintendent	320	$60.00	/hr	$19,200.00	
QA Coordinator	320	$40.00	/hr	$12,800.00	
Subcontractor:					
Surveying	2	$24,000.00	/site	$48,000.00	
Site Clearing	8	$2,300.00	/acre	$18,400.00	
Excavator Operator	7	$258.80	/day	$1,811.60	
Concrete Slab	67200	$4.39	/sf	$295,008.00	
Equipment:					
Excavator	7	$704.00	/day	$4,928.00	
Materials:					
Earthen containment berm	133	$6.00	/cy	$798.00	
Travel for Field Crew:					
Per Diem	112	$38.00	/day	$4,256.00	
Lodging	112	$80.00	/day	$8,960.00	
Rental Car	56	$40.00	/day	$2,240.00	
				Subtotal	**$416,402.00**

Table 4-9
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

5.0 Excavation of Contaminated Soil

Includes:
1. Excavation of soil with contaminants exceeding RGOs
2. Screen oversize material
3. Collect confirmatory samples to determine extent of excavation
4. Staging and characterizing waste stream

Assumptions and Calculations:

1. Cubic yards of consolidated soil excavated =	25533
2. Swell factor for soil upon excavation =	1.3
3. Cubic yards of unconsolidated soil =	33193
4. Density of unconsolidated soil (tons/cy) =	1.1
5. Mass of unconsolidated soil (tons) =	36512
6. Capacity of screening plant (tons/hr) =	100
7. Excavator: hydraulic backhoe, 1 cy bucket	
8. Excavator output (cy/day) =	600
9. Days to excavate soil =	67
10. Dump truck capacity (cy) =	12
11. Dump truck haul distance (mi.) =	0.5
12. Dump truck output (cy/day) =	250
13. No. of required dump trucks per day =	2
14. Soil sample collected for waste characterization / cy =	150
15. No. of soil samples collected for waste characterization =	221
16. Number of contractor field crew =	3
17. Number of subcontractor excavation crew =	4
18. Number of subcontractor screening crew =	3
19. Airfare included under mobilization	
20. Lineal foot of excavation per confirmation sample =	20
21. Resampling factor for confirmation sampling =	1.1
22. No.of confirmatory samples from excavated area =	633
23. Subcontractor markup on equipment =	1.25
24. Subcontractor markup on labor =	1.31
25. Excavation area (ft^2) =	85207
26. Cost multiplier for 1-week turnaround on analytical data =	1.25
27. Fraction of excavation work performed in Level C PPE =	0.10
28. Labor productivity factor for Level C work =	0.67
29. Days excavation crew in Level C =	7
30. Days screening crew in Level C =	5
31. Perimeter of excavation area (ft) =	7247
32. Excavation area (sf) =	85207
33. Volume of pit water requiring POTW disposal (gal) =	40000

Service/Materials	Unit	Unit Cost		Subtotal
Contractor Labor:				
Site Superintendent (E-8)	536	$60.00	/hr	$32,160.00
QA (Sampling) Coordinator	536	$40.00	/hr	$21,440.00
H&S Coordinator	536	$50.00	/hr	$26,800.00
Chemist (home office)	134	$51.00	/hr	$6,834.00
Subcontractor:				
Excavator Operator	67	$340.91	/day	$22,841.26
Equipment Operator	50	$326.98	/day	$16,348.80
Loader Operator	50	$312.00	/day	$15,600.00
Laborers	117	$288.00	/day	$33,696.00
Truck Drivers	201	$262.00	/day	$52,662.00
Road Repair	2	$50,000.00	/site	$100,000.00

Table 4-9
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

5.0 Excavation of Contaminated Soil (continued)					
Equipment:					
Excavator	67	$704.00	/day	$47,168.00	
100-ton/hr Screening Plant	10	$1,800.00	/wk	$18,000.00	
Radial Stacking Conveyor	10	$1,222.00	/wk	$12,220.00	
1 cy Front Wheel Loader	50	$280.86	/day	$14,043.00	
Dump Truck	134	$428.00	/day	$57,352.00	
3000 gal. Water Truck	67	$402.00	/day	$26,934.00	
150 gpm Pump	2	$2,439.00	/ea.	$4,878.00	
300 gpm Pump	2	$3,749.00	/ea.	$7,498.00	
7-ft Diameter Sand Filter	1	$22,310.00	/ea.	$22,310.00	
200-gpm GAC Adsorber (6000#-disp.)	2	$14,217.00	/ea.	$28,434.00	
20000 gal Steel Water Tank	1	$14,618.00	/ea.	$14,618.00	
Analytical:					
TCLP Extraction	221	$12.88	/ea	$2,845.38	
SVOCs (8270C)	854	$300.00	/ea	$256,200.00	
NACs (8330)	854	$197.50	/ea	$168,665.00	
Lead	854	$30.00	/ea	$25,620.00	
PCBs	854	$103.75	/ea	$88,602.50	
NAC field analyses	633	$40.00	/ea	$25,320.00	
Lead field analyses	4	$4,200.00	/mo.	$16,800.00	
Shipping	228	$40.00	/ea	$9,109.33	
Materials & Services:					
Office Trailer	8	$500.00	/mo.	$4,000.00	
Level D PPE	375	$10.00	/day	$3,750.00	
Level C PPE	43	$35.00	/day	$1,505.00	
PID rental	4	$974.00	/mo.	$3,896.00	
CGI rental	4	$380.00	/mo.	$1,520.00	
Pit Water Disposal	40	$1.62	/kgal	$64.80	
Travel for Contractor Crew:					
Perdiem	867	$38.00	/day	$32,946.00	
Lodging	867	$80.00	/day	$69,360.00	
Rental Car	351	$40.00	/day	$14,040.00	
				Subtotal	**$1,306,081.00**

Table 4-9
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

6.0 Windrow Composting of Contaminated of Soil

Includes:
1. Purchase and erection of treatment building
2. Purchase of composting equipment
3. Procurement and installation of contact water treatment equipment
4. Purchase of stockpile & amendment storage liners and covers
5. Procurement & stockpiling of composting amendments
6. Mix and compost soil and amendments
7. Pre-compliance testing: after compost formation & at end of treatment.
8. Pre-compliance testing using definitive field analysis for NAC
9. Compliance sampling for NAC, metals, PAHs, PCBs

Assumptions:

1. Volume of consolidated soil to be treated (cy) =	24797
2. Volume of unconsolidated soil to be treated (cy) =	32237
3. Compost treatment duration (months) =	21
4. Capacity of windrow turner (tons/hr) =	3,200
5. Operating life of flails (hrs) =	25
6. No. of flails on windrow turner =	172
7. Volume of compost in treatment building (cy) =	4,448
8. Bulk density of compost (tons/cy) =	0.379
9. Bermed work area (sf) =	200,000
10. Contaminated soil stockpile area (sf) =	62,370
11. Treated soil stockpile area (sf) =	6,672
12. Height of stockpiles (ft) =	9
13. Manure storage area (sf) =	192
14. Capacity of contact water treatment system (gpm) =	200
15. Loading rate of multimedia filter (gpm/sf) =	5
16. Diameter of multimedia filter (ft) =	7
17. Volume of bulking amendment (cy) =	92950
18. Volume of agricultural waste amendment (cy) =	3760
19. Total volume of compost (cy) =	128906
20. Shrinkage factor for compost =	0.60
21. Compost volume per pre-compliance sample collected (cy) =	50
22. Compost volume per compliance sample collected (cy) =	150
23. Markup on materials =	1.1
24. Subcontractor markup on equipment =	1.25
25. Subcontractor markup on labor =	1.31
26. Multiplier for 1-week turnaround on analytical costs =	1.25
27. Salvage factor for major equipment at end of project =	0.50
28. Number of contractor field crew =	2
29. Number of subcontractor field crew =	3

Service/Materials	Unit	Unit Cost		Subtotal
Contractor Labor:				
Site Superintendent	462	$480.00	/day	$221,760.00
QA (Sampling) Coordinator	462	$320.00	/day	$147,840.00
Subcontractor Labor:				
Equipment Operator	462	$326.98	/day	$151,062.91
Equipment Operator	462	$326.98	/day	$151,062.91
Equipment Operator	462	$326.98	/day	$151,062.91
PBOW Security	84	$120.00	/day	$10,080.00

Table 4-9
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

6.0 Windrow Composting of Contaminated of Soil (continued)					
Equipment:					
Windrow Turner (7' x 20')	1	$156,250.00	/ea	$156,250.00	less salvage
75 cy/hr Tub Grinder	1	$26,225.00	/ea	$26,225.00	less salvage
Bobcat	1	$16,000.00	/ea	$16,000.00	less salvage
P/U Truck	1	$20,000.00	/ea	$20,000.00	
Materials:					
Office Trailer	42	$500.00	/mo.	$21,000.00	
Treatment Building Erection	1	$95,000.00	/ea		
Treatment Building (1st 6 mos.)	6	$43,075.00	/mo.		
Treatment Building (remaining mos.)	36	$28,296.00	/mo.		
Treatment Building Dismantle	1	$76,000.00	/ea		
Erect Treatment Building	2	$35,080.00	/ea	$70,160.00	
Building Foundation & Accessories	2	$14,132.00	/ea	$28,264.00	
Treatment Building	2	$130,866.00	/ea	$261,732.00	
Treatment Building Lighting	2	$10,460.00	/ea	$20,920.00	
Dismantle Treatment Building	2	$33,500.00	/ea	$67,000.00	
Repl. Flails for Windrow Turner	4644	$9.50	/ea	$44,118.00	
40-mil Liner for Stockpiles	72494	$1.58	/sf	$114,830.65	
10-mil Cover for Stockpiles	69795	$0.83	/sf	$57,580.88	
40-mil Liner for Manure	202	$1.58	/sf	$319.33	
10-mil Cover for Manure	606	$0.83	/sf	$499.95	
Straw	92950	$13.56	/cy	$1,259,983.73	
Manure	3760	$14.97	/cy	$56,298.48	
Water	2802	$9.40	/kgpd	$26,341.06	
Level D PPE	1386	$10.00	/day	$13,860.00	
PID rental	21	$974.00	/mo.	$20,454.00	
CGI rental	21	$380.00	/mo.	$7,980.00	
Analytical:					
Pre-Compliance Sampling:					
NAC field analyses	5156	$40.00	/ea	$206,249.60	
Compliance Testing:					
SVOCs (8270C)	516	$300.00	/ea	$154,687.20	
NACs (8330)	516	$197.50	/ea	$101,835.74	
Lead	516	$30.00	/ea	$15,468.72	
PCBs	516	$103.75	/ea	$53,495.99	
Travel for Field Crew:					
Per Diem	3234	$38.00	/day	$122,892.00	
Lodging	3234	$30.00	/day	$97,020.00	long-term stay
Rental Car	647	$40.00	/day	$25,880.00	
				Subtotal	**$3,900,215.00**

Table 4-9
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

7.0 Off-Site Disposal

Includes:

1. Dispose of stabilized soil and non-hazardous soil (not stabilized) at a nonhazardous waste landfill
2. Dispose of PCB waste at a TSCA approved landfill

Assumptions and Calculations:

1. Consolidated volume of D008 soil for haz disposal (cy) =	617	
2. Consolidated volume of D030 soil for haz disposal (cy) =	0	
3. Consolidated volume of PCB soil for haz disposal (cy) =	119	
4. Consolidated volume of soil for non-haz disposal (cy) =	0	
5. Non-haz waste transportation cost ($/ton) =	6	
6. Non-haz waste disposal costs ($/ton) =	31	Erie County Landfill
7. Non-haz waste regulatory fees ($/ton) =	0	included in disposal
8. Haz waste transportation cost ($/ton) =	35	
9. D008 Haz waste disposal cost ($/ton) =	75	EO Environmental
10. D030 Haz waste disposal cost ($/ton) =	150	EO Environmental
11. PCB Haz waste disposal cost ($/ton) =	75	EO Environmental
12. Haz waste regulatory fees ($/ton) =	10	
13. No. of contractor field crew =	2	
14. No. of subcontractor field crew =	2	
14. Output of front-end loader (cy/day) =	550	
15. No. of field days =	2	

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent (E-8)	16	$60.00	/hr	$960.00	
QA Coordinator	16	$40.00	/hr	$640.00	
Subcontractor Labor:					
Front End Loader Operator	2	$346.00	/day	$692.00	
Oiler	2	$293.00	/day	$586.00	
PBOW Security	2	$120.00	/day	$240.00	
Materials:					
Level D PPE	4	$10.00	/day	$40.00	
Equipment:					
1 cy Front Wheel Loader	2	$280.86	/day	$561.72	
Disposal Costs:					
Transportation (Non-Haz Waste)	0	$6.00	/ton	$0.00	
Disposal Cost (Non-Haz waste)	0	$31.00	/ton	$0.00	
Transportation (Haz Waste)	1132	$35.00	/ton	$39,625.82	
Disposal Cost (D008 haz waste)	962	$85.00	/ton	$81,769.68	
Disposal Cost (D030 haz waste)	0	$160.00	/ton	$0.00	
Disposal Cost (PCB haz waste)	170	$85.00	/ton	$14,464.45	
Travel for contractor crew:					
Lodging	8	$80.00	/day	$640.00	
Perdiem	8	$38.00	/day	$304.00	
Rental Car	4	$40.00	/day	$160.00	
				Subtotal	**$140,684.00**

Table 4-9
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

8.0 On-Site Compost Disposal / Backfill Excavation with Clean Soil

Includes:
1. Backfill excavated areas with clean backfill.
2. Load treated compost, truck to site, spread compost across site with dozer
3. Confirmation testing under contaminated soil stockpiles.
4. Prepare site close-out report.

Assumptions and Calculations:

1. Volume of consolidated soil excavated (cy) =	25533
2. Compaction factor =	1.15
3. Volume of soil required for backfill (cy) =	29363
4. Cost of clean backfill soil delivered to site ($/cy) =	12
6. Field days required to backfill soil =	53
7. No. of contractor field crew =	2
8. No. of subcontractor backfill field crew =	1
9. No. of compost loading field crew =	7
10. No. of compost spreading field crew =	2
8. No. of confirmatory samples from clean backfill =	2
9. Total volume of compost before treatment (cy) =	128906
10. Shrinkage factor for treated compost =	0.60
11. Volume of compost after treatment (cy) =	77344
12. Loader output (cy/day) =	1575
13. Days to load treated compost =	74
14. Dump truck capacity (cy) =	12
15. Dump truck haul distance (mi.) =	0.5
16. Dump truck output (cy/day) =	250
17. No. of dump trucks per day =	6
18. Dozer (D-6H) capacity (cy/hr) =	90
19. Days to spread treated compost =	108
20. Subcontractor markup on equipment =	1.25
21. Subcontractor markup on labor =	1.31
22. Area of contaminated soil stockpile (sf) =	62370
23. Area per confirmation sample (sf) =	400
24. No. of confirmation samples under soil stockpile =	156

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent	864	$60.00	/hr	$51,840.00	
QA Coordinator	864	$40.00	/hr	$34,560.00	
Site Close-Out Report	1	$20,000.00	/ea	$20,000.00	
Subcontractor Labor:					
Front End Loader Operator	53	$312.00	/day	$16,536.00	
Front End Loader Operator	74	$312.00	/day	$23,088.00	
Dump Truck Drivers	444	$262.00	/day	$116,328.00	
Dozer Operator	108	$326.98	/day	$35,313.41	
Laborer/Oiler	108	$279.29	/day	$30,163.54	
PBOW Security	53	$120.00	/day	$6,360.00	
Equipment:					
1 cy Front End Loader	53	$280.86	/day	$14,885.58	
3 cy Front End Loader	74	$485.22	/day	$35,906.28	
Dump Trucks	444	$428.00	/day	$190,032.00	
D-6H Dozer	108	$630.70	/day	$68,115.60	
Material:					
Backfill	29363	$12.00	/cy	$352,355.40	delivered to site
PID rental	11	$974.00	/mo.	$10,714.00	
CGI rental	11	$380.00	/mo.	$4,180.00	
Level D PPE	787	$10.00	/day	$7,870.00	

Table 4-9
Alternative 2 - Excavation, Windrow Composting, On-Site and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

8.0 On-Site Compost Disposal / Backfill Excavation with Clean Soil (continued)					
Analytical:					
	RCRA Metals	2	$105.00 /ea	$210.00	
	NACs (8330)	158	$158.00 /ea	$24,964.00	
	SVOCs	2	$230.00 /ea	$460.00	
	Lead	156	$24.00 /ea	$3,744.00	
	PAHs (8270C)	156	$160.00 /ea	$24,960.00	
	PCBs	156	$83.00 /ea	$12,948.00	
	Shipping	42	$40.00 /ea	$1,680.00	
Travel for field crew:					
	Lodging	1404	$80.00 /day	$112,320.00	
	Perdiem	1404	$38.00 /day	$53,352.00	
	Rental Car	480	$40.00 /day	$19,200.00	
Subcontract:					
	Reseeding	348	$56.84 /msf	$19,780.00	
				Subtotal	**$1,291,866.00**
9.0 Overall Cost					
				Total Capital Cost	**$7,448,983.00**
				Contingency (30%)	**$2,234,695.00**
				PM Multiplier (7.5%)	**$558,674.00**
				Fee/Profit (10%)	**$744,898.00**
				Total Cost	**$10,987,000.00**

*This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

Table 4-10
Alternative 3 - Excavation, Ex-Situ Stabilization, and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

Alternative 3
Excavation/Stabilization/Off-Site Disposal Cost Estimate

Site: TNT Area A & C
Plum Brook Ordnance Works
Date: 9/11/2003

Scope:

1. Perform bench-scale treatability study, prepare stabilization work plan, H&S plan, materials list, and procurement
2. Mobilize equipment and personnel
3. Conduct pre-remediation soil sampling to better delineate the lateral and vertical extent of contamination.
4. Prepare site for remedial activity.
5. Excavate contaminated soil and perform confirmatory sampling
6. Chemically stabilize soil classified as a hazardous waste based on TCLP testing.
7. Dispose of stabilized soil and untreated non-hazardous soil in a Subtitle D landfill. Dispose of PCB remediation waste in a TSCA landfill.
8. Backfill excavated areas
9. Demobilize equipment and personnel

1.0 Bench-Scale Study, Work Plan, Health and Safety Plan, Materials List, and Procurement

Includes:

1. Perform bench-scale treatability study to test the effectiveness of stabilizing the nitroaromatics and determine stabilization amendments. Results will be used to generate the design work plan.
2. Labor to generate work plan, engineering specifications, and Health and Safety Plan
3. Procure equipment and materials

Service/Materials	Unit	Unit Cost		Subtotal	
Bench-Scale Study	1	$15,000.00	/ea	$15,000.00	
Contractor Labor:					
Senior Engineer (E-12)	40	$97.00	/hr.	$3,880.00	
Task Manager (E-8)	80	$62.00	/hr.	$4,960.00	
Geologist (E-8)	40	$62.00	/hr.	$2,480.00	
Project Engineer (E-6)	160	$50.00	/hr.	$8,000.00	
Health and Safety (E-8)	40	$62.00	/hr.	$2,480.00	
Procurement Specialist (E-6)	80	$56.00	/hr.	$4,480.00	
Drafting (E-6)	40	$50.00	/hr.	$2,000.00	
Document Repro (Draft and Final)	2	$1,000.00	/ea	$2,000.00	
				Subtotal	**$45,280.00**

Table 4-10
Alternative 3 - Excavation, Ex-Situ Stabilization, and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

2.0 Mobilization of Equipment and Personnel

Includes:
1. Mobilize equipment and personnel
2. Contractor field crew consists of a site superintendent, geologist, and a field technician.
3. Four 2-day trips for 2 contractor personnel for pre-remediation coordination.

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent	24	$60.00	/hr	$1,440.00	
QA (Sampling) Coordinator	24	$40.00	/hr	$960.00	
H&S Coordinator	16	$50.00	/hr	$800.00	
Field Geologist	2	$480.00	/day	$960.00	
Subcontractor Labor:					
Excavator Operator	2	$340.91	/day	$681.83	
Equipment Operator	2	$326.98	/day	$653.95	
Equipment Operator	2	$326.98	/day	$653.95	
Loader Operator	2	$312.00	/day	$624.00	
Loader Operator	2	$312.00	/day	$624.00	
Laborers	2	$288.00	/day	$576.00	
Truck Drivers	6	$262.00	/day	$1,572.00	
Equipment:					
Excavator	2	$704.00	/day	$1,408.00	
1 cy Front Wheel Loader	2	$280.86	/day	$561.72	
10-cy Mixing System	2	$975.00	/ea	$1,950.00	
Screening Plant	2	$1,000.00	/ea	$2,000.00	
Radial Conveyor	2	$500.00	/ea	$1,000.00	
Dump Truck	6	$428.00	/day	$2,568.00	
Travel for contractor crew:					
Perdiem	34	$38.00	/day	$1,292.00	
Lodging	34	$80.00	/day	$2,720.00	
Rental Car	18	$40.00	/day	$720.00	
Airfare	21	$600.00	/ea	$12,600.00	
				Subtotal	**$36,365.45**

Table 4-10
Alternative 3 - Excavation, Ex-Situ Stabilization, and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

3.0 Pre-Remediation Soil Sampling

Includes:
1. Hydropunch soil sampling
2. Analysis of soil samples for chemicals of concern.

Assumptions:

1. Perimeter of proposed remediation area (ft) =	7247
2. Distance between boring locations =	40
3. No. of borings =	182
4. Average depth of boring (ft) =	10
5. No. of samples collected per boring =	3
6. Total no. of samples collected =	546
7. No. of borings advanced per day =	10

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor:					
Field Geologist	19	$480.00	/day	$9,120.00	
Subcontractor:					
Mob/Demob	1	$2,000.00	/ea	$2,000.00	
Hydropunch Borings	1820	$15.00	/ft	$27,300.00	
Equipment Decon	182	$90.00	/ea	$16,380.00	
Materials:					
Field Supplies	182	$20.00	/bor.	$3,640.00	
Field Instruments	4	$400.00	/wk	$1,600.00	
Analytical:					
NACs (8330)	546	$158.00	/ea	$86,268.00	
Lead	546	$24.00	/ea	$13,104.00	
PAHs (8270C)	546	$160.00	/ea	$87,360.00	
PCBs	546	$83.00	/ea	$45,318.00	
Shipping	146	$40.00	/ea	$5,840.00	
Equipment:					
P/U Truck	19	$52.00	/day	$988.00	
Travel for Contractor Crew:					
Perdiem	19	$38.00	/day	$722.00	
Lodging	19	$80.00	/day	$1,520.00	
				Subtotal	**$301,160.00**

Table 4-10
Alternative 3 - Excavation, Ex-Situ Stabilization, and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

4.0 Site Preparation

Includes:
1. Clear remedial areas and treatment area = 8 acres
2. Construct 12" soil berm around treatment areas (500 ft x 300 ft area = 1600 ft).
3. Excavate soil for contact water retension pond.
4. Construct 6-inch reinforced concrete slab for treatment area.

Assumptions:

1. Volume of soil removed for contact water retention pond =	2,923
2. Excavator: hydraulic backhoe, 1 cy bucket	
3. Excavator output (cy/day) =	600
4. Days to excavate soil =	6
5. Volume of containment berm (cy) =	74
6. No. of contractor field crew =	2
7. Area of concrete treatment slab (150 ft x 150 ft) (sf) =	22500

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor:					
Site Superintendent	240	$60.00	/hr	$14,400.00	
QA Coordinator	240	$40.00	/hr	$9,600.00	
Subcontractor:					
Surveying	2	$24,000.00	/site	$48,000.00	
Site Clearing	8	$2,300.00	/acre	$18,400.00	
Excavator Operator	6	$340.91	/day	$2,045.49	
Concrete Slab	22500	$4.39	/sf	$98,775.00	
Equipment:					
Excavator	6	$704.00	/day	$4,224.00	
Materials:					
Earthen containment berm	74	$6.00	/cy	$444.00	
Travel for Field Crew:					
Per Diem	84	$38.00	/day	$3,192.00	
Lodging	84	$80.00	/day	$6,720.00	
Rental Car	42	$40.00	/day	$1,680.00	
				Subtotal	**$207,480.00**

Table 4-10
Alternative 3 - Excavation, Ex-Situ Stabilization, and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

5.0 Excavation of Contaminated Soil

Includes:

1. Excavation of soil with contaminants exceeding RGOs
2. Screen oversize material
3. Collect confirmatory sampling to determine extent of excavation
4. Staging and characterizing waste stream

Assumptions and Calculations:

1. Cubic yards of consolidated soil excavated =	25533
2. Swell factor for soil upon excavation =	1.3
3. Cubic yards of unconsolidated soil =	33193
4. Density of unconsolidated soil (tons/cy) =	1.1
5. Mass of unconsolidated soil (tons) =	36512
6. Capacity of screening plant (tons/hr) =	100
7. Excavator: hydraulic backhoe, 1 cy bucket ($/day) =	$704
8. Excavator output (cy/day) =	600
9. Days to excavate soil =	67
10. Dump truck capacity (cy) =	12
11. Dump truck haul distance (mi.) =	0.5
12. Dump truck output (cy/day) =	250
13. No. of required dump trucks per day =	2
14. Soil sample collected for waste characterization / cy =	150
15. No. of soil samples collected for waste characterization =	221
16. Number of contractor field crew =	3
17. Number of subcontractor excavation crew =	4
18. Number of subcontractor screening crew =	3
19. Airfare included under mobilization	
20. Lineal foot of excavation per confirmation sample =	20
21. Resampling factor for confirmation sampling =	1.1
22. No.of confirmatory samples from excavated area =	633
23. Subcontractor markup on equipment =	1.25
24. Subcontractor markup on labor =	1.31
25. Excavation area (ft^2) =	85207
26. Cost multiplier for 1-week turnaround on analytical data =	1.25
27. Fraction of excavation work performed in Level C PPE =	0.10
28. Labor productivity factor for Level C work =	0.67
29. Days excavation crew in Level C =	7
30. Days screening crew in Level C =	5
31. Perimeter of excavation area (ft) =	7247
32. Excavation area (sf) =	85207
33. Volume of pit water requiring POTW disposal (gal) =	40000

Service/Materials	Unit	Unit Cost		Subtotal
Contractor Labor:				
Site Superintendent	536	$60.00	/hr	$32,160.00
QA (Sampling) Coordinator	536	$40.00	/hr	$21,440.00
H&S Coordinator	536	$50.00	/hr	$26,800.00
Chemist (home office)	134	$51.00	/hr	$6,834.00
Subcontractor:				
Excavator Operator	67	$340.91	/day	$22,841.26
Equipment Operator	50	$326.98	/day	$16,348.80
Loader Operator	50	$312.00	/day	$15,600.00
Laborers	117	$288.00	/day	$33,696.00
Truck Drivers	201	$262.00	/day	$52,662.00
Road Repair	2	$50,000.00	/site	$100,000.00
Equipment:				
Excavator	67	$704.00	/day	$47,168.00
100-ton/hr Screening Plant	10	$1,800.00	/wk	$18,000.00
Radial Stacking Conveyor	10	$1,222.00	/wk	$12,220.00
1 cy Front Wheel Loader	50	$280.86	/day	$14,043.00
12-cy Dump Truck	134	$428.00	/day	$57,352.00
3000 gal. Water Truck	67	$402.00	/day	$26,934.00
150 gpm Pump	2	$2,439.00	/ea.	$4,878.00
300 gpm Pump	2	$3,749.00	/ea.	$7,498.00
7-ft Diameter Sand Filter	1	$22,310.00	/ea.	$22,310.00
200-gpm GAC Adsorber (6000#-disp.)	2	$14,217.00	/ea.	$28,434.00
20000 gal Steel Water Tank	1	$14,618.00	/ea.	$14,618.00

Table 4-10
Alternative 3 - Excavation, Ex-Situ Stabilization, and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

5.0 Excavation of Contaminated Soil (continued)					
Analytical:					
TCLP Extraction	221	$12.88	/ea	$2,845.38	
Lead	854	$30.00	/ea	$25,620.00	
SVOCs (8270C)	854	$300.00	/ea	$256,200.00	
NACs (8330)	854	$197.50	/ea	$168,665.00	
PCBs	854	$103.75	/ea	$88,602.50	
NAC field analyses	633	$40.00	/ea	$25,320.00	
Lead field analyses	4	$4,200.00	/mo.	$16,800.00	
Shipping	228	$40.00	/ea	$9,109.33	
Materials & Services:					
Office Trailer	8	$500.00	/mo.	$4,000.00	
Level D PPE	375	$10.00	/day	$3,750.00	
Level C PPE	43	$35.00	/day	$1,505.00	
PID rental	4	$974.00	/mo.	$3,896.00	
CGI rental	4	$380.00	/mo.	$1,520.00	
Pit Water Disposal	40	$1.62	/kgal	$64.80	
Travel for Contractor Crew:					
Perdiem	867	$38.00	/day	$32,946.00	
Lodging	867	$80.00	/day	$69,360.00	
Rental Car	351	$40.00	/day	$14,040.00	
				Subtotal	**$1,306,081.00**

Table 4-10
Alternative 3 - Excavation, Ex-Situ Stabilization, and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

6.0 Chemical Stabilization of Hazardous Soil

Includes:

1. Stabilization of hazardous soil using cement and activated carbon

Assumptions and Calculations:

1. Volume of consolidated haz. soil to be stabilized =	6180
2. Swell factor for soil upon excavation =	1.3
3. Cubic yards of unconsolidated soil to be stabilized =	8034
4. Density of soil (ton/cy) =	1.1
5. Tons of hazardous soil that needs to be stabilized =	8838
6. Mass ratio of carbon to soil =	0.02
7. Mass ratio of portland cement to soil =	0.08
8. Carbon cost ($/ton)=	2000
9. Cement cost ($/ton)=	105
10. Carbon required for stabilization (tons) =	177
11. Cement required for stabilization (tons) =	707
12. No. of contractor field crew =	2
13. Stabilization batch cycle time (min) =	15
14. Time required to stabilize soil (days) =	29
15. Swell upon stabilization =	1.132
16. Volume of stabilized soil (cy) =	9095
17. Soil sample collected for waste characterization / cy =	150
18. Subcontractor profit =	0.12
19. Subcontractor markup on labor =	1.72
20. Contractor markup on labor =	1.60
21. Subcontractor markup on equipment =	1.25
22. Subcontractor markup on labor =	1.31
23. Contaminated soil stockpile area (sf) =	15096
24. Treated soil stockpile area (sf) =	900
25. Height of stockpiles (ft) =	9.0
26. Width of soil stockpiles (ft) =	60
27. No. of subcontractor field crew =	4
28. Equipment setup/teardown (days) =	10

Service/Materials	Unit	Unit Cost		Subtotal
Contractor Labor:				
Site Superintendent	39	$480.00	/day	$18,720.00
QA (Sampling) Coordinator	39	$320.00	/day	$12,480.00
Subcontractor Labor:				
Wheel Loader Operator	39	$312.00	/day	$12,168.00
Process Equipment Operator	39	$314.40	/day	$12,261.60
Process Equipment Operator	39	$314.40	/day	$12,261.60
Laborer	39	$270.00	/day	$10,530.00
PBOW Security	39	$120.00	/day	$4,680.00
Equipment:				
1 cy Front Wheel Loader	39	$280.86	/day	$10,953.54
10-cy Mixing System	2	$6,250.00	/mo	$12,500.00
Belt Feeder for Mixing Stystem	2	$728.00	/mo	$1,456.00
Stabilization Ancilliary Equipment	2	$557.00	/mo	$1,114.00
Dust Collecton System	2	$530.00	/mo	$1,060.00
Radial Stacking Conveyor	2	$3,605.00	/mo	$7,210.00
Materials:				
Office Trailer	4	$500.00	/mo.	$2,000.00
Regen Carbon	177	$2,000.00	/ton	$354,000.00
Cement	707	$105.00	/ton	$74,235.00
40-mil Liner for Soil Stockpiles	15996	$1.58	/sf	$25,337.66
10-mil Cover for Soil Stockpiles	22955	$0.83	/sf	$18,937.88
Water	74	$9.40	/kgpd	$694.87
Level D PPE	156	$10.00	/day	$1,560.00
PID rental	2	$974.00	/mo.	$1,948.00
CGI rental	2	$380.00	/mo.	$760.00

Table 4-10
Alternative 3 - Excavation, Ex-Situ Stabilization, and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

6.0 Chemical Stabilization of Hazardous Soil (continued)

Analytical:				
TCLP Extraction	61	$10.30 /ea	$628.00	
Lead	61	$24.00 /ea	$1,464.00	
SVOCs (8270C)	61	$240.00 /ea	$14,640.00	
NACs (8330)	61	$158.00 /ea	$9,638.00	
PCBs	61	$83.00 /ea	$5,063.00	
Unconfined Compresive Strength	61	$130.00 /ea	$7,930.00	
Shipping	8	$40.00 /ea	$325.00	
Travel for contractor crew:				
Lodging	764	$80.00 /day	$61,120.00	
Perdiem	764	$38.00 /day	$29,032.00	
Rental Car	109	$40.00 /day	$4,360.00	
			Subtotal	**$731,068.00**

7.0 Off-Site Disposal

Includes:
1. Dispose of stabilized soil and non-hazardous soil (not stabilized) at a nonhazardous waste landfill
2. Dispose of PCB waste at a TSCA approved landfill

Assumptions and Calculations:

1. Cubic yards of soil not requiring stabilization =	25004	
2. Tons of soil not requiring stabilization =	27504	
3. Tons of stabilized soil =	10606	
4. Tons of soil for non-haz waste landfill disposal =	38110	
5. Unconsolidated volume of PCB waste for disposal (cy) =	155	
6. Tons of soil for haz waste landfill disposal =	170	
7. Non-haz waste transportation cost ($/ton) =	6	
8. Non-haz waste disposal costs ($/ton) =	31	Erie County Landfill
9. Non-haz waste regulatory fees ($/ton) =	0	included in disposal
10. Haz waste transportation cost ($/ton) =	35	
11. D008 Haz waste disposal cost ($/ton) =	75	EO Environmental
12. D030 Haz waste disposal cost ($/ton) =	150	EO Environmental
13. PCB Haz waste disposal cost ($/ton) =	75	EO Environmental
14. Haz waste regulatory fees ($/ton) =	10	
15. No. of contractor field crew =	2	
14. No. of subcontractor field crew =	2	
16. Output of front-end loader (cy/day) =	550	
17. No. of field days =	58	

Service/Materials	Unit	Unit Cost	Subtotal	
Contractor Labor:				
Site Superintendent	464	$60.00 /hr	$27,840.00	
QA Coordinator	464	$40.00 /hr	$18,560.00	
Subcontractor Labor:				
Front End Loader Operator	58	$312.00 /day	$18,096.00	
Laborer	58	$293.00 /day	$16,994.00	
PBOW Security	58	$120.00 /day	$6,960.00	
Materials:				
Level D PPE	116	$10.00 /day	$1,160.00	
Equipment:				
1 cy Front End Loader	58	$280.86 /day	$16,289.88	
Disposal Costs:				
Transportation (Non-Haz Waste)	38110	$6.00 /ton	$228,660.97	
Disposal Cost (Non-Haz waste)	38110	$31.00 /ton	$1,181,415.00	
Transportation (Haz Waste)	170	$35.00 /ton	$5,955.95	
Disposal Cost (D008 haz waste)	0	$85.00 /ton	$0.00	
Disposal Cost (D030 haz waste)	0	$160.00 /ton	$0.00	
Disposal Cost (PCB haz waste)	170	$85.00 /ton	$14,464.45	
Travel for field crew:				
Lodging	325	$80.00 /day	$26,000.00	
Perdiem	325	$38.00 /day	$12,350.00	
Rental Car	162	$40.00 /day	$6,480.00	
			Subtotal	**$1,581,226.00**

Table 4-10
Alternative 3 - Excavation, Ex-Situ Stabilization, and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

8.0 Backfill Excavation with Clean Soil

Includes:
1. Backfill excavated areas with clean backfill (confirm soil is clean by sampling)
2. Confirmation testing under contaminated soil stockpiles.
3. Prepare site close-out report.

Assumptions and Calculations:

1. Volume of consolidated soil excavated (cy) =	25533
2. Compaction factor =	1.15
3. Volume of soil required for backfill (cy) =	29363
4. Cost of clean backfill soil delivered to site ($/cy) =	12
5. Field days required to backfill soil =	53
6. No. of contractor field crew =	2
8. No. of subcontractor backfill field crew =	2
7. No. of confirmatory samples from backfill =	2
8. Subcontractor markup on equipment =	1.25
9. Subcontractor markup on labor =	1.31
10. Area of contaminated soil stockpile (sf) =	62370
11. Area per confirmation sample (sf) =	400
12. No. of confirmation samples under soil stockpile =	156

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent	424	$60.00	/hr	$25,440.00	
QA Coordinator	424	$40.00	/hr	$16,960.00	
Site Close-Out Report	1	$20,000.00	/ea	$20,000.00	
Subcontractor Labor:					
Front End Loader Operator	53	$312.00	/day	$16,536.00	
Laborer/Oiler	53	$279.29	/day	$14,802.48	
PBOW Security	53	$120.00	/day	$6,360.00	
Equipment:					
1 cy Front End Loader	53	$280.86	/day	$14,885.58	
Material:					
Backfill	29363	$12.00	/cy	$352,355.40	delivered to site
PID rental	3	$974.00	/mo.	$2,922.00	
CGI rental	3	$380.00	/mo.	$1,140.00	
Level D PPE	106	$10.00	/day	$1,060.00	
Analytical:					
RCRA Metals	2	$105.00	/ea	$210.00	
NACs (8330)	158	$158.00	/ea	$24,964.00	
SVOCs	2	$230.00	/ea	$460.00	
Lead	156	$24.00	/ea	$3,744.00	
PAHs (8270C)	156	$160.00	/ea	$24,960.00	
PCBs	156	$83.00	/ea	$12,948.00	
Shipping	42	$40.00	/ea	$1,680.00	
Travel for field crew:					
Lodging	297	$80.00	/day	$23,760.00	
Perdiem	297	$38.00	/day	$11,286.00	
Rental Car	148	$40.00	/day	$5,920.00	
Subcontract:					
Reseeding	348	$56.84	/msf	$19,780.00	
				Subtotal	**$602,173.00**

9.0 Overall Cost

Total Capital Cost	**$4,810,833.45**
Contingency (30%)	**$1,443,250.00**
PM Multiplier (7.5%)	**$360,813.00**
Fee/Profit (10%)	**$481,083.00**
Total Cost	**$7,096,000.00**

*This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

Table 4-11
Alternative 4 - Excavation and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

Alternative 4
Excavation/Off-Site Disposal Cost Estimate

Site: TNT Area A & C
Plum Brook Ordnance Works

Date: 9/11/2003

Scope:
1. Perform bench-scale treatability study, prepare stabilization work plan, H&S plan, materials list, and procurement
2. Mobilize equipment and personnel
3. Conduct pre-remediation soil sampling to better delineate the lateral and vertical extent of contamination.
4. Prepare site for remedial activity.
5. Excavate contaminated soil and perform confirmatory sampling
6. Dispose of untreated non-hazardous soil in a Subtitle D landfill. Dispose of untreated hazardous soil in a Subtitle C landfill. Dispose of PCB remediation waste in a TSCA landfill.
7. Backfill excavated areas
8. Demobilize equipment and personnel

1.0 Work Plan, Health and Safety Plan, Materials List, and Procurement

Includes:
1. Labor to generate work plan, engineering specifications, and Health and Safety Plan
2. Procure equipment and materials

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Senior Engineer (E-12)	40	$97.00	/hr.	$3,880.00	
Task Manager (E-8)	80	$62.00	/hr.	$4,960.00	
Geologist (E-8)	40	$62.00	/hr.	$2,480.00	
Project Engineer (E-6)	160	$50.00	/hr.	$8,000.00	
Health and Safety (E-8)	40	$62.00	/hr.	$2,480.00	
Procurement Specialist (E-6)	80	$56.00	/hr.	$4,480.00	
Drafting (E-6)	40	$50.00	/hr.	$2,000.00	
Document Repro (Draft and Final)	2	$1,000.00	/ea	$2,000.00	
				Subtotal	**$30,280.00**

2.0 Mobilization/Demobilization of Equipment and Personnel

Includes:
1. Mobilize equipment and personnel
2. Contractor field crew consists of a site superintendent, geologist, and a field technician.
3. Four 2-day trips for 2 contractor personnel for pre-remediation coordination.

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent (E-8)	24	$60.00	/hr	$1,440.00	
QA (Sampling) Coordinator	24	$40.00	/hr	$960.00	
H&S Coordinator	16	$50.00	/hr	$800.00	
Field Geologist	2	$480.00	/day	$960.00	
Subcontractor Labor:					
Excavator Operator	2	$340.91	/day	$681.83	
Equipment Operator	2	$326.98	/day	$653.95	
Loader Operator	2	$312.00	/day	$624.00	
Laborers	2	$288.00	/day	$576.00	
Truck Drivers	6	$262.00	/day	$1,572.00	
Equipment:					
Excavator	2	$704.00	/day	$1,408.00	
1 cy Front Wheel Loader	2	$280.86	/day	$561.72	
Screening Plant	2	$1,000.00	/ea	$2,000.00	
Radial Conveyor	2	$500.00	/ea	$1,000.00	
Dump Truck	6	$428.00	/day	$2,568.00	
Travel for contractor crew:					
Perdiem	30	$38.00	/day	$1,140.00	
Lodging	30	$80.00	/day	$2,400.00	
Rental Car	16	$40.00	/day	$640.00	
Airfare	19	$600.00	/ea	$11,400.00	
				Subtotal	**$31,385.50**

Table 4-11
Alternative 4 - Excavation and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

3.0 Pre-Remediation Soil Sampling

Includes:
1. Hydropunch soil sampling
2. Analysis of soil samples for chemicals of concern.

Assumptions:

1. Perimeter of proposed remediation area (ft) =	7247
2. Distance between boring locations =	40
3. No. of borings =	182
4. Average depth of boring (ft) =	10
5. No. of samples collected per boring =	3
6. Total no. of samples collected =	546
7. No. of borings advanced per day =	10

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor:					
Field Geologist	19	$480.00	/day	$9,120.00	
Subcontractor:					
Mob/Demob	1	$2,000.00	/ea	$2,000.00	
Hydropunch Borings	1820	$15.00	/ft	$27,300.00	
Equipment Decon	182	$90.00	/ea	$16,380.00	
Materials:					
Field Supplies	182	$20.00	/bor.	$3,640.00	
Field Instruments	4	$400.00	/wk	$1,600.00	
Analytical:					
NACs (8330)	546	$158.00	/ea	$86,268.00	
Lead	546	$24.00	/ea	$13,104.00	
PAHs (8270C)	546	$160.00	/ea	$87,360.00	
PCBs	546	$83.00	/ea	$45,318.00	
Shipping	146	$40.00	/ea	$5,840.00	
Equipment:					
P/U Truck	19	$52.00	/day	$988.00	
Travel for Contractor Crew:					
Perdiem	19	$38.00	/day	$722.00	
Lodging	19	$80.00	/day	$1,520.00	
				Subtotal	**$301,160.00**

Table 4-11
Alternative 4 - Excavation and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

4.0 Site Preparation

Includes:
1. Clear remedial areas and treatment area = 8 acres
2. Construct 12" soil berm around staging areas (200 ft x 250 ft area = 900 ft).
3. Excavate soil for contact water retension pond.

Assumptions:

1. Volume of soil removed for contact water retention pond =	1,644
2. Excavator: hydraulic backhoe, 1 cy bucket	
3. Excavator output (cy/day) =	600
4. Days to excavate soil =	4
5. Volume of containment berm (cy) =	74
6. No. of field crew =	2

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor:					
Site Superintendent	80	$60.00	/hr	$4,800.00	
QA Coordinator	80	$40.00	/hr	$3,200.00	
Subcontractor:					
Surveying	2	$24,000.00	/site	$48,000.00	
Site Clearing	8	$2,300.00	/acre	$18,400.00	
Excavator Operator	4	$340.91	/day	$1,363.66	
Equipment:					
Excavator	4	$704.00	/day	$2,816.00	
Materials:					
Earthen containment berm	74	$6.00	/cy	$444.00	
Travel for Field Crew:					
Per Diem	28	$38.00	/day	$1,064.00	
Lodging	28	$80.00	/day	$2,240.00	
Rental Car	14	$40.00	/day	$560.00	
				Subtotal	**$82,888.00**

Table 4-11
Alternative 4 - Excavation and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

5.0 Excavation of Contaminated Soil

Includes:
1. Excavation of soil with contaminants exceeding RGOs
2. Screen oversize material
3. Collect confirmatory sampling to determine extent of excavation
4. Staging and characterizing waste stream

Assumptions and Calculations:

1. Cubic yards of consolidated soil excavated =	25533
2. Swell factor for soil upon excavation =	1.3
3. Cubic yards of unconsolidated soil =	33193
4. Density of unconsolidated soil (tons/cy) =	1.1
5. Mass of unconsolidated soil (tons) =	36512
6. Capacity of screening plant (tons/hr) =	100
7. Excavator: hydraulic backhoe, 1 cy bucket ($/day) =	$704
8. Excavator output (cy/day) =	600
9. Days to excavate soil =	67
10. Dump truck capacity (cy) =	12
11. Dump truck haul distance (mi.) =	0.5
12. Dump truck output (cy/day) =	250
13. No. of required dump trucks per day =	2
14. Soil sample collected for waste characterization / cy =	150
15. No. of soil samples collected for waste characterization =	221
16. Number of contractor field crew =	3
17. Number of subcontractor excavation crew =	4
18. Number of subcontractor screening crew =	3
19. Airfare included under mobilization	
20. Lineal foot of excavation per confirmation sample =	20
21. Resampling factor for confirmation sampling =	1.1
22. No.of confirmatory samples from excavated area =	633
23. Subcontractor markup on equipment =	1.25
24. Subcontractor markup on labor =	1.31
25. Excavation area (ft^2) =	85207
26. Cost multiplier for 1-week turnaround on analytical data =	1.25
27. Fraction of excavation work performed in Level C PPE =	0.10
28. Labor productivity factor for Level C work =	0.67
29. Days excavation crew in Level C =	7
30. Days screening crew in Level C =	5
31. Perimeter of excavation area (ft) =	7247
32. Excavation area (sf) =	85207
33. Volume of pit water requiring POTW disposal (gal) =	40000

Service/Materials	Unit	Unit Cost		Subtotal
Contractor Labor:				
Site Superintendent (E-8)	536	$60.00	/hr	$32,160.00
QA (Sampling) Coordinator	536	$40.00	/hr	$21,440.00
H&S Coordinator	536	$50.00	/hr	$26,800.00
Chemist (home office)	134	$51.00	/hr	$6,834.00
Subcontractor:				
Excavator Operator	67	$340.91	/day	$22,841.26
Equipment Operator	50	$326.98	/day	$16,348.80
Loader Operator	50	$312.00	/day	$15,600.00
Laborers	117	$288.00	/day	$33,696.00
Truck Drivers	201	$262.00	/day	$52,662.00
Road Repair	2	$50,000.00	/site	$100,000.00
Equipment:				
Excavator	67	$704.00	/day	$47,168.00
100-ton/hr Screening Plant	10	$1,800.00	/wk	$18,000.00
Radial Stacking Conveyor	10	$1,222.00	/wk	$12,220.00
1 cy Front Wheel Loader	50	$280.86	/day	$14,043.00
12-cy Dump Truck	134	$428.00	/day	$57,352.00
3000 gal. Water Truck	67	$402.00	/day	$26,934.00
150 gpm Pump	2	$2,439.00	/ea.	$4,878.00
300 gpm Pump	2	$3,749.00	/ea.	$7,498.00
7-ft Diameter Sand Filter	1	$22,310.00	/ea.	$22,310.00
200-gpm GAC Adsorber (6000#-disp.)	2	$14,217.00	/ea.	$28,434.00
20000 gal Steel Water Tank	1	$14,618.00	/ea.	$14,618.00

Table 4-11
Alternative 4 - Excavation and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

5.0 Excavation of Contaminated Soil (continued)					
Analytical:					
TCLP Extraction	221	$12.88	/ea	$2,845.38	
Lead	854	$300.00	/ea	$256,200.00	
SVOCs (8270C)	854	$197.50	/ea	$168,665.00	
NACs (8330)	854	$30.00	/ea	$25,620.00	
PCBs	854	$103.75	/ea	$88,602.50	
NAC field analyses	633	$40.00	/ea	$25,320.00	
Lead field analyses	4	$4,200.00	/mo.	$16,800.00	
Shipping	228	$40.00	/ea	$9,109.33	
Materials & Services:					
Office Trailer	8	$500.00	/mo.	$4,000.00	
Level D PPE	375	$10.00	/day	$3,750.00	
Level C PPE	43	$35.00	/day	$1,505.00	
PID rental	4	$974.00	/mo.	$3,896.00	
CGI rental	4	$380.00	/mo.	$1,520.00	
Pit Water Disposal	40	$1.62	/kgal	$64.80	
Travel for Contractor Crew:					
Perdiem	867	$38.00	/day	$32,946.00	
Lodging	867	$80.00	/day	$69,360.00	
Rental Car	351	$40.00	/day	$14,040.00	
				Subtotal	**$1,306,081.00**

Table 4-11
Alternative 4 - Excavation and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

7.0 Off-Site Disposal

Includes:
1. Dispose of non-hazardous soil at a nonhazardous waste landfill.
2. Dispose of hazardous soil at a RCRA Subtitle C TSDF.
3. Dispose of PCB waste at a TSCA approved landfill.

Assumptions and Calculations:

1. Volume of consolidated, non-hazardous soil (cy) =	19234	
2. Volume of unconsolidated, non-hazardous soil (cy) =	25004	
3. Tons of non-hazardous soil for disposal =	27504	
4. Consolidated volume of D008 soil for haz disposal (cy) =	275	no D030 waste comingled
5. Consolidated volume of D030 soil for haz disposal (cy) =	5905	
6. Consolidated volume of PCB soil for haz disposal (cy) =	119	
7. Total volume of unconsolidated hazardous soil (cy) =	8189	
8. Non-haz waste transportation cost ($/ton) =	6	
9. Non-haz waste disposal costs ($/ton) =	31	Erie County Landfill
10. Non-haz waste regulatory fees ($/ton) =	0	included in disposal
11. Haz waste transportation cost ($/ton) =	35	
12. D008 Haz waste disposal cost ($/ton) =	75	
13. D030 Haz waste disposal cost ($/ton) =	150	
14. PCB Haz waste disposal cost ($/ton) =	75	
15. Haz waste regulatory fees ($/ton) =	10	
16. No. of contractor field crew =	2	
14. No. of subcontractor field crew =	2	
17. Output of front-end loader (cy/day) =	550	
18. No. of field days =	61	

Service/Materials	Unit	Unit Cost	Subtotal	
Contractor Labor:				
Site Superintendent (E-8)	488	$60.00 /hr	$29,280.00	
QA Coordinator	488	$40.00 /hr	$19,520.00	
Subcontractor Labor:				
Front End Loader Operator	61	$312.00 /day	$19,032.00	
Laborer	61	$293.00 /day	$17,873.00	
PBOW Security	61	$120.00 /day	$7,320.00	
Materials:				
Level D PPE	122	$10.00 /day	$1,220.00	
Equipment:				
1 cy Front End Loader	61	$280.86 /day	$17,132.46	
Disposal Costs:				
Transportation (Non-Haz Waste)	27504	$6.00 /ton	$165,024.97	
Disposal Cost (Non-Haz waste)	27504	$31.00 /ton	$852,629.00	
Transportation (Haz Waste)	9008	$35.00 /ton	$315,280.00	
Disposal Cost (D008 haz waste)	393	$85.00 /ton	$33,405.00	
Disposal Cost (D030 haz waste)	8445	$160.00 /ton	$1,351,200.00	
Disposal Cost (PCB haz waste)	170	$85.00 /ton	$14,450.00	
Travel for field crew:				
Lodging	342	$80.00 /day	$27,360.00	
Perdiem	342	$38.00 /day	$12,996.00	
Rental Car	171	$40.00 /day	$6,840.00	
			Subtotal	**$2,890,562.00**

Table 4-11
Alternative 4 - Excavation and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

8.0 Backfill Excavation with Clean Soil

Includes:
1. Backfill excavated areas with clean backfill (confirm soil is clean by sampling)
2. Confirmation testing under contaminated soil stockpiles.
3. Prepare site close-out report.

Assumptions and Calculations:

1. Volume of consolidated soil excavated (cy) =	25533
2. Compaction factor =	1.15
3. Volume of soil required for backfill (cy) =	29363
4. Cost of clean backfill soil delivered to site ($/cy) =	12
5. Field days required to backfill soil =	53
6. No. of contractor field crew =	2
8. No. of subcontractor backfill field crew =	2
7. No. of confirmatory samples from backfill =	2
8. Subcontractor markup on equipment =	1.25
9. Subcontractor markup on labor =	1.31
10. Area of contaminated soil stockpile (sf) =	62370
11. Area per confirmation sample (sf) =	400
12. No. of confirmation samples under soil stockpile =	156

Service/Materials	Unit	Unit Cost	Subtotal	
Contractor Labor:				
Site Superintendent (E-8)	424	$60.00 /hr	$25,440.00	
QA Coordinator	424	$40.00 /hr	$16,960.00	
Site Close-Out Report	1	$20,000.00 /ea	$20,000.00	
Subcontractor Labor:				
Front End Loader Operator	53	$312.00 /day	$16,536.00	
Laborer/Oiler	53	$279.29 /day	$14,802.48	
PBOW Security	53	$120.00 /day	$6,360.00	
Equipment:				
1 cy Front End Loader	53	$280.86 /day	$14,885.58	
Material:				
Backfill	29363	$12.00 /cy	$352,355.40	delivered to site
PID rental	3	$974.00 /mo.	$2,922.00	
CGI rental	3	$380.00 /mo.	$1,140.00	
Level D PPE	106	$10.00 /day	$1,060.00	
Analytical:				
RCRA Metals	2	$105.00 /ea	$210.00	
NACs (8330)	158	$158.00 /ea	$24,964.00	
SVOCs	2	$230.00 /ea	$460.00	
Lead	156	$24.00 /ea	$3,744.00	
PAHs (8270C)	156	$160.00 /ea	$24,960.00	
PCBs	156	$83.00 /ea	$12,948.00	
Shipping	42	$40.00 /ea	$1,680.00	
Travel for field crew:				
Lodging	297	$80.00 /day	$23,760.00	
Perdiem	297	$38.00 /day	$11,286.00	
Rental Car	148	$40.00 /day	$5,920.00	
Subcontract:				
Reseeding	348	$56.84 /msf	$19,780.00	
			Subtotal	**$602,173.00**

9.0 Overall Cost

Total Capital Cost	**$5,244,529.50**
Contingency (30%)	**$1,573,359.00**
PM Multiplier (7.5%)	**$393,340.00**
Fee/Profit (10%)	**$524,453.00**
Total Cost	**$7,736,000.00**

*This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

Table 4-12
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

Alternative 5
Excavation/Composting/Stabilization/Off-Site and On-Site Disposal Cost Estimate

Site: TNT Area A & C
Plum Brook Ordnance Works
Date: 9/11/2003

Scope:
1. Perform bench-scale treatability studies to test the effectiveness of windrow composting and chemical stabilization for treating chemical of concern in soil, prepare remedial work plan, H&S plan, materials list, and procurement.
2. Mobilize equipment and personnel
3. Conduct pre-remediation soil sampling to better delineate the lateral and vertical extent of contamination.
4. Prepare site for remedial activity.
5. Excavate contaminated soil and perform confirmatory sampling.
6. Treatment of soil contaminated with nitroaromatic compounds via windrow composting.
7. Chemically stabilize Pb-contaminated soil that cannot be effectively treated using windrow composting..
8. Off-site disposal of stabilized soil and PCB remediation waste..
9. Backfill excavation with clean soil and spread treated compost across site.
10. Demobilize equipment and personnel.

1.0 Bench-Scale Study, Work Plan, Health and Safety Plan, Materials List, and Procurement

Includes:
1. Perform bench-scale treatability study to (1) define most cost-effective compost mix formula and (2) determine the optimum chemical additives and mix ratio for chemical stabilization. Results will be used to generate the design work plan.
2. Labor to generate work plan, engineering specifications, and Health and Safety Plan
3. Procure equipment and materials

Service/Materials	Unit	Unit Cost		Subtotal	
Composting Treatability Study	1	$20,000.00	/ea	$20,000.00	
Stabilization Treatability Study	1	$15,000.00	/ea	$15,000.00	
Contractor Labor:					
Senior Engineer (E-12)	80	$97.00	/hr.	$7,760.00	
Task Manager (E-8)	160	$62.00	/hr.	$9,920.00	
Geologist (E-8)	40	$62.00	/hr.	$2,480.00	
Project Engineer (E-6)	320	$50.00	/hr.	$16,000.00	
Health and Safety (E-8)	80	$62.00	/hr.	$4,960.00	
Procurement Specialist (E-6)	160	$56.00	/hr.	$8,960.00	
Drafting (E-6)	80	$50.00	/hr.	$4,000.00	
Document Repro (Draft and Final)	2	$1,000.00	/ea	$2,000.00	
				Subtotal	**$91,080.00**

Table 4-12
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

2.0 Mobilization/Demobilization of Equipment and Personnel

Includes:
1. Mobilize equipment and personnel (2 events for excavation & backfill subcontractor)
2. Contractor field crew consists of site superintendent, geologist, and a field technicians
3. Four 2-day trips for 2 contractor personnel for pre-remediation coordination.

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent (E-8)	24	$60.00	/hr	$1,440.00	
QA (Sampling) Coordinator	24	$40.00	/hr	$960.00	
H&S Coordinator	16	$50.00	/hr	$800.00	
Field Geologist	2	$480.00	/day	$960.00	
Subcontractor Labor:					
Excavator Operator	2	$340.91	/day	$681.83	
Equipment Operator	2	$326.98	/day	$653.95	
Equipment Operator	2	$326.98	/day	$653.95	
Dozer Operator	2	$326.98	/day	$653.95	
Loader Operator	2	$312.00	/day	$624.00	
Loader Operator	2	$312.00	/day	$624.00	
Laborers	2	$288.00	/day	$576.00	
Truck Drivers	12	$262.00	/day	$3,144.00	
Equipment:					
Excavator	2	$704.00	/day	$1,408.00	
1 cy Front Wheel Loader	2	$280.86	/day	$561.72	
3 cy Front Wheel Loader	2	$485.22	/day	$970.44	
Windrow Turner	2	$1,000.00	/mob	$2,000.00	
10-cy Mixing System	2	$975.00	/ea	$1,950.00	
Screening Plant	2	$1,000.00	/ea	$2,000.00	
Radial Conveyor	2	$500.00	/ea	$1,000.00	
D-6H Dozer	2	$630.70	/day	$1,261.40	
Dump Trucks	12	$428.00	/day	$5,136.00	
Travel for contractor crew:					
Perdiem	42	$38.00	/day	$1,596.00	
Lodging	42	$80.00	/day	$3,360.00	
Rental Car	20	$40.00	/day	$800.00	
Airfare	25	$600.00	/ea	$15,000.00	
				Subtotal	**$48,815.00**

Table 4-12
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

3.0 Pre-Remediation Soil Sampling

Includes:
1. Hydropunch soil sampling
2. Analysis of soil samples for chemicals of concern.

Assumptions:

1. Perimeter of proposed remediation area (ft) =	7247
2. Distance between boring locations =	40
3. No. of borings =	182
4. Average depth of boring (ft) =	10
5. No. of samples collected per boring =	3
6. Total no. of samples collected =	546
7. No. of borings advanced per day =	10

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor:					
Field Geologist	19	$480.00	/day	$9,120.00	
Subcontractor:					
Mob/Demob	1	$2,000.00	/ea	$2,000.00	
Hydropunch Borings	1820	$15.00	/ft	$27,300.00	
Equipment Decon	182	$90.00	/ea	$16,380.00	
Materials:					
Field Supplies	182	$20.00	/bor.	$3,640.00	
Field Instruments	4	$400.00	/wk	$1,600.00	
Analytical:					
NACs (8330)	546	$158.00	/ea	$86,268.00	
Lead	546	$24.00	/ea	$13,104.00	
PAHs (8270C)	546	$160.00	/ea	$87,360.00	
PCBs	546	$83.00	/ea	$45,318.00	
Shipping	146	$40.00	/ea	$5,840.00	
Equipment:					
P/U Truck	19	$52.00	/day	$988.00	
Travel for Contractor Crew:					
Perdiem	19	$38.00	/day	$722.00	
Lodging	19	$80.00	/day	$1,520.00	
				Subtotal	**$301,160.00**

Table 4-12
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

4.0 Site Preparation

Includes:
1. Clear remedial areas and treatment area = 8 acres
2. Construct 12" soil berm around treatment areas (400 ft x 500 ft area = 1800 ft).
3. Excavate soil for contact water retension pond.
4. Construct 6-inch reinforced concrete slab for treatment area.

Assumptions:

1. Volume of soil removed for contact water retention pond =	3,288
2. Excavator: hydraulic backhoe, 1 cy bucket	
3. Excavator output (cy/day) =	600
4. Days to excavate soil =	7
5. Volume of containment berm (cy) =	106
6. No. of contractor field crew =	2
7. Area of concrete treatment slab (160 ft x 420 ft) (sf) =	67200

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor:					
Site Superintendent	320	$60.00	/hr	$19,200.00	
QA Coordinator	320	$40.00	/hr	$12,800.00	
Subcontractor:					
Surveying	2	$24,000.00	/site	$48,000.00	
Site Clearing	8	$2,300.00	/acre	$18,400.00	
Excavator Operator	7	$258.80	/day	$1,811.60	
Concrete Slab	67200	$4.39	/sf	$295,008.00	
Equipment:					
Excavator	7	$704.00	/day	$4,928.00	
Materials:					
Earthen containment berm	106	$6.00	/cy	$636.00	
Travel for Field Crew:					
Per Diem	112	$38.00	/day	$4,256.00	
Lodging	112	$80.00	/day	$8,960.00	
Rental Car	56	$40.00	/day	$2,240.00	
				Subtotal	**$416,240.00**

Table 4-12
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

5.0 Excavation of Contaminated Soil

Includes:
1. Excavation of soil with contaminants exceeding RGOs
2. Screen oversize material
2. Collect confirmatory samples to determine extent of excavation
3. Staging and characterizing waste stream

Assumptions and Calculations:

1. Cubic yards of consolidated soil excavated =	25533
2. Swell factor for soil upon excavation =	1.3
3. Cubic yards of unconsolidated soil =	33193
4. Density of unconsolidated soil (tons/cy) =	1.1
5. Mass of unconsolidated soil (tons) =	36512
6. Capacity of screening plant (tons/hr) =	100
7. Excavator: hydraulic backhoe, 1 cy bucket ($/day) =	602
8. Excavator output (cy/day) =	600
9. Days to excavate soil =	67
10. Dump truck capacity (cy) =	12
11. Dump truck haul distance (mi.) =	0.5
12. Dump truck output (cy/day) =	250
13. No. of required dump trucks per day =	2
14. Soil sample collected for waste characterization / cy =	150
15. No. of soil samples collected for waste characterization =	221
16. Number of contractor field crew =	3
17. Number of subcontractor excavation crew =	4
18. Number of subcontractor screening crew =	3
19. Airfare included under mobilization	
20. Lineal foot of excavation per confirmation sample =	20
21. Resampling factor for confirmation sampling =	1.1
22. No.of confirmatory samples from excavated area =	633
23. Subcontractor markup on equipment =	1.25
24. Subcontractor markup on labor =	1.31
25. Excavation area (ft^2) =	85207
26. Cost multiplier for 1-week turnaround on analytical data =	1.25
27. Fraction of excavation work performed in Level C PPE =	0.10
28. Labor productivity factor for Level C work =	0.67
29. Days excavation crew in Level C =	7
30. Days screening crew in Level C =	5
31. Perimeter of excavation area (ft) =	7247
32. Excavation area (sf) =	85207
33. Volume of pit water requiring POTW disposal (gal) =	40000

Service/Materials	Unit	Unit Cost		Subtotal
Contractor Labor:				
Site Superintendent (E-8)	536	$60.00	/hr	$32,160.00
QA (Sampling) Coordinator	536	$40.00	/hr	$21,440.00
H&S Coordinator	536	$50.00	/hr	$26,800.00
Chemist (home office)	134	$51.00	/hr	$6,834.00
Subcontractor:				
Excavator Operator	67	$340.91	/day	$22,841.26
Equipment Operator	50	$326.98	/day	$16,348.80
Loader Operator	50	$312.00	/day	$15,600.00
Laborers	117	$288.00	/day	$33,696.00
Truck Drivers	201	$262.00	/day	$52,662.00
Road Repair	2	$50,000.00	/site	$100,000.00

Table 4-12
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

5.0 Excavation of Contaminated Soil (continued)					
Equipment:					
Excavator	67	$704.00	/day	$47,168.00	
100-ton/hr Screening Plant	10	$1,800.00	/wk	$18,000.00	
Radial Stacking Conveyor	10	$1,222.00	/wk	$12,220.00	
1 cy Front Wheel Loader	50	$280.86	/day	$14,043.00	
Dump Truck	134	$428.00	/day	$57,352.00	
3000 gal. Water Truck	67	$402.00	/day	$26,934.00	
150 gpm Pump	2	$2,439.00	/ea.	$4,878.00	
300 gpm Pump	2	$3,749.00	/ea.	$7,498.00	
7-ft Diameter Sand Filter	1	$22,310.00	/ea.	$22,310.00	
200-gpm GAC Adsorber (6000#-disp.)	2	$14,217.00	/ea.	$28,434.00	
20000 gal Steel Water Tank	1	$14,618.00	/ea.	$14,618.00	
Analytical:					
TCLP Extraction	221	$12.88	/ea	$2,845.38	
SVOCs (8270C)	854	$300.00	/ea	$256,200.00	
NACs (8330)	854	$197.50	/ea	$168,665.00	
Lead	854	$30.00	/ea	$25,620.00	
PCBs	854	$103.75	/ea	$88,602.50	
NAC field analyses	633	$40.00	/ea	$25,320.00	
Lead field analyses	4	$4,200.00	/mo.	$16,800.00	
Shipping	228	$40.00	/ea	$9,109.33	
Materials & Services:					
Office Trailer	8	$500.00	/mo.	$4,000.00	
Level D PPE	375	$10.00	/day	$3,750.00	
Level C PPE	43	$35.00	/day	$1,505.00	
PID rental	4	$974.00	/mo.	$3,896.00	
CGI rental	4	$380.00	/mo.	$1,520.00	
Pit Water Disposal	40	$1.62	/kgal	$64.80	
Travel for Contractor Crew:					
Perdiem	867	$38.00	/day	$32,946.00	
Lodging	867	$80.00	/day	$69,360.00	
Rental Car	351	$40.00	/day	$14,040.00	
				Subtotal	**$1,306,081.00**

Table 4-12
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

6.0 Winrow Composting of Contaminated of Soil

Includes:
1. Purchase and erection of treatment building
2. Lease/purchase composting equipment
3. Procurement and installation of contact water treatment equipment
4. Purchase of stockpile & amendment storage liners and covers
5. Procurement & stockpiling of composting amendments
6. Mix and compost soil and amendments
7. Pre-compliance testing: after compost formation & at end of treatment.
8. Compliance sampling for NAC, metals, PAHs, PCBs

Assumptions:

1. Volume of consolidated soil to be treated (cy) =	24797
2. Volume of unconsolidated soil to be treated (cy) =	32237
3. Compost treatment duration (months) =	21
4. Capacity of windrow turner (tons/hr) =	3,200
5. Operating life of flails (hrs) =	25
6. No. of flails on windrow turner =	172
7. Volume of compost in treatment building (cy) =	4,448
8. Bulk density of compost (tons/cy) =	0.379
9. Bermed work area (sf) =	200,000
10. Contaminated soil stockpile area (sf) =	62,370
11. Treated soil stockpile area (sf) =	6,672
12. Height of stockpiles (ft) =	9
13. Manure storage area (sf) =	192
14. Capacity of contact water treatment system (gpm) =	200
15. Loading rate of multimedia filter (gpm/sf) =	5
16. Diameter of multimedia filter (ft) =	7
17. Volume of bulking amendment (cy) =	92950
18. Volume of agricultural waste amendment (cy) =	3760
19. Total volume of compost before treatment (cy) =	128906
20. Shrinkage factor for compost =	0.60
21. Compost volume per pre-compliance sample collected (cy) =	50
22. Compost volume per compliance sample collected (cy) =	150
23. Markup on materials =	1.10
24. Subcontractor markup on equipment =	1.25
25. Subcontractor markup on labor =	1.31
26. Cost multiplier for 1-week turnaround on analytical data =	1.25
27. Salvage factor for major equipment at end of project =	0.50
28. Number of contractor field crew =	2
29. Number of subcontractor field crew =	3

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent	462	$480.00	/day	$221,760.00	
QA (Sampling) Coordinator	462	$320.00	/day	$147,840.00	
Subcontractor Labor:					
Equipment Operator	462	$326.98	/day	$151,062.91	
Equipment Operator	462	$326.98	/day	$151,062.91	
Equipment Operator	462	$326.98	/day	$151,062.91	
PBOW Security	84	$120.00	/day	$10,080.00	
Equipment:					
Windrow Turner (7' x 20')	1	$156,250.00	/ea.	$156,250.00	less salvage
75 cy/hr Tub Grinder	1	$26,225.00	/ea.	$26,225.00	less salvage
Bobcat	1	$16,000.00	/ea.	$16,000.00	less salvage
P/U Truck	1	$20,000.00	/ea.	$20,000.00	

Table 4-12
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

6.0 Winrow Composting of Contaminated of Soil (continued)						
Materials:						
Office Trailer	42	$500.00	/mo.	$21,000.00		
Erect Treatment Building	2	$35,080.00	/ea	$70,160.00		
Building Foundation & Accessories	2	$14,132.00	/ea	$28,264.00		
Treatment Building	2	$130,866.00	/ea	$261,732.00		
Treatment Building Lighting	2	$10,460.00	/ea	$20,920.00		
Dismantle Treatment Building	2	$33,500.00	/ea	$67,000.00		
Repl. Flails for Windrow Turner	4644	$9.50	/ea	$44,118.00		
40-mil Liner for Soil Stockpiles	72494	$1.58	/sf	$114,830.65		
10-mil Cover for Soil Stockpiles	69795	$0.83	/sf	$57,580.88		
40-mil Liner for Manure	202	$1.58	/sf	$319.33		
10-mil Cover for Manure	606	$0.83	/sf	$499.95		
Straw	92950	$13.56	/cy	$1,259,983.73		
Manure	3760	$14.97	/cy	$56,298.48		
Water	2802	$9.40	/kgal	$26,341.06		
Level D PPE	1386	$10.00	/day	$13,860.00		
PID rental	21	$974.00	/mo.	$20,454.00		
CGI rental	21	$380.00	/mo.	$7,980.00		
Analytical:						
Pre-Compliance Sampling:						
NAC field analyses	5156	$40.00	/ea	$206,249.60		
Compliance Sampling:						
SVOCs (8270C)	516	$300.00	/ea	$154,687.20		
NACs (8330)	516	$197.50	/ea	$101,835.74		
Lead	516	$30.00	/ea	$15,468.72		
PCBs	516	$103.75	/ea	$53,495.99		
Travel for Field Crew:						
Per Diem	3234	$38.00	/day	$122,892.00		
Lodging	3234	$30.00	/day	$97,020.00	long-term stay	
Rental Car	647	$40.00	/day	$25,880.00		
				Subtotal		**$3,900,215.00**

Table 4-12
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

7.0 Stabilization of Pb-Contaminated Soil

Includes:
1. Stabilization of hazardous soil using cement and activated carbon

Assumptions and Calculations:

1. Volume of consolidated haz. soil to be stabilized =	617
2. Swell factor for soil upon excavation =	1.3
3. Cubic yards of unconsolidated soil =	802
4. Density of soil (ton/cy) =	1.1
5. Tons of hazardous soil that needs to be stabilized =	882
6. Bulk density of portland cement (tons/cy) =	1.27
7. Bulk density of activated carbon (tons/cy) =	1.31
8. Mix ratio of carbon to soil =	0.02
9. Mix ratio of portland cement to soil =	0.08
10. Carbon cost ($/ton)=	2000
11. Cement cost ($/ton)=	105
12. Carbon required for stabilization (tons) =	18
13. Cement required for stabilization (tons) =	71
14. No. of contractor field crew =	2
15. Stabilization batch cycle time (min) =	15
16. Field days required to stabilize soil =	3
17. Swell upon stabilization =	1.132
18. Soil sample collected for waste characterization / cy =	150
19. No. of soil samples collected =	6
20. Tons of stabilized soil =	1058
21. Volume of stabilized soil (cy) =	907
22. Subcontractor markup on equipment =	1.25
23. Subcontractor markup on labor =	1.31
24. Cost multiplier for 1-week turnaround on analytical data =	1.25
24. Number of subcontractor field crew =	4
25. Equipment setup/teardown (days) =	10

Service/Materials	Unit	Unit Cost		Subtotal
Contractor Labor:				
Site Superintendent	13	$480.00	/day	$6,240.00
QA (Sampling) Coordinator	13	$320.00	/day	$4,160.00
Subcontractor Labor:				
Wheel Loader Operator	13	$238.00	/day	$3,094.00
Process Equipment Operator	13	$240.00	/day	$3,120.00
Process Equipment Operator	13	$240.00	/day	$3,120.00
Laborer	13	$270.00	/day	$3,510.00
PBOW Security	13	$120.00	/day	$1,560.00
Equipment:				
1 cy Front Wheel Loader	13	$280.86	/day	$3,651.18
10-cy Mixing System	1	$6,250.00	/mo	$6,250.00
Belt Feeder for Mixing Stystem	1	$728.00	/mo	$728.00
Stabilization Ancilliary Equipment	1	$557.00	/mo	$557.00
Dust Collecton System	1	$530.00	/mo	$530.00
Radial Stacking Conveyor	1	$3,605.00	/mo	$3,605.00
Materials:				
Carbon	18	$2,000.00	/ton	$36,000.00
Cement	71	$105.00	/ton	$7,455.00
Water	7	$9.40	/kgpd	$70.25
Level D PPE	52	$10.00	/day	$520.00
PID rental	1	$974.00	/mo.	$974.00
CGI rental	1	$380.00	/mo.	$380.00

Table 4-12
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

7.0 Stabilization of Pb-Contaminated Soil (continued)				
Analytical:				
TCLP Extraction	6	$12.88 /ea	$77.00	
Lead	6	$30.00 /ea	$180.00	
SVOCs (8270C)	6	$300.00 /ea	$1,800.00	
NACs (8330)	6	$197.50 /ea	$1,185.00	
PCBs	6	$103.75 /ea	$622.50	
Unconfined Compresive Strength	6	$162.50 /ea	$975.00	
Shipping	1	$40.00 /ea	$40.00	
Travel for field crew:				
Lodging	109	$80.00 /day	$8,720.00	
Perdiem	109	$38.00 /day	$4,142.00	
Rental Car	36	$40.00 /day	$1,440.00	
			Subtotal	**$104,706.00**

Table 4-12
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

8.0 Off-Site Disposal

Includes:
1. Dispose of stabilized soil at a nonhazardous waste landfill
2. Dispose of PCB waste at a TSCA approved landfill

Assumptions and Calculations:

1. Tons of stabilized soil =	1058	
2. Tons of soil for non-haz waste landfill disposal =	1058	
3. Volume of consolidated soil for haz waste disposal (cy) =	119	
4. Volume of unconsolidated soil for haz waste disposal (cy) =	155	
5. Tons of soil for haz waste landfill disposal =	171	
6. Non-haz waste transportation cost ($/ton) =	6	
7. Non-haz waste disposal costs ($/ton) =	31	Erie County Landfill
8. Non-haz waste regulatory fees ($/ton) =	0	included in disposal
9. Haz waste transportation cost ($/ton) =	35	
10. D008 Haz waste disposal cost ($/ton) =	75	EO Environmental
11. D030 Haz waste disposal cost ($/ton) =	150	EO Environmental
12. PCB Haz waste disposal cost ($/ton) =	75	EO Environmental
13. Haz waste regulatory fees ($/ton) =	10	
14. No. of contractor field crew =	2	
14. No. of subcontractor field crew =	2	
15. Output of front-end loader (cy/day) =	550	
16. No. of field days =	2	
17. Subcontractor markup on equipment =	1.25	
18. Subcontractor markup on labor =	1.31	

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent (E-8)	16	$60.00	/hr	$960.00	
QA Coordinator	16	$40.00	/hr	$640.00	
Subcontractor Labor:					
Front End Loader Operator	2	$312.00	/day	$624.00	
Laborer/Oiler	2	$279.29	/day	$558.58	
PBOW Security	2	$120.00	/day	$240.00	
Materials:					
Level D PPE	4	$10.00	/day	$40.00	
Equipment:					
1 cy Front Wheel Loader	2	$280.86	/day	$561.72	
Disposal Costs:					
Transportation (Non-Haz Waste)	1058	$6.00	/ton	$6,348.00	
Disposal Cost (Non-Haz waste)	1058	$31.00	/ton	$32,798.00	
Transportation (Haz Waste)	171	$35.00	/ton	$5,967.50	
Disposal Cost (D008 haz waste)	0	$85.00	/ton	$0.00	
Disposal Cost (D030 haz waste)	0	$160.00	/ton	$0.00	
Disposal Cost (PCB haz waste)	171	$85.00	/ton	$14,492.50	
Travel for field crew:					
Lodging	8	$80.00	/day	$640.00	
Perdiem	8	$38.00	/day	$304.00	
Rental Car	4	$40.00	/day	$160.00	
				Subtotal	**$64,334.00**

Table 4-12
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

9.0 On-Site Compost Disposal / Backfill Excavation with Clean Soil

Includes:
1. Backfill excavated areas with clean backfill.
2. Load treated compost, truck to site, spread compost with dozer
3. Confirmation testing under contaminated soil stockpiles.
4. Prepare site close-out report.

Assumptions and Calculations:

1. Volume of consolidated soil excavated (cy) =	25533
2. Compaction factor =	1.15
3. Volume of soil required for backfill (cy) =	29363
4. Cost of clean backfill soil delivered to site ($/cy) =	12
6. Field days required to backfill soil =	53
7. No. of contractor field crew =	2
8. No. of subcontractor backfill field crew =	1
9. No. of compost loading field crew =	7
10. No. of compost spreading field crew =	2
8. No. of confirmatory samples from clean backfill =	2
9. Total volume of compost before treatment (cy) =	128906
10. Shrinkage factor for treated compost =	0.60
11. Volume of compost after treatment (cy) =	77344
12. Loader output (cy/day) =	1575
13. Days to load treated compost =	74
14. Dump truck capacity (cy) =	12
15. Dump truck haul distance (mi.) =	0.5
16. Dump truck output (cy/day) =	250
17. No. of dump trucks per day =	6
18. Dozer (D-6H) capacity (cy/hr) =	90
19. Days to spread treated compost =	108
20. Subcontractor markup on equipment =	1.25
21. Subcontractor markup on labor =	1.31
22. Area of contaminated soil stockpile (sf) =	62370
23. Area per confirmation sample (sf) =	400
24. No. of confirmation samples under soil stockpile =	156

Service/Materials	Unit	Unit Cost		Subtotal	
Contractor Labor:					
Site Superintendent	864	$60.00	/hr	$51,840.00	
QA Coordinator	864	$40.00	/hr	$34,560.00	
Site Close-Out Report	1	$20,000.00	/ea	$20,000.00	
Subcontractor Labor:					
Front End Loader Operator	53	$312.00	/day	$16,536.00	
Front End Loader Operator	74	$312.00	/day	$23,088.00	
Dump Truck Drivers	444	$262.00	/day	$116,328.00	
Dozer Operator	108	$326.98	/day	$35,313.41	
Laborer/Oiler	108	$279.29	/day	$30,163.54	
PBOW Security	53	$120.00	/day	$6,360.00	
Equipment:					
1 cy Front End Loader	53	$280.86	/day	$14,885.58	
3 cy Front End Loader	74	$485.22	/day	$35,906.28	
Dump Trucks	444	$428.00	/day	$190,032.00	
D-6H Dozer	108	$630.70	/day	$68,115.60	
Material:					
Clean Backfill	29363	$12.00	/cy	$352,355.40	delivered to site
PID rental	11	$974.00	/mo.	$10,714.00	
CGI rental	11	$380.00	/mo.	$4,180.00	
Level D PPE	787	$10.00	/day	$7,870.00	

Table 4-12
Alternative 5 - Excavation, Windrow Composting, Ex-Situ Stabilization, On-Site and Off-Site Disposal Cost Estimate
TNT Area A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

9.0 On-Site Compost Disposal / Backfill Excavation with Clean Soil (continued)					
Analytical:					
	RCRA Metals	2	$105.00 /ea	$210.00	
	NACs (8330)	158	$158.00 /ea	$24,964.00	
	SVOCs	2	$230.00 /ea	$460.00	
	Lead	156	$24.00 /ea	$3,744.00	
	PAHs (8270C)	156	$160.00 /ea	$24,960.00	
	PCBs	156	$83.00 /ea	$12,948.00	
	Shipping	42	$40.00 /ea	$1,680.00	
Travel for field crew:					
	Lodging	1404	$80.00 /day	$112,320.00	
	Perdiem	1404	$38.00 /day	$53,352.00	
	Rental Car	480	$40.00 /day	$19,200.00	
Subcontract:					
	Reseeding	348	$56.84 /msf	$19,780.00	
				Subtotal	**$1,291,866.00**
10.0 Overall Cost					
				Total Capital Cost	**$7,524,497.00**
				Contingency (30%)	**$2,257,349.00**
				PM Multiplier (7.5%)	**$564,337.00**
				Fee/Profit (10%)	**$752,450.00**
				Total Cost	**$11,099,000.00**

*This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

Table 5-1

Comparative Analysis of Remedial Alternatives
TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

Criteria	**Alternative 1:** No Action	**Alternative 2:** Excavation, Windrow Composting, and On-Site/Off-Site Disposal	**Alternative 3:** Excavation, Ex-Situ Stabilization, and Off-Site Disposal	**Alternative 4:** Excavation and Off-Site Disposal	**Alternative 5:** Excavation, Windrow Composting, Ex-Situ Stabilization, and On-Site/Off-Site Disposal
Overall Protectiveness					
Human Health Protection	No reduction in risk.	Reduces the concentration of COCs to levels below RGOs.	Reduces the concentration of COCs to levels below RGOs.	Reduces the concentration of COCs to levels below RGOs.	Reduces the concentration of COCs to levels below RGOs.
Environmental Protection	No reduction in risk.	Significantly reduces the hazard quotients calculated for ecological receptors, and lowers the likelihood of contaminant spread to other media.	Significantly reduces the hazard quotients calculated for ecological receptors, and lowers the likelihood of contaminant spread to other media.	Significantly reduces the hazard quotients calculated for ecological receptors, and lowers the likelihood of contaminant spread to other media.	Significantly reduces the hazard quotients calculated for ecological receptors, and lowers the likelihood of contaminant spread to other media.
Compliance with ARARs					
Chemical-Specific ARARs	Does not comply with the chemical-specific ARAR for PCBs.	Complies with the chemical-specific ARAR for PCBs.	Complies with the chemical-specific ARAR for PCBs.	Complies with the chemical-specific ARAR for PCBs.	Complies with the chemical-specific ARAR for PCBs.
Location-Specific ARARs	No location-specific ARARs.	Complies with all location-specific ARARs identified in Table A-1.	Complies with all location-specific ARARs identified in Table A-1.	Complies with all location-specific ARARs identified in Table A-1.	Complies with all location-specific ARARs identified in Table A-1.
Action-Specific ARARs	No action-specific ARARs.	Complies with all action-specific ARARs identified in Table A-2.	Complies with all action-specific ARARs identified in Table A-2.	Complies with all action-specific ARARs identified in Table A-2.	Complies with all action-specific ARARs identified in Table A-2.
Other Criteria and Guidance	Permits exposures to soil exceeding the USEPA 400 mg/kg screening level for lead in soil.	Prevents exposures to soil exceeding the USEPA 400 mg/kg screening level for lead in soil.	Prevents exposures to soil exceeding the USEPA 400 mg/kg screening level for lead in soil.	Prevents exposures to soil exceeding the USEPA 400 mg/kg screening level for lead in soil.	Prevents exposures to soil exceeding the USEPA 400 mg/kg screening level for lead in soil.

Comparative Analysis of Remedial Alternatives
TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

Criteria	**Alternative 1:** No Action	**Alternative 2:** Excavation, Windrow Composting, and On-Site/Off-Site Disposal	**Alternative 3:** Excavation, Ex-Situ Stabilization, and Off-Site Disposal	**Alternative 4:** Excavation and Off-Site Disposal	**Alternative 5:** Excavation, Windrow Composting, Ex-Situ Stabilization, and On-Site/Off-Site Disposal
Long-Term Effectiveness and Permanence					
Magnitude of Residual Risk	Existing risk will remain.	Residual risk will be within the risk management range.	Residual risk will be within the risk management range.	Residual risk will be within the risk management range.	Residual risk will be within the risk management range.
Adequacy and Reliability of Controls	No controls over remaining contamination. No reliability.	No long-term controls required at site.	No long-term controls required at site.	No long-term controls required at site.	No long-term controls required at site.
Reduction of Toxicity, Mobility, or Volume through Treatment					
Treatment Process Used	None	Biological treatment of nitroaromatic compounds and PAHs using windrow composting.	Ex-situ stabilization of nitroaromatic compounds, PAHs, and lead with granular activated carbon and cement.	No on-site treatment.	Biological treatment of nitroaromatic compounds and PAHs using windrow composting. Ex-situ stabilization of lead.
Amount Destroyed or Treated	None	97% of contaminated soil treated on-site..	24% of contaminated soil treated on-site.	No on-site treatment .	99% of contaminated soil treated on-site.
Irreversible Treatment	None.	Research has demonstrated that a high percentage (>80%) of TNT-carbon is irreversibly bound to the soil through covalent binding with humic substances.	Stabilization is not an irreversible process, but placement of stabilized waste in an engineered disposal cell minimizes the possibility that conditions conducive to leaching will be created.	No on-site treatment.	Research has demonstrated that a high percentage (>80%) of TNT-carbon is irreversibly bound to the soil through covalent binding with humic substances. Stabilization is not an irreversible process, but placement of stabilized waste in an engineered disposal cell minimizes the possibility that conditions conducive to leaching will be created.

Table 5-1

Comparative Analysis of Remedial Alternatives
TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

Criteria	Alternative 1: No Action	Alternative 2: Excavation, Windrow Composting, and On-Site/Off-Site Disposal	Alternative 3: Excavation, Ex-Situ Stabilization, and Off-Site Disposal	Alternative 4: Excavation and Off-Site Disposal	Alternative 5: Excavation, Windrow Composting, Ex-Situ Stabilization, and On-Site/Off-Site Disposal
Type and Quantity of Residuals Remaining after Treatment	Contaminated soil remains.	49,880 cy of treated compost for on-site disposal. 480 tons of potentially hazardous lead- and PCB-contaminated soil for off-site treatment and/or disposal.	24,286 tons of non-hazardous soil (including stabilized soil) for offsite disposal. 170 tons of PCB-contaminated soil for offsite disposal.	17,644 tons of non-hazardous soil for off-site disposal. 5,705 tons of potentially hazardous soil for offsite treatment and/or disposal.	49,880 cy of treated compost for on-site disposal. 372 tons of non-hazardous stabilized soil for off-site disposal. 170 tons of PCB-contaminated soil for offsite disposal.
Short-Term Effectiveness					
Community Protection	May present future risk to community.	Normal safeguards would be required during transportation of waste materials offsite.	Normal safeguards would be required during transportation of waste materials offsite.	Normal safeguards would be required during transportation of waste materials offsite.	Normal safeguards would be required during transportation of waste materials offsite.
Worker Protection	No risk to workers	Safeguards would be required to protect workers from chemical exposures. Dust released during excavation, screening, amendment mixing, and windrow turning may require controls.	Dust released during excavation, screening, and stabilization may require controls.	Dust released during excavation and screening may require controls.	Safeguards would be required to protect workers from chemical exposures. Dust released during excavation, screening, amendment mixing, windrow turning, and stabilization may require controls.

Table 5-1

Comparative Analysis of Remedial Alternatives
TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

Criteria	**Alternative 1:** No Action	**Alternative 2:** Excavation, Windrow Composting, and On-Site/Off-Site Disposal	**Alternative 3:** Excavation, Ex-Situ Stabilization, and Off-Site Disposal	**Alternative 4:** Excavation and Off-Site Disposal	**Alternative 5:** Excavation, Windrow Composting, Ex-Situ Stabilization, and On-Site/Off-Site Disposal
Environmental Impacts	Continued impact from existing conditions.	Design of staging piles (contaminated soil and amendments) would require safeguards to prevent migration of contaminants. Treatment area would be bermed and a contact water retention and treatment system provided to control stormwater run-on and run-off.	Design of staging piles would require safeguards to prevent migration of contaminants. Treatment area would be bermed and a contact water retention and treatment system provided to control stormwater run-on and run-off.	Design of staging piles would require safeguards to prevent migration of contaminants.	Design of staging piles (contaminated soil and amendments) would require safeguards to prevent migration of contaminants. Treatment area would be bermed and a contact water retention and treatment system provided to control stormwater run-on and run-off.
Time Until Action is Complete	Not applicable	30 to 36 months	16 to 22 months	12 to 18 months	31 to 37 months
Implementability					
Ability to Construct and Operate	No construction or operation.	Technology well developed and implemented on a full-scale basis at numerous sites..	Technology well developed and implemented on a full-scale basis at numerous sites.	No significant issues.	Technologies well developed and implemented on a full-scale basis at numerous sites.

Table 5-1

Comparative Analysis of Remedial Alternatives
TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

Criteria	**Alternative 1:** No Action	**Alternative 2:** Excavation, Windrow Composting, and On-Site/Off-Site Disposal	**Alternative 3:** Excavation, Ex-Situ Stabilization, and Off-Site Disposal	**Alternative 4:** Excavation and Off-Site Disposal	**Alternative 5:** Excavation, Windrow Composting, Ex-Situ Stabilization, and On-Site/Off-Site Disposal
Ease of Doing More Action if Needed	May require ROD amendment if future problems arise.	Composted soil that does not meet requirements for placement on site may be landfilled at an approved TSDF.	Stabilized soil that does not meet waste acceptance criteria could be sent offsite to a RCRA hazardous waste TSDF for additional treatment.	Alternative does not preclude additional action.	Composted soil that does not meet requirements for placement on site may be chemically stabilized on-site and/or landfilled at an approved TSDF. Stabilized soil that does not meet waste acceptance criteria could be sent offsite to a RCRA hazardous waste TSDF for additional treatment.
Ability to Monitor Effectiveness	No monitoring required.	Effectiveness of excavation is evaluated by confirmatory soil sampling and analysis. Effectiveness of composting is evaluated by post-treatment sampling and analysis of compost .	Effectiveness of excavation is evaluated by confirmatory soil sampling and analysis. Effectiveness of stabilization process evaluated through leaching tests.	Effectiveness of excavation is evaluated by confirmatory soil sampling and analysis.	Effectiveness of excavation is evaluated by confirmatory soil sampling and analysis. Effectiveness of stabilization process evaluated through leaching tests. Effectiveness of composting is evaluated by post-treatment sampling and analysis of compost
Ability to Obtain Approvals and Coordinate with Other Agencies	None required	OEPA approval of disposal facility would be required.	Regulatory approval of stabilized material acceptance testing would be required. OEPA approval of disposal facility would be required.	OEPA approval of disposal facility would be required.	OEPA approval of disposal facility would be required.

Table 5-1

Comparative Analysis of Remedial Alternatives
TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

Criteria	**Alternative 1:** No Action	**Alternative 2:** Excavation, Windrow Composting, and On-Site/Off-Site Disposal	**Alternative 3:** Excavation, Ex-Situ Stabilization, and Off-Site Disposal	**Alternative 4:** Excavation and Off-Site Disposal	**Alternative 5:** Excavation, Windrow Composting, Ex-Situ Stabilization, and On-Site/Off-Site Disposal
Availability of Equipment, Specialists, and Materials	None required	Equipment, technical specialists, and materials readily available.	Equipment, technical specialists, and materials readily available	Equipment, technical specialists, and materials readily available	Equipment, technical specialists, and materials readily available
Availability of Technologies	None required	Available	Available	Available	Available
Cost					
Capital Cost	None	$7,688,000	$4,655,000	$4,923,000	$7,815,000
Annual O&M Cost	None	None	None	None	None
Present Worth Cost	None	$7,688,000	$4,655,000	$4,923,000	$7,815,000
State Acceptance	Not acceptable	To be determined	To be determined	To be determined	To be determined
Community Acceptance	Not acceptable	To be determined	To be determined	To be determined	To be determined

ARAR - Applicable or relevant and appropriate requirement.
COC - Contaminant of concern.
cy - Cubic yard.
mg/kg - Milligrams per kilogram.
O&M - Operation and maintenance.
OEPA - Ohio Environmental Protection Agency.
PAH - Polynuclear aromatic hydrocarbon.
PCB - Polychlorinated biphenyl.
RCRA - Resource Conservation and Recovery Act.
RGO - Remedial goal option.
ROD - Record of decision.
TNT - Trinitrotoluene.
TSDF - Treatment, storage, and disposal facility.
USEPA - U.S. Environmental Protection Agency.

Table 5-2

Comparative Analysis of Remedial Alternatives
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Criteria	**Alternative 1:** No Action	**Alternative 2:** Excavation, Windrow Composting, and On-Site/Off-Site Disposal	**Alternative 3:** Excavation, Ex-Situ Stabilization, and Off-Site Disposal	**Alternative 4:** Excavation and Off-Site Disposal	**Alternative 5:** Excavation, Windrow Composting, Ex-Situ Stabilization, and On-Site/Off-Site Disposal
Overall Protectiveness					
Human Health Protection	No reduction in risk.	Reduces the concentration of COCs to levels below RGOs.	Reduces the concentration of COCs to levels below RGOs.	Reduces the concentration of COCs to levels below RGOs.	Reduces the concentration of COCs to levels below RGOs.
Environmental Protection	No reduction in risk.	Significantly reduces the hazard quotients calculated for ecological receptors, and lowers the likelihood of contaminant spread to other media.	Significantly reduces the hazard quotients calculated for ecological receptors, and lowers the likelihood of contaminant spread to other media.	Significantly reduces the hazard quotients calculated for ecological receptors, and lowers the likelihood of contaminant spread to other media.	Significantly reduces the hazard quotients calculated for ecological receptors, and lowers the likelihood of contaminant spread to other media.
Compliance with ARARs					
Chemical-Specific ARARs	Does not comply with the chemical-specific ARAR for PCBs.	Complies with the chemical-specific ARAR for PCBs.	Complies with the chemical-specific ARAR for PCBs.	Complies with the chemical-specific ARAR for PCBs.	Complies with the chemical-specific ARAR for PCBs.
Location-Specific ARARs	No location-specific ARARs.	Complies with all location-specific ARARs identified in Table A-1.	Complies with all location-specific ARARs identified in Table A-1.	Complies with all location-specific ARARs identified in Table A-1.	Complies with all location-specific ARARs identified in Table A-1.
Action-Specific ARARs	No action-specific ARARs.	Complies with all action-specific ARARs identified in Table A-2.	Complies with all action-specific ARARs identified in Table A-2.	Complies with all action-specific ARARs identified in Table A-2.	Complies with all action-specific ARARs identified in Table A-2.
Other Criteria and Guidance	Permits exposures to soil exceeding the USEPA 400 mg/kg screening level for lead in soil.	Prevents exposures to soil exceeding the USEPA 400 mg/kg screening level for lead in soil.	Prevents exposures to soil exceeding the USEPA 400 mg/kg screening level for lead in soil.	Prevents exposures to soil exceeding the USEPA 400 mg/kg screening level for lead in soil.	Prevents exposures to soil exceeding the USEPA 400 mg/kg screening level for lead in soil.

Table 5-2

Comparative Analysis of Remedial Alternatives
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Criteria	**Alternative 1:** No Action	**Alternative 2:** Excavation, Windrow Composting, and On-Site/Off-Site Disposal	**Alternative 3:** Excavation, Ex-Situ Stabilization, and Off-Site Disposal	**Alternative 4:** Excavation and Off-Site Disposal	**Alternative 5:** Excavation, Windrow Composting, Ex-Situ Stabilization, and On-Site/Off-Site Disposal
Long-Term Effectiveness and Permanence					
Magnitude of Residual Risk	Existing risk will remain.	Residual risk will be within the risk management range.	Residual risk will be within the risk management range.	Residual risk will be within the risk management range.	Residual risk will be within the risk management range.
Adequacy and Reliability of Controls	No controls over remaining contamination. No reliability.	No long-term controls required at site.	No long-term controls required at site.	No long-term controls required at site.	No long-term controls required at site.
Reduction of Toxicity, Mobility, or Volume through Treatment					
Treatment Process Used	None	Biological treatment of nitroaromatic compounds and PAHs using windrow composting.	Ex-situ stabilization of nitroaromatic compounds and metals with granular activated carbon and cement.	No on-site treatment.	Biological treatment of nitroaromatic compounds and PAHs using windrow composting. Ex-situ stabilization of lead.
Amount Destroyed or Treated	None	97% of contaminated soil treated on-site.	24% of contaminated soil treated on-site.	No on-site treatment.	99% of contaminated soil treated on-site.
Irreversible Treatment	None.	Research has demonstrated that a high percentage (>80%) of TNT-carbon is irreversibly bound to the soil through covalent binding with humic substances.	Stabilization is not an irreversible process, but placement of stabilized waste in an engineered disposal cell minimizes the possibility that conditions conducive to leaching will be created.	No on-site treatment.	Research has demonstrated that a high percentage (>80%) of TNT-carbon is irreversibly bound to the soil through covalent binding with humic substances. Stabilization is not an irreversible process, but placement of stabilized waste in an engineered disposal cell minimizes the possibility that conditions conducive to leaching will be created.

Table 5-2

Comparative Analysis of Remedial Alternatives
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Criteria	**Alternative 1:** No Action	**Alternative 2:** Excavation, Windrow Composting, and On-Site/Off-Site Disposal	**Alternative 3:** Excavation, Ex-Situ Stabilization, and Off-Site Disposal	**Alternative 4:** Excavation and Off-Site Disposal	**Alternative 5:** Excavation, Windrow Composting, Ex-Situ Stabilization, and On-Site/Off-Site Disposal
Type and Quantity of Residuals Remaining after Treatment	Contaminated soil remains.	27,464 cy of treated compost for on-site disposal. 572 tons of potentially hazardous lead- contaminated soil for off-site treatment and/or disposal.	13,824 tons of non-hazardous soil (including stabilized soil) for offsite disposal.	9,860 tons of non-hazardous soil for off-site disposal. 3,303 tons of potentially hazardous soil for offsite treatment and/or disposal.	27,464 cy of treated compost for on-site disposal. 686 tons of non-hazardous stabilized soil for off-site disposal.
Short-Term Effectiveness					
Community Protection	May present future risk to community.	Normal safeguards would be required during transportation of waste materials offsite.	Normal safeguards would be required during transportation of waste materials offsite.	Normal safeguards would be required during transportation of waste materials offsite.	Normal safeguards would be required during transportation of waste materials offsite.
Worker Protection	No risk to workers	Safeguards would be required to protect workers from chemical exposures. Dust released during excavation, screening, amendment mixing, and windrow turning may require controls.	Dust released during excavation, screening, and stabilization may require controls.	Dust released during excavation and screening may require controls.	Safeguards would be required to protect workers from chemical exposures. Dust released during excavation, screening, amendment mixing, windrow turning, and stabilization may require controls.

Table 5-2

Comparative Analysis of Remedial Alternatives
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Criteria	**Alternative 1:** No Action	**Alternative 2:** Excavation, Windrow Composting, and On-Site/Off-Site Disposal	**Alternative 3:** Excavation, Ex-Situ Stabilization, and Off-Site Disposal	**Alternative 4:** Excavation and Off-Site Disposal	**Alternative 5:** Excavation, Windrow Composting, Ex-Situ Stabilization, and On-Site/Off-Site Disposal
Environmental Impacts	Continued impact from existing conditions.	Design of staging piles (contaminated soil and amendments) would require safeguards to prevent migration of contaminants. Treatment area would be bermed and a contact water retention and treatment system provided to control stormwater run-on and run-off.	Design of staging piles would require safeguards to prevent migration of contaminants. Treatment area would be bermed and a contact water retention and treatment system provided to control stormwater run-on and run-off.	Design of staging piles would require safeguards to prevent migration of contaminants.	Design of staging piles (contaminated soil and amendments) would require safeguards to prevent migration of contaminants. Treatment area would be bermed and a contact water retention and treatment system provided to control stormwater run-on and run-off.
Time Until Action is Complete	Not applicable	22 to 28 months	13 to 19 months	10 to 16 months	23 to 29 months
Implementability					
Ability to Construct and Operate	No construction or operation.	Technology well developed and implemented on a full-scale basis at numerous sites..	Technology well developed and implemented on a full-scale basis at numerous sites.	No significant issues.	Technologies well developed and implemented on a full-scale basis at numerous sites.

Table 5-2

Comparative Analysis of Remedial Alternatives
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Criteria	**Alternative 1:** No Action	**Alternative 2:** Excavation, Windrow Composting, and On-Site/Off-Site Disposal	**Alternative 3:** Excavation, Ex-Situ Stabilization, and Off-Site Disposal	**Alternative 4:** Excavation and Off-Site Disposal	**Alternative 5:** Excavation, Windrow Composting, Ex-Situ Stabilization, and On-Site/Off-Site Disposal
Ease of Doing More Action if Needed	May require ROD amendment if future problems arise.	Composted soil that does not meet requirements for placement on site may be landfilled at an approved TSDF.	Stabilized soil that does not meet waste acceptance criteria could be sent offsite to a RCRA hazardous waste TSDF for additional treatment.	Alternative does not preclude additional action.	Composted soil that does not meet requirements for placement on site may be chemically stabilized on-site and/or landfilled at an approved TSDF. Stabilized soil that does not meet waste acceptance criteria could be sent offsite to a RCRA hazardous waste TSDF for additional treatment.
Ability to Monitor Effectiveness	No monitoring required.	Effectiveness of excavation is evaluated by confirmatory soil sampling and analysis. Effectiveness of composting is evaluated by post-treatment sampling and analysis of compost .	Effectiveness of excavation is evaluated by confirmatory soil sampling and analysis. Effectiveness of stabilization process evaluated through leaching tests.	Effectiveness of excavation is evaluated by confirmatory soil sampling and analysis.	Effectiveness of excavation is evaluated by confirmatory soil sampling and analysis. Effectiveness of stabilization process evaluated through leaching tests. Effectiveness of composting is evaluated by post-treatment sampling and analysis of compost
Ability to Obtain Approvals and Coordinate with Other Agencies	None required	OEPA approval of disposal facility would be required.	Regulatory approval of stabilized material acceptance testing would be required. OEPA approval of disposal facility would be required.	OEPA approval of disposal facility would be required.	OEPA approval of disposal facility would be required.

Table 5-2

Comparative Analysis of Remedial Alternatives
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Criteria	**Alternative 1:** No Action	**Alternative 2:** Excavation, Windrow Composting, and On-Site/Off-Site Disposal	**Alternative 3:** Excavation, Ex-Situ Stabilization, and Off-Site Disposal	**Alternative 4:** Excavation and Off-Site Disposal	**Alternative 5:** Excavation, Windrow Composting, Ex-Situ Stabilization, and On-Site/Off-Site Disposal
Availability of Equipment, Specialists, and Materials	None required	Equipment, technical specialists, and materials readily available.	Equipment, technical specialists, and materials readily available	Equipment, technical specialists, and materials readily available	Equipment, technical specialists, and materials readily available
Availability of Technologies	None required	Available	Available	Available	Available
Cost					
Capital Cost	None	$5,377,000	$3,102,000	$3,119,000	$5,504,000
Annual O&M Cost	None	None	None	None	None
Present Worth Cost	None	$5,377,000	$3,102,000	$3,119,000	$5,504,000
State Acceptance	Not acceptable	To be determined	To be determined	To be determined	To be determined
Community Acceptance	Not acceptable	To be determined	To be determined	To be determined	To be determined

ARAR - Applicable or relevant and appropriate requirement.
COC - Contaminant of concern.
cy - Cubic yard.
mg/kg - Milligrams per kilogram.
O&M - Operation and maintenance.
OEPA - Ohio Environmental Protection Agency.
PAH - Polynuclear aromatic hydrocarbon.
PCB - Polychlorinated biphenyl.
RCRA - Resource Conservation and Recovery Act.
RGO - Remedial goal option.
ROD - Record of decision.
TNT - Trinitrotoluene.
TSDF - Treatment, storage, and disposal facility.
USEPA - U.S. Environmental Protection Agency.

Table 5-3

Remedial Duration Summary
Remediation of Contaminated Soil
TNT Manufacturing Areas A and C
Former Plum Brook Ordnance Works
Sandusky, Ohio

Area	Alternative 1 (months)	Alternative 2 (months)	Alternative 3 (months)	Alternative 4 (months)	Alternative 5 (months)
TNT A only	0	30 to 36	16 to 22	12 to 18	31 to 37
TNT C only	0	22 to 28	13 to 19	10 to 16	23 to 29
Total (TNT A&C)	0	41 to 47	20 to 26	16 to 22	42 to 48

Alternative 1: No action
Alternative 2: Excavation, composting, and onsite & offsite disposal
Alternative 3: Excavation, chemical stabilization, and offsite disposal
Alternative 4: Excavation and offsite disposal
Alternative 5: Excavation, composting, chemical stabilization, and onsite & offsite disposal

Notes:
Total row presents the remediation of TNTA and TNTC during one field event. Total remedial duration would be longer if remediation of these areas are completed in separate field efforts.

Table 5-4

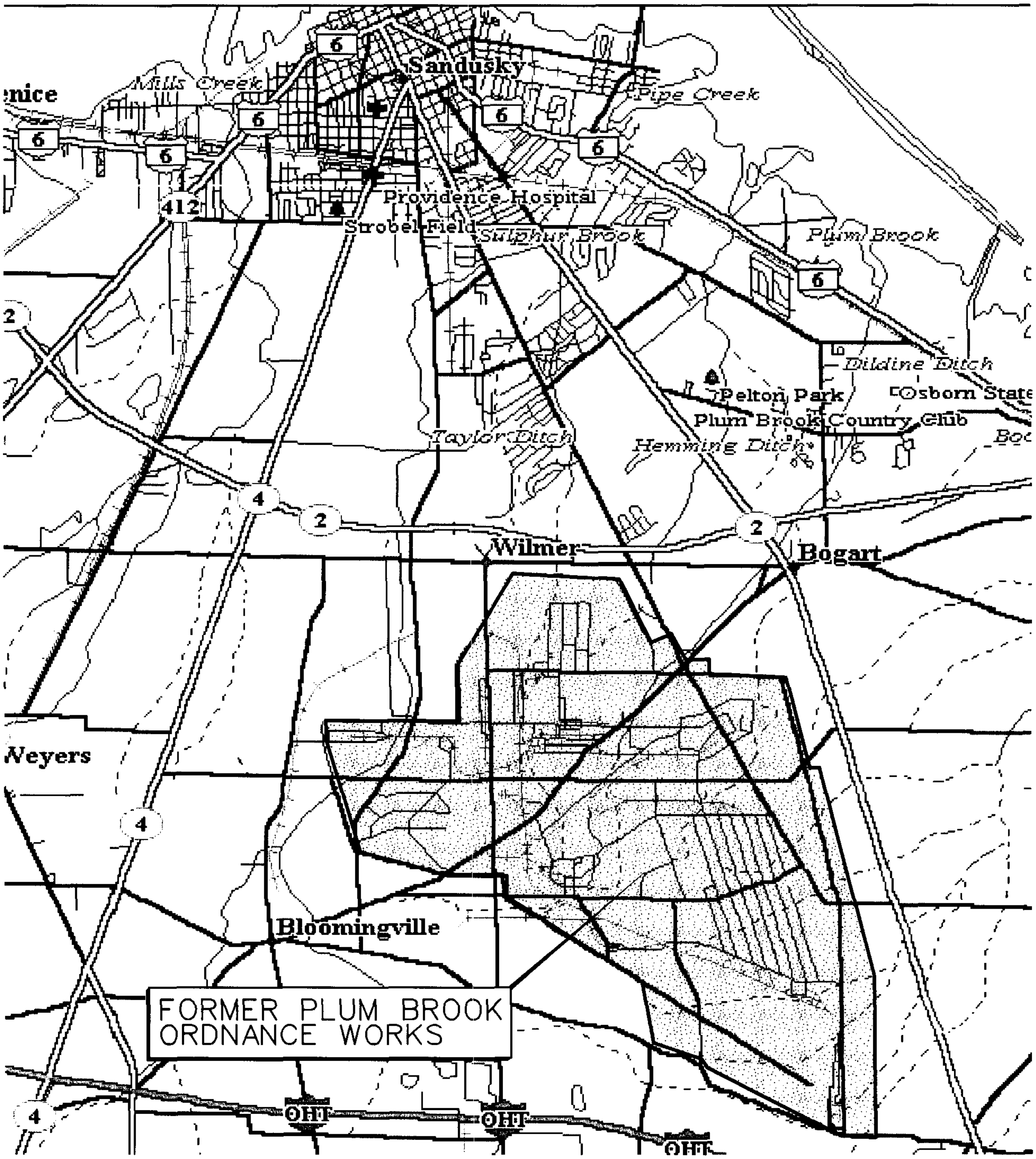
Cost Summary
Remediation of Contaminated Soil
TNT Manufacturing Areas A and C
Former Plum Brook Ordnance Works
Sandusky, Ohio

Area	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
TNT A only	$0	$7,688,000	$4,655,000	$4,923,000	$7,815,000
TNT C only	$0	$5,377,000	$3,102,000	$3,119,000	$5,504,000
Total (TNT A&C)	$0	$10,987,000	$7,096,000	$7,736,000	$11,099,000

Alternative 1: No action
Alternative 2: Excavation, composting, and onsite & offsite disposal
Alternative 3: Excavation, chemical stabilization, and offsite disposal
Alternative 4: Excavation and offsite disposal
Alternative 5: Excavation, composting, chemical stabilization, and onsite & offsite disposal

Notes:
Total cost row presents the remediation of TNTA and TNTC during one field event. Total costs of remediation would be higher if remediation of these areas are completed in separate field efforts.

FIGURES

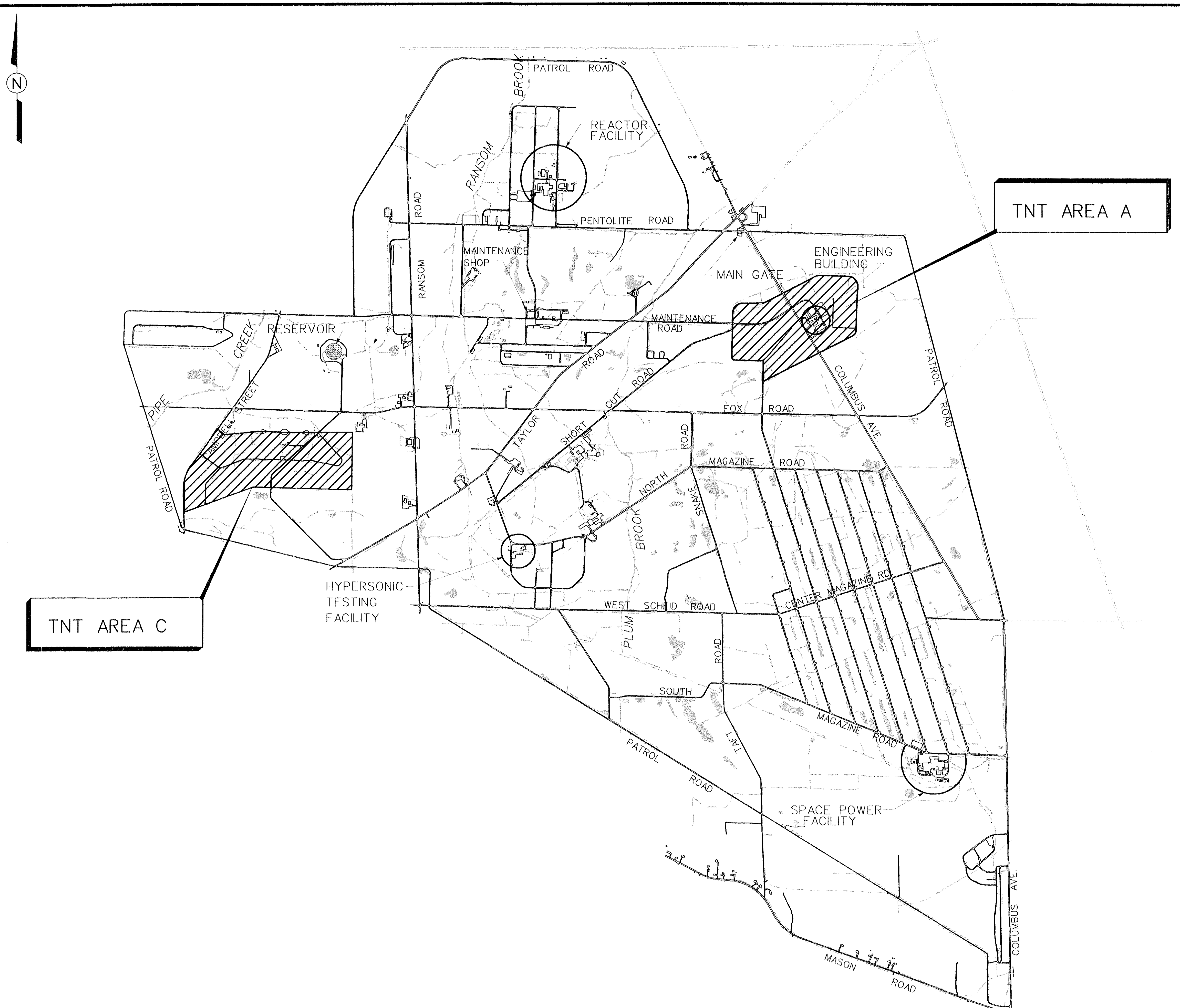


NOT TO SCALE

FIGURE 1-1
VICINITY MAP

FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw® Shaw Environmental, Inc.



LEGEND:

- BUILDINGS
- STREAMS OR DITCHES
- ROAD
- SURFACE WATER
- AREA OF CONCERN

SCALE

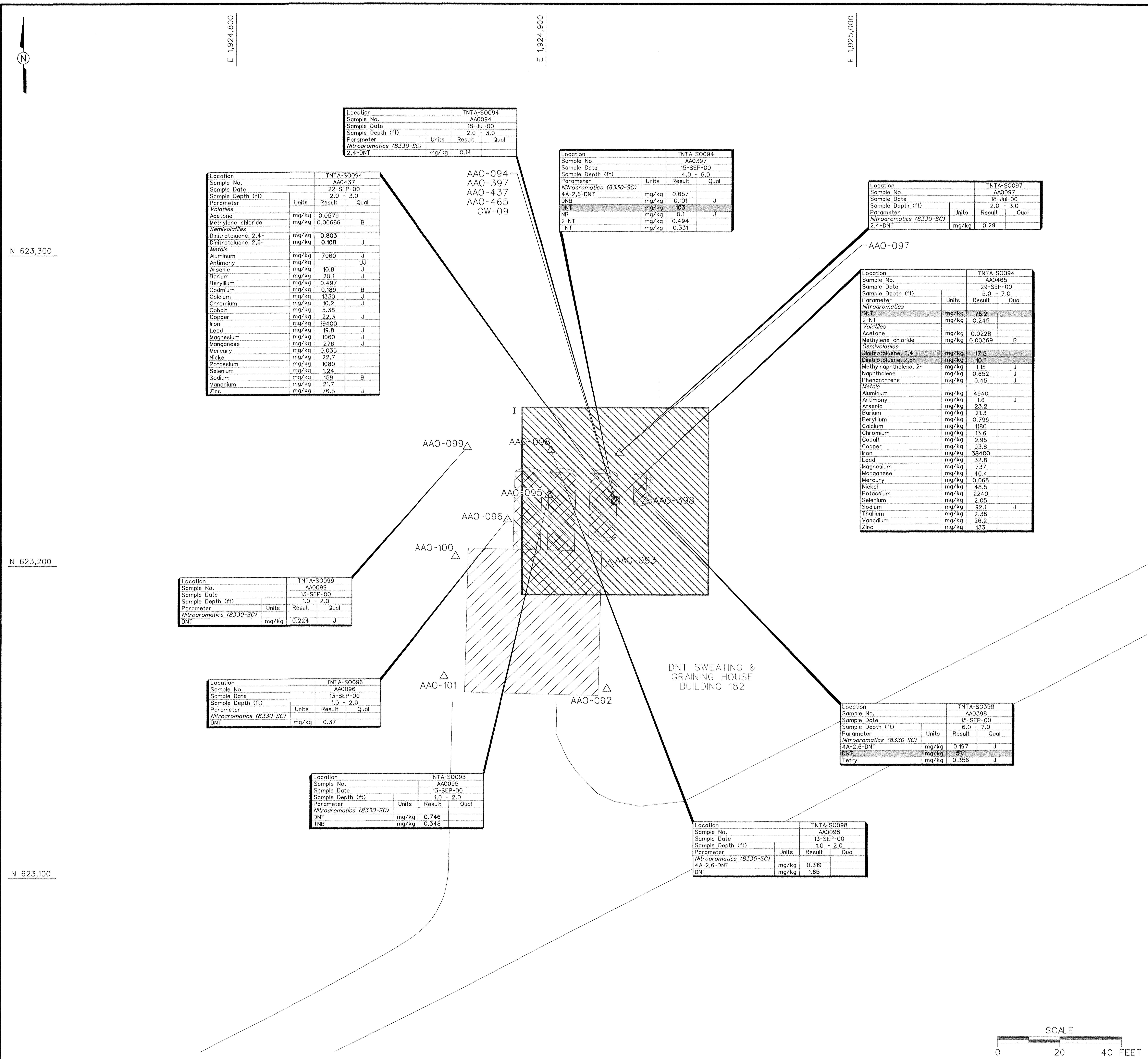
0 2400 4800 FEET

FIGURE 1-2
TNT AREAS A AND C
LOCATION MAP

FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw Environmental, Inc.

STARTING DATE: 10/21/02 | DATE LAST REV.: | DRAFT. CHCK. BY: C. TUMLIN | INITIATOR: T. SARD | DWG. NO.: 807111ES.071
DRAWN BY: B.VANDERGRIFF | DRAWN BY: | ENGR. CHCK. BY: T. SARD | PROJ. MGR.: S. DOWNEY | PROJ. NO.: 807111



Location		TNTA-S0094	
Sample No.		AA0094	
Sample Date		18-Jul-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.14	

Location		TNTA-S0094	
Sample No.		AA0437	
Sample Date		22-SEP-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Volatiles			
Acetone	mg/kg	0.0579	
Methylene chloride	mg/kg	0.00666	B
Semivolatiles			
Dinitrotoluene, 2,4-	mg/kg	**0.803**	
Dinitrotoluene, 2,6-	mg/kg	**0.108**	J
Metals			
Aluminum	mg/kg	7060	J
Antimony	mg/kg		UJ
Arsenic	mg/kg	**10.9**	J
Barium	mg/kg	20.1	J
Beryllium	mg/kg	0.497	
Cadmium	mg/kg	0.189	B
Calcium	mg/kg	1330	J
Chromium	mg/kg	10.2	J
Cobalt	mg/kg	5.38	
Copper	mg/kg	22.3	J
Iron	mg/kg	19400	
Lead	mg/kg	19.8	J
Magnesium	mg/kg	1060	J
Manganese	mg/kg	276	J
Mercury	mg/kg	0.035	
Nickel	mg/kg	22.7	
Potassium	mg/kg	1080	
Selenium	mg/kg	1.24	
Sodium	mg/kg	158	B
Vanadium	mg/kg	21.7	
Zinc	mg/kg	76.5	J

Location		TNTA-S0094	
Sample No.		AA0397	
Sample Date		15-SEP-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	0.657	
DNB	mg/kg	0.101	J
DNT	mg/kg	**103**	
NB	mg/kg	0.1	J
2-NT	mg/kg	0.494	
TNT	mg/kg	0.331	

Location		TNTA-S0097	
Sample No.		AA0097	
Sample Date		18-Jul-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.29	

Location		TNTA-S0094	
Sample No.		AA0465	
Sample Date		29-SEP-00	
Sample Depth (ft)		5.0 - 7.0	
Parameter	Units	Result	Qual
Nitroaromatics			
DNT	mg/kg	**76.2**	
2-NT	mg/kg	0.245	
Volatiles			
Acetone	mg/kg	0.0228	
Methylene chloride	mg/kg	0.00369	B
Semivolatiles			
Dinitrotoluene, 2,4-	mg/kg	**17.5**	
Dinitrotoluene, 2,6-	mg/kg	**10.1**	
Methylnaphthalene, 2-	mg/kg	1.15	J
Naphthalene	mg/kg	0.652	J
Phenanthrene	mg/kg	0.45	J
Metals			
Aluminum	mg/kg	4940	
Antimony	mg/kg	1.6	J
Arsenic	mg/kg	**23.2**	
Barium	mg/kg	21.3	
Beryllium	mg/kg	0.796	
Calcium	mg/kg	1180	
Chromium	mg/kg	13.6	
Cobalt	mg/kg	9.95	
Copper	mg/kg	93.8	
Iron	mg/kg	**38400**	
Lead	mg/kg	32.8	
Magnesium	mg/kg	737	
Manganese	mg/kg	40.4	
Mercury	mg/kg	0.068	
Nickel	mg/kg	48.5	
Potassium	mg/kg	2240	
Selenium	mg/kg	2.05	
Sodium	mg/kg	92.1	J
Thallium	mg/kg	2.38	
Vanadium	mg/kg	26.2	
Zinc	mg/kg	133	

Location		TNTA-S0099	
Sample No.		AA0099	
Sample Date		13-SEP-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
DNT	mg/kg	0.224	J

Location		TNTA-S0096	
Sample No.		AA0096	
Sample Date		13-SEP-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
DNT	mg/kg	0.37	

Location		TNTA-S0398	
Sample No.		AA0398	
Sample Date		15-SEP-00	
Sample Depth (ft)		6.0 - 7.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	0.197	J
DNT	mg/kg	**51.1**	
Tetryl	mg/kg	0.356	J

Location		TNTA-S0095	
Sample No.		AA0095	
Sample Date		13-SEP-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
DNT	mg/kg	**0.746**	
TNB	mg/kg	0.348	

Location		TNTA-S0098	
Sample No.		AA0098	
Sample Date		13-SEP-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	0.319	
DNT	mg/kg	**1.65**	

LEGEND:

- △ AAO-092 — SCREENING SOIL SAMPLING LOCATION
- ○ GW-09 — GROUNDWATER SAMPLING LOCATION
- □ AAO-437 — CONFIRMATION SOIL SAMPLING LOCATION
- FORMER TANK LOCATION
- FORMER BUILDING LOCATION
- POTENTIAL NITROAROMATIC REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 PRELIMINARY REMEDIATION GOALS ARE SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLING DEPTHS

SAMPLE	DEPTH (FT)
AA0092	2.0 - 3.0
AA0093	2.5 - 3.5
AA0094	2.0 - 3.0
AA0095	1.0 - 2.0
AA0096	1.0 - 2.0
AA0097	2.0 - 3.0
AA0098	1.0 - 2.0
AA0099	1.0 - 2.0
AA0100	1.0 - 2.0
AA0101	1.0 - 2.0
AA0397	4.0 - 6.0
AA0398	6.0 - 7.0
AA0437	2.0 - 3.0
AA0438	2.0 - 3.0
AA0439	2.0 - 3.0
AA0465	5.0 - 7.0

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	3600	7	933

8. GROUNDWATER ENCOUNTERED ON TOP OF BEDROCK AT 7 FEET IN SEPTEMBER 2000 BORING A-397/398. GROUNDWATER MEASURED IN TEMPORARY PIEZOMETER GW-09 AT 5.40 FEET OCTOBER 12, 2000 (IT, 2001a).

SCALE
0 20 40 FEET

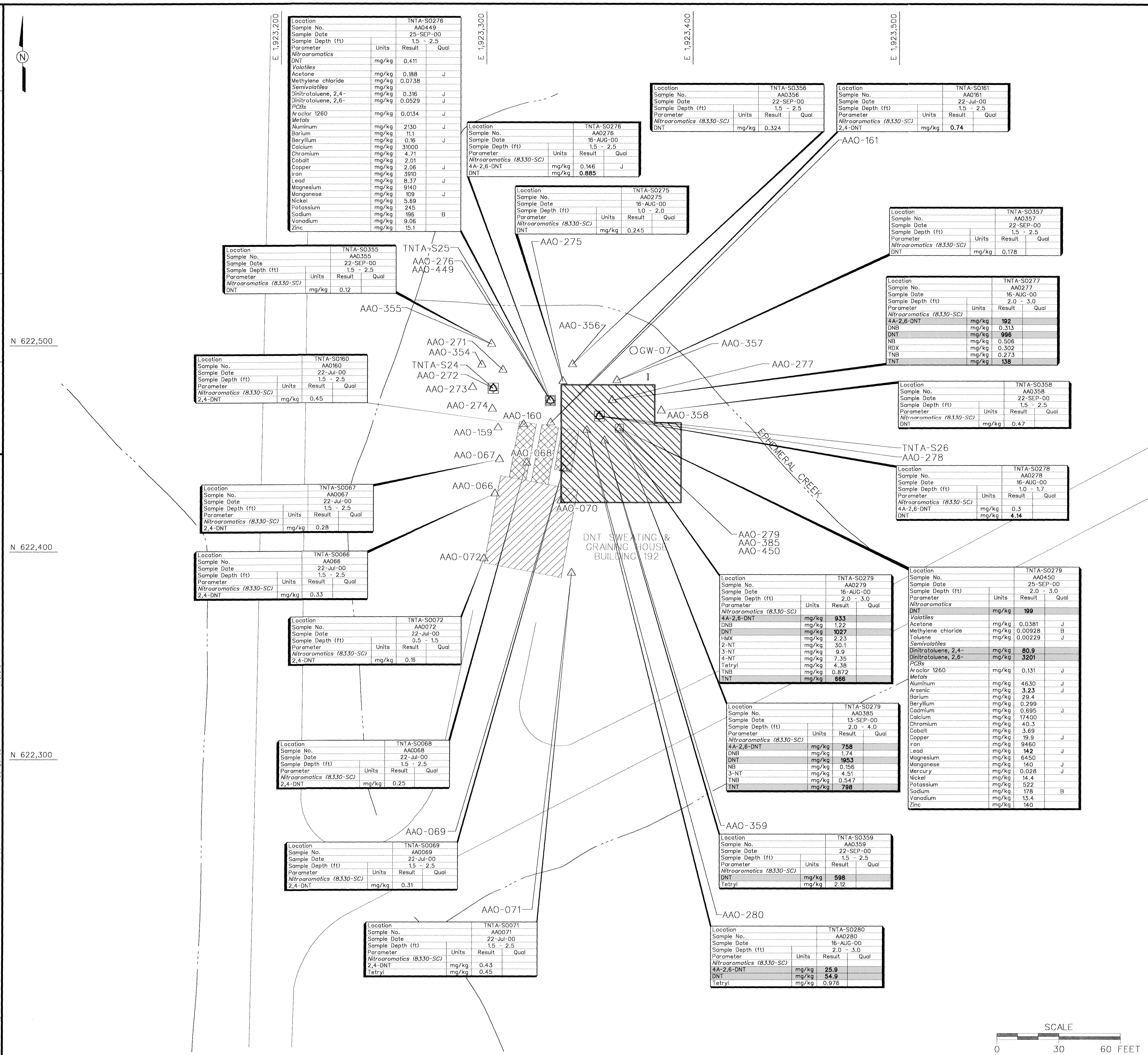
FIGURE 1-3
TNT AREA A
BUILDING 182 DNT SWEATING & GRAINING HOUSE
ANALYTICAL RESULTS AND ESTIMATED AREA/VOLUME OF SOIL REQUIRING REMEDIATION

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw Environmental, Inc.

waters
08/26/03
12:41:03 PM
p:\cadd\design\807111es.071

STARTING DATE: 10/18/01 | DATE LAST REV.: | DRAFT. CHCK. BY: C. TUMLIN | INITIATOR: T. SIARD | DWG. NO.: 807111es.060
DRAWN BY: B. VANDERGRIFF | DRAWN BY: | ENGR. CHCK. BY: T. SIARD | PROJ. MGR.: S. DOWNEY | PROJ. NO.: 807111



Location		TNTA-SO276	
Sample No.		AA0449	
Sample Date		25-SEP-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics			
DNT	mg/kg	0.411	
Volatiles			
Acetone	mg/kg	0.188	J
Methylene chloride	mg/kg	0.0738	
Semivolatiles	mg/kg		
Dinitrotoluene, 2,4-	mg/kg	0.316	J
Dinitrotoluene, 2,6-	mg/kg	0.0529	J
PCBs			
Aroclor 1260	mg/kg	0.0134	J
Metals			
Aluminum	mg/kg	2130	J
Barium	mg/kg	11.1	
Beryllium	mg/kg	0.16	J
Calcium	mg/kg	31000	
Chromium	mg/kg	4.71	
Cobalt	mg/kg	2.01	
Copper	mg/kg	2.06	J
Iron	mg/kg	3910	
Lead	mg/kg	8.37	J
Magnesium	mg/kg	9140	
Manganese	mg/kg	109	J
Nickel	mg/kg	5.69	
Potassium	mg/kg	245	
Sodium	mg/kg	196	B
Vanadium	mg/kg	9.06	
Zinc	mg/kg	15.1	

Location		TNTA-SO276	
Sample No.		AA0276	
Sample Date		16-AUG-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	0.146	J
DNT	mg/kg	**0.885**	

Location		TNTA-SO275	
Sample No.		AA0275	
Sample Date		16-AUG-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
DNT	mg/kg	0.245	

Location		TNTA-SO356	
Sample No.		AA0356	
Sample Date		22-SEP-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
DNT	mg/kg	0.324	

Location		TNTA-SO161	
Sample No.		AA0161	
Sample Date		22-Jul-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	**0.74**	

Location		TNTA-SO355	
Sample No.		AA0355	
Sample Date		22-SEP-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
DNT	mg/kg	0.12	

Location		TNTA-SO357	
Sample No.		AA0357	
Sample Date		22-SEP-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
DNT	mg/kg	0.178	

Location		TNTA-SO277	
Sample No.		AA0277	
Sample Date		16-AUG-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	**192**	
DNB	mg/kg	0.313	
DNT	mg/kg	**996**	
NB	mg/kg	0.506	
RDX	mg/kg	0.302	
TNB	mg/kg	0.273	
TNT	mg/kg	**138**	

Location		TNTA-SO160	
Sample No.		AA0160	
Sample Date		22-Jul-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.45	

Location		TNTA-SO358	
Sample No.		AA0358	
Sample Date		22-SEP-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
DNT	mg/kg	0.47	

Location		TNTA-SO278	
Sample No.		AA0278	
Sample Date		16-AUG-00	
Sample Depth (ft)		1.0 - 1.7	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	0.3	
DNT	mg/kg	**4.14**	

Location		TNTA-SO067	
Sample No.		AA0067	
Sample Date		22-Jul-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.28	

Location		TNTA-SO066	
Sample No.		AA066	
Sample Date		22-Jul-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.33	

Location		TNTA-SO279	
Sample No.		AA0279	
Sample Date		16-AUG-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	**933**	
DNB	mg/kg	1.22	
DNT	mg/kg	**1027**	
HMX	mg/kg	2.23	
2-NT	mg/kg	30.1	
3-NT	mg/kg	9.9	
4-NT	mg/kg	7.35	
Tetryl	mg/kg	4.38	
TNB	mg/kg	0.872	
TNT	mg/kg	**666**	

Location		TNTA-SO279	
Sample No.		AA0450	
Sample Date		25-SEP-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics			
DNT	mg/kg	**199**	
Volatiles			
Acetone	mg/kg	0.0381	J
Methylene chloride	mg/kg	0.00928	B
Toluene	mg/kg	0.00229	J
Semivolatiles			
Dinitrotoluene, 2,4-	mg/kg	**80.9**	
Dinitrotoluene, 2,6-	mg/kg	**3201**	
PCBs			
Aroclor 1260	mg/kg	0.131	J
Metals			
Aluminum	mg/kg	4630	J
Arsenic	mg/kg	**3.23**	J
Barium	mg/kg	29.4	
Beryllium	mg/kg	0.299	
Cadmium	mg/kg	0.695	J
Calcium	mg/kg	17400	
Chromium	mg/kg	40.3	
Cobalt	mg/kg	3.69	
Copper	mg/kg	19.9	J
Iron	mg/kg	9460	
Lead	mg/kg	**142**	J
Magnesium	mg/kg	6450	
Manganese	mg/kg	140	J
Mercury	mg/kg	0.028	J
Nickel	mg/kg	14.4	
Potassium	mg/kg	522	
Sodium	mg/kg	178	B
Vanadium	mg/kg	13.4	
Zinc	mg/kg	140	

Location		TNTA-SO072	
Sample No.		AA0072	
Sample Date		22-Jul-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.16	

Location		TNTA-SO279	
Sample No.		AA0385	
Sample Date		13-SEP-00	
Sample Depth (ft)		2.0 - 4.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	**758**	
DNB	mg/kg	1.74	
DNT	mg/kg	**1953**	
NB	mg/kg	0.156	
3-NT	mg/kg	4.51	
TNB	mg/kg	0.547	
TNT	mg/kg	**798**	

Location		TNTA-SO068	
Sample No.		AA0068	
Sample Date		22-Jul-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.25	

Location		TNTA-SO359	
Sample No.		AA0359	
Sample Date		22-SEP-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
DNT	mg/kg	**598**	
Tetryl	mg/kg	2.12	

Location		TNTA-SO069	
Sample No.		AA0069	
Sample Date		22-Jul-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.31	

Location		TNTA-SO071	
Sample No.		AA0071	
Sample Date		22-Jul-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.43	
Tetryl	mg/kg	0.45	

Location		TNTA-SO280	
Sample No.		AA0280	
Sample Date		16-AUG-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	**25.9**	
DNT	mg/kg	**54.9**	
Tetryl	mg/kg	0.976	

LEGEND:

- △ AAO-066 — SCREENING SOIL SAMPLING LOCATION
- ○ GW-07 — GROUNDWATER SAMPLING LOCATION
- □ AAO-450 — CONFIRMATION SOIL SAMPLING LOCATION
- TNTA-S24 — HISTORICAL SOIL BORING LOCATION WITH EXPLOSIVES DETECTION
- FORMER TANK LOCATION
- FORMER BUILDING LOCATION
- POTENTIAL NITROAROMATIC REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 PRELIMINARY REMEDIATION GOALS ARE SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLING DEPTHS

SAMPLE	DEPTH (FT)
AA0066	1.5 - 2.5
AA0067	1.5 - 2.5
AA0068	1.3 - 2.3
AA0069	1.0 - 2.0
AA0070	1.6 - 2.6
AA0071	1.5 - 2.5
AA0072	1.5 - 2.5
AA0159	1.5 - 2.5
AA0160	1.5 - 2.5
AA0161	1.5 - 2.5
AA0271	1.6 - 2.6
AA0272	2.0 - 3.0
AA0273	2.0 - 3.0
AA0274	2.0 - 3.0
AA0275	1.0 - 2.0
AA0276	1.5 - 2.5
AA0277	2.0 - 3.0
AA0278	1.0 - 1.75
AA0279	2.0 - 3.0
AA0280	2.0 - 3.0
AA0354	1.5 - 2.5
AA0355	1.5 - 2.5
AA0356	1.5 - 2.5
AA0357	1.5 - 2.5
AA0359	1.5 - 2.5
AA0385	2.0 - 4.0
AA0449	1.5 - 2.5
AA0450	2.0 - 3.0

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	3102	4	460

8. VERTICAL DEPTH OF 4 FEET (REFUSAL) FROM SEPTEMBER 2000 BORELOGS (IT, 2001a). GROUNDWATER ENCOUNTERED AT 3.8 FEET.

FIGURE 1-4
TNT AREA A
BUILDING 192 DNT SWEATING & GRAINING HOUSE, ANALYTICAL RESULTS AND ESTIMATED AREA/ VOLUME OF SOIL REQUIRING REMEDIATION

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw Environmental, Inc.

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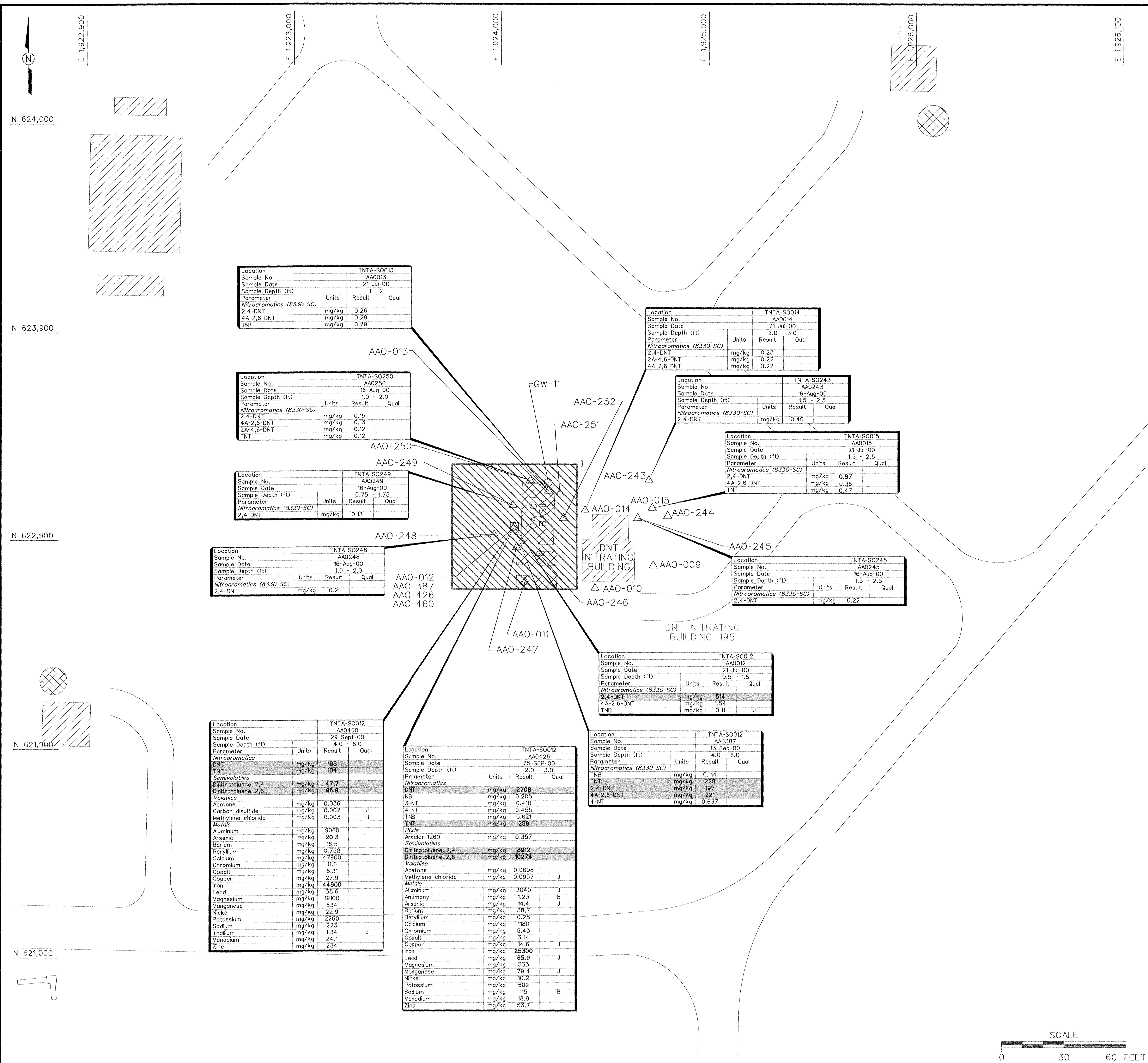

Location		TNTA-S0013	
Sample No.		AA0013	
Sample Date		21-Jul-00	
Sample Depth (ft)		1 - 2	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.26	
4A-2,6-DNT	mg/kg	0.29	
TNT	mg/kg	0.29	

Location		TNTA-S0250	
Sample No.		AA0250	
Sample Date		16-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.15	
4A-2,6-DNT	mg/kg	0.13	
2A-4,6-DNT	mg/kg	0.12	
TNT	mg/kg	0.12	

Location		TNTA-S0249	
Sample No.		AA0249	
Sample Date		16-Aug-00	
Sample Depth (ft)		0.75 - 1.75	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.13	

Location		TNTA-S0248	
Sample No.		AA0248	
Sample Date		16-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.2	

Location		TNTA-S0014	
Sample No.		AA0014	
Sample Date		21-Jul-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.23	
2A-4,6-DNT	mg/kg	0.22	
4A-2,6-DNT	mg/kg	0.22	

Location		TNTA-S0243	
Sample No.		AA0243	
Sample Date		16-Aug-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.46	

Location		TNTA-S0015	
Sample No.		AA0015	
Sample Date		21-Jul-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	**0.87**	
4A-2,6-DNT	mg/kg	0.36	
TNT	mg/kg	0.47	

Location		TNTA-S0245	
Sample No.		AA0245	
Sample Date		16-Aug-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.22	

Location		TNTA-S0012	
Sample No.		AA0012	
Sample Date		21-Jul-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	**514**	
4A-2,6-DNT	mg/kg	1.54	
TNB	mg/kg	0.11	J

Location		TNTA-S0012	
Sample No.		AA0387	
Sample Date		13-Sep-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.114	
TNT	mg/kg	229	
2,4-DNT	mg/kg	197	
4A-2,6-DNT	mg/kg	221	
4-NT	mg/kg	0.637	

Location		TNTA-S0012	
Sample No.		AA0460	
Sample Date		29-Sept-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics			
DNT	mg/kg	**195**	
TNT	mg/kg	**104**	
Semivolatiles			
Dinitrotoluene, 2,4-	mg/kg	**47.7**	
Dinitrotoluene, 2,6-	mg/kg	**96.9**	
Volatiles			
Acetone	mg/kg	0.036	
Carbon disulfide	mg/kg	0.002	J
Methylene chloride	mg/kg	0.003	B
Metals			
Aluminum	mg/kg	9060	
Arsenic	mg/kg	**20.3**	
Barium	mg/kg	16.5	
Beryllium	mg/kg	0.758	
Calcium	mg/kg	47900	
Chromium	mg/kg	11.6	
Cobalt	mg/kg	6.31	
Copper	mg/kg	27.9	
Iron	mg/kg	**44800**	
Lead	mg/kg	38.6	
Magnesium	mg/kg	19100	
Manganese	mg/kg	834	
Nickel	mg/kg	22.9	
Potassium	mg/kg	2260	
Sodium	mg/kg	223	
Thallium	mg/kg	1.34	J
Vanadium	mg/kg	24.1	
Zinc	mg/kg	234	

Location		TNTA-S0012	
Sample No.		AA0426	
Sample Date		25-SEP-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics			
DNT	mg/kg	**2708**	
NB	mg/kg	0.205	
3-NT	mg/kg	0.410	
4-NT	mg/kg	0.455	
TNB	mg/kg	0.621	
TNT	mg/kg	**259**	
PCBs			
Aroclor 1260	mg/kg	**0.357**	
Semivolatiles			
Dinitrotoluene, 2,4-	mg/kg	**8912**	
Dinitrotoluene, 2,6-	mg/kg	**10274**	
Volatiles			
Acetone	mg/kg	0.0608	
Methylene chloride	mg/kg	0.0957	J
Metals			
Aluminum	mg/kg	3040	J
Antimony	mg/kg	1.23	B
Arsenic	mg/kg	**14.4**	J
Barium	mg/kg	38.7	
Beryllium	mg/kg	0.28	
Calcium	mg/kg	1180	
Chromium	mg/kg	5.43	
Cobalt	mg/kg	3.14	
Copper	mg/kg	14.6	J
Iron	mg/kg	**25300**	
Lead	mg/kg	**65.9**	J
Magnesium	mg/kg	533	
Manganese	mg/kg	79.4	J
Nickel	mg/kg	10.2	
Potassium	mg/kg	609	
Sodium	mg/kg	115	B
Vanadium	mg/kg	18.9	
Zinc	mg/kg	53.7	

LEGEND:

- △ AAO-009 — SCREENING SOIL SAMPLING LOCATION
- □ AAO-426 — CONFIRMATION SOIL SAMPLING LOCATION
- ○ GW-11 — AUGUST 2001 TEMPORARY PIEZOMETER LOCATION (DRY)
- FORMER TANK LOCATION
- FORMER BUILDING LOCATION
- POTENTIAL NITROAROMATIC REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 PRELIMINARY REMEDIATION GOALS ARE SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLING DEPTHS

SAMPLE	DEPTH (FT)
AA0009	2.0 - 3.0
AA0010	2.0 - 3.0
AA0011	0.5 - 1.5
AA0012	0.5 - 1.5
AA0013	1.0 - 2.0
AA0014	2.0 - 3.0
AA0015	1.5 - 2.5
AA0243	1.5 - 2.5
AA0244	1.0 - 2.0
AA0245	1.5 - 2.5
AA0246	0.75 - 2.00
AA0247	0.75 - 1.75
AA0248	1.0 - 2.0
AA0249	0.75 - 1.75
AA0250	1.0 - 2.0
AA0251	1.0 - 2.0
AA0252	1.5 - 2.5
AA0387	4.0 - 6.0
AA0426	2.0 - 3.0
AA0460	4.0 - 6.0

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	3600	7	933

8. VERTICAL DEPTH OF 7 FEET (REFUSAL) FROM OCTOBER 2000 BORELOG (IT, 2001a).
9. AUGUST 2001 PROBE REFUSAL FOR TEMPORARY PIEZOMETER GW-11 AT 4 FEET. GROUNDWATER NOT ENCOUNTERED.

SCALE
0 30 60 FEET

FIGURE 1-5
TNT AREA A
BUILDING 195 DNT NITRATING
ANALYTICAL RESULTS AND
ESTIMATED AREA/VOLUME OF
SOIL REQUIRING REMEDIATION

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw Shaw Environmental, Inc.

STARTING DATE: 10/16/02 | DATE LAST REV.: | DRAFT. CHCK. BY: C. TUMLIN | INITIATOR: T. SIARD | DWG. NO.: 80711ES.061
DRAWN BY: B.VANDERGRIFF | DRAWN BY: | ENGR. CHCK. BY: T. SIARD | PROJ. MGR.: S. DOWNEY | PROJ. NO.: 807111

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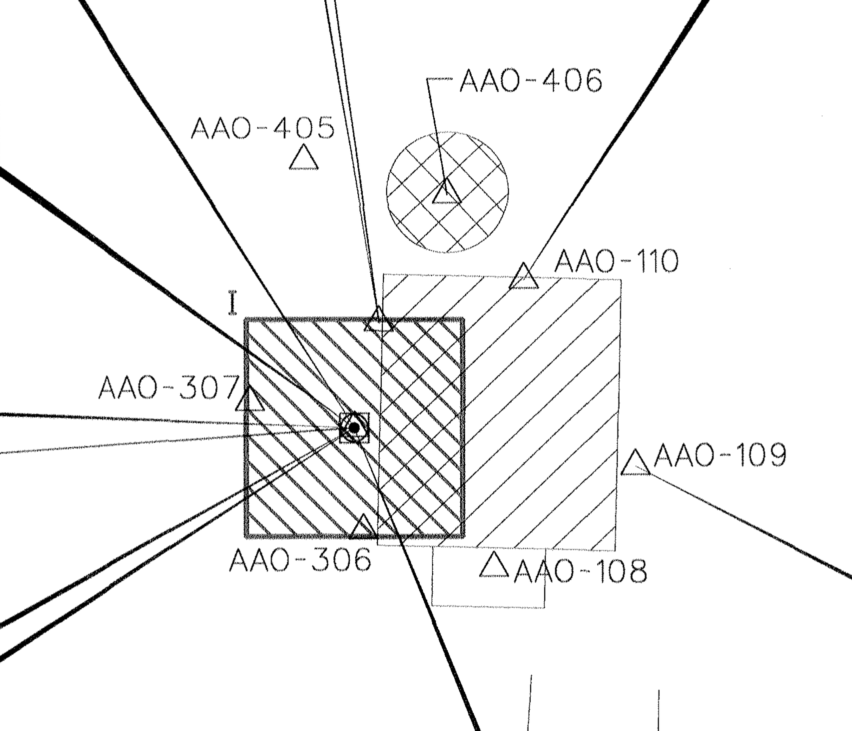
STARTING DATE: 10/21/02 | DATE LAST REV.: | DRAFT. CHCK. BY: C. TUMLIN | INITIATOR: T. SIARD | DWG. NO.: 80711ES.070
DRAWN BY: B.VANDERGRIFF | DRAWN BY: | ENGR. CHCK. BY: T. SIARD | PROJ. MGR.: S. DOWNEY | PROJ. NO.: 807111



Location		TNTA-SO305	
Sample No.		AA0305	
Sample Date		15-Aug-00	
Sample Depth (ft)		2.0-3.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.37	
2,4-DNT	mg/kg	**0.74**	
2A-4,6-DNT	mg/kg	0.34	
4A-2,6-DNT	mg/kg	0.65	

Location		TNTA-SO111	
Sample No.		AA0361	
Sample Date		12-SEP-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	2.87	
2A-4,6-DNT	mg/kg	1.75	
2,4-DNT	mg/kg	**12**	
2-NT	mg/kg	2.69	
3-NT	mg/kg	0.902	
4-NT	mg/kg	1.07	
Tetryl	mg/kg	0.798	
TNT	mg/kg	0.483	

Location		TNTA-SO111	
Sample No.		AA0362	
Sample Date		12-SEP-00	
Sample Depth (ft)		8.0 - 10.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2-NT	mg/kg	0.614	
4-NT	mg/kg	0.449	J

Location		TNTA-SO110	
Sample No.		AA0110	
Sample Date		20-Jul-00	
Sample Depth (ft)		0.5 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.18	J
2,4-DNT	mg/kg	0.61	
2A-4,6-DNT	mg/kg	0.84	
4A-2,6-DNT	mg/kg	1.31	

Location		TNTA-SO111	
Sample No.		AA0111	
Sample Date		20-Jul-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.191	J
2,4-DNT	mg/kg	**1.24**	
2A-4,6-DNT	mg/kg	0.53	
4A-2,6-DNT	mg/kg	1.31	

Location		TNTA-SO111	
Sample No.		AA0469	
Sample Date		28-SEP-00	
Sample Depth (ft)		8.0 - 10.0	
Parameter	Units	Result	Qual
Nitroaromatics			
DNT	mg/kg	0.17	
2-NT	mg/kg	0.38	
4-NT	mg/kg	0.423	
Volatiles			
Acetone	mg/kg	0.0221	J
Carbon disulfide	mg/kg	0.00917	
Methylene chloride	mg/kg	0.00612	B
Toluene	mg/kg	0.00196	J
Metals			
Aluminum	mg/kg	6630	J
Arsenic	mg/kg	**3.27**	
Barium	mg/kg	23	
Beryllium	mg/kg	0.398	
Calcium	mg/kg	1770	
Chromium	mg/kg	9.31	
Cobalt	mg/kg	3.64	
Copper	mg/kg	4.9	
Iron	mg/kg	10000	
Lead	mg/kg	9.55	
Magnesium	mg/kg	920	
Manganese	mg/kg	132	
Mercury	mg/kg	0.022	J
Nickel	mg/kg	8.67	
Potassium	mg/kg	425	
Sodium	mg/kg	145	B
Vanadium	mg/kg	18.2	
Zinc	mg/kg	29	

Location		TNTA-SO111	
Sample No.		AA0468	
Sample Date		28-SEP-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	0.373	
DNT	mg/kg	**3.14**	
NB	mg/kg	0.0778	J
2-NT	mg/kg	1.41	
3-NT	mg/kg	0.476	
4-NT	mg/kg	0.376	
TNT	mg/kg	0.213	
Volatiles			
Methylene chloride	mg/kg	0.00714	B
Toluene	mg/kg	0.013	J
Semivolatiles			
Bis(2-ethylhexyl)phthalate	mg/kg	0.026	J
Dinitrotoluene, 2,4-	mg/kg	0.558	
Dinitrotoluene, 2,6-	mg/kg	0.208	J
PCBs			
Aroclor 1260	mg/kg	0.0125	J
Metals			
Aluminum	mg/kg	5670	J
Arsenic	mg/kg	**4.23**	
Barium	mg/kg	26.6	
Beryllium	mg/kg	0.346	
Cadmium	mg/kg	0.131	J
Calcium	mg/kg	3200	
Chromium	mg/kg	8.4	
Cobalt	mg/kg	2.97	
Copper	mg/kg	5.52	
Iron	mg/kg	9140	
Lead	mg/kg	21.7	
Magnesium	mg/kg	990	
Manganese	mg/kg	124	
Nickel	mg/kg	7.88	
Potassium	mg/kg	393	
Sodium	mg/kg	140	B
Vanadium	mg/kg	15.8	
Zinc	mg/kg	36.5	

Location		TNTA-SO111	
Sample No.		AA0441	
Sample Date		22-SEP-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Volatiles			
Acetone	mg/kg	0.0582	J
Butanone, 2-	mg/kg	0.0098	
Methylene chloride	mg/kg	0.00398	B
PCBs			
Aroclor 1260	mg/kg	0.133	J
Metals			
Aluminum	mg/kg	5530	J
Antimony	mg/kg	1.38	B
Arsenic	mg/kg	**4.11**	J
Barium	mg/kg	33.5	J
Beryllium	mg/kg	0.226	
Cadmium	mg/kg	0.518	B
Calcium	mg/kg	4080	J
Chromium	mg/kg	10.8	J
Cobalt	mg/kg	2.82	
Copper	mg/kg	18.4	J
Iron	mg/kg	10400	
Lead	mg/kg	**122**	J
Magnesium	mg/kg	1090	J
Manganese	mg/kg	230	J
Mercury	mg/kg	0.077	
Nickel	mg/kg	7.42	
Potassium	mg/kg	481	
Sodium	mg/kg	217	B
Vanadium	mg/kg	16.1	
Zinc	mg/kg	148	J

Location		TNTA-SO109	
Sample No.		AA0109	
Sample Date		20-Jul-00	
Sample Depth (ft)		0.5 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.16	J
2,4-DNT	mg/kg	0.40	
2A-4,6-DNT	mg/kg	0.58	
4A-2,6-DNT	mg/kg	0.52	

LEGEND:

- △ AAO-108 — SCREENING SOIL SAMPLING LOCATION
- • AAO-314 — SURFACE SOIL SAMPLE (0 - 1 FT)
- ○ GW-01 — GROUNDWATER SAMPLING LOCATION
- □ AAO-441 — CONFIRMATION SOIL SAMPLING LOCATION
- FORMER TANK LOCATION
- FORMER BUILDING LOCATION
- POTENTIAL NITROAROMATIC REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 PRELIMINARY REMEDIATION GOALS ARE SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLING DEPTHS

SAMPLE	DEPTH (FT)
AA0108	1.0 - 2.0
AA0109	0.5 - 1.5
AA0110	0.5 - 1.5
AA0111	1.0 - 2.0
AA0305	2.0 - 3.0
AA0306	0.5 - 1.5
AA0307	1.0 - 2.0
AA0314	0.0 - 1.0
AA0361	4.0 - 6.0
AA0362	8.0 - 10.0
AA0405	0.5 - 1.5
AA0406	0.5 - 1.5
AA0441	1.0 - 2.0
AA0468	4.0 - 6.0
AA0469	8.0 - 10.0

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	400	6	89

8. GROUNDWATER ENCOUNTERED IN OCTOBER 2000 BORING A-361/362 AT 6 FEET, BEDROCK ENCOUNTERED AT 10 FEET (IT 2001a).

SCALE
0 20 40 FEET

FIGURE 1-6
TNT AREA A
BUILDING 111 MONO HOUSE
ANALYTICAL RESULTS AND
ESTIMATED AREA/VOLUME OF
SOIL REQUIRING REMEDIATION

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw Environmental, Inc.

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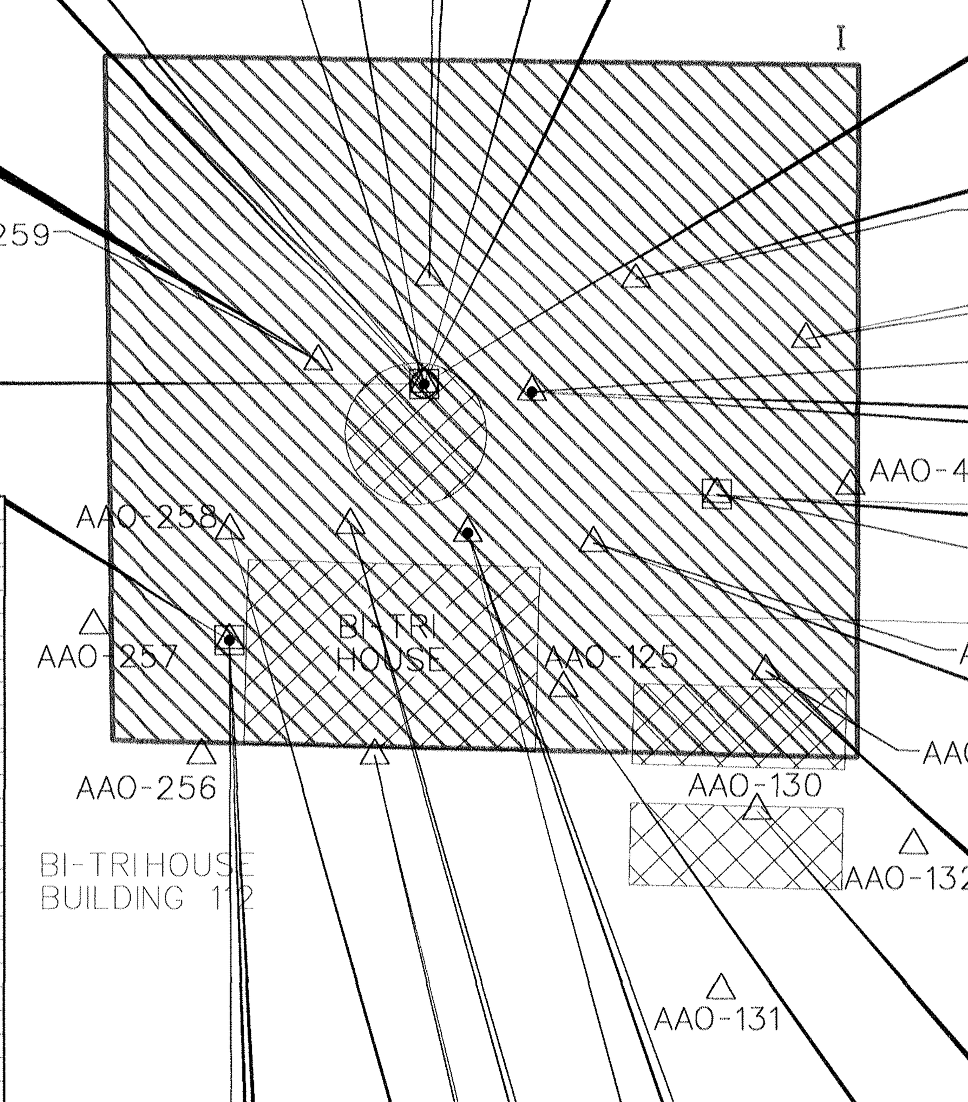
DWG. NO.: 807111ES.062 | PROJ. NO.: 807111
INITIATOR: T. SIARD | PROJ. MGR.: S. DOWNEY
DRAFT. CHCK. BY: C. TUMLIN | ENGR. CHCK. BY: T. SIARD
DATE LAST REV.: | DRAWN BY:
STARTING DATE: 10/16/02 | DRAWN BY: B.VANDERGRIFF



Location		TNTA-S0128	
Sample No.		AA0128	
Sample Date		19-Jul-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.98	
DNB	mg/kg	0.20	J
TNT	mg/kg	**1298**	
2,4-DNT	mg/kg	**865**	
RDX	mg/kg	0.60	
Tetryl	mg/kg	0.11	J

Location		TNTA-S0128	
Sample No.		AA0445	
Sample Date		25-Sept-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	1.78	J
2A-4,6-DNT	mg/kg	1.24	J
TNT	mg/kg	3.99	B
PCBs			
Aroclor 1260	mg/kg	0.0352	J
Volatiles			
Acetone	mg/kg	0.0217	
Methylene chloride	mg/kg	0.0323	B
Metals			
Aluminum	mg/kg	2980	J
Arsenic	mg/kg	**1.07**	J
Barium	mg/kg	19	
Beryllium	mg/kg	0.16	J
Calcium	mg/kg	1260	
Chromium	mg/kg	5.51	
Cobalt	mg/kg	1.54	
Copper	mg/kg	5.92	J
Iron	mg/kg	7820	
Lead	mg/kg	26.5	J
Magnesium	mg/kg	598	
Manganese	mg/kg	86.9	J
Nickel	mg/kg	4.27	
Potassium	mg/kg	348	
Sodium	mg/kg	99.6	B
Vanadium	mg/kg	11.3	
Zinc	mg/kg	20.8	

Location		TNTA-S0253	
Sample No.		AA0253	
Sample Date		16-Aug-00	
Sample Depth (ft)		1.6 - 2.6	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	1.71	
2A-4,6-DNT	mg/kg	0.72	
4A-2,6-DNT	mg/kg	0.93	

Location		TNTA-S0128	
Sample No.		AA0325	
Sample Date		15-Aug-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.16	J
2,4-DNT	mg/kg	**15.60**	
2A-4,6-DNT	mg/kg	**12.4**	
4A-2,6-DNT	mg/kg	**12.60**	
TNT	mg/kg	**558**	

Location		TNTA-S0128	
Sample No.		AA0363	
Sample Date		12-SEP-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	1.76	
2A-4,6-DNT	mg/kg	2.4	
DNB	mg/kg	0.0872	J
2,4-DNT	mg/kg	0.327	
3-NT	mg/kg	1.06	
TNB	mg/kg	0.281	
TNT	mg/kg	**64.4**	

Location		TNTA-S0128	
Sample No.		AA0364	
Sample Date		12-SEP-00	
Sample Depth (ft)		8.0 - 10.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	1.48	
2A-4,6-DNT	mg/kg	0.594	
DNB	mg/kg	0.0657	J
2,4-DNT	mg/kg	0.215	J
TNB	mg/kg	0.492	
TNT	mg/kg	5.97	

Location		TNTA-S0128	
Sample No.		AA0471	
Sample Date		28-Sept-00	
Sample Depth (ft)		8.0 - 10.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	1.62	
2A-4,6-DNT	mg/kg	2.43	
DNT	mg/kg	0.645	
2-NT	mg/kg	0.235	
3-NT	mg/kg	0.335	
4-NT	mg/kg	0.278	
TNB	mg/kg	0.562	
TNT	mg/kg	8.57	
Semivolatiles			
Dinitrotoluene, 2,4-	mg/kg	**0.831**	
Dinitrotoluene, 2,6-	mg/kg	0.248	J
Volatiles			
Acetone	mg/kg	0.051	J
Carbon disulfide	mg/kg	0.00287	J
Methylene chloride	mg/kg	0.00392	B
Metals			
Aluminum	mg/kg	4730	J
Arsenic	mg/kg	**7.59**	
Barium	mg/kg	14.5	
Beryllium	mg/kg	0.305	
Calcium	mg/kg	2240	
Chromium	mg/kg	7.23	
Cobalt	mg/kg	3.8	
Copper	mg/kg	8.14	
Iron	mg/kg	10500	
Lead	mg/kg	4.91	B
Magnesium	mg/kg	1150	
Manganese	mg/kg	217	
Nickel	mg/kg	9.48	
Potassium	mg/kg	635	
Sodium	mg/kg	231	B
Vanadium	mg/kg	16.8	
Zinc	mg/kg	38.3	

Location		TNTA-S0408	
Sample No.		AA0408	
Sample Date		21-Sep-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	2.25	
2,4-DNT	mg/kg	0.41	
2A-4,6-DNT	mg/kg	1.90	
4A-2,6-DNT	mg/kg	1.40	

Location		TNTA-S0487	
Sample No.		AA0487	
Sample Date		13-Oct-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2A-4,6-DNT	mg/kg	0.062	J
4A-2,6-DNT	mg/kg	0.176	

Location		TNTA-S0259	
Sample No.		AA0259	
Sample Date		16-Aug-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.19	J
2,4-DNT	mg/kg	0.14	J
2A-4,6-DNT	mg/kg	0.23	J
4A-2,6-DNT	mg/kg	0.36	

Location		TNTA-S0254	
Sample No.		AA0407	
Sample Date		21-Sep-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.982	
2,4-DNT	mg/kg	0.164	J
2A-4,6-DNT	mg/kg	0.688	
4A-2,6-DNT	mg/kg	0.656	

Location		TNTA-S0128	
Sample No.		AA0470	
Sample Date		28-Sept-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	**3.96**	
2A-4,6-DNT	mg/kg	1.18	
DNT	mg/kg	0.549	
2-NT	mg/kg	0.276	
3-NT	mg/kg	0.823	
4-NT	mg/kg	0.555	
TNT	mg/kg	7.89	
PCBs			
Aroclor 1260	mg/kg	0.0448	J
Volatiles			
Acetone	mg/kg	0.0314	J
Carbon disulfide	mg/kg	0.00185	J
Methylene chloride	mg/kg	0.00878	B
Metals			
Aluminum	mg/kg	4490	J
Arsenic	mg/kg	**2.34**	
Barium	mg/kg	23.8	
Beryllium	mg/kg	0.269	
Calcium	mg/kg	1250	
Chromium	mg/kg	6.29	
Cobalt	mg/kg	1.54	
Copper	mg/kg	5.82	
Iron	mg/kg	7420	
Lead	mg/kg	15.4	
Magnesium	mg/kg	695	
Manganese	mg/kg	107	
Mercury	mg/kg	0.021	J
Nickel	mg/kg	4.98	
Potassium	mg/kg	334	
Sodium	mg/kg	96.3	B
Vanadium	mg/kg	11.4	
Zinc	mg/kg	25.2	

Location		TNTA-S0123	
Sample No.		AA0442	
Sample Date		22-Sept-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
PCBs			
Aroclor 1260	mg/kg	**0.507**	J
Volatiles			
Acetone	mg/kg	0.114	
Carbon disulfide	mg/kg	0.00218	J
Methylene chloride	mg/kg	0.00376	B
Metals			
Aluminum	mg/kg	4660	J
Arsenic	mg/kg	**3.71**	J
Barium	mg/kg	24.6	J
Beryllium	mg/kg	0.179	
Cadmium	mg/kg	1.15	
Calcium	mg/kg	13600	J
Chromium	mg/kg	7.52	J
Cobalt	mg/kg	3.05	
Copper	mg/kg	8.26	J
Iron	mg/kg	9280	
Lead	mg/kg	**115**	J
Magnesium	mg/kg	3350	J
Manganese	mg/kg	218	J
Mercury	mg/kg	0.049	
Nickel	mg/kg	8.96	
Potassium	mg/kg	572	
Sodium	mg/kg	249	B
Vanadium	mg/kg	14.7	
Zinc	mg/kg	241	J

Location		TNTA-S0409	
Sample No.		AA0409	
Sample Date		21-Sep-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	29.3	
2,4-DNT	mg/kg	0.364	
2A-4,6-DNT	mg/kg	0.330	
4A-2,6-DNT	mg/kg	0.296	

Location		TNTA-S0254	
Sample No.		AA0254	
Sample Date		16-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.24	
TNT	mg/kg	**284**	
2A-4,6-DNT	mg/kg	0.56	
4A-2,6-DNT	mg/kg	**3.64**	
Tetryl	mg/kg	**4.81**	
3-NT	mg/kg	0.38	J

Location		TNTA-S0129	
Sample No.		AA0129	
Sample Date		19-Jul-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.162	J
4A-2,6-DNT	mg/kg	0.194	J

Location		TNTA-S0255	
Sample No.		AA0255	
Sample Date		16-Aug-00	
Sample Depth (ft)		1.6 - 2.6	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	**20.1**	
2,4-DNT	mg/kg	0.27	
2A-4,6-DNT	mg/kg	1.12	
4A-2,6-DNT	mg/kg	0.81	

Location		TNTA-S0130	
Sample No.		AA0130	
Sample Date		19-Jul-00	
Sample Depth (ft)		3 - 4	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.57	
2,4-DNT	mg/kg	0.13	J

Location		TNTA-S0125	
Sample No.		AA0125	
Sample Date		19-Jul-00	
Sample Depth (ft)		3 - 4	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.27	
2A-4,6-DNT	mg/kg	0.37	

Location		TNTA-S0123	
Sample No.		AA0323	
Sample Date		15-Aug-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.53	J

Location		TNTA-S0123	
Sample No.		AA0123	
Sample Date		19-Jul-00	
Sample Depth (ft)		2 - 3	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.11	J
TNT	mg/kg	**39.1**	
2A-4,6-DNT	mg/kg	**8.0**	
4A-2,6-DNT	mg/kg	**5.3**	
Tetryl	mg/kg	0.25	J
3-NT	mg/kg	0.43	J

Location		TNTA-S0126	
Sample No.		AA0126	
Sample Date		19-Jul-00	
Sample Depth (ft)		3 - 4	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.27	
2,4-DNT	mg/kg	**4.22**	
4A-2,6-DNT	mg/kg	**3.7**	
HMX	mg/kg	**29.9**	

Location		TNTA-S0126	
Sample No.		AA0324	
Sample Date		15-Aug-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.17	J
2,4-DNT	mg/kg	0.26	
2A-4,6-DNT	mg/kg	0.55	
4A-2,6-DNT	mg/kg	0.34	

Location		TNTA-S0258	
Sample No.		AA0258	
Sample Date		16-Aug-00	
Sample Depth (ft)		2.0 - 3.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2A-4,6-DNT	mg/kg	0.40	

Location		TNTA-S0124	
Sample No.		AA0124	
Sample Date		19-Jul-00	
Sample Depth (ft)		2 - 3	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.14	J
2A-4,6-DNT	mg/kg	0.17	J

Location		TNTA-S0127	
Sample No.		AA0127	
Sample Date		19-Jul-00	
Sample Depth (ft)		2 - 3	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.31	
2A-4,6-DNT	mg/kg	0.19	J
4A-2,6-DNT	mg/kg	0.17	J

LEGEND:

- △ AAO-123 — SCREENING SOIL SAMPLING LOCATION
- • AAO-323 — SURFACE SOIL SAMPLE (0 - 1 FT)
- ○ GW-02 — GROUNDWATER SAMPLING LOCATION
- □ AAO-442 — CONFIRMATION SOIL SAMPLING LOCATION
- FORMER TANK LOCATION
- FORMER BUILDING LOCATION
- POTENTIAL NITROAROMATIC REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 PRELIMINARY REMEDIATION GOALS ARE SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLING DEPTHS

SAMPLE	DEPTH (FT)
AA0123	2.0 - 3.0
AA0124	2.0 - 3.0
AA0125	3.0 - 4.0
AA0126	3.0 - 4.0
AA0127	2.0 - 3.0
AA0128	1.5 - 2.5
AA0129	1.5 - 2.5
AA0130	3.0 - 4.0
AA0131	2.5 - 3.5
AA0132	2.5 - 3.5
AA0253	1.6 - 2.6
AA0254	1.0 - 2.0
AA0255	1.6 - 2.6
AA0256	1.0 - 2.0
AA0257	2.0 - 3.0
AA0258	2.0 - 3.5
AA0259	0.5 - 1.5
AA0323	0.0 - 1.0
AA0324	0.0 - 1.0
AA0325	0.0 - 1.0
AA0363	4.0 - 6.0
AA0364	8.0 - 10.0
AA0407	0.5 - 1.5
AA0408	0.5 - 1.5
AA0409	0.5 - 1.5
AA0442	2.0 - 3.0
AA0443	2.0 - 3.0
AA0444	2.0 - 3.0
AA0445	1.5 - 2.5
AA0470	4.0 - 6.0
AA0471	8.0 - 10.0
AA0481	0.5 - 1.5
AA0487	1.5 - 2.5
AA0488	1.0 - 2.0

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	4444	9.5	1564

8. BEDROCK ENCOUNTERED AT 15 FEET AND GROUNDWATER MEASURED AT 9.54 FEET BELOW GROUND SURFACE IN GW-02 (OCTOBER 2000).
9. AUGUST 2001 PROBE REFUSAL FOR TEMPORARY PIEZOMETER GW-29 AT 6 FEET. GROUNDWATER NOT ENCOUNTERED.

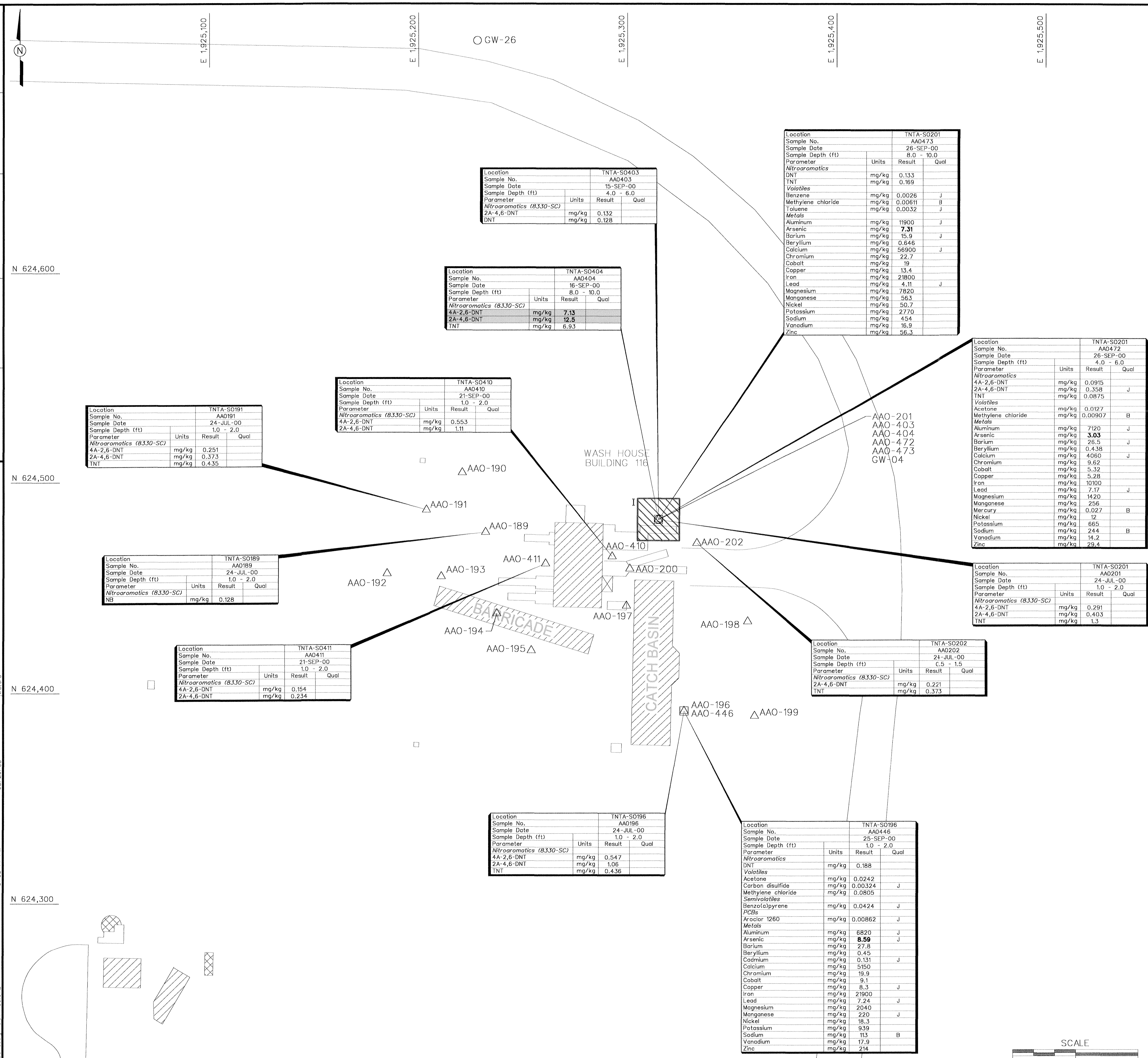
SCALE
0 20 40 FEET

FIGURE 1-7
TNT AREA A BUILDING 112 BI-TRIHOUSE ANALYTICAL RESULTS AND ESTIMATED AREA/VOLUME OF SOIL REQUIRING REMEDIATION

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw Environmental, Inc.

DWG. NO.: 807111ES.072 | PROJ. NO.: 807111
INITIATOR: T. SARD | PROJ. MGR.: S. DOWNEY
DRAFT. CHCK. BY: C. TUMLIN | ENGR. CHCK. BY: T. SARD
STARTING DATE: 10/21/02 | DRAWN BY: B. VANDERGRIFF
DATE LAST REV.: | DRAWN BY:



Location		TNTA-S0403	
Sample No.		AA0403	
Sample Date		15-SEP-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2A-4,6-DNT	mg/kg	0.132	
DNT	mg/kg	0.128	

Location		TNTA-S0404	
Sample No.		AA0404	
Sample Date		16-SEP-00	
Sample Depth (ft)		8.0 - 10.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	**7.13**	
2A-4,6-DNT	mg/kg	**12.5**	
TNT	mg/kg	6.93	

Location		TNTA-S0201	
Sample No.		AA0473	
Sample Date		26-SEP-00	
Sample Depth (ft)		8.0 - 10.0	
Parameter	Units	Result	Qual
Nitroaromatics			
DNT	mg/kg	0.133	
TNT	mg/kg	0.169	
Volatiles			
Benzene	mg/kg	0.0026	J
Methylene chloride	mg/kg	0.00611	B
Toluene	mg/kg	0.0032	J
Metals			
Aluminum	mg/kg	11900	J
Arsenic	mg/kg	**7.31**	
Barium	mg/kg	15.9	J
Beryllium	mg/kg	0.646	
Calcium	mg/kg	56900	J
Chromium	mg/kg	22.7	
Cobalt	mg/kg	19	
Copper	mg/kg	13.4	
Iron	mg/kg	21800	
Lead	mg/kg	4.11	J
Magnesium	mg/kg	7820	
Manganese	mg/kg	563	
Nickel	mg/kg	50.7	
Potassium	mg/kg	2770	
Sodium	mg/kg	454	
Vanadium	mg/kg	16.9	
Zinc	mg/kg	56.3	

Location		TNTA-S0410	
Sample No.		AA0410	
Sample Date		21-SEP-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	0.553	
2A-4,6-DNT	mg/kg	1.11	

Location		TNTA-S0191	
Sample No.		AA0191	
Sample Date		24-JUL-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	0.251	
2A-4,6-DNT	mg/kg	0.373	
TNT	mg/kg	0.435	

Location		TNTA-S0201	
Sample No.		AA0472	
Sample Date		26-SEP-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	0.0915	
2A-4,6-DNT	mg/kg	0.358	J
TNT	mg/kg	0.0875	
Volatiles			
Acetone	mg/kg	0.0127	
Methylene chloride	mg/kg	0.00907	B
Metals			
Aluminum	mg/kg	7120	J
Arsenic	mg/kg	**3.03**	
Barium	mg/kg	26.5	J
Beryllium	mg/kg	0.438	
Calcium	mg/kg	4060	J
Chromium	mg/kg	9.62	
Cobalt	mg/kg	5.32	
Copper	mg/kg	5.28	
Iron	mg/kg	10100	
Lead	mg/kg	7.17	J
Magnesium	mg/kg	1420	
Manganese	mg/kg	256	
Mercury	mg/kg	0.027	B
Nickel	mg/kg	12	
Potassium	mg/kg	665	
Sodium	mg/kg	244	B
Vanadium	mg/kg	14.2	
Zinc	mg/kg	29.4	

Location		TNTA-S0189	
Sample No.		AA0189	
Sample Date		24-JUL-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
NB	mg/kg	0.128	

Location		TNTA-S0201	
Sample No.		AA0201	
Sample Date		24-JUL-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	0.291	
2A-4,6-DNT	mg/kg	0.403	
TNT	mg/kg	1.3	

Location		TNTA-S0411	
Sample No.		AA0411	
Sample Date		21-SEP-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	0.154	
2A-4,6-DNT	mg/kg	0.234	

Location		TNTA-S0202	
Sample No.		AA0202	
Sample Date		24-JUL-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2A-4,6-DNT	mg/kg	0.221	
TNT	mg/kg	0.373	

Location		TNTA-S0196	
Sample No.		AA0196	
Sample Date		24-JUL-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	0.547	
2A-4,6-DNT	mg/kg	1.06	
TNT	mg/kg	0.436	

Location		TNTA-S0196	
Sample No.		AA0446	
Sample Date		25-SEP-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics			
DNT	mg/kg	0.188	
Volatiles			
Acetone	mg/kg	0.0242	
Carbon disulfide	mg/kg	0.00324	J
Methylene chloride	mg/kg	0.0805	
Semivolatiles			
Benzo(a)pyrene	mg/kg	0.0424	J
PCBs			
Aroclor 1260	mg/kg	0.00862	J
Metals			
Aluminum	mg/kg	6820	J
Arsenic	mg/kg	**8.59**	J
Barium	mg/kg	27.8	
Beryllium	mg/kg	0.45	
Cadmium	mg/kg	0.131	J
Calcium	mg/kg	5150	
Chromium	mg/kg	19.9	
Cobalt	mg/kg	9.1	
Copper	mg/kg	8.3	J
Iron	mg/kg	21900	
Lead	mg/kg	7.24	J
Magnesium	mg/kg	2040	
Manganese	mg/kg	220	J
Nickel	mg/kg	18.3	
Potassium	mg/kg	939	
Sodium	mg/kg	113	B
Vanadium	mg/kg	17.9	
Zinc	mg/kg	214	

LEGEND:

- △ AAO-189 — SCREENING SOIL SAMPLING LOCATION
- ○ GW-04 — GROUNDWATER SAMPLING LOCATION
- □ AAO-446 — CONFIRMATION SOIL SAMPLING LOCATION
- FORMER TANK LOCATION
- FORMER BUILDING LOCATION
- POTENTIAL NITROAROMATIC REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 PRELIMINARY REMEDIATION GOALS ARE SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLE DEPTHS

SAMPLE	DEPTH (FT)
AA0189	1.0 - 2.0
AA0190	1.0 - 2.0
AA0191	1.0 - 2.0
AA0192	0.5 - 1.5
AA0193	0.1 - 1.1
AA0194	0.5 - 1.5
AA0195	0.0 - 1.0
AA0196	1.0 - 2.0
AA0197	1.0 - 2.0
AA0198	1.0 - 2.0
AA0199	1.0 - 2.0
AA0200	1.0 - 2.0
AA0201	1.0 - 2.0
AA0202	0.5 - 1.5
AA0403	4.0 - 6.0
AA0404	8.0 - 10.0
AA0410	1.0 - 2.0
AA0411	1.0 - 2.0
AA0446	1.0 - 2.0
AA0472	4.0 - 6.0
AA0473	8.0 - 10.0

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

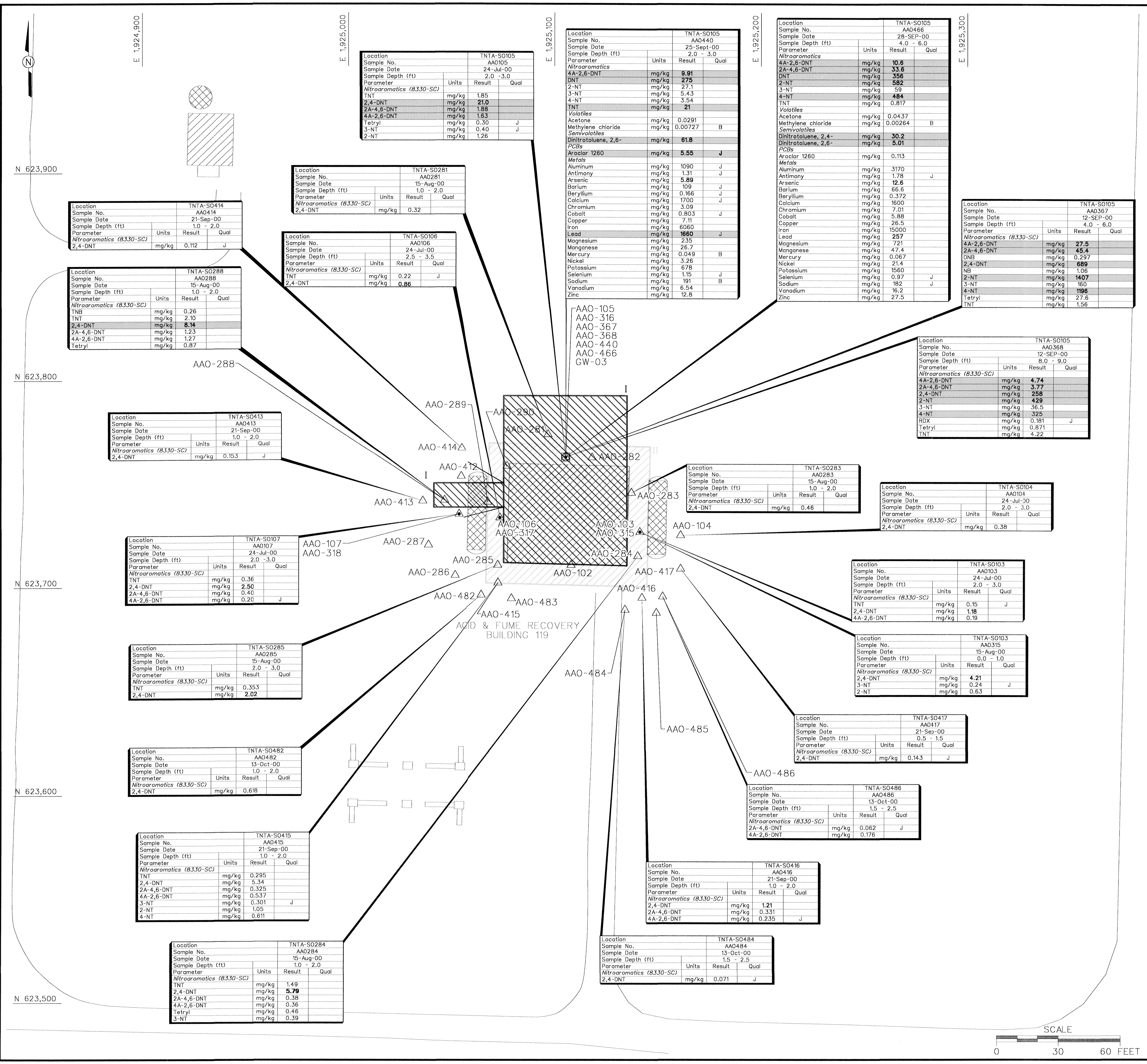
AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	400	15	222

8. PERCHED GROUNDWATER ZONE ENCOUNTERED IN BORING A-472/473 AT 3.5 FEET. TOTAL DEPTH OF BORING 19.5 FEET ON SHALE BEDROCK.
9. NO GROUNDWATER ENCOUNTERED IN AUGUST 2001 TEMPORARY PIEZOMETER GW-26. PROBE REFUSAL ENCOUNTERED AT 15.1 FEET.

FIGURE 1-8
TNT AREA A
BUILDING 116 WASH HOUSE LINE 1
SAMPLE LOCATIONS AND
ANALYTICAL RESULTS

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw Environmental, Inc.



Location		TNTA-S0105	
Sample No.		AA0105	
Sample Date		24-Jul-00	
Sample Depth (ft)		2.0 -3.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	1.85	
2,4-DNT	mg/kg	**21.0**	
2A-4,6-DNT	mg/kg	**1.88**	
4A-2,6-DNT	mg/kg	**1.63**	
Tetryl	mg/kg	0.30	J
3-NT	mg/kg	0.40	J
2-NT	mg/kg	1.26	

Location		TNTA-S0105	
Sample No.		AA0440	
Sample Date		25-Sept-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	**9.91**	
DNT	mg/kg	**275**	
2-NT	mg/kg	27.1	
3-NT	mg/kg	5.43	
4-NT	mg/kg	3.54	
TNT	mg/kg	**21**	
Volatiles			
Acetone	mg/kg	0.0291	
Methylene chloride	mg/kg	0.00727	B
Semivolatiles			
Dinitrotoluene, 2,6-	mg/kg	**61.8**	
PCBs			
Aroclor 1260	mg/kg	**5.55**	**J**
Metals			
Aluminum	mg/kg	1090	J
Antimony	mg/kg	1.31	J
Arsenic	mg/kg	**5.89**	
Barium	mg/kg	109	J
Beryllium	mg/kg	0.166	J
Calcium	mg/kg	1700	J
Chromium	mg/kg	3.09	
Cobalt	mg/kg	0.803	J
Copper	mg/kg	7.11	
Iron	mg/kg	6060	
Lead	mg/kg	**1660**	J
Magnesium	mg/kg	235	
Manganese	mg/kg	26.7	
Mercury	mg/kg	0.049	B
Nickel	mg/kg	3.26	
Potassium	mg/kg	678	
Selenium	mg/kg	1.15	J
Sodium	mg/kg	191	B
Vanadium	mg/kg	6.54	
Zinc	mg/kg	12.8	

Location		TNTA-S0105	
Sample No.		AA0466	
Sample Date		28-SEP-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	**10.6**	
2A-4,6-DNT	mg/kg	**33.6**	
DNT	mg/kg	**356**	
2-NT	mg/kg	**582**	
3-NT	mg/kg	59	
4-NT	mg/kg	**484**	
TNT	mg/kg	0.817	
Volatiles			
Acetone	mg/kg	0.0437	
Methylene chloride	mg/kg	0.00264	B
Semivolatiles			
Dinitrotoluene, 2,4-	mg/kg	**30.2**	
Dinitrotoluene, 2,6-	mg/kg	**5.01**	
PCBs			
Aroclor 1260	mg/kg	0.113	
Metals			
Aluminum	mg/kg	3170	
Antimony	mg/kg	1.78	J
Arsenic	mg/kg	**12.6**	
Barium	mg/kg	66.6	
Beryllium	mg/kg	0.372	
Calcium	mg/kg	1600	
Chromium	mg/kg	7.01	
Cobalt	mg/kg	5.88	
Copper	mg/kg	26.5	
Iron	mg/kg	15000	
Lead	mg/kg	**257**	
Magnesium	mg/kg	721	
Manganese	mg/kg	47.4	
Mercury	mg/kg	0.067	
Nickel	mg/kg	21.4	
Potassium	mg/kg	1560	
Selenium	mg/kg	0.97	J
Sodium	mg/kg	182	J
Vanadium	mg/kg	16.2	
Zinc	mg/kg	27.5	

Location		TNTA-S0281	
Sample No.		AA0281	
Sample Date		15-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.32	

Location		TNTA-S0414	
Sample No.		AA0414	
Sample Date		21-Sep-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.112	J

Location		TNTA-S0106	
Sample No.		AA0106	
Sample Date		24-Jul-00	
Sample Depth (ft)		2.5 - 3.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.22	J
2,4-DNT	mg/kg	**0.86**	

Location		TNTA-S0288	
Sample No.		AA0288	
Sample Date		15-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.26	
TNT	mg/kg	2.10	
2,4-DNT	mg/kg	**8.14**	
2A-4,6-DNT	mg/kg	1.23	
4A-2,6-DNT	mg/kg	1.27	
Tetryl	mg/kg	0.87	

Location		TNTA-S0105	
Sample No.		AA0367	
Sample Date		12-SEP-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	**27.5**	
2A-4,6-DNT	mg/kg	**45.4**	
DNB	mg/kg	0.297	
2,4-DNT	mg/kg	**689**	
NB	mg/kg	1.06	
2-NT	mg/kg	**1407**	
3-NT	mg/kg	160	
4-NT	mg/kg	**1196**	
Tetryl	mg/kg	27.6	
TNT	mg/kg	1.56	

Location		TNTA-S0105	
Sample No.		AA0368	
Sample Date		12-SEP-00	
Sample Depth (ft)		8.0 - 9.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	**4.74**	
2A-4,6-DNT	mg/kg	**3.77**	
2,4-DNT	mg/kg	**258**	
2-NT	mg/kg	**429**	
3-NT	mg/kg	36.5	
4-NT	mg/kg	**325**	
RDX	mg/kg	0.181	J
Tetryl	mg/kg	0.871	
TNT	mg/kg	4.22	

Location		TNTA-S0413	
Sample No.		AA0413	
Sample Date		21-Sep-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.153	J

Location		TNTA-S0283	
Sample No.		AA0283	
Sample Date		15-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.46	

Location		TNTA-S0104	
Sample No.		AA0104	
Sample Date		24-Jul-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.38	

Location		TNTA-S0107	
Sample No.		AA0107	
Sample Date		24-Jul-00	
Sample Depth (ft)		2.0 -3.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.36	
2,4-DNT	mg/kg	**2.50**	
2A-4,6-DNT	mg/kg	0.40	
4A-2,6-DNT	mg/kg	0.20	J

Location		TNTA-S0103	
Sample No.		AA0103	
Sample Date		24-Jul-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.15	J
2,4-DNT	mg/kg	**1.18**	
4A-2,6-DNT	mg/kg	0.19	

Location		TNTA-S0103	
Sample No.		AA0315	
Sample Date		15-Aug-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	**4.21**	
3-NT	mg/kg	0.24	J
2-NT	mg/kg	0.63	

Location		TNTA-S0285	
Sample No.		AA0285	
Sample Date		15-Aug-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.353	
2,4-DNT	mg/kg	**2.02**	

Location		TNTA-S0417	
Sample No.		AA0417	
Sample Date		21-Sep-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.143	J

Location		TNTA-S0482	
Sample No.		AA0482	
Sample Date		13-Oct-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.618	

Location		TNTA-S0486	
Sample No.		AA0486	
Sample Date		13-Oct-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2A-4,6-DNT	mg/kg	0.062	J
4A-2,6-DNT	mg/kg	0.176	

Location		TNTA-S0415	
Sample No.		AA0415	
Sample Date		21-Sep-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.295	
2,4-DNT	mg/kg	5.34	
2A-4,6-DNT	mg/kg	0.325	
4A-2,6-DNT	mg/kg	0.537	
3-NT	mg/kg	0.301	J
2-NT	mg/kg	1.05	
4-NT	mg/kg	0.611	

Location		TNTA-S0416	
Sample No.		AA0416	
Sample Date		21-Sep-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	**1.21**	
2A-4,6-DNT	mg/kg	0.331	
4A-2,6-DNT	mg/kg	0.235	J

Location		TNTA-S0284	
Sample No.		AA0284	
Sample Date		15-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	1.49	
2,4-DNT	mg/kg	**5.79**	
2A-4,6-DNT	mg/kg	0.38	
4A-2,6-DNT	mg/kg	0.36	
Tetryl	mg/kg	0.46	
3-NT	mg/kg	0.39	

Location		TNTA-S0484	
Sample No.		AA0484	
Sample Date		13-Oct-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.071	J

LEGEND:

- △ AAO-103 — SCREENING SOIL SAMPLING LOCATION
- • AAO-315 — SURFACE SOIL SAMPLE (0 - 1 FT)
- ○ GW-03 — GROUNDWATER SAMPLING LOCATION
- □ AAO-440 — CONFIRMATION SOIL SAMPLING LOCATION
- FORMER TANK LOCATION
- FORMER BUILDING LOCATION
- POTENTIAL NITROAROMATIC REMEDIATION AREA
- POTENTIAL LEAD/PCB REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 PRELIMINARY REMEDIATION GOALS ARE SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLING DEPTHS

SAMPLE	DEPTH (FT)
AA0102	2.0 - 3.0
AA0103	2.0 - 3.0
AA0104	2.0 - 3.0
AA0105	2.0 - 3.0
AA0106	2.5 - 3.5
AA0107	2.0 - 3.0
AA0281	1.0 - 2.0
AA0282	1.0 - 2.0
AA0283	1.0 - 2.0
AA0284	1.0 - 2.0
AA0285	2.0 - 3.0
AA0286	1.6 - 2.6
AA0287	1.0 - 2.0
AA0288	1.0 - 2.0
AA0289	0.5 - 1.5
AA0290	1.0 - 2.0
AA0315	0.0 - 1.0
AA0316	0.0 - 1.0
AA0317	0.0 - 1.0
AA0318	0.0 - 1.0
AA0367	4.0 - 6.0
AA0368	8.0 - 9.0
AA0412	0.0 - 0.6
AA0413	1.0 - 2.0
AA0414	1.0 - 2.0
AA0415	1.0 - 2.0
AA0416	1.0 - 2.0
AA0417	0.5 - 1.5
AA0440	2.0 - 3.0
AA0466	4.0 - 6.0
AA0482	1.0 - 2.0
AA0483	1.0 - 2.0
AA0484	1.5 - 2.5
AA0485	1.5 - 2.5
AA0486	1.5 - 2.5

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	5376	9	1792
II	1854	4	275
TOTAL	7230		2067

8. VERTICAL DEPTH OF 9 FEET (REFUSAL) FROM OCTOBER 2000 A-367/368 BORING. GROUNDWATER WAS NOT ENCOUNTERED DRILLING BUT MEASURED IN TEMPORARY PIEZOMETER GW-03 AT A DEPTH OF 1.62 FEET BGS.

SCALE
0 30 60 FEET

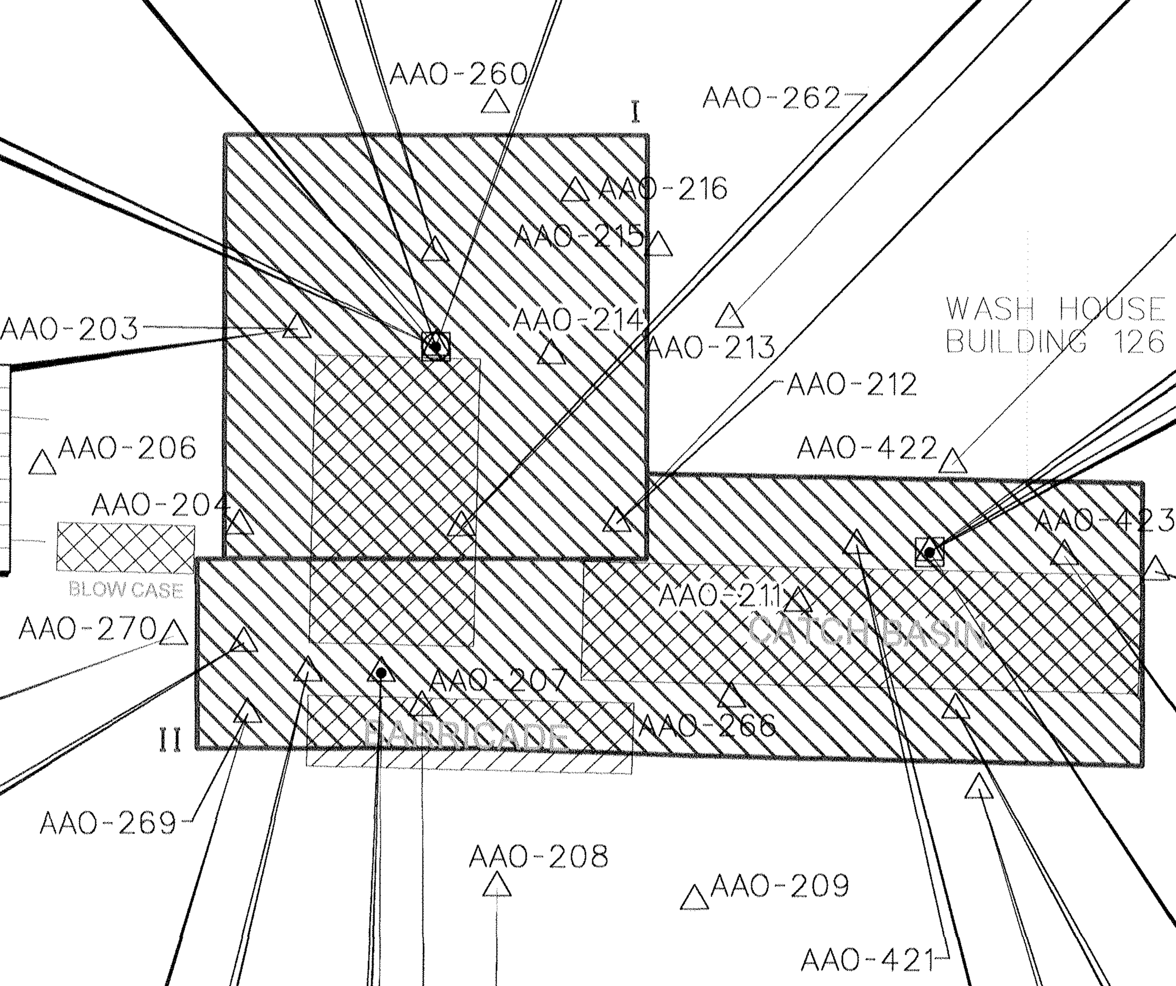
FIGURE 1-9
TNT AREA A BUILDING 119 ACID & FUME RECOVERY, ANALYTICAL RESULTS AND ESTIMATED AREA/VOLUME OF SOIL REQUIRING REMEDIATION

Shaw Environmental, Inc.

DWG. NO.: 807711ES.063
PROJ. NO.: 807711
INITIATOR: T. SIARD
PROJ. MGR.: S. DOWNEY
DRAFT. CHCK. BY: C. TUMLIN
ENGR. CHCK. BY: T. SIARD
DATE LAST REV.:
DRAWN BY:
STARTING DATE: 10/17/02
DRAWN BY: B.VANDERGRIFF

cbentley
09/30/03
08:25:00 PM
c:\cadd\design\807711es.063

STARTING DATE: 10/17/02 | DATE LAST REV.: | DRAFT. CHCK. BY: C. TUMLIN | INITIATOR: T. SIARD | DWG. NO.: 807111es.064
DRAWN BY: B. VANDERGRIFF | DRAWN BY: | ENGR. CHCK. BY: T. SIARD | PROJ. MGR.: S. DOWNEY | PROJ. NO.: 807111



Location		TNTA-S0261	
Sample No.		AA0474	
Sample Date		26-SEP-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics			
TNT	mg/kg	4.81	
Volatiles			
Acetone	mg/kg	0.00713	J
Benzene	mg/kg	0.00285	
Methylene chloride	mg/kg	0.00972	B
Toluene	mg/kg	0.0049	J
Metals			
Aluminum	mg/kg	10800	J
Arsenic	mg/kg	**5.29**	J
Barium	mg/kg	33.6	
Beryllium	mg/kg	0.704	
Calcium	mg/kg	75800	
Chromium	mg/kg	20.4	
Cobalt	mg/kg	15.2	
Copper	mg/kg	17.6	J
Iron	mg/kg	**28600**	
Lead	mg/kg	8.47	J
Magnesium	mg/kg	5000	
Manganese	mg/kg	873	J
Nickel	mg/kg	44.1	J
Potassium	mg/kg	2690	
Sodium	mg/kg	433	B
Vanadium	mg/kg	15.2	
Zinc	mg/kg	30.3	

Location		TNTA-S0261	
Sample No.		AA0261	
Sample Date		17-Aug-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	**170**	
2A-4,6-DNT	mg/kg	**4.97**	
4A-2,6-DNT	mg/kg	**5.11**	

Location		TNTA-S0261	
Sample No.		AA0475	
Sample Date		26-SEP-00	
Sample Depth (ft)		8.0 - 10.0	
Parameter	Units	Result	Qual
Nitroaromatics			
TNT	mg/kg	**259**	
Volatiles			
Methylene chloride	mg/kg	0.00327	B
Metals			
Aluminum	mg/kg	11700	J
Arsenic	mg/kg	**7.97**	
Barium	mg/kg	20.3	J
Beryllium	mg/kg	0.641	
Calcium	mg/kg	65500	J
Chromium	mg/kg	22.2	
Cobalt	mg/kg	15.5	
Copper	mg/kg	13.2	
Iron	mg/kg	**23000**	
Lead	mg/kg	4.76	J
Magnesium	mg/kg	7500	
Manganese	mg/kg	703	
Nickel	mg/kg	44.1	
Potassium	mg/kg	2940	
Sodium	mg/kg	350	B
Vanadium	mg/kg	16.2	
Zinc	mg/kg	33.8	

Location		TNTA-S0419	
Sample No.		AA0419	
Sample Date		21-SEP-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.335	

Location		TNTA-S0261	
Sample No.		AA0370	
Sample Date		13-Sep-00	
Sample Depth (ft)		8.0 - 10.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	0.467	
2A-4,6-DNT	mg/kg	1.76	
TNT	mg/kg	**62.3**	

Location		TNTA-S0261	
Sample No.		AA0369	
Sample Date		13-Sep-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	0.206	J
2A-4,6-DNT	mg/kg	0.211	J
2,4-DNT	mg/kg	0.351	
2-NT	mg/kg	0.502	
4-NT	mg/kg	0.358	J
TNT	mg/kg	**28.2**	

Location		TNTA-S0213	
Sample No.		AA0213	
Sample Date		25-Jul-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.27	

Location		TNTA-S0262	
Sample No.		AA0262	
Sample Date		17-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.65	
2A-4,6-DNT	mg/kg	0.62	
4A-2,6-DNT	mg/kg	0.29	

Location		TNTA-S0212	
Sample No.		AA0212	
Sample Date		25-Jul-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.24	J
2A-4,6-DNT	mg/kg	0.55	
4A-2,6-DNT	mg/kg	0.33	

Location		TNTA-S0422	
Sample No.		AA0422	
Sample Date		21-SEP-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	0.23	
2A-4,6-DNT	mg/kg	0.236	
DNT	mg/kg	0.0902	
TNT	mg/kg	0.724	

Location		TNTA-S0263	
Sample No.		AA0263	
Sample Date		17-Aug-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	1.21	
DNB	mg/kg	0.134	J
TNT	mg/kg	**150**	
2,4-DNT	mg/kg	**1.34**	
2A-4,6-DNT	mg/kg	**19.6**	
4A-2,6-DNT	mg/kg	**6.76**	
Tetryl	mg/kg	1.38	
3-NT	mg/kg	0.63	

Location		TNTA-S0261	
Sample No.		AA0447	
Sample Date		25-SEP-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	0.358	
2A-4,6-DNT	mg/kg	0.467	
NB	mg/kg	0.0713	J
TNT	mg/kg	**62.8**	D
Volatiles			
Acetone	mg/kg	0.08	J
Carbon disulfide	mg/kg	0.00267	J
Methylene chloride	mg/kg	0.0629	
Semivolatiles			
Dinitrotoluene, 2,4-	mg/kg	0.48	
Dinitrotoluene, 2,6-	mg/kg	0.0622	J
PCBs			
Aroclor 1260	mg/kg	**0.346**	J
Metals			
Aluminum	mg/kg	9000	J
Arsenic	mg/kg	**6.01**	J
Barium	mg/kg	67.3	
Beryllium	mg/kg	0.671	
Calcium	mg/kg	57200	
Chromium	mg/kg	14.3	
Cobalt	mg/kg	9.9	
Copper	mg/kg	14.3	J
Iron	mg/kg	22000	
Lead	mg/kg	19.4	J
Magnesium	mg/kg	3320	
Manganese	mg/kg	1370	J
Mercury	mg/kg	0.022	J
Nickel	mg/kg	25.5	
Potassium	mg/kg	1700	
Sodium	mg/kg	381	B
Vanadium	mg/kg	19.3	
Zinc	mg/kg	41.5	

Location		TNTA-S0203	
Sample No.		AA0203	
Sample Date		25-Jul-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.14	
2A-4,6-DNT	mg/kg	0.89	
4A-2,6-DNT	mg/kg	0.74	

Location		TNTA-S0263	
Sample No.		AA0420	
Sample Date		22-SEP-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	0.154	
2A-4,6-DNT	mg/kg	0.249	
TNT	mg/kg	0.395	

Location		TNTA-S0263	
Sample No.		AA0448	
Sample Date		25-SEP-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	0.599	
2A-4,6-DNT	mg/kg	0.878	
DNT	mg/kg	0.114	
TNT	mg/kg	0.72	
Volatiles			
Acetone	mg/kg	0.00949	J
Methylene chloride	mg/kg	0.0913	
Toluene	mg/kg	0.0027	J
PCBs			
Aroclor 1260	mg/kg	0.0174	J
Metals			
Aluminum	mg/kg	6690	J
Arsenic	mg/kg	**5.42**	J
Barium	mg/kg	26.9	
Beryllium	mg/kg	0.405	
Cadmium	mg/kg	0.103	J
Calcium	mg/kg	7330	
Chromium	mg/kg	13.2	
Cobalt	mg/kg	4.62	
Copper	mg/kg	20.5	J
Iron	mg/kg	14600	
Lead	mg/kg	17.4	J
Magnesium	mg/kg	2060	
Manganese	mg/kg	340	J
Mercury	mg/kg	0.03	J
Nickel	mg/kg	12	
Potassium	mg/kg	727	
Sodium	mg/kg	346	B
Vanadium	mg/kg	18	
Zinc	mg/kg	109	

Location		TNTA-S0270	
Sample No.		AA0270	
Sample Date		17-Aug-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.20	J

Location		TNTA-S0423	
Sample No.		AA0423	
Sample Date		21-SEP-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2A-4,6-DNT	mg/kg	0.125	
DNT	mg/kg	0.279	
TNT	mg/kg	0.48	

Location		TNTA-S0264	
Sample No.		AA0264	
Sample Date		17-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	1.36	
2,4-DNT	mg/kg	0.67	
2A-4,6-DNT	mg/kg	0.22	J
4A-2,6-DNT	mg/kg	0.17	J

Location		TNTA-S0205	
Sample No.		AA0205	
Sample Date		25-Jul-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.18	J
TNT	mg/kg	**51.9**	
2A-4,6-DNT	mg/kg	1.02	
4A-2,6-DNT	mg/kg	1.04	

Location		TNTA-S0269	
Sample No.		AA0269	
Sample Date		17-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.33	
2A-4,6-DNT	mg/kg	0.16	J
4A-2,6-DNT	mg/kg	0.13	J

Location		TNTA-S0263	
Sample No.		AA0372	
Sample Date		15-SEP-00	
Sample Depth (ft)		8.0 - 10.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	1.04	

Location		TNTA-S0268	
Sample No.		AA0268	
Sample Date		17-Aug-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	**24.3**	
2A-4,6-DNT	mg/kg	0.61	
4A-2,6-DNT	mg/kg	0.75	

Location		TNTA-S0421	
Sample No.		AA0421	
Sample Date		21-SEP-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	0.228	
2A-4,6-DNT	mg/kg	0.577	
TNT	mg/kg	0.339	

Location		TNTA-S0265	
Sample No.		AA0265	
Sample Date		17-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.41	
2A-4,6-DNT	mg/kg	1.10	
4A-2,6-DNT	mg/kg	0.68	

Location		TNTA-S0267	
Sample No.		AA0424	
Sample Date		22-SEP-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2A-4,6-DNT	mg/kg	0.299	

Location		TNTA-S0208	
Sample No.		AA0208	
Sample Date		25-Jul-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.13	J
2A-4,6-DNT	mg/kg	0.20	J
4A-2,6-DNT	mg/kg	0.18	J

Location		TNTA-S0210	
Sample No.		AA0210	
Sample Date		25-Jul-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.31	

Location		TNTA-S0267	
Sample No.		AA0267	
Sample Date		17-Aug-00	
Sample Depth (ft)		2.5 - 3.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	1.02	
TNT	mg/kg	**62.9**	
2,4-DNT	mg/kg	0.77	
2A-4,6-DNT	mg/kg	**11.1**	
4A-2,6-DNT	mg/kg	**3.21**	
Tetryl	mg/kg	0.80	

Location		TNTA-S0207	
Sample No.		AA0207	
Sample Date		25-Jul-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.14	J

LEGEND:

- △ AAO-203 SCREENING SOIL SAMPLING LOCATION
- • AAO-314 SURFACE SOIL SAMPLE 0 - 1FT
- ○ GW-01 GROUNDWATER SAMPLING LOCATION
- □ AAO-441 CONFIRMATION SOIL SAMPLING LOCATION
- FORMER TANK LOCATION
- FORMER BUILDING LOCATION
- POTENTIAL NITROAROMATIC REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 PRELIMINARY REMEDIATION GOALS ARE SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLING DEPTHS

SAMPLE	DEPTH (FT)
AA0203	1.5 - 2.5
AA0204	2.0 - 3.0
AA0205	0.5 - 1.5
AA0206	1.0 - 2.0
AA0207	1.0 - 2.0
AA0208	1.0 - 2.0
AA0209	1.0 - 2.0
AA0210	1.0 - 2.0
AA0211	1.0 - 2.0
AA0212	1.0 - 2.0
AA0213	0.0 - 1.0
AA0214	1.5 - 2.5
AA0215	0.0 - 1.0
AA0216	0.0 - 1.0
AA0260	0.25 - 1.25
AA0261	1.5 - 2.5
AA0262	1.0 - 2.0
AA0263	2.0 - 3.0
AA0264	1.0 - 2.0
AA0265	1.0 - 2.0
AA0266	1.0 - 2.0
AA0267	2.5 - 3.5
AA0268	0.5 - 1.5
AA0269	1.0 - 2.0
AA0270	0.5 - 1.5
AA0369	4.0 - 6.0
AA0370	8.0 - 10.0
AA0371	4.0 - 6.0
AA0372	8.0 - 10.0
AA0418	0.0 - 1.0
AA0419	1.0 - 2.0
AA0420	0.0 - 1.0
AA0421	1.0 - 2.0
AA0422	1.0 - 2.0
AA0423	1.0 - 2.0
AA0424	0.0 - 1.0
AA0447	1.5 - 2.5
AA0448	2.0 - 3.0
AA0474	4.0 - 6.0
AA0475	8.0 - 10.0

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	3600	11	1467
II	4505	8	1335
TOTAL	8105		2802

8. GROUNDWATER ENCOUNTERED AT 4 FEET BELOW GROUND SURFACE IN OCTOBER 2000. A-369/370 BORING (AREA I).

   GROUNDWATER WAS NOT ENCOUNTERED IN OCTOBER 2000 DURING DRILLING OF BORING A-474/475. TOTAL DEPTH WAS 10 FEET (AREA I).

   GROUNDWATER MEASURED AT 12.9 FEET IN OCTOBER 2000 TEMPORARY PIEZOMETER GW-06. PIEZOMETER INSTALLED TO A DEPTH OF 15 FEET. BEDROCK NOT ENCOUNTERED.

   GROUNDWATER ENCOUNTERED AT 8 FEET BELOW GROUND SURFACE IN OCTOBER 2000. A-371/372 BORING (AREA III).

FIGURE 1-10
TNT AREA A
BUILDING 126
WASH HOUSE LINE 2
ANALYTICAL RESULTS AND ESTIMATED AREA/VOLUME OF SOIL REQUIRING REMEDIATION

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

SCALE 0 30 60 FEET

Shaw Environmental, Inc.

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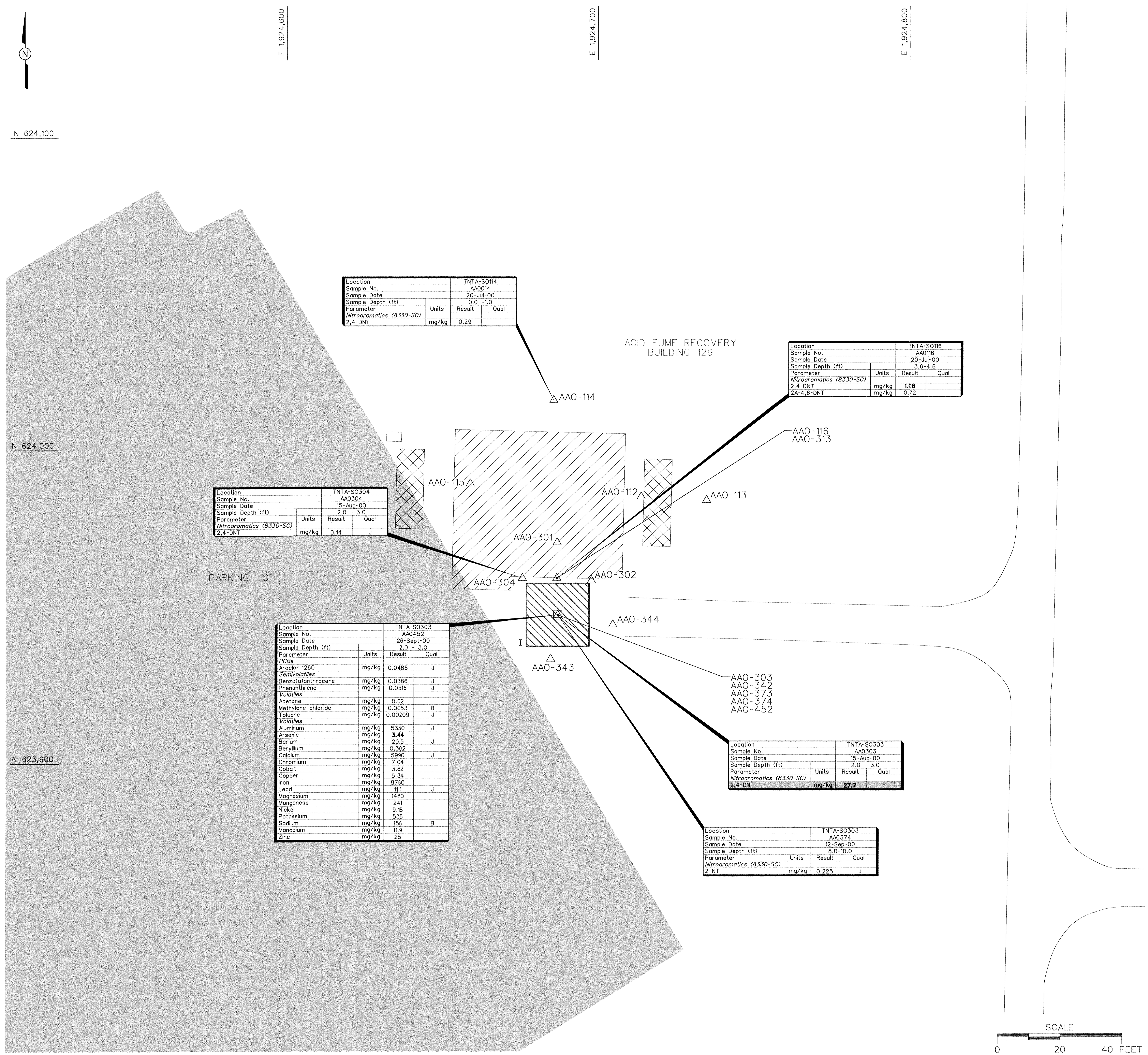
STARTING DATE: 10/22/02 | DATE LAST REV.: | DRAFT. CHCK. BY: C. TUMLIN | INITIATOR: T. SIARD | DWG. NO.: 807111ES.073
DRAWN BY: B.VANDERGRIFF | DRAWN BY: | ENGR. CHCK. BY: T. SIARD | PROJ. MGR.: S. DOWNEY | PROJ. NO.: 807111



Location		TNTA-SO114	
Sample No.		AA0014	
Sample Date		20-Jul-00	
Sample Depth (ft)		0.0 -1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.29	

Location		TNTA-SO116	
Sample No.		AA0116	
Sample Date		20-Jul-00	
Sample Depth (ft)		3.6-4.6	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	**1.08**	
2A-4,6-DNT	mg/kg	0.72	

Location		TNTA-SO304	
Sample No.		AA0304	
Sample Date		15-Aug-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.14	J

Location		TNTA-SO303	
Sample No.		AA0452	
Sample Date		26-Sept-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
PCBs			
Aroclor 1260	mg/kg	0.0486	J
Semivolatiles			
Benzo(a)anthracene	mg/kg	0.0386	J
Phenanthrene	mg/kg	0.0516	J
Volatiles			
Acetone	mg/kg	0.02	
Methylene chloride	mg/kg	0.0053	B
Toluene	mg/kg	0.00209	J
Volatiles			
Aluminum	mg/kg	5350	J
Arsenic	mg/kg	**3.44**	
Barium	mg/kg	20.5	J
Beryllium	mg/kg	0.302	
Calcium	mg/kg	5990	J
Chromium	mg/kg	7.04	
Cobalt	mg/kg	3.62	
Copper	mg/kg	5.34	
Iron	mg/kg	8760	
Lead	mg/kg	11.1	J
Magnesium	mg/kg	1480	
Manganese	mg/kg	241	
Nickel	mg/kg	9.18	
Potassium	mg/kg	535	
Sodium	mg/kg	156	B
Vanadium	mg/kg	11.9	
Zinc	mg/kg	25	

Location		TNTA-SO303	
Sample No.		AA0303	
Sample Date		15-Aug-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	**27.7**	

Location		TNTA-SO303	
Sample No.		AA0374	
Sample Date		12-Sep-00	
Sample Depth (ft)		8.0-10.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2-NT	mg/kg	0.225	J

LEGEND:

- △ AAO-112 — SCREENING SOIL SAMPLING LOCATION
- • AAO-313 — SURFACE SOIL SAMPLE (0 - 1FT)
- □ AAO-452 — CONFIRMATION SOIL SAMPLING LOCATION
- FORMER TANK LOCATION
- FORMER BUILDING LOCATION
- POTENTIAL NITROAROMATIC REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 PRELIMINARY REMEDIATION GOALS ARE SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLING DEPTHS

SAMPLE	DEPTH (FT)
AA0112	1.0 - 2.0
AA0113	3.6 - 4.6
AA0114	3.6 - 4.6
AA0115	3.6 - 4.6
AA0116	3.6 - 4.6
AA0301	1.5 - 2.5
AA0302	1.5 - 2.5
AA0303	2.0 - 3.0
AA0304	2.0 - 3.0
AA0313	0.0 - 1.0
AA0342	0.0 - 1.0
AA0343	1.0 - 1.5
AA0344	1.0 - 1.5
AA0373	4.0 - 6.0
AA0374	8.0 - 10.0
AA0452	2.0 - 3.0

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	400	7	104

8. GROUNDWATER ENCOUNTERED IN SEPTEMBER 2000 BORING A-373/374 AT 7 FEET. DRILLED TO 10 FEET. BEDROCK NOT ENCOUNTERED (IT, 2001a).

FIGURE 1-11
TNT AREA A
BUILDING 129 ACID AND FUME RECOVERY, SAMPLE LOCATIONS AND ANALYTICAL RESULTS

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw® Shaw Environmental, Inc.

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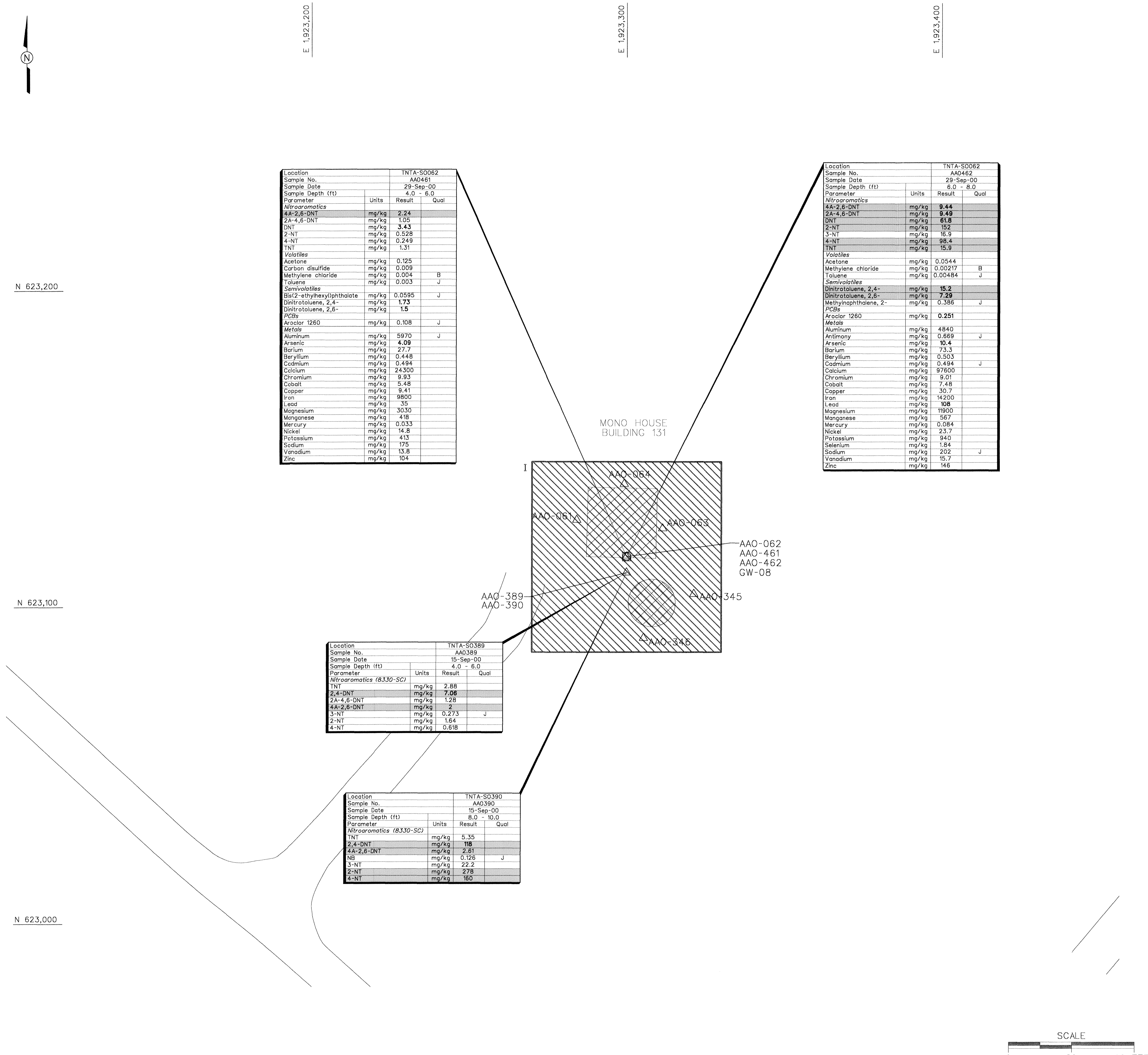
STARTING DATE: 10/17/02	DATE LAST REV.:	DRAFT. CHCK. BY: C. TUMLIN	INITIATOR: T. SIARD
DRAWN BY: B.VANDERGRIFF	DRAWN BY:	ENGR. CHCK. BY: T. SIARD	PROJ. MGR.: S. DOWNEY
DWG. NO.: 807111ES.065	PROJ. NO.: 807111		



Location		TNTA-S0062	
Sample No.		AA0461	
Sample Date		29-Sep-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	2.24	
2A-4,6-DNT	mg/kg	1.05	
DNT	mg/kg	**3.43**	
2-NT	mg/kg	0.528	
4-NT	mg/kg	0.249	
TNT	mg/kg	1.31	
Volatiles			
Acetone	mg/kg	0.125	
Carbon disulfide	mg/kg	0.009	
Methylene chloride	mg/kg	0.004	B
Toluene	mg/kg	0.003	J
Semivolatiles			
Bis(2-ethylhexyl)phthalate	mg/kg	0.0595	J
Dinitrotoluene, 2,4-	mg/kg	**1.73**	
Dinitrotoluene, 2,6-	mg/kg	**1.5**	
PCBs			
Aroclor 1260	mg/kg	0.108	J
Metals			
Aluminum	mg/kg	5970	J
Arsenic	mg/kg	**4.09**	
Barium	mg/kg	27.7	
Beryllium	mg/kg	0.448	
Cadmium	mg/kg	0.494	
Calcium	mg/kg	24300	
Chromium	mg/kg	9.93	
Cobalt	mg/kg	5.48	
Copper	mg/kg	9.41	
Iron	mg/kg	9800	
Lead	mg/kg	35	
Magnesium	mg/kg	3030	
Manganese	mg/kg	418	
Mercury	mg/kg	0.033	
Nickel	mg/kg	14.8	
Potassium	mg/kg	413	
Sodium	mg/kg	175	
Vanadium	mg/kg	13.8	
Zinc	mg/kg	104	

Location		TNTA-S0062	
Sample No.		AA0462	
Sample Date		29-Sep-00	
Sample Depth (ft)		6.0 - 8.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	**9.44**	
2A-4,6-DNT	mg/kg	**9.49**	
DNT	mg/kg	**61.8**	
2-NT	mg/kg	152	
3-NT	mg/kg	16.9	
4-NT	mg/kg	98.4	
TNT	mg/kg	15.9	
Volatiles			
Acetone	mg/kg	0.0544	
Methylene chloride	mg/kg	0.00217	B
Toluene	mg/kg	0.00484	J
Semivolatiles			
Dinitrotoluene, 2,4-	mg/kg	**15.2**	
Dinitrotoluene, 2,6-	mg/kg	**7.29**	
Methylnaphthalene, 2-	mg/kg	0.386	J
PCBs			
Aroclor 1260	mg/kg	**0.251**	
Metals			
Aluminum	mg/kg	4840	
Antimony	mg/kg	0.669	J
Arsenic	mg/kg	**10.4**	
Barium	mg/kg	73.3	
Beryllium	mg/kg	0.503	
Cadmium	mg/kg	0.494	J
Calcium	mg/kg	97600	
Chromium	mg/kg	9.01	
Cobalt	mg/kg	7.48	
Copper	mg/kg	30.7	
Iron	mg/kg	14200	
Lead	mg/kg	**108**	
Magnesium	mg/kg	11900	
Manganese	mg/kg	567	
Mercury	mg/kg	0.084	
Nickel	mg/kg	23.7	
Potassium	mg/kg	940	
Selenium	mg/kg	1.84	
Sodium	mg/kg	202	J
Vanadium	mg/kg	15.7	
Zinc	mg/kg	146	

Location		TNTA-S0389	
Sample No.		AA0389	
Sample Date		15-Sep-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	2.88	
2,4-DNT	mg/kg	**7.06**	
2A-4,6-DNT	mg/kg	1.28	
4A-2,6-DNT	mg/kg	2	
3-NT	mg/kg	0.273	J
2-NT	mg/kg	1.64	
4-NT	mg/kg	0.618	

Location		TNTA-S0390	
Sample No.		AA0390	
Sample Date		15-Sep-00	
Sample Depth (ft)		8.0 - 10.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	5.35	
2,4-DNT	mg/kg	**118**	
4A-2,6-DNT	mg/kg	2.61	
NB	mg/kg	0.126	J
3-NT	mg/kg	22.2	
2-NT	mg/kg	278	
4-NT	mg/kg	160	

LEGEND:

- △ AAO-061 — SCREENING SURFACE SOIL SAMPLING LOCATION
- □ AAO-461 — CONFIRMATION SOIL SAMPLING LOCATION
- ○ GW-08 — GROUNDWATER SAMPLING LOCATION
- FORMER TANK LOCATION
- FORMER BUILDING LOCATION
- POTENTIAL NITROAROMATIC REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 PRELIMINARY REMEDIATION GOALS ARE SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLE DEPTHS

SAMPLE	DEPTH (FT)
AA0061	0.5 - 1.5
AA0062	0.4 - 1.4
AA0063	0.5 - 1.5
AA0064	1.5 - 2.5
AA0345	0.8 - 1.8
AA0346	1.5 - 2.5
AA0389	4.0 - 6.0
AA0390	8.0 - 10.0
AA0461	4.0 - 6.0
AA0462	6.0 - 8.0

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	3600	13	1733

8. PERCHED GROUNDWATER MEASURED AT 6.04 FEET IN OCTOBER 2000 TEMPORARY PIEZOMETER GW-08. BORING A-389/390 DRILLED TO 10 FEET, BEDROCK NOT ENCOUNTERED. ESTIMATED EXCAVATION DEPTH TO BE 13 FEET BGS.

FIGURE 1-12
TNT AREA A BUILDING 131 MONO HOUSE ANALYTICAL RESULTS AND ESTIMATED AREA/VOLUME OF SOIL REQUIRING REMEDIATION

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw Shaw Environmental, Inc.

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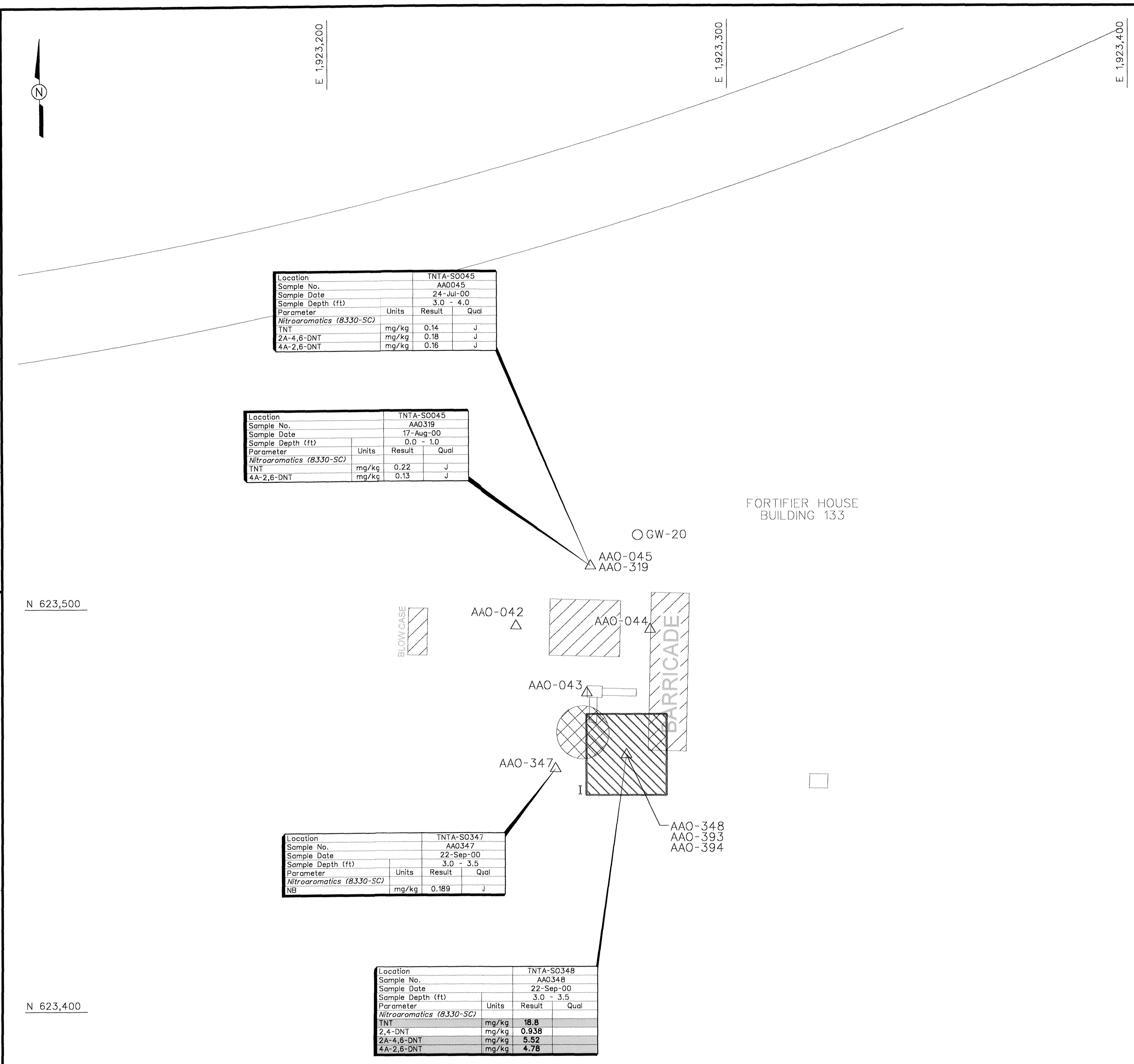
STARTING DATE: 10/18/02 | DATE LAST REV.: | DRAFT. CHCK. BY: C. TUMLIN | INITIATOR: T. SIARD | DWG. NO.: 80711ES.074
DRAWN BY: B.VANDERGRIFF | DRAWN BY: | ENGR. CHCK. BY: T. SIARD | PROJ. MGR.: S. DOWNEY | PROJ. NO.: 807111



Location		TNTA-S0045	
Sample No.		AA0045	
Sample Date		24-Jul-00	
Sample Depth (ft)		3.0 - 4.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.14	J
2A-4,6-DNT	mg/kg	0.18	J
4A-2,6-DNT	mg/kg	0.16	J

Location		TNTA-S0045	
Sample No.		AA0319	
Sample Date		17-Aug-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.22	J
4A-2,6-DNT	mg/kg	0.13	J

Location		TNTA-S0347	
Sample No.		AA0347	
Sample Date		22-Sep-00	
Sample Depth (ft)		3.0 - 3.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
NB	mg/kg	0.189	J

Location		TNTA-S0348	
Sample No.		AA0348	
Sample Date		22-Sep-00	
Sample Depth (ft)		3.0 - 3.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	**18.8**	
2,4-DNT	mg/kg	**0.938**	
2A-4,6-DNT	mg/kg	**5.52**	
4A-2,6-DNT	mg/kg	**4.78**	

LEGEND:

- △ AAO-042 — SCREENING SURFACE SOIL SAMPLING LOCATION
- ○ GW-20 — GROUNDWATER SAMPLING LOCATION
- FORMER TANK LOCATION
- FORMER BUILDING LOCATION
- POTENTIAL NITROAROMATIC REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 PRELIMINARY REMEDIATION GOALS ARE SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLE DEPTHS

SAMPLE	DEPTH (FT)
AA0042	3.0 - 4.0
AA0043	3.0 - 4.0
AA0044	3.0 - 4.0
AA0045	3.0 - 4.0
AA0319	0.0 - 1.0
AA0347	3.0 - 3.5
AA0348	3.0 - 3.5
AA0393	4.0 - 6.0
AA0394	8.0 - 10.0

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	400	6	89

8. GROUNDWATER ENCOUNTERED IN SEPTEMBER 2000 BORING A-393/394 AT 6 FEET. BORING DRILLED TO 10 FEET. BEDROCK NOT ENCOUNTERED (IT, 2001a).
9. ENCOUNTERED TRACE GROUNDWATER (0.2 FEET) IN JULY 2001 TEMPORARY PIEZOMETER GW-20. PROBE REFUSAL DEPTH AT 8 FEET.

FIGURE 1-13
TNT AREA A
BUILDING 133 FORTIFER HOUSE
SAMPLE LOCATIONS AND
ANALYTICAL RESULTS

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

SCALE
0 20 40 FEET

Shaw Environmental, Inc.

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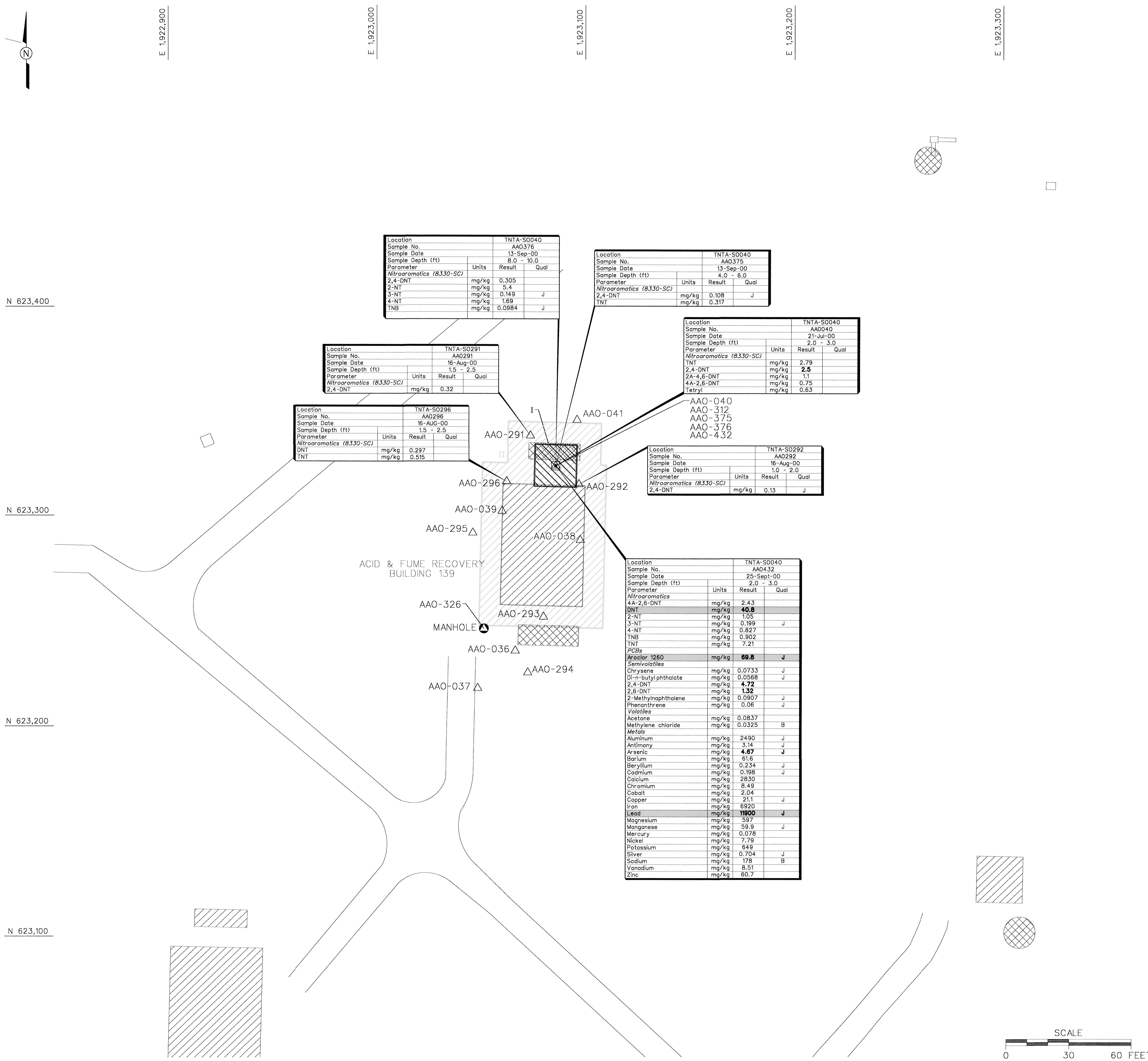
STARTING DATE: 10/18/02 | DATE LAST REV.: | DRAFT. CHCK. BY: C. TUMLIN | INITIATOR: T. SIARD | DWG. NO.: 807111ES.066
DRAWN BY: B.VANDERGRIFF | DRAWN BY: | ENGR. CHCK. BY: T. SIARD | PROJ. MGR.: S. DOWNEY | PROJ. NO.: 807111



Location		TNTA-S0040	
Sample No.		AA0376	
Sample Date		13-Sep-00	
Sample Depth (ft)		8.0 - 10.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.305	
2-NT	mg/kg	5.4	
3-NT	mg/kg	0.149	J
4-NT	mg/kg	1.69	
TNB	mg/kg	0.0984	J

Location		TNTA-S0040	
Sample No.		AA0375	
Sample Date		13-Sep-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.108	J
TNT	mg/kg	0.317	

Location		TNTA-S0040	
Sample No.		AA0040	
Sample Date		21-Jul-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	2.79	
2,4-DNT	mg/kg	**2.5**	
2A-4,6-DNT	mg/kg	1.1	
4A-2,6-DNT	mg/kg	0.75	
Tetryl	mg/kg	0.63	

Location		TNTA-S0291	
Sample No.		AA0291	
Sample Date		16-Aug-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.32	

Location		TNTA-S0296	
Sample No.		AA0296	
Sample Date		16-AUG-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
DNT	mg/kg	0.297	
TNT	mg/kg	0.515	

Location		TNTA-S0292	
Sample No.		AA0292	
Sample Date		16-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.13	J

Location		TNTA-S0040	
Sample No.		AA0432	
Sample Date		25-Sept-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	2.43	
DNT	mg/kg	**40.8**	
2-NT	mg/kg	1.05	
3-NT	mg/kg	0.199	J
4-NT	mg/kg	0.827	
TNB	mg/kg	0.902	
TNT	mg/kg	7.21	
PCBs			
Aroclor 1260	mg/kg	**69.8**	**J**
Semivolatiles			
Chrysene	mg/kg	0.0733	J
Di-n-butyl phthalate	mg/kg	0.0568	J
2,4-DNT	mg/kg	**4.72**	
2,6-DNT	mg/kg	**1.32**	
2-Methylnaphthalene	mg/kg	0.0907	J
Phenanthrene	mg/kg	0.06	J
Volatiles			
Acetone	mg/kg	0.0837	
Methylene chloride	mg/kg	0.0325	B
Metals			
Aluminum	mg/kg	2490	J
Antimony	mg/kg	3.14	J
Arsenic	mg/kg	**4.67**	**J**
Barium	mg/kg	61.6	
Beryllium	mg/kg	0.234	J
Cadmium	mg/kg	0.198	J
Calcium	mg/kg	2830	
Chromium	mg/kg	8.49	
Cobalt	mg/kg	2.04	
Copper	mg/kg	21.1	J
Iron	mg/kg	6920	
Lead	mg/kg	**11900**	**J**
Magnesium	mg/kg	597	
Manganese	mg/kg	59.9	J
Mercury	mg/kg	0.078	
Nickel	mg/kg	7.79	
Potassium	mg/kg	649	
Silver	mg/kg	0.704	J
Sodium	mg/kg	178	B
Vanadium	mg/kg	8.51	
Zinc	mg/kg	60.7	

LEGEND:

- △ AAO-036 — SCREENING SOIL SAMPLING LOCATION
- • AAO-312 — SURFACE SOIL SAMPLE (0 - 1 FT)
- □ AAO-432 — CONFIRMATION SOIL SAMPLING LOCATION
- FORMER TANK LOCATION
- FORMER BUILDING LOCATION
- POTENTIAL NITROAROMATIC REMEDIATION AREA
- POTENTIAL LEAD/PCB REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 REMEDIATION GOAL OBJECTIVES SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLING DEPTHS

SAMPLE	DEPTH (FT)
AA0036	1.0 - 2.0
AA0037	2.5 - 3.5
AA0038	0.5 - 1.5
AA0039	0.5 - 1.5
AA0040	2.0 - 3.0
AA0041	1.0 - 2.0
AA0291	1.5 - 2.5
AA0292	1.0 - 2.0
AA0293	1.0 - 2.0
AA0294	1.6 - 2.6
AA0295	1.0 - 2.0
AA0296	1.5 - 2.5
AA0312	0.0 - 1.0
AA0326	3.0 - 4.0
AA0375	4.0 - 6.0
AA0376	8.0 - 10.0
AA0432	2.0 - 3.0

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	400	8	119
II	2835	4	420
TOTAL	3235		539

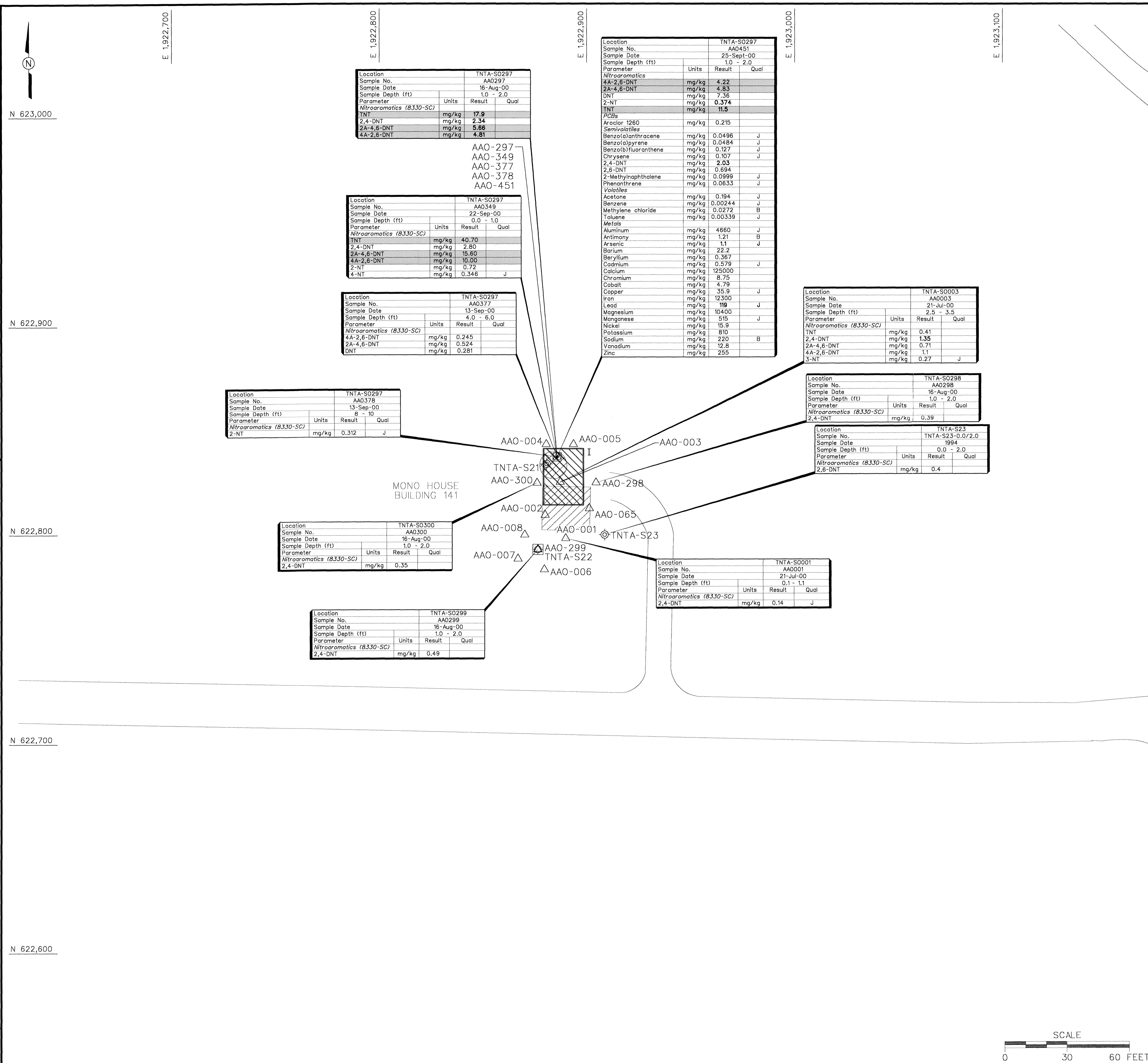
8. VERTICAL DEPTH OF 10 FEET OBTAINED IN OCTOBER 2000 A-375/376 BORING. GROUNDWATER WAS NOT ENCOUNTERED (IT, 2000a). BEDROCK IS ESTIMATED AT 15 FEET.

FIGURE 1-14
TNT AREA A
BUILDING 139 ACID & FUME RECOVERY, ANALYTICAL RESULTS AND ESTIMATED AREA/VOLUME OF SOIL REQUIRING REMEDIATION

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw Environmental, Inc.

STARTING DATE: 10/21/02 | DATE LAST REV.: | DRAFT. CHCK. BY: C. TUMLIN | INITIATOR: T. SIARD | DWG. NO.: 807111es.067
DRAWN BY: B.VANDERGRIFF | DRAWN BY: | ENGR. CHCK. BY: T. SIARD | PROJ. MGR.: S. DOWNEY | PROJ. NO.: 807111



Location		TNTA-S0297	
Sample No.		AA0297	
Sample Date		16-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	**17.9**	
2,4-DNT	mg/kg	**2.34**	
2A-4,6-DNT	mg/kg	**5.86**	
4A-2,6-DNT	mg/kg	**4.81**	

Location		TNTA-S0297	
Sample No.		AA0349	
Sample Date		22-Sep-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	40.70	
2,4-DNT	mg/kg	2.80	
2A-4,6-DNT	mg/kg	15.60	
4A-2,6-DNT	mg/kg	10.00	
2-NT	mg/kg	0.72	
4-NT	mg/kg	0.346	J

Location		TNTA-S0297	
Sample No.		AA0377	
Sample Date		13-Sep-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	0.245	
2A-4,6-DNT	mg/kg	0.524	
DNT	mg/kg	0.281	

Location		TNTA-S0297	
Sample No.		AA0378	
Sample Date		13-Sep-00	
Sample Depth (ft)		8 - 10	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2-NT	mg/kg	0.312	J

Location		TNTA-S0297	
Sample No.		AA0451	
Sample Date		25-Sept-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	4.22	
2A-4,6-DNT	mg/kg	4.83	
DNT	mg/kg	7.36	
2-NT	mg/kg	**0.374**	
TNT	mg/kg	**11.5**	
PCBs			
Aroclor 1260	mg/kg	0.215	
Semivolatiles			
Benzo(a)anthracene	mg/kg	0.0496	J
Benzo(a)pyrene	mg/kg	0.0484	J
Benzo(b)fluoranthene	mg/kg	0.127	J
Chrysene	mg/kg	0.107	J
2,4-DNT	mg/kg	**2.03**	
2,6-DNT	mg/kg	0.694	
2-Methylnaphthalene	mg/kg	0.0999	J
Phenanthrene	mg/kg	0.0633	J
Volatiles			
Acetone	mg/kg	0.194	J
Benzene	mg/kg	0.00244	J
Methylene chloride	mg/kg	0.0272	B
Toluene	mg/kg	0.00339	J
Metals			
Aluminum	mg/kg	4660	J
Antimony	mg/kg	1.21	B
Arsenic	mg/kg	**1.1**	J
Barium	mg/kg	22.2	
Beryllium	mg/kg	0.367	
Cadmium	mg/kg	0.579	J
Calcium	mg/kg	125000	
Chromium	mg/kg	8.75	
Cobalt	mg/kg	4.79	
Copper	mg/kg	35.9	J
Iron	mg/kg	12300	
Lead	mg/kg	**119**	J
Magnesium	mg/kg	10400	
Manganese	mg/kg	515	J
Nickel	mg/kg	15.9	
Potassium	mg/kg	810	
Sodium	mg/kg	220	B
Vanadium	mg/kg	12.8	
Zinc	mg/kg	255	

Location		TNTA-S0003	
Sample No.		AA0003	
Sample Date		21-Jul-00	
Sample Depth (ft)		2.5 - 3.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.41	
2,4-DNT	mg/kg	**1.35**	
2A-4,6-DNT	mg/kg	0.71	
4A-2,6-DNT	mg/kg	1.1	
3-NT	mg/kg	0.27	J

Location		TNTA-S0298	
Sample No.		AA0298	
Sample Date		16-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.39	

Location		TNTA-S23	
Sample No.		TNTA-S23-0.0/2.0	
Sample Date		1994	
Sample Depth (ft)		0.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,6-DNT	mg/kg	0.4	

Location		TNTA-S0300	
Sample No.		AA0300	
Sample Date		16-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.35	

Location		TNTA-S0001	
Sample No.		AA0001	
Sample Date		21-Jul-00	
Sample Depth (ft)		0.1 - 1.1	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.14	J

Location		TNTA-S0299	
Sample No.		AA0299	
Sample Date		16-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.49	

LEGEND:

- △ AAO-001 — SCREENING SOIL SAMPLING LOCATION
- • AAO-349 — SURFACE SOIL SAMPLE (0 - 1 FT)
- □ AAO-451 — CONFIRMATION SOIL SAMPLING LOCATION
- TNTA-S21 — HISTORICAL SOIL BORING LOCATION
- TNTA-S22 — HISTORICAL SOIL BORING LOCATION WITH EXPLOSIVES DETECTION
- FORMER TANK LOCATION
- FORMER BUILDING LOCATION
- POTENTIAL NITROAROMATIC REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 PRELIMINARY REMEDIATION GOALS ARE SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLING DEPTHS

SAMPLE	DEPTH (FT)
AA0001	0.1 - 1.1
AA0002	0.5 - 1.5
AA0003	2.5 - 3.5
AA0004	1.5 - 2.5
AA0005	1.0 - 2.0
AA0006	1.5 - 2.5
AA0007	1.5 - 2.5
AA0008	2.5 - 3.5
AA0065	2.5 - 3.5
AA0297	1.0 - 2.0
AA0298	1.0 - 2.0
AA0299	1.0 - 2.0
AA0300	1.0 - 2.0
AA0349	0.0 - 1.0
AA0377	4.0 - 6.0
AA0378	8.0 - 10.0
AA0451	1.0 - 2.0

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	515	4	76

8. VERTICAL DEPTH OF 10 FEET OBTAINED IN OCTOBER 2000 BORING A-377/378 (IT, 2001a). GROUNDWATER NOT ENCOUNTERED. BEDROCK ESTIMATED AT 12 FEET.

FIGURE 1-15
TNT AREA A
BUILDING 141 MONO HOUSE
ANALYTICAL RESULTS AND ESTIMATED AREA/VOLUME OF SOIL REQUIRING REMEDIATION

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw Shaw Environmental, Inc.

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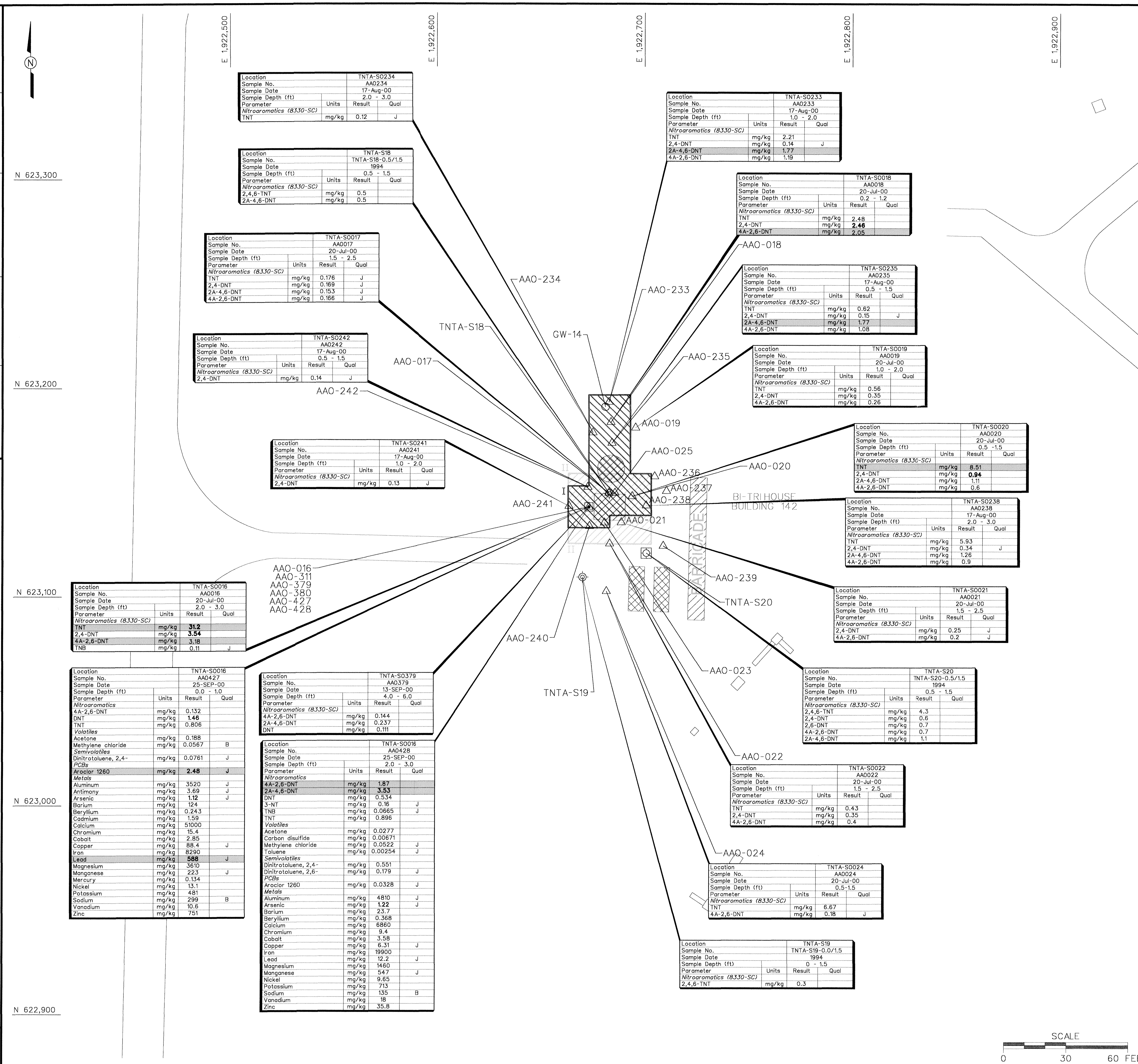


Location		TNTA-S0234	
Sample No.		AA0234	
Sample Date		17-Aug-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.12	J

Location		TNTA-S18	
Sample No.		TNTA-S18-0.5/1.5	
Sample Date		1994	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4,6-TNT	mg/kg	0.5	
2A-4,6-DNT	mg/kg	0.5	

Location		TNTA-S0017	
Sample No.		AA0017	
Sample Date		20-Jul-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.176	J
2,4-DNT	mg/kg	0.169	J
2A-4,6-DNT	mg/kg	0.153	J
4A-2,6-DNT	mg/kg	0.166	J

Location		TNTA-S0242	
Sample No.		AA0242	
Sample Date		17-Aug-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.14	J

Location		TNTA-S0241	
Sample No.		AA0241	
Sample Date		17-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.13	J

Location		TNTA-S0233	
Sample No.		AA0233	
Sample Date		17-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	2.21	
2,4-DNT	mg/kg	0.14	J
2A-4,6-DNT	mg/kg	1.77	
4A-2,6-DNT	mg/kg	1.19	

Location		TNTA-S0018	
Sample No.		AA0018	
Sample Date		20-Jul-00	
Sample Depth (ft)		0.2 - 1.2	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	2.48	
2,4-DNT	mg/kg	**2.46**	
4A-2,6-DNT	mg/kg	2.05	

Location		TNTA-S0235	
Sample No.		AA0235	
Sample Date		17-Aug-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.62	
2,4-DNT	mg/kg	0.15	J
2A-4,6-DNT	mg/kg	1.77	
4A-2,6-DNT	mg/kg	1.08	

Location		TNTA-S0019	
Sample No.		AA0019	
Sample Date		20-Jul-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.56	
2,4-DNT	mg/kg	0.35	
4A-2,6-DNT	mg/kg	0.26	

Location		TNTA-S0020	
Sample No.		AA0020	
Sample Date		20-Jul-00	
Sample Depth (ft)		0.5 -1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	8.51	
2,4-DNT	mg/kg	**0.94**	
2A-4,6-DNT	mg/kg	1.11	
4A-2,6-DNT	mg/kg	0.6	

Location		TNTA-S0238	
Sample No.		AA0238	
Sample Date		17-Aug-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	5.93	
2,4-DNT	mg/kg	0.34	J
2A-4,6-DNT	mg/kg	1.26	
4A-2,6-DNT	mg/kg	0.9	

Location		TNTA-S0021	
Sample No.		AA0021	
Sample Date		20-Jul-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.25	J
4A-2,6-DNT	mg/kg	0.2	J

Location		TNTA-S20	
Sample No.		TNTA-S20-0.5/1.5	
Sample Date		1994	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4,6-TNT	mg/kg	4.3	
2,4-DNT	mg/kg	0.6	
2,6-DNT	mg/kg	0.7	
4A-2,6-DNT	mg/kg	0.7	
2A-4,6-DNT	mg/kg	1.1	

Location		TNTA-S0022	
Sample No.		AA0022	
Sample Date		20-Jul-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.43	
2,4-DNT	mg/kg	0.35	
4A-2,6-DNT	mg/kg	0.4	

Location		TNTA-S0024	
Sample No.		AA0024	
Sample Date		20-Jul-00	
Sample Depth (ft)		0.5-1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	6.67	
4A-2,6-DNT	mg/kg	0.18	J

Location		TNTA-S19	
Sample No.		TNTA-S19-0.0/1.5	
Sample Date		1994	
Sample Depth (ft)		0 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4,6-TNT	mg/kg	0.3	

Location		TNTA-S0016	
Sample No.		AA0016	
Sample Date		20-Jul-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	**31.2**	
2,4-DNT	mg/kg	**3.54**	
4A-2,6-DNT	mg/kg	3.18	
TNB	mg/kg	0.11	J

Location		TNTA-S0016	
Sample No.		AA0427	
Sample Date		25-SEP-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	0.132	
DNT	mg/kg	**1.46**	
TNT	mg/kg	0.806	
Volatiles			
Acetone	mg/kg	0.188	
Methylene chloride	mg/kg	0.0567	B
Semivolatiles			
Dinitrotoluene, 2,4-	mg/kg	0.0761	J
PCBs			
Aroclor 1260	mg/kg	**2.48**	J
Metals			
Aluminum	mg/kg	3520	J
Antimony	mg/kg	3.69	J
Arsenic	mg/kg	**1.12**	J
Barium	mg/kg	124	
Beryllium	mg/kg	0.243	
Cadmium	mg/kg	1.59	
Calcium	mg/kg	51000	
Chromium	mg/kg	15.4	
Cobalt	mg/kg	2.85	
Copper	mg/kg	88.4	J
Iron	mg/kg	8290	
Lead	mg/kg	**588**	J
Magnesium	mg/kg	3610	
Manganese	mg/kg	223	J
Mercury	mg/kg	0.134	
Nickel	mg/kg	13.1	
Potassium	mg/kg	481	
Sodium	mg/kg	299	B
Vanadium	mg/kg	10.6	
Zinc	mg/kg	751	

Location		TNTA-S0379	
Sample No.		AA0379	
Sample Date		13-SEP-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	0.144	
2A-4,6-DNT	mg/kg	0.237	
DNT	mg/kg	0.111	

Location		TNTA-S0016	
Sample No.		AA0428	
Sample Date		25-SEP-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	1.87	
2A-4,6-DNT	mg/kg	**3.53**	
DNT	mg/kg	0.534	
3-NT	mg/kg	0.16	J
TNB	mg/kg	0.0665	J
TNT	mg/kg	0.896	
Volatiles			
Acetone	mg/kg	0.0277	
Carbon disulfide	mg/kg	0.00671	
Methylene chloride	mg/kg	0.0522	J
Toluene	mg/kg	0.00254	J
Semivolatiles			
Dinitrotoluene, 2,4-	mg/kg	0.551	
Dinitrotoluene, 2,6-	mg/kg	0.179	J
PCBs			
Aroclor 1260	mg/kg	0.0328	J
Metals			
Aluminum	mg/kg	4810	J
Arsenic	mg/kg	**1.22**	J
Barium	mg/kg	23.7	
Beryllium	mg/kg	0.368	
Calcium	mg/kg	6860	
Chromium	mg/kg	9.4	
Cobalt	mg/kg	3.58	
Copper	mg/kg	6.31	J
Iron	mg/kg	19900	
Lead	mg/kg	12.2	J
Magnesium	mg/kg	1460	
Manganese	mg/kg	547	J
Nickel	mg/kg	9.65	
Potassium	mg/kg	713	
Sodium	mg/kg	135	B
Vanadium	mg/kg	18	
Zinc	mg/kg	35.8	

LEGEND:

- △ AAO-016 — SCREENING SOIL SAMPLING LOCATION
- • AAO-311 — SURFACE SOIL SAMPLE (0 - 1 FT)
- □ AAO-427 — CONFIRMATION SOIL SAMPLING LOCATION
- ○ GW-14 — GROUNDWATER SAMPLING LOCATION
- TNTA-S18 — HISTORICAL SOIL BORING LOCATION
- TNTA-S20 — HISTORICAL SOIL BORING LOCATION WITH EXPLOSIVES DETECTION
- FORMER TANK LOCATION
- FORMER BUILDING LOCATION
- POTENTIAL NITROAROMATIC REMEDIATION AREA
- POTENTIAL LEAD/PCB REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 PRELIMINARY REMEDIATION GOALS ARE SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLING DEPTHS

SAMPLE	DEPTH (FT)
AA0016	2.0 - 3.0
AA0017	1.5 - 2.5
AA0018	0.2 - 1.2
AA0019	1.0 - 2.0
AA0020	0.5 - 1.5
AA0021	1.5 - 2.5
AA0022	1.5 - 2.5
AA0023	1.5 - 2.5
AA0024	0.5 - 1.5
AA0025	1.5 - 2.0
AA0233	1.0 - 2.0
AA0234	2.0 - 3.0
AA0235	0.5 - 1.5
AA0236	0.5 - 1.5
AA0237	0.5 - 1.5
AA0238	2.0 - 3.0
AA0239	1.0 - 2.0
AA0240	1.0 - 2.0
AA0241	1.0 - 2.0
AA0242	0.5 - 1.5
AA0311	0.0 - 1.0
AA0379	4.0 - 6.0
AA0380	8.0 - 10.0
AA0427	0.0 - 1.0
AA0428	2.0 - 3.0
AA0429	2.0 - 3.0
AA0430	2.0 - 3.0

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	1740	4	258
II	547	2	41
TOTAL	2287		299

8. GROUNDWATER ENCOUNTERED AT 4 FEET IN OCTOBER 2000 BORING A-379/380. DRILLED TO 10 FEET, NO REFUSAL.
9. GROUNDWATER ENCOUNTERED AT 7.70 FEET IN AUGUST 2001 TEMPORARY PIEZOMETER GW-14. BEDROCK ENCOUNTERED AT 10 FEET.

FIGURE 1-16

TNT AREA A BUILDING 142 BI-TRI HOUSE ANALYTICAL RESULTS AND ESTIMATED AREA/VOLUME OF SOIL REQUIRING REMEDIATION

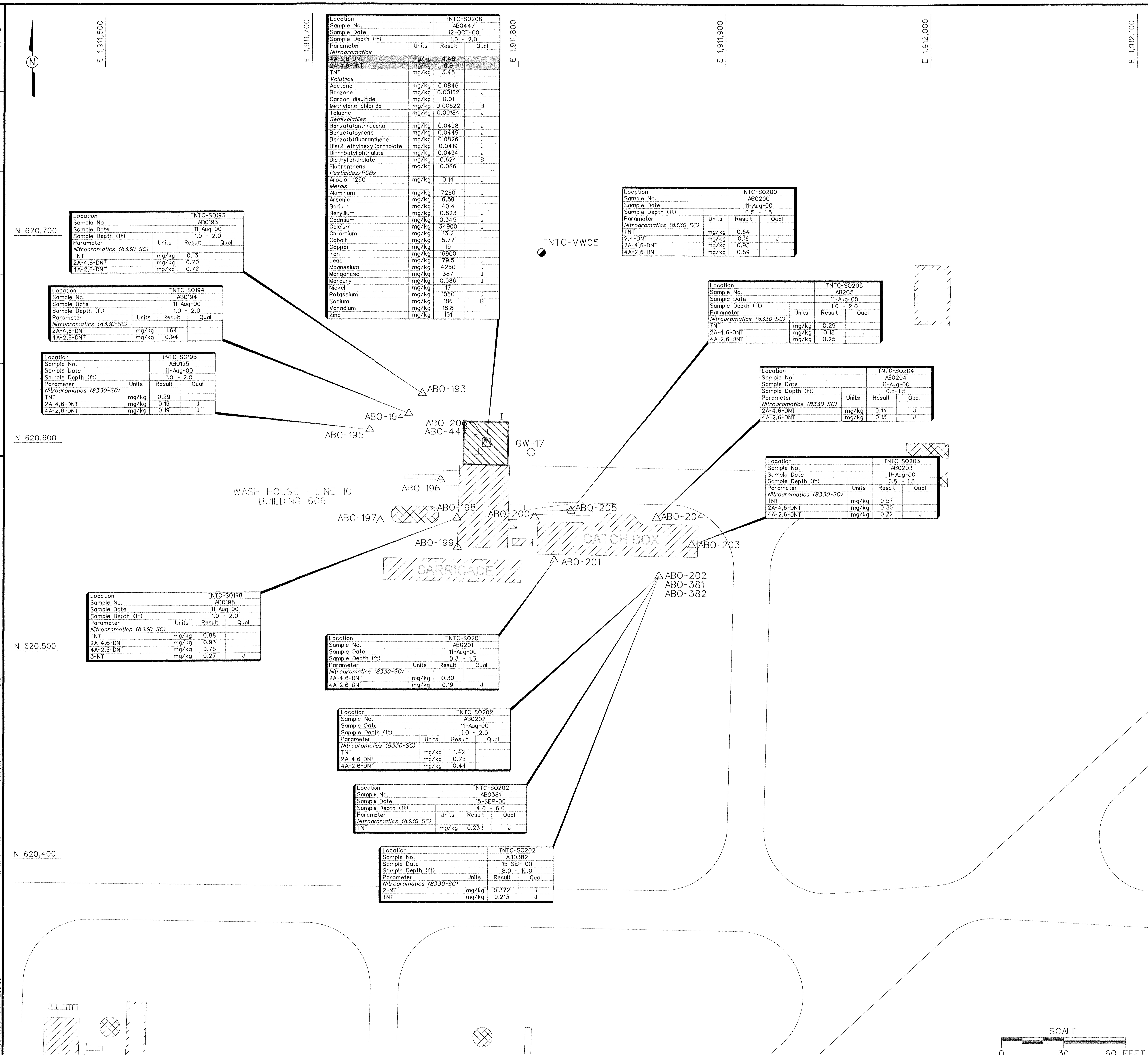
PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

SCALE
0 30 60 FEET

Shaw Environmental, Inc.

STARTING DATE: 10/21/02 | DATE LAST REV.: | DRAFT. CHCK. BY: C. TUMLIN | INITIATOR: T. SIARD | DWG. NO.: 807111es.068
DRAWN BY: B.VANDERGRIFF | DRAWN BY: | ENGR. CHCK. BY: T. SIARD | PROJ. MGR.: S. DOWNEY | PROJ. NO.: 807111

c:\cadd\design\807111es.068 01:22:12 PM 08/26/03 jwaters



Location		TNTC-S0206	
Sample No.		AB0447	
Sample Date		12-OCT-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	**4.48**	
2A-4,6-DNT	mg/kg	**6.9**	
TNT	mg/kg	3.45	
Volatiles			
Acetone	mg/kg	0.0846	
Benzene	mg/kg	0.00162	J
Carbon disulfide	mg/kg	0.01	
Methylene chloride	mg/kg	0.00622	B
Toluene	mg/kg	0.00184	J
Semivolatiles			
Benzo(a)anthracene	mg/kg	0.0498	J
Benzo(a)pyrene	mg/kg	0.0449	J
Benzo(b)fluoranthene	mg/kg	0.0826	J
Bis(2-ethylhexyl)phthalate	mg/kg	0.0419	J
Di-n-butyl phthalate	mg/kg	0.0494	J
Diethyl phthalate	mg/kg	0.624	B
Fluoranthene	mg/kg	0.086	J
Pesticides/PCBs			
Aroclor 1260	mg/kg	0.14	J
Metals			
Aluminum	mg/kg	7260	J
Arsenic	mg/kg	**6.59**	
Barium	mg/kg	40.4	
Beryllium	mg/kg	0.823	J
Cadmium	mg/kg	0.345	J
Calcium	mg/kg	34900	J
Chromium	mg/kg	13.2	
Cobalt	mg/kg	5.77	
Copper	mg/kg	19	
Iron	mg/kg	16900	
Lead	mg/kg	**79.5**	J
Magnesium	mg/kg	4250	J
Manganese	mg/kg	387	J
Mercury	mg/kg	0.086	J
Nickel	mg/kg	17	
Potassium	mg/kg	1080	J
Sodium	mg/kg	186	B
Vanadium	mg/kg	18.8	
Zinc	mg/kg	151	

Location		TNTC-S0193	
Sample No.		AB0193	
Sample Date		11-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.13	
2A-4,6-DNT	mg/kg	0.70	
4A-2,6-DNT	mg/kg	0.72	

Location		TNTC-S0194	
Sample No.		AB0194	
Sample Date		11-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2A-4,6-DNT	mg/kg	1.64	
4A-2,6-DNT	mg/kg	0.94	

Location		TNTC-S0195	
Sample No.		AB0195	
Sample Date		11-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.29	
2A-4,6-DNT	mg/kg	0.16	J
4A-2,6-DNT	mg/kg	0.19	J

Location		TNTC-S0200	
Sample No.		AB0200	
Sample Date		11-Aug-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.64	
2,4-DNT	mg/kg	0.16	J
2A-4,6-DNT	mg/kg	0.93	
4A-2,6-DNT	mg/kg	0.59	

Location		TNTC-S0205	
Sample No.		AB205	
Sample Date		11-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.29	
2A-4,6-DNT	mg/kg	0.18	J
4A-2,6-DNT	mg/kg	0.25	

Location		TNTC-S0204	
Sample No.		AB0204	
Sample Date		11-Aug-00	
Sample Depth (ft)		0.5-1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2A-4,6-DNT	mg/kg	0.14	J
4A-2,6-DNT	mg/kg	0.13	J

Location		TNTC-S0203	
Sample No.		AB0203	
Sample Date		11-Aug-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.57	
2A-4,6-DNT	mg/kg	0.30	
4A-2,6-DNT	mg/kg	0.22	J

Location		TNTC-S0198	
Sample No.		AB0198	
Sample Date		11-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.88	
2A-4,6-DNT	mg/kg	0.93	
4A-2,6-DNT	mg/kg	0.75	
3-NT	mg/kg	0.27	J

Location		TNTC-S0201	
Sample No.		AB0201	
Sample Date		11-Aug-00	
Sample Depth (ft)		0.3 - 1.3	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2A-4,6-DNT	mg/kg	0.30	
4A-2,6-DNT	mg/kg	0.19	J

Location		TNTC-S0202	
Sample No.		AB0202	
Sample Date		11-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	1.42	
2A-4,6-DNT	mg/kg	0.75	
4A-2,6-DNT	mg/kg	0.44	

Location		TNTC-S0202	
Sample No.		AB0381	
Sample Date		15-SEP-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.233	J

Location		TNTC-S0202	
Sample No.		AB0382	
Sample Date		15-SEP-00	
Sample Depth (ft)		8.0 - 10.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2-NT	mg/kg	0.372	J
TNT	mg/kg	0.213	J

LEGEND:

- △ ABO-193 SCREENING SOIL SAMPLING LOCATION
- □ ABO-447 CONFIRMATION SOIL SAMPLING LOCATION
- ○ GW-17 GROUNDWATER SAMPLING LOCATION
- ◐ TNTC-MW05 OVERBURDEN MONITORING WELL LOCATION
- FORMER TANK LOCATION
- FORMER BUILDING LOCATION
- POTENTIAL NITROAROMATIC REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 PRELIMINARY REMEDIATION GOALS ARE SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLING DEPTHS

SAMPLE	DEPTH (FT)
AB0193	1.0 - 2.0
AB0194	1.0 - 2.0
AB0195	1.0 - 2.0
AB0196	1.0 - 2.0
AB0197	1.0 - 2.0
AB0198	1.0 - 2.0
AB0199	1.0 - 2.0
AB0200	0.5 - 1.5
AB0201	0.3 - 1.3
AB0202	1.0 - 2.0
AB0203	0.5 - 1.5
AB0204	0.5 - 1.5
AB0205	1.0 - 2.0
AB0206	1.0 - 2.0
AB0381	4.0 - 6.0
AB0382	8.0 - 10.0
AB0447	1.0 - 2.0

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING PRGs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	400	7	104

8. GROUNDWATER WAS ENCOUNTERED IN SEPTEMBER 2000 BORING C-381/382 AT 6 FEET. BEDROCK WAS NOT ENCOUNTERED.
9. GROUNDWATER WAS NOT ENCOUNTERED IN AUGUST 2001 TEMPORARY PIEZOMETER GW-17. BEDROCK WAS ENCOUNTERED AT 8 FEET.

FIGURE 1-29
TNT AREA C
BUILDING 606
WASH HOUSE - LINE 10
ANALYTICAL RESULTS AND ESTIMATED AREA/VOLUME OF SOIL REQUIRING REMEDIATION

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw Environmental, Inc.

STARTING DATE: 10/22/02 | DATE LAST REV.: | DRAFT. CHCK. BY: C. TUMLIN | INITIATOR: T. SIARD | DWG. NO.: 807112es.067
DRAWN BY: B.VANDERDRIFF | DRAWN BY: | ENGR. CHCK. BY: T. SIARD | PROJ. MGR.: S. DOWNEY | PROJ. NO.: 807112

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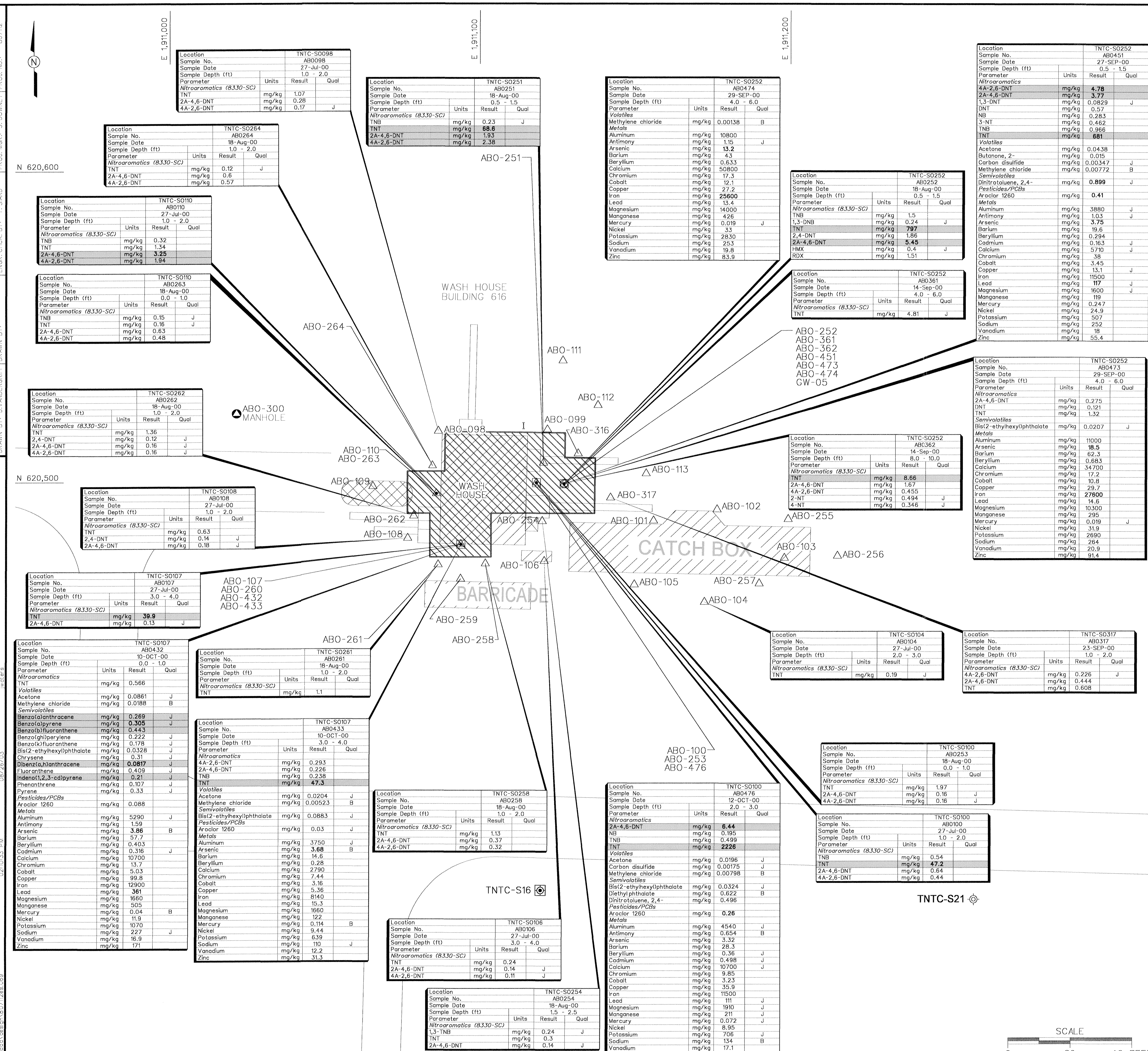

Location		TNTC-S0098	
Sample No.		AB0098	
Sample Date		27-Jul-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	1.07	
2A-4,6-DNT	mg/kg	0.28	
4A-2,6-DNT	mg/kg	0.17	J

Location		TNTC-S0251	
Sample No.		AB0251	
Sample Date		18-Aug-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.23	J
TNT	mg/kg	**88.6**	
2A-4,6-DNT	mg/kg	1.93	
4A-2,6-DNT	mg/kg	2.38	

Location		TNTC-S0264	
Sample No.		AB0264	
Sample Date		18-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.12	J
2A-4,6-DNT	mg/kg	0.6	
4A-2,6-DNT	mg/kg	0.57	

Location		TNTC-S0110	
Sample No.		AB0110	
Sample Date		27-Jul-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.32	
TNT	mg/kg	1.34	
2A-4,6-DNT	mg/kg	**3.25**	
4A-2,6-DNT	mg/kg	1.94	

Location		TNTC-S0110	
Sample No.		AB0263	
Sample Date		18-Aug-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.15	J
TNT	mg/kg	0.16	J
2A-4,6-DNT	mg/kg	0.63	
4A-2,6-DNT	mg/kg	0.48	

Location		TNTC-S0262	
Sample No.		AB0262	
Sample Date		18-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	1.36	
2,4-DNT	mg/kg	0.12	J
2A-4,6-DNT	mg/kg	0.16	J
4A-2,6-DNT	mg/kg	0.16	J

Location		TNTC-S0108	
Sample No.		AB0108	
Sample Date		27-Jul-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.63	
2,4-DNT	mg/kg	0.14	J
2A-4,6-DNT	mg/kg	0.18	J

Location		TNTC-S0107	
Sample No.		AB0107	
Sample Date		27-Jul-00	
Sample Depth (ft)		3.0 - 4.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	**39.9**	
2A-4,6-DNT	mg/kg	0.13	J

Location		TNTC-S0107	
Sample No.		AB0432	
Sample Date		10-OCT-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics			
TNT	mg/kg	0.566	
Volatiles			
Acetone	mg/kg	0.0861	J
Methylene chloride	mg/kg	0.0188	B
Semivolatiles			
Benzo(a)anthracene	mg/kg	**0.269**	J
Benzo(a)pyrene	mg/kg	**0.305**	J
Benzo(b)fluoranthene	mg/kg	**0.443**	
Benzo(ghi)perylene	mg/kg	0.222	J
Benzo(k)fluoranthene	mg/kg	0.178	J
Bis(2-ethylhexyl)phthalate	mg/kg	0.0328	J
Chrysene	mg/kg	0.31	J
Dibenz(a,h)anthracene	mg/kg	**0.0817**	J
Fluoranthene	mg/kg	0.409	J
Indeno(1,2,3-cd)pyrene	mg/kg	0.21	J
Phenanthrene	mg/kg	0.107	J
Pyrene	mg/kg	0.33	J
Pesticides/PCBs			
Aroclor 1260	mg/kg	0.088	
Metals			
Aluminum	mg/kg	5290	J
Antimony	mg/kg	1.59	
Arsenic	mg/kg	**3.86**	B
Barium	mg/kg	57.7	
Beryllium	mg/kg	0.403	
Cadmium	mg/kg	0.316	J
Calcium	mg/kg	10700	
Chromium	mg/kg	13.7	
Cobalt	mg/kg	5.03	
Copper	mg/kg	99.8	
Iron	mg/kg	12900	
Lead	mg/kg	**361**	
Magnesium	mg/kg	1660	
Manganese	mg/kg	505	
Mercury	mg/kg	0.04	B
Nickel	mg/kg	11.9	
Potassium	mg/kg	1070	
Sodium	mg/kg	227	J
Vanadium	mg/kg	16.9	
Zinc	mg/kg	171	

Location		TNTC-S0261	
Sample No.		AB0261	
Sample Date		18-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	1.1	

Location		TNTC-S0107	
Sample No.		AB0433	
Sample Date		10-OCT-00	
Sample Depth (ft)		3.0 - 4.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	0.293	
2A-4,6-DNT	mg/kg	0.226	
TNB	mg/kg	0.238	
TNT	mg/kg	**47.3**	
Volatiles			
Acetone	mg/kg	0.0204	J
Methylene chloride	mg/kg	0.00523	B
Semivolatiles			
Bis(2-ethylhexyl)phthalate	mg/kg	0.0883	J
Pesticides/PCBs			
Aroclor 1260	mg/kg	0.03	J
Metals			
Aluminum	mg/kg	3750	J
Arsenic	mg/kg	**3.68**	B
Barium	mg/kg	14.6	
Beryllium	mg/kg	0.28	
Calcium	mg/kg	2790	
Chromium	mg/kg	7.44	
Cobalt	mg/kg	3.16	
Copper	mg/kg	5.36	
Iron	mg/kg	8140	
Lead	mg/kg	15.3	
Magnesium	mg/kg	1660	
Manganese	mg/kg	122	
Mercury	mg/kg	0.114	B
Nickel	mg/kg	9.44	
Potassium	mg/kg	639	
Sodium	mg/kg	110	J
Vanadium	mg/kg	12.2	
Zinc	mg/kg	31.3	

Location		TNTC-S0258	
Sample No.		AB0258	
Sample Date		18-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	1.13	
2A-4,6-DNT	mg/kg	0.37	
4A-2,6-DNT	mg/kg	0.32	

Location		TNTC-S0106	
Sample No.		AB0106	
Sample Date		27-Jul-00	
Sample Depth (ft)		3.0 - 4.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.24	
2A-4,6-DNT	mg/kg	0.14	J
4A-2,6-DNT	mg/kg	0.11	J

Location		TNTC-S0254	
Sample No.		AB0254	
Sample Date		18-Aug-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
1,3-TNB	mg/kg	0.24	J
TNT	mg/kg	0.3	
2A-4,6-DNT	mg/kg	0.14	J

Location		TNTC-S0252	
Sample No.		AB0474	
Sample Date		29-SEP-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Volatiles			
Methylene chloride	mg/kg	0.00138	B
Metals			
Aluminum	mg/kg	10800	
Antimony	mg/kg	1.15	J
Arsenic	mg/kg	**13.2**	
Barium	mg/kg	43	
Beryllium	mg/kg	0.633	
Calcium	mg/kg	50800	
Chromium	mg/kg	17.3	
Cobalt	mg/kg	12.1	
Copper	mg/kg	27.2	
Iron	mg/kg	**25600**	
Lead	mg/kg	13.4	
Magnesium	mg/kg	14000	
Manganese	mg/kg	426	
Mercury	mg/kg	0.019	J
Nickel	mg/kg	33	
Potassium	mg/kg	2830	
Sodium	mg/kg	253	
Vanadium	mg/kg	19.8	
Zinc	mg/kg	83.9	

Location		TNTC-S0252	
Sample No.		AB0252	
Sample Date		18-Aug-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	1.5	
1,3-DNB	mg/kg	0.24	J
TNT	mg/kg	**797**	
2,4-DNT	mg/kg	1.86	
2A-4,6-DNT	mg/kg	**5.45**	
HMX	mg/kg	0.4	J
RDX	mg/kg	1.51	

Location		TNTC-S0252	
Sample No.		AB0361	
Sample Date		14-Sep-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	4.81	J

Location		TNTC-S0252	
Sample No.		AB0362	
Sample Date		14-Sep-00	
Sample Depth (ft)		8.0 - 10.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	**8.66**	
2A-4,6-DNT	mg/kg	1.67	
4A-2,6-DNT	mg/kg	0.455	
2-NT	mg/kg	0.494	J
4-NT	mg/kg	0.346	J

Location		TNTC-S0252	
Sample No.		AB0451	
Sample Date		27-SEP-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	**4.78**	
2A-4,6-DNT	mg/kg	**3.77**	
1,3-DNT	mg/kg	0.0829	J
DNT	mg/kg	0.57	
NB	mg/kg	0.283	
3-NT	mg/kg	0.462	
TNB	mg/kg	0.966	
TNT	mg/kg	**681**	
Volatiles			
Acetone	mg/kg	0.0438	
Butanone, 2-	mg/kg	0.015	
Carbon disulfide	mg/kg	0.00347	J
Methylene chloride	mg/kg	0.00772	B
Semivolatiles			
Dinitrotoluene, 2,4-	mg/kg	**0.899**	J
Pesticides/PCBs			
Aroclor 1260	mg/kg	**0.41**	
Metals			
Aluminum	mg/kg	3880	J
Antimony	mg/kg	1.03	J
Arsenic	mg/kg	**3.75**	
Barium	mg/kg	19.6	
Beryllium	mg/kg	0.294	
Cadmium	mg/kg	0.163	J
Calcium	mg/kg	5710	J
Chromium	mg/kg	38	
Cobalt	mg/kg	3.45	
Copper	mg/kg	13.1	J
Iron	mg/kg	11500	
Lead	mg/kg	**117**	J
Magnesium	mg/kg	1600	J
Manganese	mg/kg	119	
Mercury	mg/kg	0.247	
Nickel	mg/kg	24.9	
Potassium	mg/kg	507	
Sodium	mg/kg	252	
Vanadium	mg/kg	18	
Zinc	mg/kg	55.4	

Location		TNTC-S0252	
Sample No.		AB0473	
Sample Date		29-SEP-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics			
2A-4,6-DNT	mg/kg	0.275	
DNT	mg/kg	0.121	
TNT	mg/kg	1.32	
Semivolatiles			
Bis(2-ethylhexyl)phthalate	mg/kg	0.0207	J
Metals			
Aluminum	mg/kg	11000	
Arsenic	mg/kg	**18.5**	
Barium	mg/kg	62.3	
Beryllium	mg/kg	0.683	
Calcium	mg/kg	34700	
Chromium	mg/kg	17.2	
Cobalt	mg/kg	10.8	
Copper	mg/kg	29.7	
Iron	mg/kg	**27600**	
Lead	mg/kg	14.6	
Magnesium	mg/kg	10300	
Manganese	mg/kg	295	
Mercury	mg/kg	0.019	J
Nickel	mg/kg	31.9	
Potassium	mg/kg	2690	
Sodium	mg/kg	264	
Vanadium	mg/kg	20.9	
Zinc	mg/kg	91.4	

Location		TNTC-S0104	
Sample No.		AB0104	
Sample Date		27-Jul-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.19	J

Location		TNTC-S0317	
Sample No.		AB0317	
Sample Date		23-SEP-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2A-4,6-DNT	mg/kg	0.226	J
4A-2,6-DNT	mg/kg	0.444	
TNT	mg/kg	0.608	

Location		TNTC-S0100	
Sample No.		AB0253	
Sample Date		18-Aug-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	1.97	
2A-4,6-DNT	mg/kg	0.16	J
4A-2,6-DNT	mg/kg	0.16	J

Location		TNTC-S0100	
Sample No.		AB0100	
Sample Date		27-Jul-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.54	
TNT	mg/kg	**47.2**	
2A-4,6-DNT	mg/kg	0.64	
4A-2,6-DNT	mg/kg	0.44	

Location		TNTC-S0100	
Sample No.		AB0476	
Sample Date		12-OCT-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics			
2A-4,6-DNT	mg/kg	**6.44**	
NB	mg/kg	0.195	
TNB	mg/kg	0.499	
TNT	mg/kg	**2226**	
Volatiles			
Acetone	mg/kg	0.0196	J
Carbon disulfide	mg/kg	0.00175	J
Methylene chloride	mg/kg	0.00798	B
Semivolatiles			
Bis(2-ethylhexyl)phthalate	mg/kg	0.0324	J
Diethylphthalate	mg/kg	0.622	B
Dinitrotoluene, 2,4-	mg/kg	0.496	
Pesticides/PCBs			
Aroclor 1260	mg/kg	**0.26**	
Metals			
Aluminum	mg/kg	4540	J
Antimony	mg/kg	0.654	B
Arsenic	mg/kg	3.32	
Barium	mg/kg	28.3	
Beryllium	mg/kg	0.36	J
Cadmium	mg/kg	0.498	J
Calcium	mg/kg	10700	J
Chromium	mg/kg	9.85	
Cobalt	mg/kg	3.23	
Copper	mg/kg	35.9	
Iron	mg/kg	11500	
Lead	mg/kg	111	J
Magnesium	mg/kg	1910	J
Manganese	mg/kg	211	J
Mercury	mg/kg	0.072	J
Nickel	mg/kg	8.95	
Potassium	mg/kg	706	J
Sodium	mg/kg	134	B
Vanadium	mg/kg	17.1	
Zinc	mg/kg	86.1	

LEGEND:

- △ ABO-101 — SCREENING SOIL SAMPLING LOCATION
- • ABO-253 — SURFACE SOIL SAMPLE (0 - 2 FT)
- ○ GW-05 — GROUNDWATER SAMPLING LOCATION
- □ ABO-476 — CONFIRMATION SOIL SAMPLING LOCATION
- TNTC-S21 — HISTORICAL SOIL BORING LOCATION
- TNTB-S6 — HISTORICAL SOIL BORING LOCATION WITH EXPLOSIVES DETECTION
- FORMER TANK LOCATION
- FORMER BUILDING LOCATION
- POTENTIAL NITROAROMATIC REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 PRELIMINARY REMEDIATION GOALS ARE SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLING DEPTHS

SAMPLE	DEPTH (FT)
AB0098	1.0 - 2.0
AB0099	0.5 - 1.5
AB0100	2.0 - 3.0
AB0101	0.5 - 1.5
AB0102	1.0 - 2.0
AB0103	1.0 - 2.0
AB0104	2.0 - 3.0
AB0105	0.5 - 1.5
AB0106	3.0 - 4.0
AB0107	3.0 - 4.0
AB0108	1.0 - 2.0
AB0109	1.0 - 2.0
AB0110	1.0 - 2.0
AB0111	0.5 - 1.5
AB0112	0.5 - 1.5
AB0113	0.5 - 1.5
AB0251	0.5 - 1.5
AB0252	0.5 - 1.5
AB0253	0.0 - 1.0
AB0254	1.5 - 2.5
AB0255	1.0 - 2.0
AB0256	0.5 - 1.5
AB0257	1.0 - 2.0
AB0258	1.0 - 2.0
AB0259	0.5 - 1.5
AB0260	0.0 - 1.0
AB0261	1.0 - 2.0
AB0262	1.0 - 2.0
AB0263	0.0 - 1.0
AB0264	1.0 - 2.0
AB0300	5.0 - 6.0
AB0316	1.0 - 2.0
AB0317	1.0 - 2.0
AB0361	4.0 - 6.0
AB0362	8.0 - 10.0
AB0432	0.0 - 1.0
AB0433	3.0 - 4.0
AB0449	0.5 - 1.5
AB0450	0.5 - 1.5
AB0451	0.5 - 1.5
AB0473	4.0 - 6.0
AB0474	8.0 - 10.0
AB0476	2.0 - 3.0

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	1619	8	480

8. GROUNDWATER ENCOUNTERED AT 8 FEET IN SEPTEMBER 2000, C-361/362 BORING. GROUNDWATER MEASURED IN TEMPORARY PIEZOMETER GW-05 AT 0.90 FEET. BEDROCK WAS ENCOUNTERED AT 16.55 FEET.
9. COMBINED PAH CHEMICALS OF CONCERN EXCEEDING 1 mg/kg RGO IN SAMPLE AB0432.

FIGURE 1-30
TNT AREA C BUILDING 616 WASH HOUSE LINE 11, ANALYTICAL RESULTS AND ESTIMATED AREA/VOLUME OF SOIL REQUIRING REMEDIATION

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

SCALE 0 20 40 FEET

Shaw Environmental, Inc.

DWG. NO.: 807112ES.069 | PROJ. NO.: 807112
INITIATOR: T. SIARD | PROJ. MGR.: S. DOWNEY
DRAFT. CHCK. BY: C. TUMLIN | ENGR. CHCK. BY: T. SIARD
DATE LAST REV.: | DRAWN BY:
STARTING DATE: 10/22/02 | DRAWN BY: B.VANDERGRIFF

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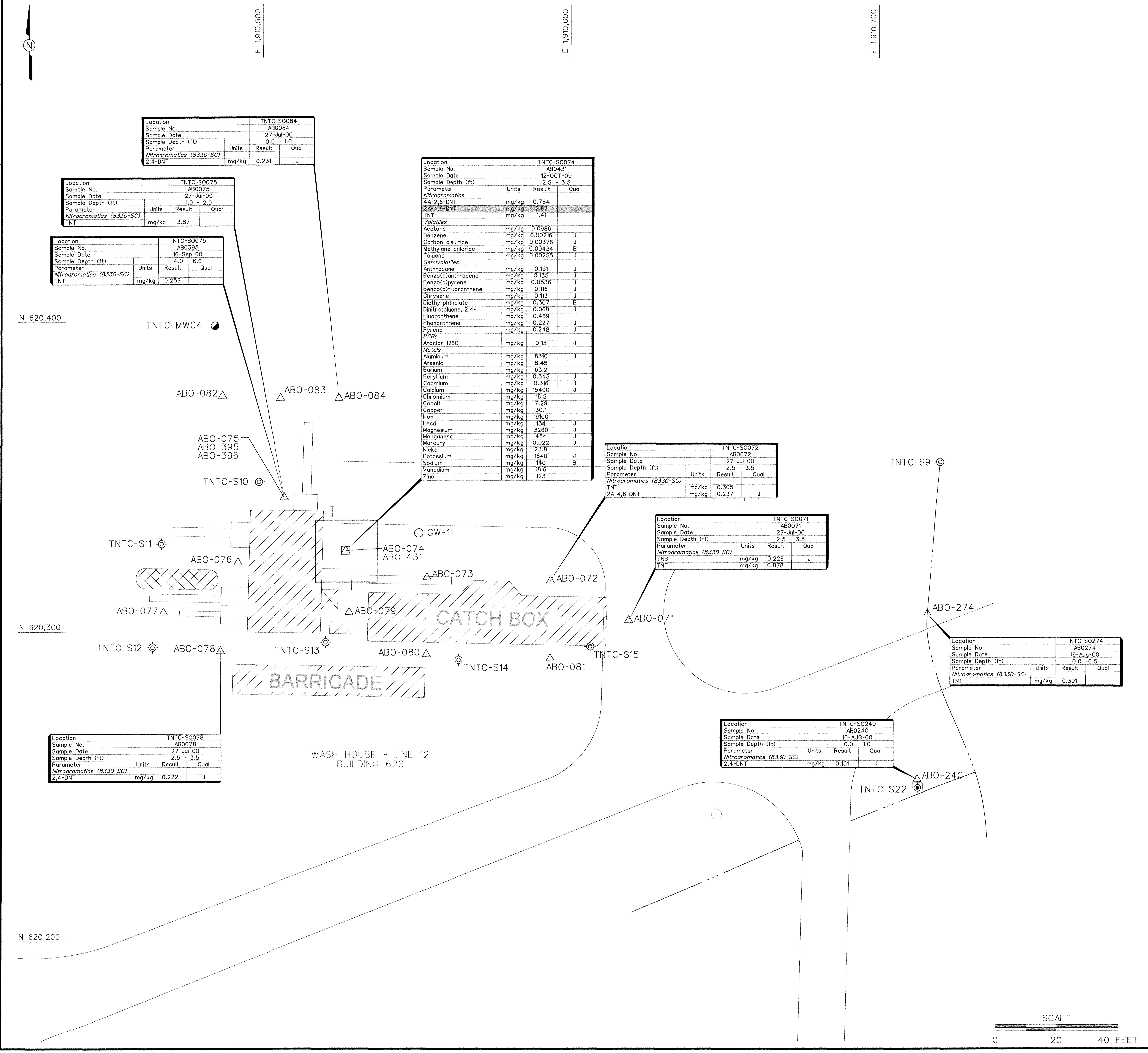


Location		TNTC-S0084	
Sample No.		AB0084	
Sample Date		27-Jul-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.231	J

Location		TNTC-S0075	
Sample No.		AB0075	
Sample Date		27-Jul-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	3.87	

Location		TNTC-S0075	
Sample No.		AB0395	
Sample Date		16-Sep-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.259	

Location		TNTC-S0074	
Sample No.		AB0431	
Sample Date		12-OCT-00	
Sample Depth (ft)		2.5 - 3.5	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	0.784	
2A-4,6-DNT	mg/kg	2.67	
TNT	mg/kg	1.41	
Volatiles			
Acetone	mg/kg	0.0986	
Benzene	mg/kg	0.00216	J
Carbon disulfide	mg/kg	0.00376	J
Methylene chloride	mg/kg	0.00434	B
Toluene	mg/kg	0.00255	J
Semivolatiles			
Anthracene	mg/kg	0.151	J
Benzo(a)anthracene	mg/kg	0.135	J
Benzo(a)pyrene	mg/kg	0.0536	J
Benzo(b)fluoranthene	mg/kg	0.116	J
Chrysene	mg/kg	0.113	J
Diethyl phthalate	mg/kg	0.307	B
Dinitrotoluene, 2,4-	mg/kg	0.068	J
Fluoranthene	mg/kg	0.469	
Phenanthrene	mg/kg	0.227	J
Pyrene	mg/kg	0.248	J
PCBs			
Aroclor 1260	mg/kg	0.15	J
Metals			
Aluminum	mg/kg	8310	J
Arsenic	mg/kg	**8.45**	
Barium	mg/kg	63.2	
Beryllium	mg/kg	0.543	J
Cadmium	mg/kg	0.316	J
Calcium	mg/kg	15400	J
Chromium	mg/kg	16.5	
Cobalt	mg/kg	7.29	
Copper	mg/kg	30.1	
Iron	mg/kg	19100	
Lead	mg/kg	**134**	J
Magnesium	mg/kg	3260	J
Manganese	mg/kg	454	J
Mercury	mg/kg	0.022	J
Nickel	mg/kg	23.8	
Potassium	mg/kg	1640	J
Sodium	mg/kg	140	B
Vanadium	mg/kg	18.6	
Zinc	mg/kg	123	

Location		TNTC-S0072	
Sample No.		AB0072	
Sample Date		27-Jul-00	
Sample Depth (ft)		2.5 - 3.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.305	
2A-4,6-DNT	mg/kg	0.237	J

Location		TNTC-S0071	
Sample No.		AB0071	
Sample Date		27-Jul-00	
Sample Depth (ft)		2.5 - 3.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.226	J
TNT	mg/kg	0.878	

Location		TNTC-S0274	
Sample No.		AB0274	
Sample Date		19-Aug-00	
Sample Depth (ft)		0.0 -0.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.301	

Location		TNTC-S0078	
Sample No.		AB0078	
Sample Date		27-Jul-00	
Sample Depth (ft)		2.5 - 3.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.222	J

Location		TNTC-S0240	
Sample No.		AB0240	
Sample Date		10-AUG-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.151	J

LEGEND:

- △ ABO-178 — SCREENING SOIL SAMPLING LOCATION
- □ ABO-465 — CONFIRMATION SOIL SAMPLING LOCATION
- TNTC-S10 — HISTORICAL SOIL BORING LOCATION
- TNTC-S22 — HISTORICAL SOIL BORING LOCATION WITH EXPLOSIVES DETECTION
- TNTC-MW04 — OVERBURDEN MONITORING WELL LOCATION
- ○ GW-11 — JULY 2001 TEMPORARY PIEZOMETER LOCATION (DRY)
- FORMER TANK LOCATION
- FORMER BUILDING FOUNDATION
- POTENTIAL REMEDIATION AREA
- FIRE HYDRANT

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 PRELIMINARY REMEDIATION GOALS ARE SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLING DEPTHS

SAMPLE	DEPTH (FT)
AB0071	2.5 - 3.5
AB0072	2.5 - 3.5
AB0073	2.5 - 3.5
AB0074	2.5 - 3.5
AB0075	1.0 - 2.0
AB0076	2.5 - 3.5
AB0077	2.5 - 3.5
AB0078	2.5 - 3.5
AB0079	2.5 - 3.5
AB0080	2.5 - 3.5
AB0081	2.5 - 3.5
AB0082	0.0 - 1.0
AB0083	0.0 - 1.0
AB0084	0.0 - 1.0
AB0240	0.0 - 1.0
AB0395	4.0 - 6.0
AB0396	8.0 - 10.0
AB0431	2.5 - 3.5

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	400	8	119

8. ENCOUNTERED GROUNDWATER AT 8 FEET IN SEPTEMBER 2000 BORING C-395/396. BEDROCK NOT DETECTED IN 10 FOOT BORING.
9. GROUNDWATER NOT PRESENT IN JULY 2001 TEMPORARY PIEZOMETER GW-11, BEDROCK ENCOUNTERED AT 8.5 FEET.
10. ENCOUNTERED BEDROCK AT 18 FEET, GROUNDWATER AT 16 FEET IN OCTOBER 1994 BORING TNTC-MW04.

SCALE
0 20 40 FEET

FIGURE 1-31
TNT AREA C
BUILDING 626
WASH HOUSE - LINE 12
ANALYTICAL RESULTS AND
ESTIMATED AREA/VOLUME
OF SOIL REQUIRING REMEDIATION

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw Environmental, Inc.

DWG. NO.: 807112ES.028 | PROJ. NO.: 807112 | INITIATOR: T. SIARD | PROJ. MGR.: S. DOWNEY | DRAFT. CHCK. BY: | ENGR. CHCK. BY: D. KESSLER | DATE LAST REV.: | DRAWN BY: | STARTING DATE: 10/30/00 | DRAWN BY: B.VANDERGRIFF

c:\cadd\design\807112es.028 02:16:08 PM 08/26/03 iwaters

STARTING DATE: 10/22/02	DATE LAST REV.:	DRAFT. CHCK. BY: C. TUMLIN	INITIATOR: T. SIARD	DWG. NO.: 807112es.070
DRAWN BY: B.VANDERGRIFF	DRAWN BY:	ENGR. CHCK. BY: T. SIARD	PROJ. MGR.: S. DOWNEY	PROJ. NO.: 807112

E 1,910,000 | E 1,910,100 | E 1,910,200 | E 1,910,300 | E 1,910,400

N 619,900 | N 619,800 | N 619,700 | N 619,600

Location		TNTC-S0066	
Sample No.		AB0066	
Sample Date		26-Jul-00	
Sample Depth (ft)		2.5 - 3.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.42	
DNB	mg/kg	0.15	J
TNT	mg/kg	**14.5**	
2,4-DNT	mg/kg	**40.5**	
4A-2,6-DNT	mg/kg	5.04	
Tetryl	mg/kg	3.9	
2-NT	mg/kg	0.59	
4-NT	mg/kg	0.33	

Location		TNTC-S0066	
Sample No.		AB0429	
Sample Date		27-SEP-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	0.0721	J
2A-4,6-DNT	mg/kg	0.0538	J
DNT	mg/kg	0.451	
TNT	mg/kg	0.164	
Volatiles			
Acetone	mg/kg	0.445	
Butanone, 2-	mg/kg	0.0818	
Carbon disulfide	mg/kg	0.0123	
Methylene chloride	mg/kg	0.0188	B
Semivolatiles			
Dinitrotoluene, 2,4-	mg/kg	0.239	J
Dinitrotoluene, 2,6-	mg/kg	0.0668	J
PCBs			
Aroclor 1260	mg/kg	5.07	
Metals			
Aluminum	mg/kg	6560	J
Antimony	mg/kg	8.15	J
Arsenic	mg/kg	**7.55**	
Barium	mg/kg	365	
Beryllium	mg/kg	0.602	
Calcium	mg/kg	18500	J
Chromium	mg/kg	11	
Cobalt	mg/kg	9.63	
Copper	mg/kg	17.1	J
Iron	mg/kg	**35500**	
Lead	mg/kg	**132**	J
Magnesium	mg/kg	5780	J
Manganese	mg/kg	**5160**	
Mercury	mg/kg	0.048	
Nickel	mg/kg	15.8	
Potassium	mg/kg	800	
Sodium	mg/kg	223	J
Vanadium	mg/kg	16	
Zinc	mg/kg	93.1	

Location		TNTC-S0066	
Sample No.		AB0363	
Sample Date		14-Sep-00	
Sample Depth (ft)		5.0 - 7.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	4.06	
DNB	mg/kg	0.176	J
TNT	mg/kg	1.21	
2,4-DNT	mg/kg	**319**	
4A-2,6-DNT	mg/kg	0.908	
3-NT	mg/kg	13.6	
2-NT	mg/kg	88.2	
4-NT	mg/kg	120	

Location		TNTC-S0066	
Sample No.		AB0364	
Sample Date		14-Sep-00	
Sample Depth (ft)		8.0 - 10.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.321	
DNB	mg/kg	0.359	
TNT	mg/kg	**84.2**	
2,4-DNT	mg/kg	**456**	
NB	mg/kg	0.382	
3-NT	mg/kg	71.7	
2-NT	mg/kg	**628**	
4-NT	mg/kg	**597**	

Location		TNTC-S0066	
Sample No.		AB0272	
Sample Date		18-Aug-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.44	
2,4-DNT	mg/kg	**1.41**	
2A-4,6-DNT	mg/kg	0.46	
4A-2,6-DNT	mg/kg	0.32	

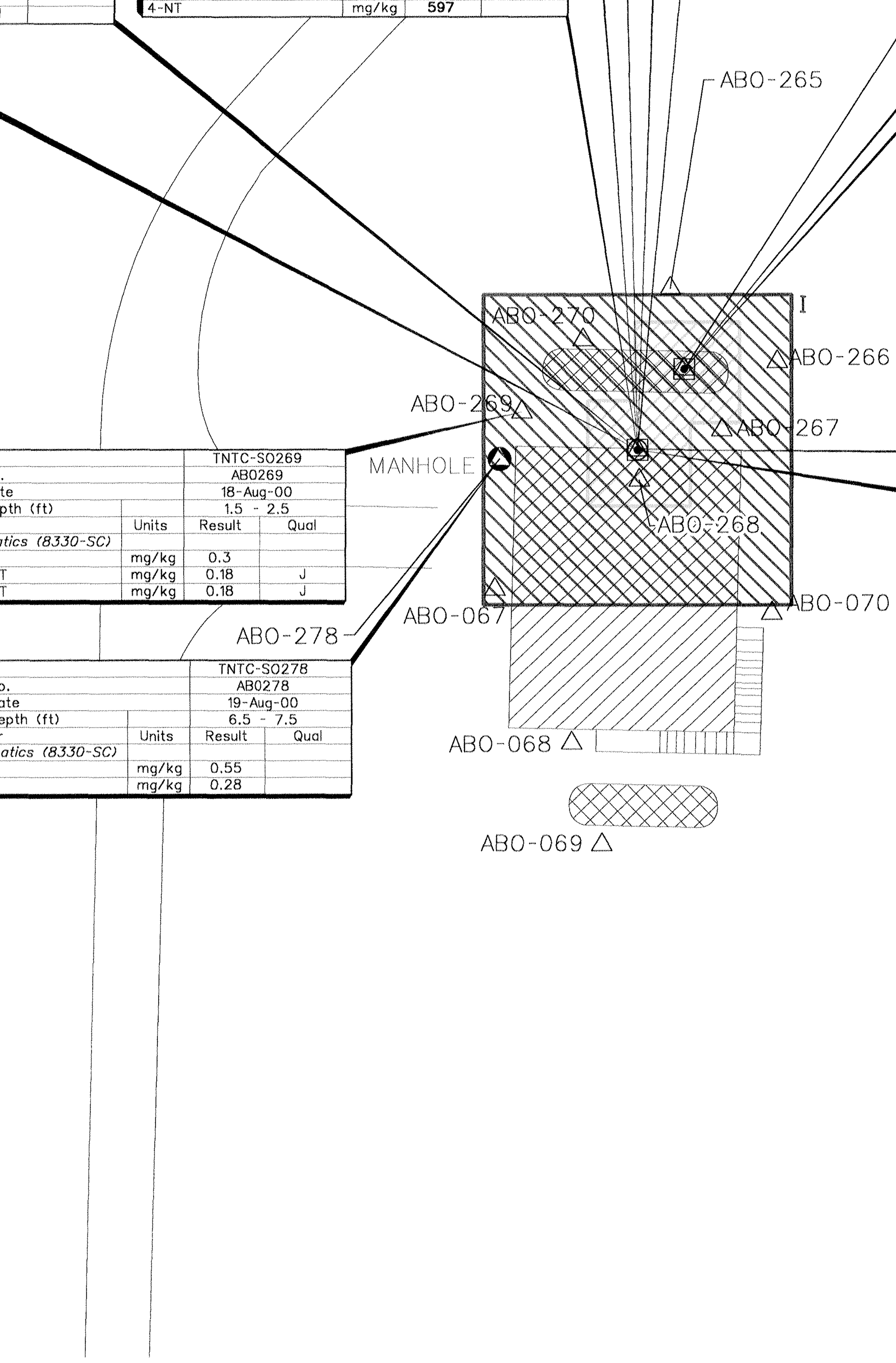
Location		TNTC-S0065	
Sample No.		AB0065	
Sample Date		26-Jul-00	
Sample Depth (ft)		2.5 - 3.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.49	
2,4-DNT	mg/kg	**1.06**	

Location		TNTC-S0065	
Sample No.		AB0475	
Sample Date		12-OCT-00	
Sample Depth (ft)		2.5 - 3.5	
Parameter	Units	Result	Qual
Volatiles			
Acetone	mg/kg	0.112	
Benzene	mg/kg	0.00241	J
Carbon disulfide	mg/kg	0.0109	
Methylene chloride	mg/kg	0.0061	B
Toluene	mg/kg	0.00385	J
Semivolatiles			
Benzo(a)anthracene	mg/kg	0.0454	J
Benzo(a)pyrene	mg/kg	0.043	J
Bis(2-ethylhexyl)phthalate	mg/kg	0.0237	J
Diethyl phthalate	mg/kg	0.585	B
Dinitrotoluene, 2,4-	mg/kg	0.0558	J
PCBs			
Aroclor 1254	mg/kg	**0.969**	
Aroclor 1260	mg/kg	**1.58**	
Metals			
Aluminum	mg/kg	11200	J
Antimony	mg/kg	1.09	B
Arsenic	mg/kg	**6.79**	
Barium	mg/kg	96.6	
Beryllium	mg/kg	0.721	J
Cadmium	mg/kg	0.194	J
Calcium	mg/kg	28700	J
Chromium	mg/kg	14.3	
Cobalt	mg/kg	7.71	
Copper	mg/kg	12.9	
Iron	mg/kg	**30500**	
Lead	mg/kg	41.1	J
Magnesium	mg/kg	3320	J
Manganese	mg/kg	**2120**	J
Mercury	mg/kg	0.068	J
Nickel	mg/kg	21.8	
Potassium	mg/kg	951	J
Sodium	mg/kg	140	B
Vanadium	mg/kg	24.6	
Zinc	mg/kg	96.1	

Location		TNTC-S0066	
Sample No.		AB0461	
Sample Date		28-SEP-00	
Sample Depth (ft)		5.0 - 7.0	
Parameter	Units	Result	Qual
Nitroaromatics			
DNT	mg/kg	**297**	
2-NT	mg/kg	50.8	
3-NT	mg/kg	8.61	
4-NT	mg/kg	67.4	
TNB	mg/kg	3.59	
TNT	mg/kg	5.19	
Volatiles			
Benzene	mg/kg	0.00342	J
Methylene chloride	mg/kg	0.00358	B
Toluene	mg/kg	0.0781	J
Xylene, o-	mg/kg	0.0019	J
Semivolatiles			
Dinitrotoluene, 2,4-	mg/kg	**170**	
Dinitrotoluene, 2,6-	mg/kg	**65.5**	
PCBs			
Aroclor 1260	mg/kg	0.16	J
Metals			
Aluminum	mg/kg	7850	J
Arsenic	mg/kg	**6.06**	
Barium	mg/kg	35.4	
Beryllium	mg/kg	0.595	
Calcium	mg/kg	157000	
Chromium	mg/kg	13.7	
Cobalt	mg/kg	12	
Copper	mg/kg	19.2	
Iron	mg/kg	**32600**	
Lead	mg/kg	9.86	
Magnesium	mg/kg	3670	
Manganese	mg/kg	1130	
Nickel	mg/kg	46.6	
Potassium	mg/kg	2730	
Sodium	mg/kg	292	B
Vanadium	mg/kg	12	
Zinc	mg/kg	44.5	

Location		TNTC-S0269	
Sample No.		AB0269	
Sample Date		18-Aug-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.3	
2A-4,6-DNT	mg/kg	0.18	J
4A-2,6-DNT	mg/kg	0.18	J

Location		TNTC-S0278	
Sample No.		AB0278	
Sample Date		19-Aug-00	
Sample Depth (ft)		6.5 - 7.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.55	
2,4-DNT	mg/kg	0.28	



Location		TNTC-S0066	
Sample No.		AB0462	
Sample Date		28-SEP-00	
Sample Depth (ft)		8.0 - 10.0	
Parameter	Units	Result	Qual
Nitroaromatics			
DNT	mg/kg	**36.3**	
2-NT	mg/kg	6.32	
3-NT	mg/kg	1.09	
4-NT	mg/kg	6.59	
TNT	mg/kg	0.167	
Volatiles			
Benzene	mg/kg	0.00492	J
Ethylbenzene	mg/kg	0.00248	J
Methylene chloride	mg/kg	0.00456	B
Toluene	mg/kg	0.0186	J
Xylene, o-	mg/kg	0.00323	J
Xylenes, m,p-	mg/kg	0.00605	J
Semivolatiles			
Dinitrotoluene, 2,4-	mg/kg	**13.2**	
Dinitrotoluene, 2,6-	mg/kg	**6.83**	
PCBs			
Aroclor 1260	mg/kg	0.103	J
Metals			
Aluminum	mg/kg	5180	J
Arsenic	mg/kg	**2.47**	
Barium	mg/kg	22.9	
Beryllium	mg/kg	0.5	
Calcium	mg/kg	225000	
Chromium	mg/kg	9.53	
Cobalt	mg/kg	6.24	
Copper	mg/kg	11	
Iron	mg/kg	11300	
Lead	mg/kg	4.86	B
Magnesium	mg/kg	3390	
Manganese	mg/kg	1620	
Nickel	mg/kg	18.5	
Potassium	mg/kg	2410	
Sodium	mg/kg	387	
Vanadium	mg/kg	8.92	
Zinc	mg/kg	10.9	

Location		TNTC-S0066	
Sample No.		AB0430	
Sample Date		12-OCT-00	
Sample Depth (ft)		2.5 - 3.5	
Parameter	Units	Result	Qual
Nitroaromatics			
DNT	mg/kg	**165**	
2-NT	mg/kg	2.05	
3-NT	mg/kg	4.82	
TNT	mg/kg	**38**	
Volatiles			
Acetone	mg/kg	0.0495	J
Carbon disulfide	mg/kg	0.00365	J
Methylene chloride	mg/kg	0.00902	B
Semivolatiles			
Dinitrotoluene, 2,4-	mg/kg	**43.1**	
Dinitrotoluene, 2,6-	mg/kg	**6.92**	
PCBs			
Aroclor 1260	mg/kg	**2.09**	J
Metals			
Aluminum	mg/kg	2330	J
Arsenic	mg/kg	**7.43**	
Barium	mg/kg	427	
Beryllium	mg/kg	0.219	J
Calcium	mg/kg	28200	J
Chromium	mg/kg	3.71	
Cobalt	mg/kg	0.297	J
Copper	mg/kg	3.56	
Iron	mg/kg	4010	
Lead	mg/kg	**761**	J
Magnesium	mg/kg	422	J
Manganese	mg/kg	105	J
Mercury	mg/kg	0.059	J
Nickel	mg/kg	4.17	
Potassium	mg/kg	1180	J
Sodium	mg/kg	78.2	B
Vanadium	mg/kg	6.68	
Zinc	mg/kg	5.8	

LEGEND:

- △ ABO-065 SCREENING SOIL SAMPLING LOCATION
- • ABO-271 SURFACE SOIL SAMPLE (0 - 2 FT)
- ○ GW-01 SEPTEMBER 2000 TEMPORARY PIEZOMETER LOCATION (DRY)
- □ ABO-475 CONFIRMATION SOIL SAMPLING LOCATION
- FORMER TANK LOCATION
- FORMER BUILDING LOCATION
- POTENTIAL NITROAROMATIC REMEDIATION AREA
- POTENTIAL LEAD/PCB REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 REMEDIATION GOAL OBJECTIVES SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLING DEPTHS

SAMPLE	DEPTH (FT)
AB0065	2.5 - 3.5
AB0066	2.5 - 3.5
AB0067	0.0 - 1.0
AB0068	1.0 - 2.0
AB0069	1.0 - 2.0
AB0070	0.0 - 1.0
AB0265	1.0 - 2.0
AB0266	1.0 - 2.0
AB0267	1.0 - 1.75
AB0268	1.0 - 2.0
AB0269	1.5 - 2.5
AB0270	1.0 - 2.0
AB0271	0.0 - 1.0
AB0272	0.0 - 1.0
AB0278	6.5 - 7.0
AB0297	0.0 - 1.0
AB0363	5.0 - 7.0
AB0364	8.0 - 10.0
AB0427	1.0 - 2.0
AB0428	1.0 - 2.0
AB0429	0.0 - 1.0
AB0430	2.5 - 3.5
AB0461	5.0 - 7.0
AB0462	8.0 - 10.0
AB0475	2.5 - 3.5

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	3600	10	1333

8. GROUNDWATER NOT ENCOUNTERED IN SEPTEMBER 2000 BORING C-363/364.
9. GROUNDWATER NOT PRESENT IN SEPTEMBER 2000 TEMPORARY PIEZOMETER GW-01. BEDROCK (PROBE REFUSAL) ENCOUNTERED AT 10 FEET.

FIGURE 1-32
TNT AREA C BUILDING 629 ACID & FUME RECOVERY ANALYTICAL RESULTS AND ESTIMATED AREA/VOLUME OF SOIL REQUIRING REMEDIATION

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

SCALE
0 30 60 FEET

Shaw Environmental, Inc.

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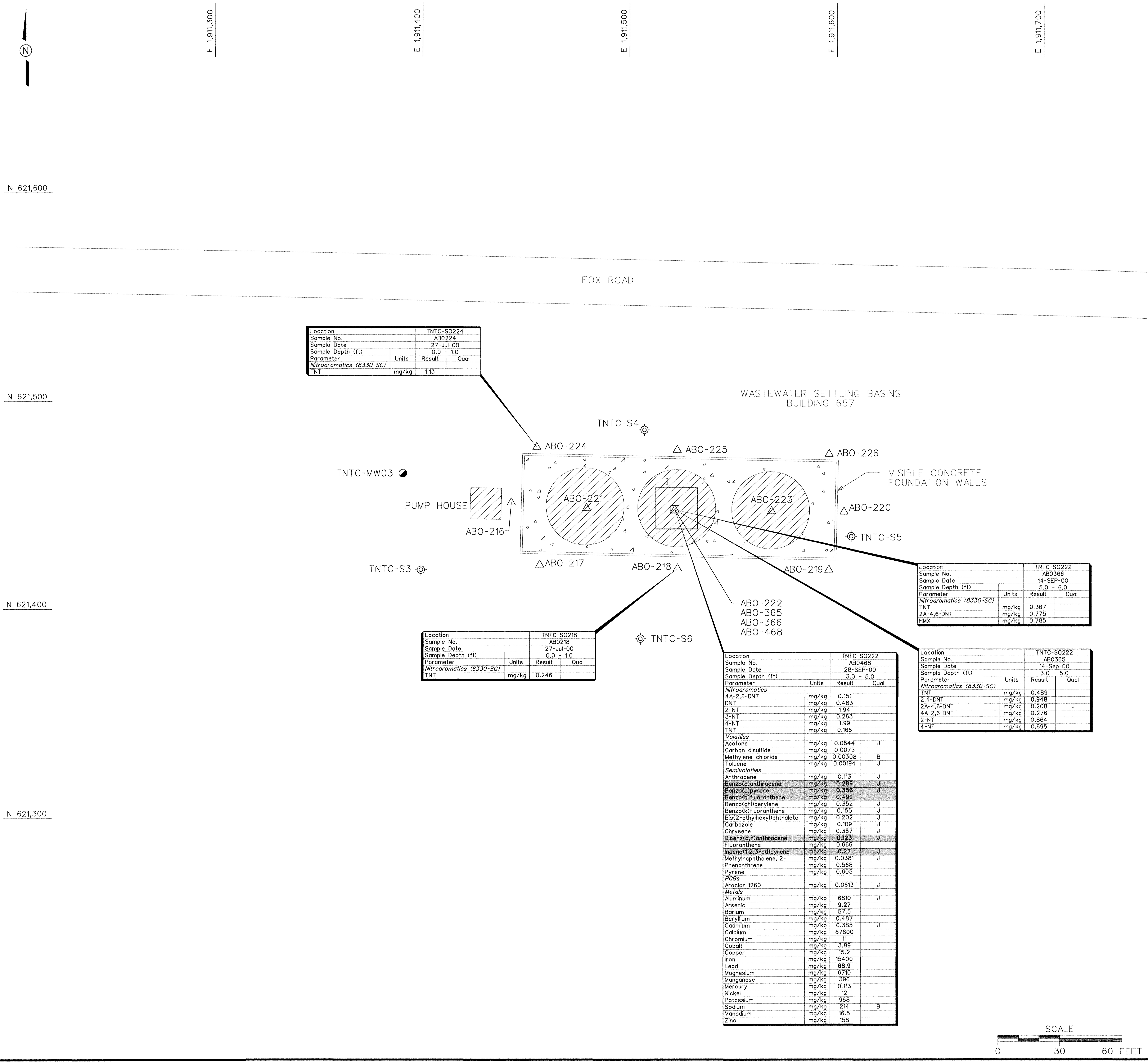
STARTING DATE: 11/01/00 | DATE LAST REV.: | DRAFT. CHCK. BY: C. TUMLIN | INTIATOR: GUNDERSON | DWG. NO.: 807112es.073
DRAWN BY: B.VANDERGRIFF | DRAWN BY: | ENGR. CHCK. BY: S. MUFFLER | PROJ. MGR.: SPANGBERG | PROJ. NO.: 807112
c:\cadd\design\807112es.073 01:28:39 PM 09/04/03 cbentley



Location		TNTC-S0224	
Sample No.		AB0224	
Sample Date		27-Jul-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	1.13	

Location		TNTC-S0218	
Sample No.		AB0218	
Sample Date		27-Jul-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.246	

Location		TNTC-S0222	
Sample No.		AB0366	
Sample Date		14-SEP-00	
Sample Depth (ft)		5.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.367	
2A-4,6-DNT	mg/kg	0.775	
HMX	mg/kg	0.785	

Location		TNTC-S0222	
Sample No.		AB0365	
Sample Date		14-Sep-00	
Sample Depth (ft)		3.0 - 5.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.489	
2,4-DNT	mg/kg	**0.948**	
2A-4,6-DNT	mg/kg	0.208	J
4A-2,6-DNT	mg/kg	0.276	
2-NT	mg/kg	0.864	
4-NT	mg/kg	0.695	

Location		TNTC-S0222	
Sample No.		AB0468	
Sample Date		28-SEP-00	
Sample Depth (ft)		3.0 - 5.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	0.151	
DNT	mg/kg	0.483	
2-NT	mg/kg	1.94	
3-NT	mg/kg	0.263	
4-NT	mg/kg	1.99	
TNT	mg/kg	0.166	
Volatiles			
Acetone	mg/kg	0.0644	J
Carbon disulfide	mg/kg	0.0075	
Methylene chloride	mg/kg	0.00308	B
Toluene	mg/kg	0.00194	J
Semivolatiles			
Anthracene	mg/kg	0.113	J
Benzo(a)anthracene	mg/kg	0.289	J
Benzo(a)pyrene	mg/kg	**0.356**	J
Benzo(b)fluoranthene	mg/kg	0.492	
Benzo(ghi)perylene	mg/kg	0.352	J
Benzo(k)fluoranthene	mg/kg	0.155	J
Bis(2-ethylhexyl)phthalate	mg/kg	0.202	J
Carbazole	mg/kg	0.109	J
Chrysene	mg/kg	0.357	J
Dibenz(a,h)anthracene	mg/kg	**0.123**	J
Fluoranthene	mg/kg	0.666	
Indeno(1,2,3-cd)pyrene	mg/kg	0.27	J
Methylnaphthalene, 2-	mg/kg	0.0381	J
Phenanthrene	mg/kg	0.568	
Pyrene	mg/kg	0.605	
PCBs			
Aroclor 1260	mg/kg	0.0613	J
Metals			
Aluminum	mg/kg	6810	J
Arsenic	mg/kg	**9.27**	
Barium	mg/kg	57.5	
Beryllium	mg/kg	0.487	
Cadmium	mg/kg	0.385	J
Calcium	mg/kg	67600	
Chromium	mg/kg	11	
Cobalt	mg/kg	3.89	
Copper	mg/kg	15.2	
Iron	mg/kg	15400	
Lead	mg/kg	**68.9**	
Magnesium	mg/kg	6710	
Manganese	mg/kg	396	
Mercury	mg/kg	0.113	
Nickel	mg/kg	12	
Potassium	mg/kg	968	
Sodium	mg/kg	214	B
Vanadium	mg/kg	16.5	
Zinc	mg/kg	158	

LEGEND:

- △ ABO-216 — SCREENING SOIL SAMPLING LOCATION
- □ ABO-468 — CONFIRMATION SOIL SAMPLING LOCATION
- TNTC-MW03 — OVERBURDEN MONITORING WELL LOCATION
- TNTC-S3 — HISTORICAL SOIL BORING LOCATION
- FORMER BUILDING LOCATION
- FORMER SETTLING BASIN LOCATION
- POTENTIAL REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 REMEDIATION GOAL OBJECTIVES ARE SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLING DEPTHS

SAMPLE	DEPTH (FT)
AB0216	0.0 - 1.0
AB0217	0.0 - 1.0
AB0218	0.0 - 1.0
AB0219	0.0 - 1.0
AB0220	0.0 - 1.0
AB0221	0.0 - 1.0
AB0222	0.0 - 1.0
AB0223	0.0 - 1.0
AB0224	0.0 - 1.0
AB0225	0.0 - 1.0
AB0226	0.0 - 1.0
AB0365	3.0 - 5.0
AB0366	5.0 - 6.0
AB0468	3.0 - 5.0

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	400	7	104

8. PROBE REFUSAL AT 7 FEET (POSSIBLE PAD BOTTOM) IN SEPTEMBER 2000 BORING C-365/366.

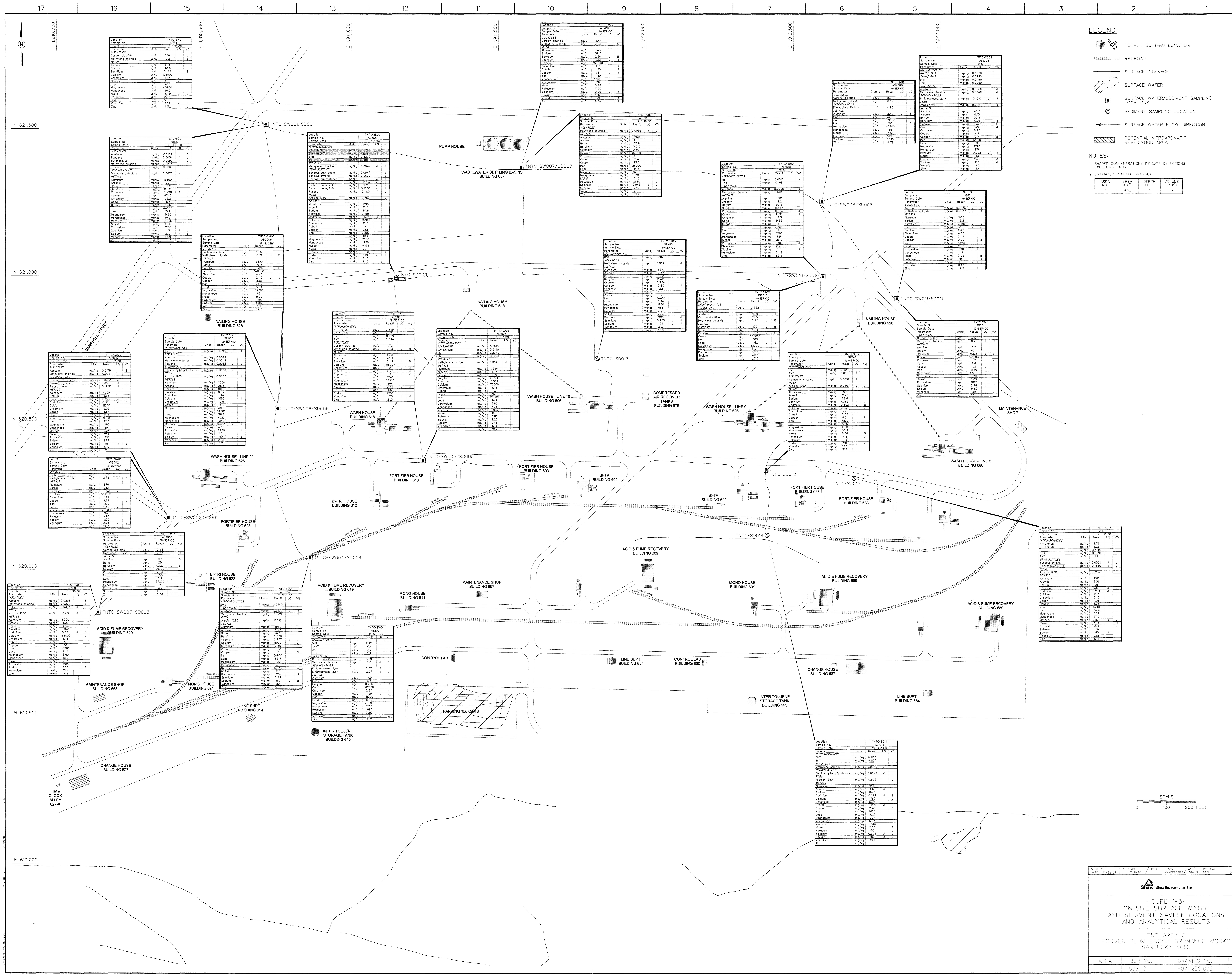
AUGER REFUSAL AT 14.5 FEET IN OCTOBER 1994 BORING TNTC-MW03. GROUNDWATER NO ENCOUNTERED.

GROUNDWATER WAS MEASURED IN WELL TNTC-MW03 NOVEMBER 21, 2002 AT A DEPTH OF 13.3 FEET BELOW GROUND SURFACE.

FIGURE 1-33
TNT AREA C
BUILDING 657 WASTEWATER SETTLING BASINS AND PUMP HOUSE
ANALYTICAL RESULTS AND ESTIMATED AREA/VOLUME OF SOIL REQUIRING REMEDIATION

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw® Shaw Environmental, Inc.



LEGEND:

- FORMER BUILDING LOCATION
- RAILROAD
- SURFACE DRAINAGE
- SURFACE WATER
- SURFACE WATER/SEDIMENT SAMPLING LOCATIONS
- SEDIMENT SAMPLING LOCATION
- SURFACE WATER FLOW DIRECTION
- POTENTIAL NITROAROMATIC REMEDIATION AREA

NOTES:

1. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
2. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	600	2	44

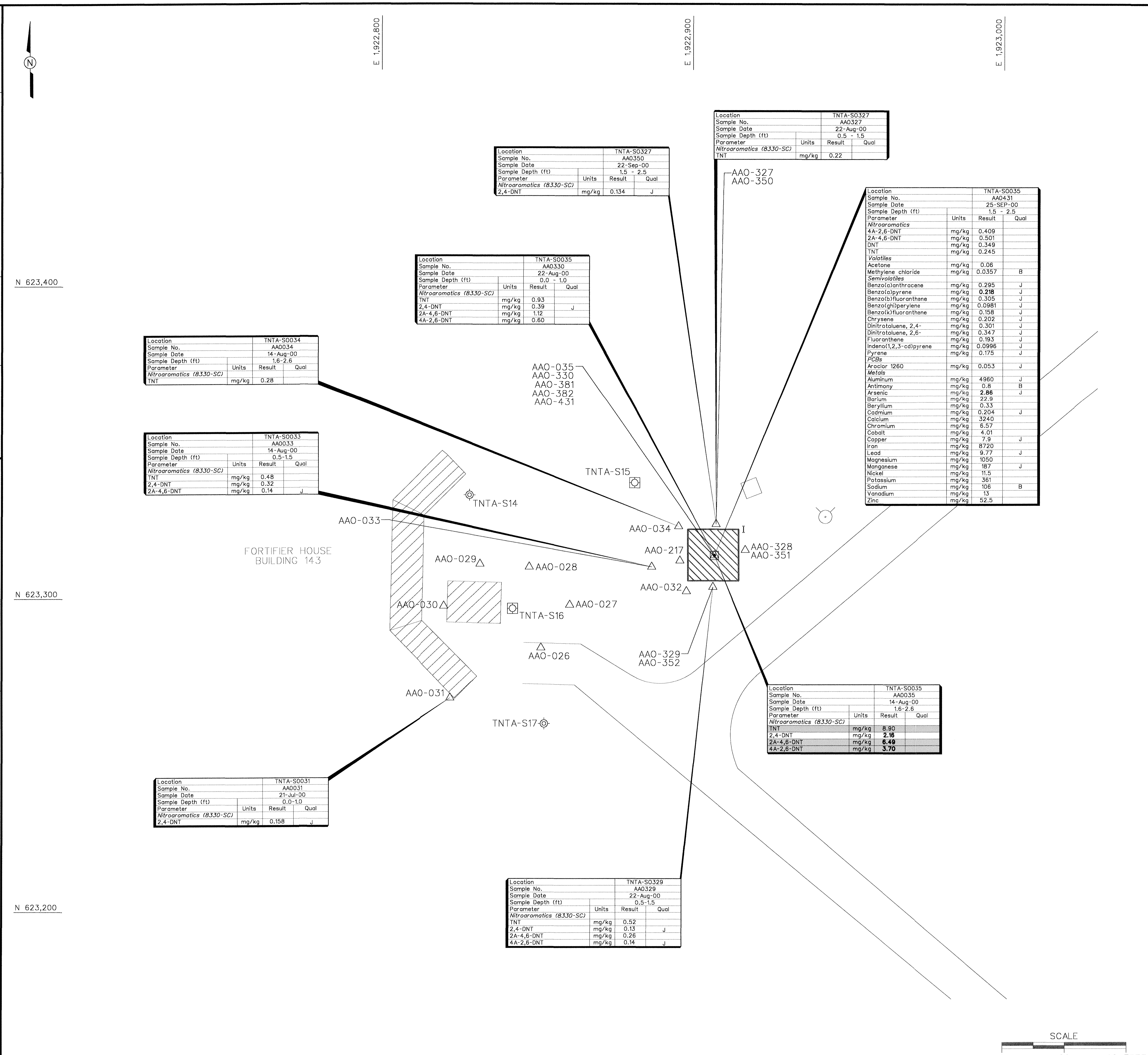
STARTING DATE	INITIATOR	CHKD	DRAWN	CHKD	PROJECT MNGR
10/22/02	T. SIARD		VANDERGRIFF	TUMLIN	S. DOWNEY

Shaw Environmental, Inc.

FIGURE 1-34
ON-SITE SURFACE WATER AND SEDIMENT SAMPLE LOCATIONS AND ANALYTICAL RESULTS

TNT AREA C
FORMER PLUM BROOK ORDNANCE WORKS
SANDUSKY, OHIO

AREA	JOB NO.	DRAWING NO.	REV
	807112	807112ES.072	



Location		TNTA-S0327	
Sample No.		AA0327	
Sample Date		22-Aug-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.22	

Location		TNTA-S0327	
Sample No.		AA0350	
Sample Date		22-Sep-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.134	J

Location		TNTA-S0035	
Sample No.		AA0330	
Sample Date		22-Aug-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.93	
2,4-DNT	mg/kg	0.39	J
2A-4,6-DNT	mg/kg	1.12	
4A-2,6-DNT	mg/kg	0.60	

Location		TNTA-S0034	
Sample No.		AA0034	
Sample Date		14-Aug-00	
Sample Depth (ft)		1.6-2.6	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.28	

Location		TNTA-S0033	
Sample No.		AA0033	
Sample Date		14-Aug-00	
Sample Depth (ft)		0.5-1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.48	
2,4-DNT	mg/kg	0.32	
2A-4,6-DNT	mg/kg	0.14	J

Location		TNTA-S0035	
Sample No.		AA0431	
Sample Date		25-SEP-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	0.409	
2A-4,6-DNT	mg/kg	0.501	
DNT	mg/kg	0.349	
TNT	mg/kg	0.245	
Volatiles			
Acetone	mg/kg	0.06	
Methylene chloride	mg/kg	0.0357	B
Semivolatiles			
Benzo(a)anthracene	mg/kg	0.295	J
Benzo(a)pyrene	mg/kg	**0.218**	J
Benzo(b)fluoranthene	mg/kg	0.305	J
Benzo(ghi)perylene	mg/kg	0.0981	J
Benzo(k)fluoranthene	mg/kg	0.158	J
Chrysene	mg/kg	0.202	J
Dinitrotoluene, 2,4-	mg/kg	0.301	J
Dinitrotoluene, 2,6-	mg/kg	0.347	J
Fluoranthene	mg/kg	0.193	J
Indeno(1,2,3-cd)pyrene	mg/kg	0.0996	J
Pyrene	mg/kg	0.175	J
PCBs			
Aroclor 1260	mg/kg	0.053	J
Metals			
Aluminum	mg/kg	4960	J
Antimony	mg/kg	0.8	B
Arsenic	mg/kg	**2.86**	J
Barium	mg/kg	22.9	
Beryllium	mg/kg	0.33	
Cadmium	mg/kg	0.204	J
Calcium	mg/kg	3240	
Chromium	mg/kg	6.57	
Cobalt	mg/kg	4.01	
Copper	mg/kg	7.9	J
Iron	mg/kg	8720	
Lead	mg/kg	9.77	J
Magnesium	mg/kg	1050	
Manganese	mg/kg	187	J
Nickel	mg/kg	11.5	
Potassium	mg/kg	361	
Sodium	mg/kg	106	B
Vanadium	mg/kg	13	
Zinc	mg/kg	52.5	

Location		TNTA-S0035	
Sample No.		AA0035	
Sample Date		14-Aug-00	
Sample Depth (ft)		1.6-2.6	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	**8.90**	
2,4-DNT	mg/kg	**2.16**	
2A-4,6-DNT	mg/kg	**6.49**	
4A-2,6-DNT	mg/kg	**3.70**	

Location		TNTA-S0031	
Sample No.		AA0031	
Sample Date		21-Jul-00	
Sample Depth (ft)		0.0-1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.158	J

Location		TNTA-S0329	
Sample No.		AA0329	
Sample Date		22-Aug-00	
Sample Depth (ft)		0.5-1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.52	
2,4-DNT	mg/kg	0.13	J
2A-4,6-DNT	mg/kg	0.26	
4A-2,6-DNT	mg/kg	0.14	J

LEGEND:

- △ AA0-027 — SCREENING SOIL SAMPLING LOCATION
- • AA0-330 — SURFACE SOIL SAMPLE (0 - 1FT)
- □ AA0-431 — CONFIRMATION SOIL SAMPLING LOCATION
- TNTA-S18 — HISTORICAL SOIL BORING LOCATION
- TNTA-S20 — HISTORICAL SOIL BORING LOCATION WITH EXPLOSIVES DETECTION
- FIRE HYDRANT
- FORMER TANK LOCATION
- FORMER BUILDING LOCATION
- POTENTIAL NITROAROMATIC REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 PRELIMINARY REMEDIATION GOALS ARE SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLING DEPTHS

SAMPLE	DEPTH (FT)
AA0026	2.0 - 3.0
AA0027	1.6 - 2.6
AA0028	1.6 - 2.6
AA0029	2.0 - 3.0
AA0030	1.0 - 2.0
AA0031	0.0 - 1.0
AA0032	1.6 - 2.6
AA0033	0.5 - 1.5
AA0034	1.6 - 2.6
AA0035	1.6 - 2.6
AA0217	1.5 - 2.5
AA0327	0.5 - 1.5
AA0328	0.5 - 1.5
AA0329	0.5 - 1.5
AA0330	0.0 - 1.0
AA0350	1.5 - 2.5
AA0351	1.5 - 2.5
AA0352	1.5 - 2.5
AA0381	4.0 - 6.0
AA0382	8.0 - 10.0
AA0431	1.5 - 2.5

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	266	7	69

8. GROUNDWATER ENCOUNTERED AT 7 FEET IN SEPTEMBER 2000 BORING A-381/382. BORING DRILLED TO 10 FEET, BEDROCK NOT ENCOUNTERED (IT, 2001a).

FIGURE 1-17
TNT AREA A
BUILDING 143 FORTIFIER HOUSE
ANALYTICAL RESULTS AND
ESTIMATED AREA/VOLUME OF SOIL
REQUIRING REMEDIATION

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw Environmental, Inc.

STARTING DATE: 10/22/02 | DATE LAST REV.: | DRAFT. CHCK. BY: C. TUMLIN | INITIATOR: T. SIARD | DWG. NO.: 807111ES.075
DRAWN BY: B.VANDERGRIFF | DRAWN BY: | ENGR. CHCK. BY: T. SIARD | PROJ. MGR.: S. DOWNEY | PROJ. NO.: 807111

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DWG. NO.: 807111ES.069	PROJ. NO.: 807111	INITIATOR: T. SARD	PROJ. MGR.: S. DOWNEY
DRAFT. CHCK. BY: C. TUMLIN	ENGR. CHCK. BY: T. SARD	DATE LAST REV.:	DRAWN BY:
STARTING DATE: 10/21/02	DRAWN BY: B.VANDERGRIFF		

E 1,922,400 E 1,922,500 E 1,922,600 E 1,922,700 E 1,922,800

N 623,600 N 623,500 N 623,400 N 623,300 N 623,200

Location		TNTA-S0080	
Sample No.		AA0463	
Sample Date		29-Sept-00	
Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	**16**	
2A-4,6-DNT	mg/kg	**32.6**	
NB	mg/kg	0.119	
TNB	mg/kg	0.123	
TNT	mg/kg	**530**	
Volatiles			
Acetone	mg/kg	0.0401	
Carbon disulfide	mg/kg	0.00202	J
Methylene chloride	mg/kg	0.00201	B
Semivolatiles			
Bis(2-ethylhexyl)phthalate	mg/kg	0.0231	J
Di-n-butylphthalate	mg/kg	0.216	J
Dinitrotoluene, 2,4-	mg/kg	0.296	J
PCBs			
Aroclor 1260	mg/kg	0.152	J
Metals			
Aluminum	mg/kg	11000	
Arsenic	mg/kg	**7.52**	
Barium	mg/kg	23	
Beryllium	mg/kg	0.61	
Calcium	mg/kg	30400	
Chromium	mg/kg	19.6	
Cobalt	mg/kg	12.9	
Copper	mg/kg	12.8	
Iron	mg/kg	18400	
Lead	mg/kg	22.5	
Magnesium	mg/kg	6600	
Manganese	mg/kg	336	
Mercury	mg/kg	0.034	J
Nickel	mg/kg	35.4	
Potassium	mg/kg	3190	
Sodium	mg/kg	338	
Vanadium	mg/kg	19.1	
Zinc	mg/kg	45.5	

Location		TNTA-S0384	
Sample No.		AA0384	
Sample Date		13-Sep-00	
Depth (ft)		8.0 - 10.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	85.3	
2,4-DNT	mg/kg	0.294	J
2A-4,6-DNT	mg/kg	1.54	J
4A-2,6-DNT	mg/kg	0.556	

Location		TNTA-S0332	
Sample No.		AA0332	
Sample Date		23-Aug-00	
Depth (ft)		0.5-1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.24	

Location		TNTA-S0222	
Sample No.		AA0222	
Sample Date		14-AUG-00	
Sample Depth (ft)		2.0 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	**4.01**	
2A-4,6-DNT	mg/kg	**4.73**	
DNT	mg/kg	**0.902**	
RDX	mg/kg	0.653	
TNB	mg/kg	0.689	
TNT	mg/kg	**469**	

Location		TNTA-S0223	
Sample No.		AA0223	
Sample Date		14-AUG-00	
Sample Depth (ft)		2.0 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	0.308	
2A-4,6-DNT	mg/kg	0.52	
TNT	mg/kg	2.55	

Location		TNTA-S0079	
Sample No.		AA0308	
Sample Date		15-Aug-00	
Depth (ft)		0.0-1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.13	J
2A-4,6-DNT	mg/kg	0.14	J
4A-2,6-DNT	mg/kg	0.2	J

Location		TNTA-S0079	
Sample No.		AA0079	
Sample Date		21-Jul-00	
Sample Depth (ft)		2 - 3	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	**103**	
2A-4,6-DNT	mg/kg	**3.97**	
4A-2,6-DNT	mg/kg	1.54	
TNB	mg/kg	1.02	

Location		TNTA-S0080	
Sample No.		AA0309	
Sample Date		15-Aug-00	
Depth (ft)		0.0-1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.47	
TNT	mg/kg	**261**	
2,4-DNT	mg/kg	0.36	
2A-4,6-DNT	mg/kg	**14.1**	
4A-2,6-DNT	mg/kg	**10.5**	

Location		TNTA-S0080	
Sample No.		AA0080	
Sample Date		21-Jul-00	
Sample Depth (ft)		0.5 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	4.66	
TNT	mg/kg	**1596**	
2,4-DNT	mg/kg	**9.18**	
2A-4,6-DNT	mg/kg	1.3	
NB	mg/kg	0.61	
DNB	mg/kg	1.18	

Location		TNTA-S0226	
Sample No.		AA0226	
Sample Date		14-AUG-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	0.679	
2A-4,6-DNT	mg/kg	1.01	
TNT	mg/kg	2.09	

Location		TNTA-S0080	
Sample No.		AA0383	
Sample Date		13-Sep-00	
Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.33	
2A-4,6-DNT	mg/kg	0.24	J
4A-2,6-DNT	mg/kg	0.225	J

Location		TNTA-S0227	
Sample No.		AA0227	
Sample Date		14-AUG-00	
Sample Depth (ft)		1.6 - 2.6	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	0.274	
2A-4,6-DNT	mg/kg	0.361	

Location		TNTA-S0081	
Sample No.		AA0310	
Sample Date		15-Aug-00	
Depth (ft)		0.0-1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	1.62	
2A-4,6-DNT	mg/kg	1.96	
4A-2,6-DNT	mg/kg	1.42	

Location		TNTA-S0081	
Sample No.		AA0081	
Sample Date		21-Jul-00	
Sample Depth (ft)		0.8 - 1.8	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	4.29	
DNB	mg/kg	1.03	
TNT	mg/kg	**2385**	
2,4-DNT	mg/kg	**14.1**	
2A-4,6-DNT	mg/kg	2.74	
HMX	mg/kg	0.60	
NB	mg/kg	0.28	

Location		TNTA-S0087	
Sample No.		AA0087	
Sample Date		21-Jul-00	
Sample Depth (ft)		0 - 1	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.143	J
2,4-DNT	mg/kg	0.33	

Location		TNTA-S0081	
Sample No.		AA0434	
Sample Date		25-SEP-00	
Depth (ft)		0.8 - 1.8	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	**5.84**	
2A-4,6-DNT	mg/kg	**9.59**	
TNB	mg/kg	0.178	
TNT	mg/kg	**163**	
Volatiles			
Acetone	mg/kg	0.0636	
Methylene chloride	mg/kg	0.037	B
Semivolatiles			
Dinitrotoluene, 2,4-	mg/kg	0.173	J
PCBs			
Aroclor 1260	mg/kg	**0.0634**	J
Metals			
Aluminum	mg/kg	6290	J
Arsenic	mg/kg	**2.94**	J
Barium	mg/kg	27.5	
Beryllium	mg/kg	0.396	
Cadmium	mg/kg	0.193	J
Calcium	mg/kg	11500	
Chromium	mg/kg	11.9	
Cobalt	mg/kg	3.76	
Copper	mg/kg	17.3	J
Iron	mg/kg	11500	
Lead	mg/kg	**50.3**	J
Magnesium	mg/kg	2190	
Manganese	mg/kg	267	J
Mercury	mg/kg	0.08	
Nickel	mg/kg	9.38	
Potassium	mg/kg	632	
Sodium	mg/kg	147	B
Vanadium	mg/kg	20.4	
Zinc	mg/kg	51.4	

Location		TNTA-S0232	
Sample No.		AA0232	
Sample Date		14-AUG-00	
Sample Depth (ft)		1.1 - 2.1	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
DNT	mg/kg	0.211	

Location		TNTA-S0085	
Sample No.		AA0085	
Sample Date		22-Jul-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
Tetryl	mg/kg	0.41	

Location		TNTA-S0083	
Sample No.		AA0083	
Sample Date		22-Jul-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.19	J

Location		TNTA-S0224	
Sample No.		AA0224	
Sample Date		14-AUG-00	
Sample Depth (ft)		1.6 - 2.6	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	0.179	
2A-4,6-DNT	mg/kg	0.195	
TNT	mg/kg	0.46	

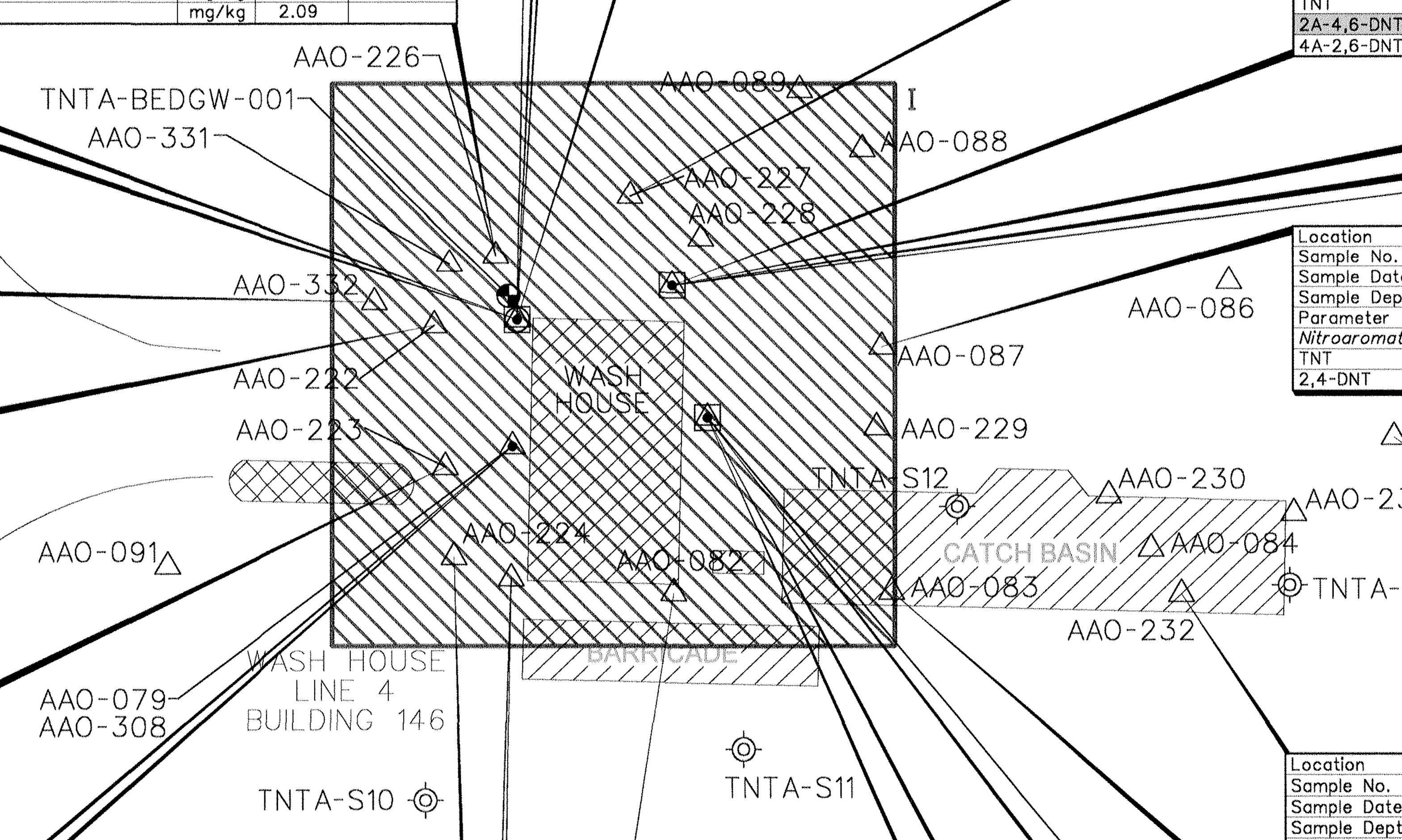
Location		TNTA-S0078	
Sample No.		AA0078	
Sample Date		21-Jul-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.2	
2,4-DNT	mg/kg	0.2	
4A-2,6-DNT	mg/kg	0.24	

Location		TNTA-S0082	
Sample No.		AA0082	
Sample Date		7/21/00	
Sample Depth (ft)		2 - 3	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.65	

Location		TNTA-S0225	
Sample No.		AA0353	
Sample Date		22-Sep-00	
Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	3.41	
2A-4,6-DNT	mg/kg	3.98	
4A-2,6-DNT	mg/kg	2.06	

Location		TNTA-S0225	
Sample No.		AA0225	
Sample Date		14-AUG-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	**47.6**	
2A-4,6-DNT	mg/kg	**4.64**	
DNB	mg/kg	0.487	
DNT	mg/kg	**5.65**	
NB	mg/kg	0.178	
RDX	mg/kg	2.48	
TNB	mg/kg	1.38	
TNT	mg/kg	**734**	

Location		TNTA-S0225	
Sample No.		AA0480	
Sample Date		11-OCT-00	
Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	**7.45**	
2A-4,6-DNT	mg/kg	**20.7**	
TNT	mg/kg	**205**	
Volatiles			
Acetone	mg/kg	0.0368	J
Methylene chloride	mg/kg	0.00695	B
Semivolatiles			
Bis(2-ethylhexyl)phthalate	mg/kg	0.0242	J
Dinitrotoluene, 2,4-	mg/kg	0.165	J
Dinitrotoluene, 2,6-	mg/kg	0.058	J
Metals			
Aluminum	mg/kg	11700	
Arsenic	mg/kg	**5.07**	
Barium	mg/kg	68.7	
Beryllium	mg/kg	0.759	
Cadmium	mg/kg	0.133	J
Calcium	mg/kg	7120	J
Chromium	mg/kg	19.3	J
Cobalt	mg/kg	11.1	
Copper	mg/kg	9.23	
Iron	mg/kg	19700	
Lead	mg/kg	11.1	J
Magnesium	mg/kg	3040	J
Manganese	mg/kg	423	
Mercury	mg/kg	0.078	J
Nickel	mg/kg	26.8	
Potassium	mg/kg	1960	J
Selenium	mg/kg	1	B
Sodium	mg/kg	201	J
Vanadium	mg/kg	22.4	
Zinc	mg/kg	47.2	J



LEGEND:

△ AAO-078	SCREENING SOIL SAMPLING LOCATION
• AAO-309	SURFACE SOIL SAMPLE (0 - 1 FT)
○ GW-05	SEPTEMBER 2000 TEMPORARY PIEZOMETER LOCATION (DRY)
□ AAO-434	CONFIRMATION SOIL SAMPLING LOCATION
TNTA-S12	HISTORIC SOIL BORING LOCATION
PB-TNTA-MW11	OVERBURDEN MONITORING WELL LOCATION
TNTA-BEDGW-001	BEDROCK MONITORING WELL LOCATION
	FORMER TANK LOCATION
	FORMER BUILDING LOCATION
	POTENTIAL NITROAROMATIC REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 PRELIMINARY REMEDIATION GOALS ARE SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLING DEPTHS

SAMPLE	DEPTH (FT)
AA0078	1.5 - 2.5
AA0079	2.0 - 3.0
AA0080	0.5 - 1.0
AA0081	0.8 - 1.8
AA0082	2.0 - 3.0
AA0083	1.5 - 2.5
AA0084	1.5 - 2.5
AA0085	1.5 - 2.5
AA0086	1.5 - 2.5
AA0087	0.0 - 1.0
AA0088	0.0 - 1.0
AA0089	0.0 - 1.0
AA0090	0.0 - 1.0
AA0091	1.0 - 2.0
AA0225	2.0 - 3.0
AA0229	1.0 - 2.0
AA0230	1.3 - 2.3
AA0231	1.6 - 2.6
AA0232	1.1 - 2.1
AA0233	1.0 - 2.0
AA0308	0.0 - 1.0
AA0309	0.0 - 1.0
AA0310	0.0 - 1.0
AA0331	0.3 - 1.5
AA0332	0.5 - 1.5
AA0353	0.0 - 1.0
AA0383	4.0 - 6.0
AA0384	8.0 - 10.0
AA0434	0.8 - 1.8
AA0435	0.8 - 1.8
AA0436	0.8 - 1.8
AA0463	4.0 - 6.0
AA0464	8.0 - 10.0
AA0480	2.0 - 3.0

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	7744	15	4302

8. OVERBURDEN GROUNDWATER AT MONITORING WELL TNTA-BEDGW-001 NOT ENCOUNTERED, AUGER REFUSAL (BEDROCK) AT 55 FEET. FOR CALCULATION PURPOSES, VERTICAL DEPTH ESTIMATED TO BE 15 FEET.

FIGURE 1-18
TNT AREA A
BUILDING 146
WASH HOUSE LINE 4
ANALYTICAL RESULTS AND ESTIMATED AREA/VOLUME OF SOIL REQUIRING REMEDIATION

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

SCALE
0 30 60 FEET

Shaw Environmental, Inc.

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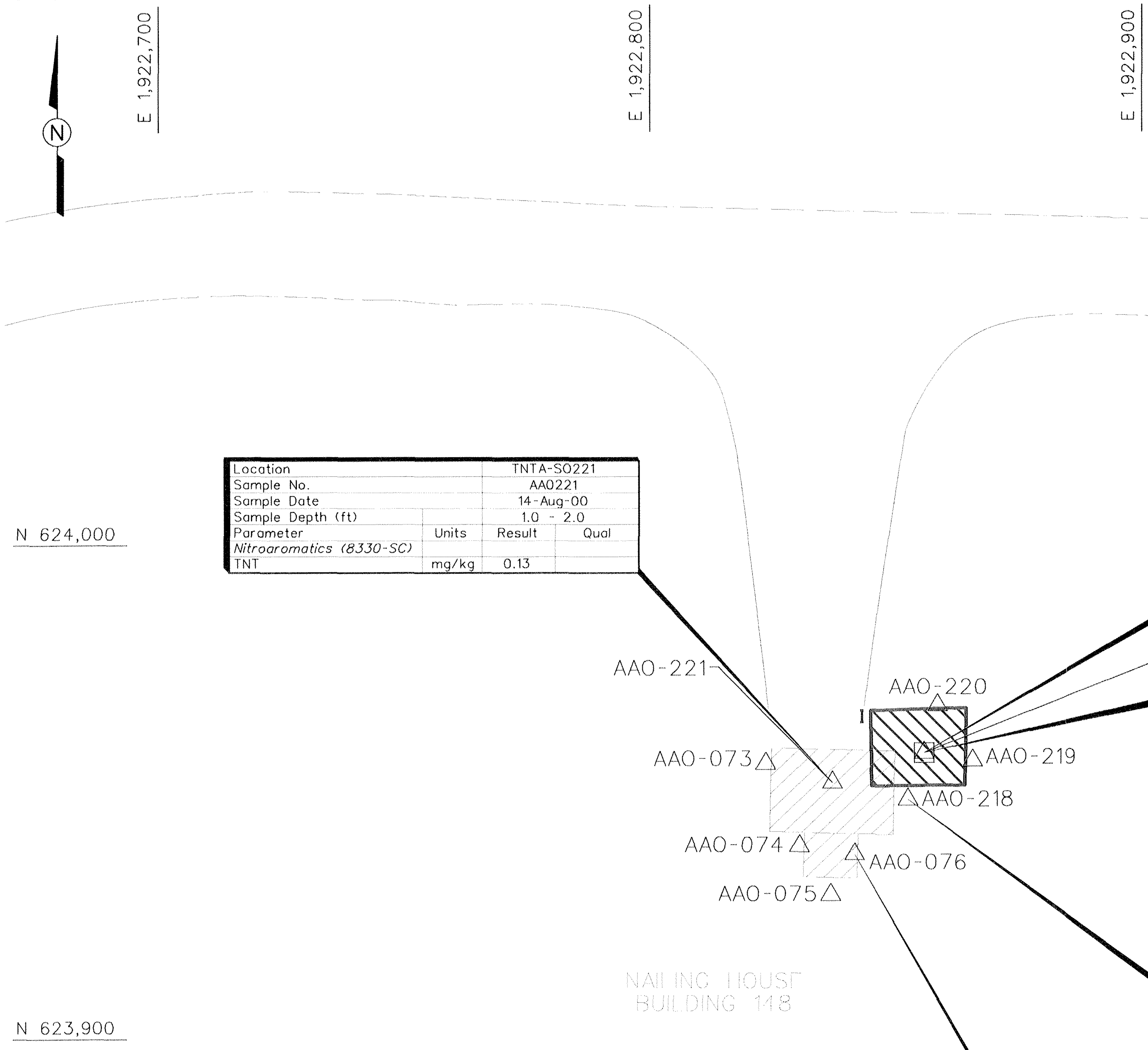


Location		TNTA-S0221	
Sample No.		AA0221	
Sample Date		14-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.13	

Location		TNTA-S0077	
Sample No.		AA0433	
Sample Date		25-Sept-00	
Sample Depth (ft)		0.7 - 1.7	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	0.329	
2A-4,6-DNT	mg/kg	1.04	
DNT	mg/kg	0.677	
TNT	mg/kg	1.27	
PCBs			
Aroclor 1260	mg/kg	**0.24**	
Semivolatiles			
2,4-DNT	mg/kg	0.092	J
Volatiles			
Acetone	mg/kg	0.055	
Methylene chloride	mg/kg	0.080	J
Metals			
Aluminum	mg/kg	5400	J
Arsenic	mg/kg	**3.67**	**J**
Barium	mg/kg	20.5	
Beryllium	mg/kg	0.331	
Cadmium	mg/kg	0.198	J
Calcium	mg/kg	5150	
Chromium	mg/kg	8.25	
Cobalt	mg/kg	4.17	
Copper	mg/kg	7.86	J
Iron	mg/kg	10400	
Lead	mg/kg	25.9	J
Magnesium	mg/kg	1220	
Manganese	mg/kg	221	J
Mercury	mg/kg	0.022	J
Nickel	mg/kg	11.2	
Potassium	mg/kg	516	
Sodium	mg/kg	151	B
Vanadium	mg/kg	15.3	
Zinc	mg/kg	50.3	

Location		TNTA-S0077	
Sample No.		AA0077	
Sample Date		22-Jul-00	
Sample Depth (ft)		0.7 - 1.7	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	13.2	
2,4-DNT	mg/kg	0.69	
2A-4,6-DNT	mg/kg	**4.55**	
4A-2,6-DNT	mg/kg	2.34	
TNB	mg/kg	0.14	J

Location		TNTA-S0218	
Sample No.		AA0218	
Sample Date		14-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.1	

Location		TNTA-S0076	
Sample No.		AA0076	
Sample Date		22-Jul-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.25	
2A-4,6-DNT	mg/kg	0.23	J
4A-2,6-DNT	mg/kg	0.22	J

LEGEND:

- △ AAO-073 — SCREENING SOIL SAMPLING LOCATION
- □ AAO-433 — CONFIRMATION SOIL SAMPLING LOCATION
- FORMER BUILDING LOCATION
- POTENTIAL NITROAROMATIC REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 PRELIMINARY REMEDIATION GOALS ARE SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLING DEPTHS

SAMPLE	DEPTH (FT)
AA0073	0.5 - 1.5
AA0074	0.5 - 1.5
AA0075	0.3 - 1.3
AA0076	0.5 - 1.5
AA0077	0.7 - 1.7
AA0218	1.0 - 2.0
AA0219	1.0 - 2.0
AA0220	1.0 - 2.0
AA0221	1.0 - 2.0
AA0433	0.7 - 1.7

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	296	7	77

8. NO SUBSURFACE DRILLING CONDUCTED.

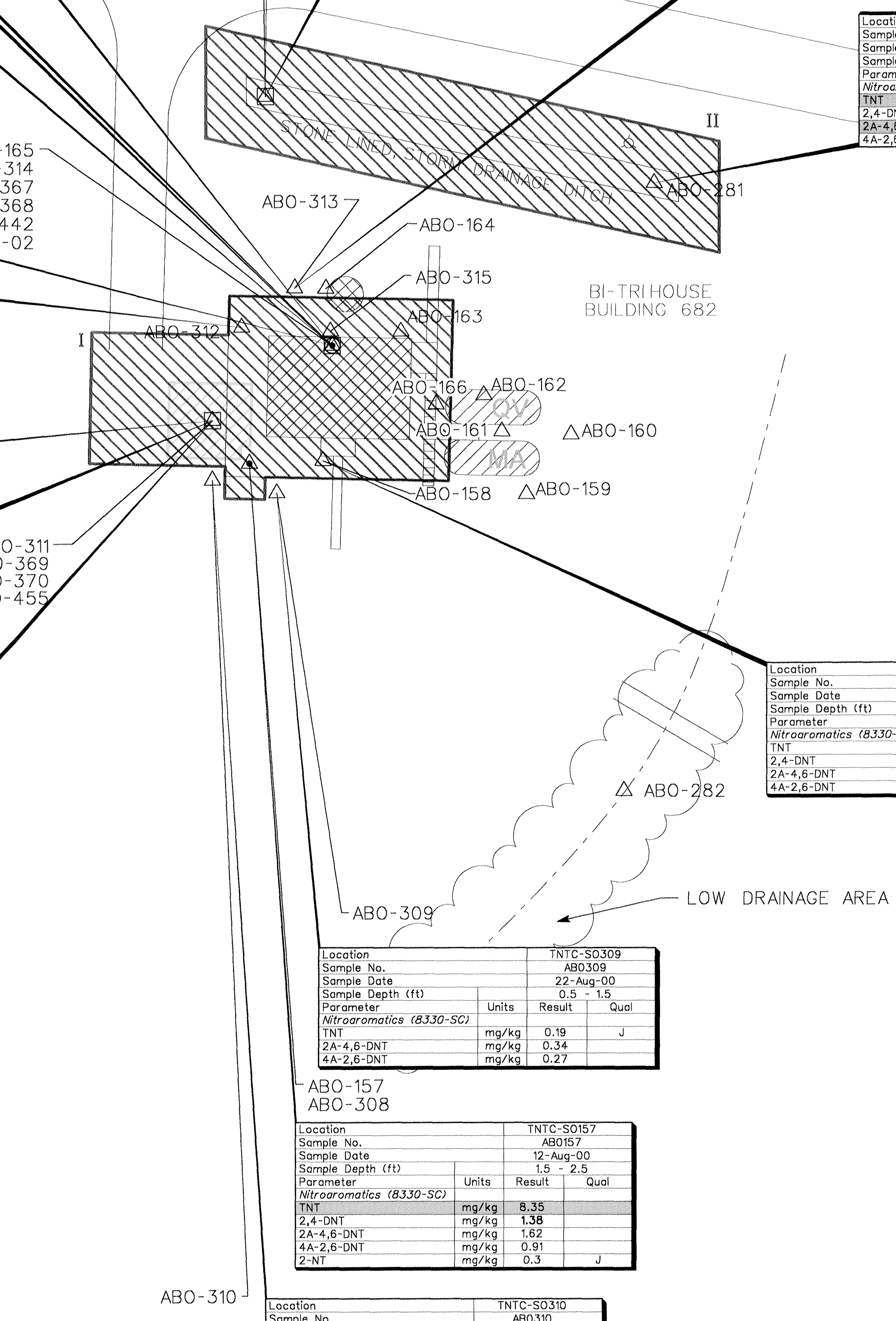
SCALE

0 30 60 FEET

FIGURE 1-19
TNT AREA A BUILDING 148 NAILING HOUSE ANALYTICAL RESULTS AND ESTIMATED AREA/VOLUME OF SOIL REQUIRING REMEDIATION

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw Environmental, Inc.



Location		TNTC-S0165	
Sample No.		AB0442	
Sample Date		27-SEP-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	**7.28**	
2A-4,6-DNT	mg/kg	**11.9**	
DNT	mg/kg	**5.63**	
NB	mg/kg	0.0966	J
3-NT	mg/kg	1.28	
Tetryl	mg/kg	0.626	
TNB	mg/kg	7.93	
TNT	mg/kg	**1343**	
Volatiles			
Acetone	mg/kg	0.0114	J
Carbon disulfide	mg/kg	0.0022	J
Methylene chloride	mg/kg	0.0155	B
Semivolatiles			
Dinitrotoluene, 2,4-	mg/kg	**10.6**	
Dinitrotoluene, 2,6-	mg/kg	**2.88**	
PCBs			
Aroclor 1260	mg/kg	**0.509**	
Metals			
Aluminum	mg/kg	2610	J
Arsenic	mg/kg	**2.26**	
Barium	mg/kg	28.2	
Beryllium	mg/kg	0.156	J
Calcium	mg/kg	9330	J
Chromium	mg/kg	4.36	
Cobalt	mg/kg	1.39	
Copper	mg/kg	4.54	B
Iron	mg/kg	6600	
Lead	mg/kg	25.6	J
Magnesium	mg/kg	1040	J
Manganese	mg/kg	74	
Mercury	mg/kg	0.027	J
Nickel	mg/kg	4.48	
Potassium	mg/kg	308	
Sodium	mg/kg	195	
Vanadium	mg/kg	7.9	
Zinc	mg/kg	25.6	

Location		TNTC-S0165	
Sample No.		AB0165	
Sample Date		12-Aug-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.95	
TNT	mg/kg	**729**	
2,4-DNT	mg/kg	0.63	
2A-4,6-DNT	mg/kg	2.23	
4A-2,6-DNT	mg/kg	1.26	

Location		TNTC-S0165	
Sample No.		AB0367	
Sample Date		14-SEP-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.601	
TNT	mg/kg	3.43	
2A-4,6-DNT	mg/kg	0.43	
4A-2,6-DNT	mg/kg	0.494	

Location		TNTC-S0165	
Sample No.		AB0368	
Sample Date		14-SEP-00	
Sample Depth (ft)		8.0 - 10.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.114	J
TNT	mg/kg	4.14	
2,4-DNT	mg/kg	0.194	J
2A-4,6-DNT	mg/kg	0.46	
4A-2,6-DNT	mg/kg	0.992	

Location		TNTC-S0165	
Sample No.		AB0314	
Sample Date		22-Aug-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	**8.67**	
2,4-DNT	mg/kg	0.13	J
2A-4,6-DNT	mg/kg	0.76	
4A-2,6-DNT	mg/kg	0.58	

Location		TNTC-S0280	
Sample No.		AB0280	
Sample Date		19-Aug-00	
Sample Depth (ft)		0.3 - 1.3	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.12	J
TNT	mg/kg	**62.9**	
2,4-DNT	mg/kg	0.67	
2A-4,6-DNT	mg/kg	**3.57**	
4A-2,6-DNT	mg/kg	**3.54**	
3-NT	mg/kg	0.30	J

Location		TNTC-S0280	
Sample No.		AB0454	
Sample Date		27-SEP-00	
Sample Depth (ft)		0.25 - 1.2	
Parameter	Units	Result	Qual
Nitroaromatics			
1,3-DNT	mg/kg	0.566	
DNT	mg/kg	**22.1**	
NB	mg/kg	0.227	
TNB	mg/kg	10.1	J
TNT	mg/kg	**54969**	
Volatiles			
Acetone	mg/kg	0.118	
Methylene chloride	mg/kg	0.00831	B
Semivolatiles			
Dinitrotoluene, 2,4-	mg/kg	**13.9**	
Dinitrotoluene, 2,6-	mg/kg	**8.43**	
PCBs			
Aroclor 1260	mg/kg	**0.883**	
Metals			
Aluminum	mg/kg	1870	J
Arsenic	mg/kg	**3.83**	
Barium	mg/kg	30.3	
Beryllium	mg/kg	0.159	J
Calcium	mg/kg	959	J
Chromium	mg/kg	3.04	
Cobalt	mg/kg	1.14	
Copper	mg/kg	6.38	J
Iron	mg/kg	5520	
Lead	mg/kg	**97**	J
Magnesium	mg/kg	388	J
Manganese	mg/kg	46.7	
Mercury	mg/kg	0.034	
Nickel	mg/kg	3.3	
Potassium	mg/kg	390	
Sodium	mg/kg	163	J
Vanadium	mg/kg	6.56	
Zinc	mg/kg	25.2	

Location		TNTC-S0313	
Sample No.		AB0313	
Sample Date		22-Aug-00	
Sample Depth (ft)		2.0 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.28	
2,4-DNT	mg/kg	0.12	J
2A-4,6-DNT	mg/kg	0.74	
4A-2,6-DNT	mg/kg	0.71	

Location		TNTC-S0281	
Sample No.		AB0281	
Sample Date		19-Aug-00	
Sample Depth (ft)		0.3 - 1.3	
Parameter	Units	Resul:	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	**47.5**	
2,4-DNT	mg/kg	**0.87**	
2A-4,6-DNT	mg/kg	**2.3**	
4A-2,6-DNT	mg/kg	1.29	

Location		TNTC-S0312	
Sample No.		AB0312	
Sample Date		22-Aug-00	
Sample Depth (ft)		0.25 - 1.25	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.85	
2A-4,6-DNT	mg/kg	1.18	
4A-2,6-DNT	mg/kg	0.91	

Location		TNTC-S0311	
Sample No.		AB0455	
Sample Date		27-SEP-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	0.588	
2A-4,6-DNT	mg/kg	0.948	
DNT	mg/kg	**0.781**	
TNT	mg/kg	1.35	
Volatiles			
Acetone	mg/kg	0.0375	
Carbon disulfide	mg/kg	0.00343	J
Methylene chloride	mg/kg	0.00864	B
Semivolatiles			
Dinitrotoluene, 2,4-	mg/kg	**1.72**	
Dinitrotoluene, 2,6-	mg/kg	**0.428**	
PCBs			
Aroclor 1260	mg/kg	0.162	
Metals			
Aluminum	mg/kg	4060	J
Antimony	mg/kg	0.82	J
Arsenic	mg/kg	**5.59**	
Barium	mg/kg	27.9	
Beryllium	mg/kg	0.311	
Cadmium	mg/kg	0.285	J
Calcium	mg/kg	5300	J
Chromium	mg/kg	12.5	
Cobalt	mg/kg	2.41	
Copper	mg/kg	23.3	J
Iron	mg/kg	9560	
Lead	mg/kg	**721**	J
Magnesium	mg/kg	1270	J
Manganese	mg/kg	63.7	
Mercury	mg/kg	0.022	J
Nickel	mg/kg	12.3	
Potassium	mg/kg	678	
Sodium	mg/kg	251	
Vanadium	mg/kg	11.3	
Zinc	mg/kg	112	

Location		TNTC-S0311	
Sample No.		AB0311	
Sample Date		22-Aug-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.33	
2,4-DNT	mg/kg	**99.4**	J
2A-4,6-DNT	mg/kg	0.15	J
4A-2,6-DNT	mg/kg	0.11	J

Location		TNTC-S0311	
Sample No.		AB0369	
Sample Date		14-SEP-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.181	J
2-NT	mg/kg	0.272	J
4-NT	mg/kg	0.24	J

Location		TNTC-S0158	
Sample No.		AB0158	
Sample Date		12-Aug-00	
Sample Depth (ft)		2.5 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.46	
2,4-DNT	mg/kg	0.21	J
2A-4,6-DNT	mg/kg	0.57	
4A-2,6-DNT	mg/kg	0.58	

Location		TNTC-S0309	
Sample No.		AB0309	
Sample Date		22-Aug-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.19	J
2A-4,6-DNT	mg/kg	0.34	
4A-2,6-DNT	mg/kg	0.27	

Location		TNTC-S0157	
Sample No.		AB0157	
Sample Date		12-Aug-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	**8.35**	
2,4-DNT	mg/kg	**1.38**	
2A-4,6-DNT	mg/kg	1.62	
4A-2,6-DNT	mg/kg	0.91	
2-NT	mg/kg	0.3	J

Location		TNTC-S0310	
Sample No.		AB0310	
Sample Date		22-Aug-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.63	
2,4-DNT	mg/kg	0.27	
2A-4,6-DNT	mg/kg	0.49	
4A-2,6-DNT	mg/kg	0.29	

LEGEND:

- △ ABO-157 SCREENING SOIL SAMPLING LOCATION
- • ABO-308 SURFACE SOIL SAMPLE (0 - 2 FT)
- ○ GW-02 GROUNDWATER SAMPLING LOCATION
- □ ABO-455 CONFIRMATION SOIL SAMPLING LOCATION
- FORMER TANK LOCATION
- FORMER BUILDING LOCATION
- FIRE HYDRANT
- POTENTIAL NITROAROMATIC REMEDIATION AREA
- POTENTIAL LEAD REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 PRELIMINARY REMEDIATION GOALS ARE SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLING DEPTHS

SAMPLE	DEPTH (FT)
AB0157	1.5 - 2.5
AB0158	2.5 - 3.5
AB0159	1.0 - 2.0
AB0160	0.5 - 1.5
AB0161	1.0 - 2.0
AB0162	1.0 - 2.0
AB0163	1.5 - 2.5
AB0164	1.5 - 2.5
AB0165	1.5 - 2.5
AB0166	1.5 - 1.8
AB0280	0.25 - 1.25
AB0281	0.25 - 1.25
AB0282	0.25 - 1.25
AB0308	0.0 - 1.0
AB0309	0.5 - 1.5
AB0310	0.5 - 1.5
AB0311	0.5 - 1.5
AB0312	0.25 - 1.5
AB0313	2.0 - 2.5
AB0314	0.0 - 1.0
AB0315	0.25 - 1.25
AB0367	4.0 - 6.0
AB0368	8.0 - 10.0
AB0369	4.0 - 6.0
AB0370	8.0 - 10.0
AB0442	1.5 - 2.5
AB0452	0.25 - 1.25
AB0453	0.25 - 1.25
AB0454	0.25 - 1.25
AB0455	0.5 - 1.5

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	3644	4	540
II	763	5*	141
	2885	8*	855
TOTAL	7292		1536

* VERTICAL DEPTH 5 FEET FROM DRAINAGE DITCH SURFACE, 8 FEET FROM GROUND SURFACE.

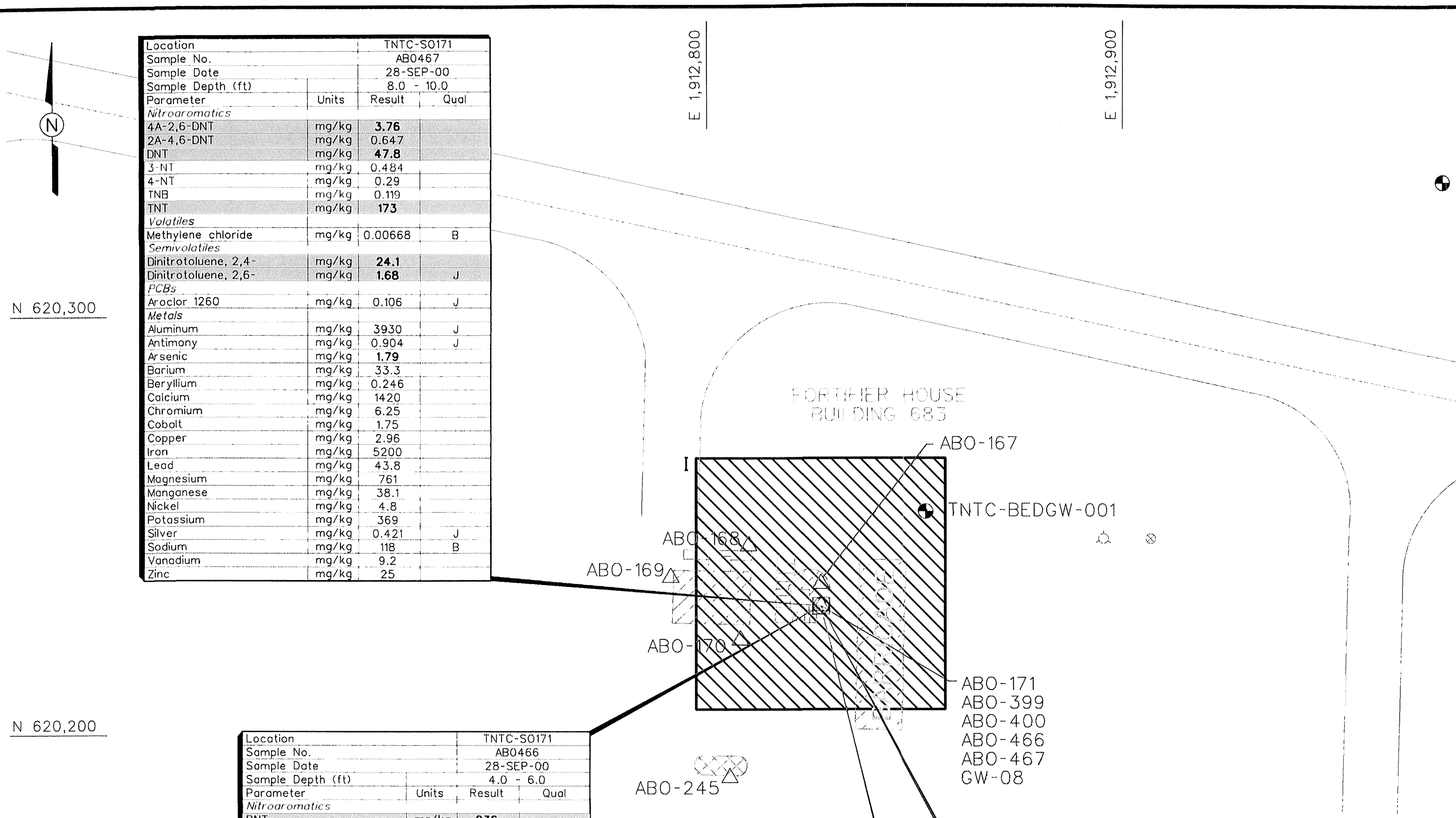
8. GROUNDWATER ENCOUNTERED IN SEPTEMBER 2000 BORING C-369/370 AT 8 FEET.

GROUNDWATER MEASURED IN GW-02 AT A DEPTH OF 9.57 FEET OCTOBER 10, 2000. BEDROCK ENCOUNTERED AT 15 FEET IN GW-02 BORING.

FIGURE 1-20
TNT AREA C
BUILDING 682 BI-TRIHOUSE
ANALYTICAL RESULTS AND ESTIMATED AREA/VOLUME OF SOIL REQUIRING REMEDIATION

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw Environmental, Inc.



Location		TNTC-S0171	
Sample No.		AB0467	
Sample Date		28-SEP-00	
Sample Depth (ft)		8.0 - 10.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	**3.76**	
2A-4,6-DNT	mg/kg	0.647	
DNT	mg/kg	**47.8**	
3-NT	mg/kg	0.484	
4-NT	mg/kg	0.29	
TNB	mg/kg	0.119	
TNT	mg/kg	**173**	
Volatiles			
Methylene chloride	mg/kg	0.00668	B
Semivolatiles			
Dinitrotoluene, 2,4-	mg/kg	**24.1**	
Dinitrotoluene, 2,6-	mg/kg	**1.68**	J
PCBs			
Aroclor 1260	mg/kg	0.106	J
Metals			
Aluminum	mg/kg	3930	J
Antimony	mg/kg	0.904	J
Arsenic	mg/kg	**1.79**	
Barium	mg/kg	33.3	
Beryllium	mg/kg	0.246	
Calcium	mg/kg	1420	
Chromium	mg/kg	6.25	
Cobalt	mg/kg	1.75	
Copper	mg/kg	2.96	
Iron	mg/kg	5200	
Lead	mg/kg	43.8	
Magnesium	mg/kg	761	
Manganese	mg/kg	38.1	
Nickel	mg/kg	4.8	
Potassium	mg/kg	369	
Silver	mg/kg	0.421	J
Sodium	mg/kg	118	B
Vanadium	mg/kg	9.2	
Zinc	mg/kg	25	

Location		TNTC-S0171	
Sample No.		AB0466	
Sample Date		28-SEP-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics			
DNT	mg/kg	**236**	
NB	mg/kg	0.0963	J
TNB	mg/kg	0.146	
TNT	mg/kg	**448**	
Volatiles			
Carbon disulfide	mg/kg	0.00337	J
Methylene chloride	mg/kg	0.00625	B
Semivolatiles			
Dinitrotoluene, 2,4-	mg/kg	**275**	
Dinitrotoluene, 2,6-	mg/kg	**23.8**	J
PCBs			
Aroclor 1260	mg/kg	0.0768	J
Metals			
Aluminum	mg/kg	3150	J
Arsenic	mg/kg	**1.77**	
Barium	mg/kg	31.9	
Beryllium	mg/kg	0.203	J
Calcium	mg/kg	1430	
Chromium	mg/kg	5.24	
Cobalt	mg/kg	1.37	
Copper	mg/kg	1.36	
Iron	mg/kg	4310	
Lead	mg/kg	8.8	
Magnesium	mg/kg	658	
Manganese	mg/kg	33.7	
Nickel	mg/kg	3.72	
Potassium	mg/kg	242	
Sodium	mg/kg	249	B
Vanadium	mg/kg	8.01	
Zinc	mg/kg	23.9	

Location		TNTC-S0171	
Sample No.		AB0399	
Sample Date		16-SEP-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	**18.2**	
2A-4,6-DNT	mg/kg	1.45	
4A-2,6-DNT	mg/kg	1.53	
3-NT	mg/kg	0.597	

Location		TNTC-S0171	
Sample No.		AB0400	
Sample Date		16-SEP-00	
Sample Depth (ft)		8.0 - 10.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.249	
TNT	mg/kg	**16.4**	
2A-4,6-DNT	mg/kg	2.05	
4A-2,6-DNT	mg/kg	2.86	

SCALE
0 30 60 FEET

LEGEND:

- △ ABO-167 — SCREENING SOIL SAMPLING LOCATION
- ○ GW-08 — GROUNDWATER SAMPLING LOCATION
- □ ABO-466 — CONFIRMATION SOIL SAMPLING LOCATION
- TNTC-BEDGW-001 — BEDROCK MONITORING WELL LOCATION
- FORMER TANK LOCATION
- FORMER BUILDING LOCATION
- FIRE HYDRANT
- WATER CONTROL VALVE
- POTENTIAL NITROAROMATIC REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 REMEDIATION GOAL OBJECTIVES ARE SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLING DEPTHS

SAMPLE	DEPTH (FT)
AB0167	0.5 - 1.0
AB0168	1.0 - 2.0
AB0169	1.5 - 2.5
AB0170	1.0 - 1.5
AB0171	0.5 - 1.0
AB0245	1.0 - 2.0
AB0399	4.0 - 6.0
AB0400	8.0 - 10.0
AB0466	4.0 - 6.0
AB0467	8.0 - 10.0

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	3600	9	1200

8. GROUNDWATER ENCOUNTERED IN SEPTEMBER 2000 BORING C-399/400 AT 9 FEET.

FIGURE 1-21
TNT AREA C BUILDING 683 FORTIFIER HOUSE ANALYTICAL RESULTS AND ESTIMATED AREA/VOLUME OF SOIL REQUIRING REMEDIATION

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw Environmental, Inc.

STARTING DATE: 10/18/02 | DRAWN BY: B.VANDERGRIFT | DATE LAST REV.: | DRAWN BY: | DRAFT. CHCK. BY: C. TUMA | ENGR CHCK. BY: T. SIARD | INITIATOR: T. SIARD | PROJ MGR: S. DOWNEY | DWG NO.: 807712es063 | PROJ NO.: 807712

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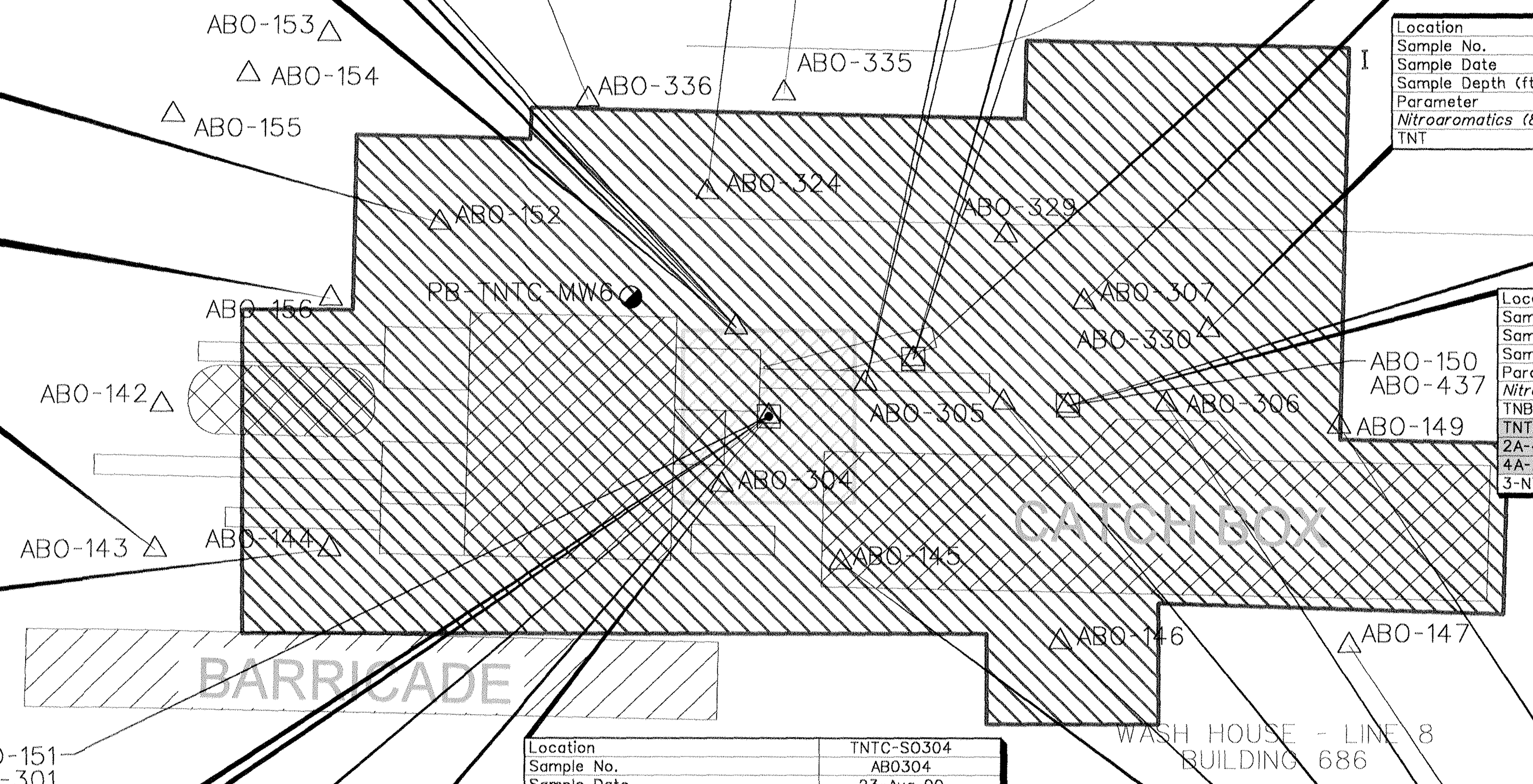
DWG. NO.: 807112ES.061 | PROJ. NO.: 807112 | INITIATOR: T. SIARD | PROJ. MGR.: S. DOWNEY | DRAFT. CHCK. BY: C. TOMLIN | ENGR. CHCK. BY: T. SIARD | DATE LAST REV.: | DRAWN BY: | STARTING DATE: 10/22/02 | DRAWN BY: B.VANDERGRIFF

E 1,912,900 — E 1,913,000 — E 1,913,100 — E 1,913,200

N 620,500 — N 620,400 — N 620,300



ABO-302 / ABO-371 / ABO-372

ABO-303

ABO-325 / ABO-478

ABO-150 / ABO-437

ABO-149

ABO-148

ABO-147

ABO-151 / ABO-301 / ABO-438 / ABO-439

Location		TNTC-S0336	
Sample No.		AB0336	
Sample Date		13-OCT-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	1.31	
2A-4,6-DNT	mg/kg	0.687	
4A-2,6-DNT	mg/kg	1.23	
3-NT	mg/kg	2.38	

Location		TNTC-S0324	
Sample No.		AB0324	
Sample Date		23-SEP-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.184	J
TNT	mg/kg	**22.5**	
2A-4,6-DNT	mg/kg	1.89	
4A-2,6-DNT	mg/kg	1.39	
NB	mg/kg	0.127	J

Location		TNTC-S0335	
Sample No.		AB0335	
Sample Date		13-OCT-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.842	
2A-4,6-DNT	mg/kg	0.566	
4A-2,6-DNT	mg/kg	0.488	

Location		TNTC-S0303	
Sample No.		AB0303	
Sample Date		23-Aug-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.68	
TNT	mg/kg	**383**	
2A-4,6-DNT	mg/kg	**6.55**	
4A-2,6-DNT	mg/kg	**4.42**	
3-NT	mg/kg	0.5	J

Location		TNTC-S0325	
Sample No.		AB0325	
Sample Date		23-SEP-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.326	
TNT	mg/kg	**19.2**	
2A-4,6-DNT	mg/kg	**11.1**	
4A-2,6-DNT	mg/kg	**6.53**	
Tetryl	mg/kg	0.395	J

Location		TNTC-S0325	
Sample No.		AB0478	
Sample Date		12-OCT-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	**2.45**	
2A-4,6-DNT	mg/kg	**11.4**	
TNB	mg/kg	0.283	
TNT	mg/kg	**33.7**	
Volatiles			
Acetone	mg/kg	0.0602	
Benzene	mg/kg	0.00184	J
Methylene chloride	mg/kg	0.0122	B
Toluene	mg/kg	0.0032	J
Semivolatiles			
Diethylphthalate	mg/kg	0.672	B
Dinitrotoluene, 2,4-	mg/kg	0.06	J
Pesticides/PCBs			
Aroclor 1260	mg/kg	0.0542	J
Metals			
Aluminum	mg/kg	3750	J
Arsenic	mg/kg	**2.14**	
Barium	mg/kg	14.1	
Beryllium	mg/kg	0.277	J
Calcium	mg/kg	7300	J
Chromium	mg/kg	6.27	
Cobalt	mg/kg	2.2	
Copper	mg/kg	3.73	
Iron	mg/kg	6800	
Lead	mg/kg	14.2	J
Magnesium	mg/kg	1870	J
Manganese	mg/kg	111	J
Mercury	mg/kg	0.021	J
Nickel	mg/kg	6.44	
Potassium	mg/kg	354	J
Sodium	mg/kg	151	B
Vanadium	mg/kg	12.4	
Zinc	mg/kg	19.2	

Location		TNTC-S0302	
Sample No.		AB0302	
Sample Date		23-Aug-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	1.75	
TNT	mg/kg	**902**	
2A-4,6-DNT	mg/kg	**10.5**	
4A-2,6-DNT	mg/kg	**10.3**	
NB	mg/kg	0.35	
Tetryl	mg/kg	0.65	
3-NT	mg/kg	0.58	

Location		TNTC-S0302	
Sample No.		AB0371	
Sample Date		14-SEP-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.192	J
2A-4,6-DNT	mg/kg	0.48	
4A-2,6-DNT	mg/kg	0.18	J
4-NT	mg/kg	0.195	J

Location		TNTC-S0302	
Sample No.		AB0372	
Sample Date		14-SEP-00	
Sample Depth (ft)		8.0 - 10.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.555	
2A-4,6-DNT	mg/kg	0.208	J
2-NT	mg/kg	0.365	J
4-NT	mg/kg	0.324	J

Location		TNTC-S0307	
Sample No.		AB0307	
Sample Date		23-Aug-00	
Sample Depth (ft)		0.8 - 1.8	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	1.26	
TNT	mg/kg	**159**	
2,4-DNT	mg/kg	2.27	
2A-4,6-DNT	mg/kg	**13.4**	
4A-2,6-DNT	mg/kg	**12.3**	
Tetryl	mg/kg	0.69	

Location		TNTC-S0152	
Sample No.		AB0152	
Sample Date		12-Aug-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.69	
2A-4,6-DNT	mg/kg	1.97	
4A-2,6-DNT	mg/kg	1.68	

Location		TNTC-S0330	
Sample No.		AB0330	
Sample Date		23-SEP-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.975	

Location		TNTC-S0156	
Sample No.		AB0156	
Sample Date		12-Aug-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2A-4,6-DNT	mg/kg	0.38	
4A-2,6-DNT	mg/kg	0.19	J

Location		TNTC-S0150	
Sample No.		AB0150	
Sample Date		12-Aug-00	
Sample Depth (ft)		0.3 - 1.3	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.21	J
TNT	mg/kg	**38.1**	
2A-4,6-DNT	mg/kg	**12.8**	
4A-2,6-DNT	mg/kg	**7.69**	
3-NT	mg/kg	0.69	

Location		TNTC-S0150	
Sample No.		AB0437	
Sample Date		10-OCT-00	
Sample Depth (ft)		0.33 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	**14.6**	
2A-4,6-DNT	mg/kg	**38**	
1,3-DNT	mg/kg	0.12	
3-NT	mg/kg	1.71	
TNB	mg/kg	0.902	
TNT	mg/kg	**51.1**	
Volatiles			
Acetone	mg/kg	0.187	J
Ethylbenzene	mg/kg	0.00156	J
Methylene chloride	mg/kg	0.0266	B
Toluene	mg/kg	0.0142	J
Xylene, o-	mg/kg	0.00246	J
Semivolatiles			
Acenaphthylene	mg/kg	0.545	J
Anthracene	mg/kg	0.351	J
Benzo(a)anthracene	mg/kg	**3.32**	
Benzo(a)pyrene	mg/kg	**3.63**	
Benzo(b)fluoranthene	mg/kg	**4.82**	
Benzo(ghi)perylene	mg/kg	1.78	
Benzo(k)fluoranthene	mg/kg	1.65	
Chrysene	mg/kg	3.02	
Dibenz(a,h)anthracene	mg/kg	**0.601**	
Fluoranthene	mg/kg	4.75	
Indeno(1,2,3-cd)pyrene	mg/kg	**1.89**	
Phenanthrene	mg/kg	0.667	J
Pyrene	mg/kg	4.61	
Pesticides/PCBs			
Aroclor 1260	mg/kg	**1.37**	J
Metals			
Aluminum	mg/kg	3630	J
Antimony	mg/kg	0.68	J
Arsenic	mg/kg	**3.94**	B
Barium	mg/kg	24.1	
Beryllium	mg/kg	0.297	
Cadmium	mg/kg	0.272	J
Calcium	mg/kg	35600	
Chromium	mg/kg	6.76	
Cobalt	mg/kg	2.25	
Copper	mg/kg	43.7	
Iron	mg/kg	10900	
Lead	mg/kg	**195**	
Magnesium	mg/kg	5890	
Manganese	mg/kg	334	
Mercury	mg/kg	0.269	
Nickel	mg/kg	8.17	
Potassium	mg/kg	441	
Sodium	mg/kg	223	J
Vanadium	mg/kg	10.9	
Zinc	mg/kg	121	

Location		TNTC-S0143	
Sample No.		AB0143	
Sample Date		12-Aug-00	
Sample Depth (ft)		1.6 - 2.6	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.14	J
2A-4,6-DNT	mg/kg	0.17	J
4A-2,6-DNT	mg/kg	0.14	J

Location		TNTC-S0144	
Sample No.		AB0144	
Sample Date		12-Aug-00	
Sample Depth (ft)		2.5 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	9.19	
2A-4,6-DNT	mg/kg	0.82	
4A-2,6-DNT	mg/kg	1.14	
3-NT	mg/kg	0.3	J

Location		TNTC-S0304	
Sample No.		AB0304	
Sample Date		23-Aug-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.43	

Location		TNTC-S0301	
Sample No.		AB0301	
Sample Date		23-Aug-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.13	J
TNT	mg/kg	**20.1**	
2A-4,6-DNT	mg/kg	1.33	
4A-2,6-DNT	mg/kg	1.17	
NB	mg/kg	0.11	J

Location		TNTC-S0151	
Sample No.		AB0151	
Sample Date		12-Aug-00	
Sample Depth (ft)		1.3 - 2.3	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	1.85	
TNT	mg/kg	**196**	
2A-4,6-DNT	mg/kg	**3.48**	
4A-2,6-DNT	mg/kg	2.17	
Tetryl	mg/kg	0.43	J

Location		TNTC-S0151	
Sample No.		AB0438	
Sample Date		10-OCT-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	**10.8**	
2A-4,6-DNT	mg/kg	**9.41**	
1,3-DNT	mg/kg	0.142	
DNT	mg/kg	**1.59**	
TNB	mg/kg	2.43	
TNT	mg/kg	**5067**	
Volatiles			
Acetone	mg/kg	0.0969	J
Benzene	mg/kg	0.00194	J
Methylene chloride	mg/kg	0.00597	B
Toluene	mg/kg	0.00324	J
Semivolatiles			
Anthracene	mg/kg	1.34	J
Benzo(a)anthracene	mg/kg	**6.94**	
Benzo(a)pyrene	mg/kg	**6.33**	
Benzo(b)fluoranthene	mg/kg	**9.05**	
Benzo(ghi)perylene	mg/kg	2.78	J
Benzo(k)fluoranthene	mg/kg	3.02	J
Chrysene	mg/kg	6.28	
Dibenz(a,h)anthracene	mg/kg	**1.03**	J
Dinitrotoluene, 2,4-	mg/kg	**1.65**	J
Fluoranthene	mg/kg	12.9	
Indeno(1,2,3-cd)pyrene	mg/kg	**2.91**	J
Phenanthrene	mg/kg	4.13	J
Pyrene	mg/kg	10.1	
Pesticides/PCBs			
Aroclor 1260	mg/kg	**2.11**	J
Metals			
Aluminum	mg/kg	3090	J
Arsenic	mg/kg	**4.02**	B
Barium	mg/kg	26.4	
Beryllium	mg/kg	0.247	J
Cadmium	mg/kg	0.545	J
Calcium	mg/kg	55100	
Chromium	mg/kg	8.17	
Cobalt	mg/kg	2.25	
Copper	mg/kg	28.6	
Iron	mg/kg	11400	
Lead	mg/kg	**621**	
Magnesium	mg/kg	6770	
Manganese	mg/kg	286	
Mercury	mg/kg	0.39	
Nickel	mg/kg	8.74	
Potassium	mg/kg	452	
Sodium	mg/kg	173	J
Vanadium	mg/kg	10.5	
Zinc	mg/kg	240	

Location		TNTC-S0151	
Sample No.		AB0439	
Sample Date		10-OCT-00	
Sample Depth (ft)		1.3 - 2.3	
Parameter	Units	Result	Qual
Nitroaromatics			
2A-4,6-DNT	mg/kg	**4.8**	
1,3-DNT	mg/kg	0.127	
3-NT	mg/kg	0.271	
TNB	mg/kg	2.69	
TNT	mg/kg	**2588**	
Volatiles			
Toluene	mg/kg	0.00726	J
Xylene, o-	mg/kg	0.00166	J
Xylenes, m,p-	mg/kg	0.00399	J
Pesticides/PCBs			
Aroclor 1260	mg/kg	**1.02**	J
Metals			
Aluminum	mg/kg	3690	J
Antimony	mg/kg	0.783	J
Arsenic	mg/kg	**2.95**	B
Barium	mg/kg	22.5	
Beryllium	mg/kg	0.275	
Cadmium	mg/kg	0.606	J
Calcium	mg/kg	13400	
Chromium	mg/kg	7.85	
Cobalt	mg/kg	2.56	
Copper	mg/kg	30.3	
Iron	mg/kg	9550	
Lead	mg/kg	**212**	
Magnesium	mg/kg	2710	
Manganese	mg/kg	199	
Nickel	mg/kg	8.26	
Potassium	mg/kg	469	
Sodium	mg/kg	207	J
Vanadium	mg/kg	11.7	
Zinc	mg/kg	193	

Location		TNTC-S0145	
Sample No.		AB0145	
Sample Date		12-Aug-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.13	J
2,4-DNT	mg/kg	0.15	J

Location		TNTC-S0146	
Sample No.		AB0146	
Sample Date		12-Aug-00	
Sample Depth (ft)		1.0 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	8.33	
2A-4,6-DNT	mg/kg	0.5	
4A-2,6-DNT	mg/kg	0.32	

Location		TNTC-S0305	
Sample No.		AB0305	
Sample Date		23-Aug-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	**26.2**	
2A-4,6-DNT	mg/kg	**4.88**	
4A-2,6-DNT	mg/kg	**3.73**	
3-NT	mg/kg	0.85	

Location		TNTC-S0306	
Sample No.		AB0306	
Sample Date		23-Aug-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	3.73	
2A-4,6-DNT	mg/kg	1.51	
4A-2,6-DNT	mg/kg	0.98	

Location		TNTC-S0148	
Sample No.		AB0148	
Sample Date		12-Aug-00	
Sample Depth (ft)		0.3 - 1.3	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	1.64	
2A-4,6-DNT	mg/kg	0.13	J

Location		TNTC-S0149	
Sample No.		AB0149	
Sample Date		12-Aug-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.69	
2A-4,6-DNT	mg/kg	0.15	J
4A-2,6-DNT	mg/kg	0.14	J

Location		TNTC-S0147	
Sample No.		AB0147	
Sample Date		12-Aug-00	
Sample Depth (ft)		0.3 - 1.3	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.11	J
2,4-DNT	mg/kg	0.15	J

LEGEND:

- △ ABO-142 — SCREENING SOIL SAMPLING LOCATION
- • ABO-288 — SURFACE SOIL SAMPLE (0 - 2 FT)
- □ ABO-438 — CONFIRMATION SOIL SAMPLING LOCATION
- FORMER TANK LOCATION
- FORMER BUILDING LOCATION
- POTENTIAL NITROAROMATIC REMEDIATION AREA
- POTENTIAL LEAD/PCB REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 PRELIMINARY REMEDIATION GOALS ARE SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLING DEPTHS

SAMPLE	DEPTH (FT)
AB0142	2.0 - 3.0
AB0143	1.6 - 2.6
AB0144	2.5 - 3.0
AB0145	2.0 - 3.0
AB0146	1.0 - 1.5
AB0147	0.33 - 1.0
AB0148	0.33 - 1.0
AB0149	0.0 - 1.0
AB0150	0.33 - 1.0
AB0151	1.3 - 2.3
AB0152	2.0 - 3.0
AB0153	1.0 - 2.0
AB0154	1.0 - 2.0
AB0155	2.5 - 3.5
AB0156	2.0 - 3.0
AB0301	0.0 - 1.0
AB0302	0.5 - 1.5
AB0303	0.5 - 1.5
AB0304	0.5 - 1.5
AB0305	0.5 - 1.5
AB0306	0.5 - 1.5
AB0307	0.75 - 1.25
AB0324	1.0 - 2.0
AB0325	1.0 - 2.0
AB0329	1.0 - 2.0
AB0330	1.0 - 2.0
AB0335	1.0 - 2.0
AB0336	1.0 - 2.0
AB0371	4.0 - 6.0
AB0372	8.0 - 10.0
AB0437	0.3 - 1.0
AB0438	0.0 - 1.0
AB0439	1.3 - 2.3
AB0478	1.0 - 2.0

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	8277	4	1226

8. GROUNDWATER ENCOUNTERED AT 3 FEET IN SEPTEMBER 2000 C-371/372 BORING. DRILLED TO 10 FEET, BEDROCK NOT ENCOUNTERED.

GROUNDWATER WAS ENCOUNTERED IN OVERBURDEN MONITORING WELL TNTC-MW06 AT 3.5 FEET DURING OCTOBER 1994 DRILLING. BEDROCK WAS DETECTED AT 12.2 FEET.

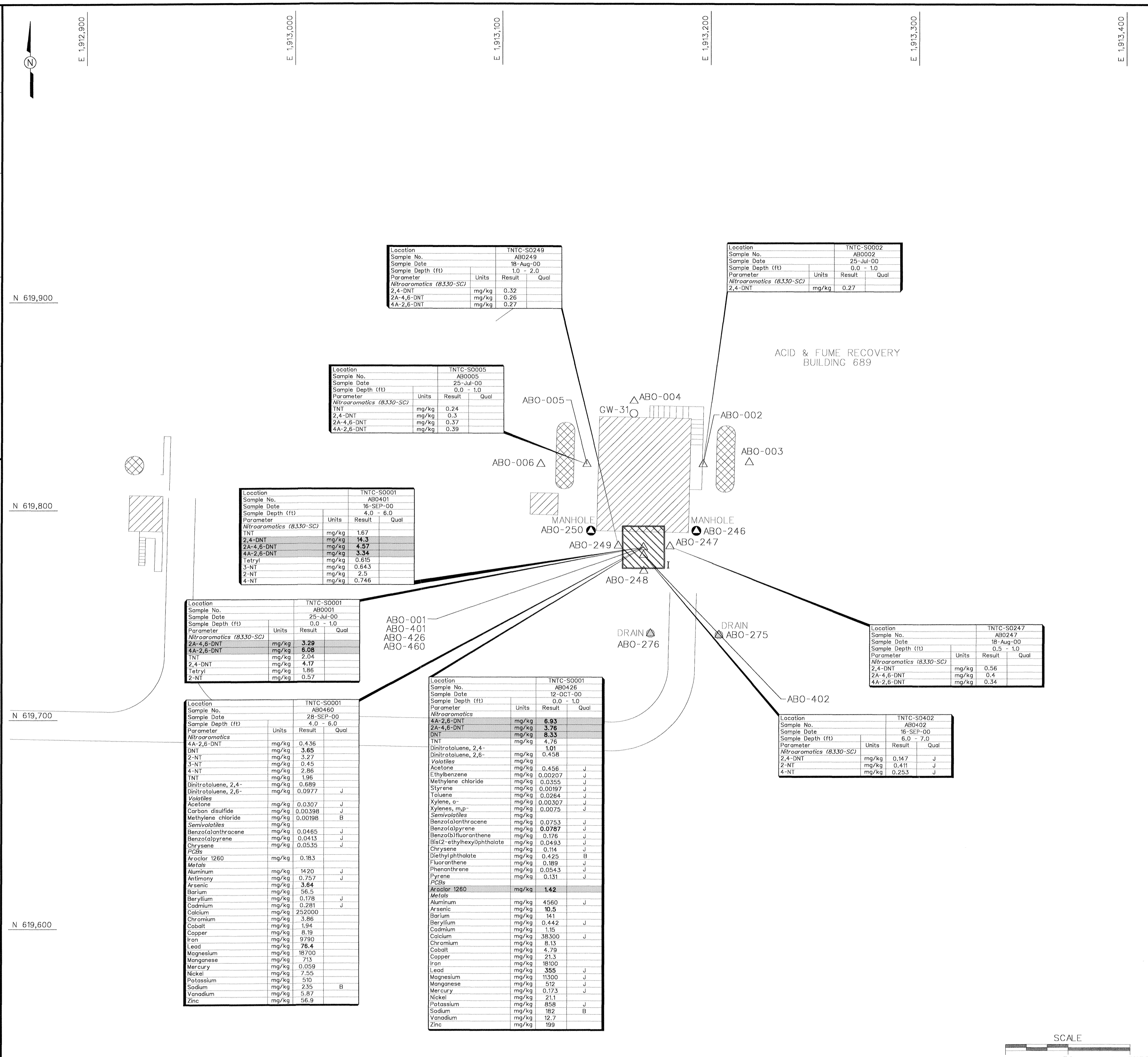
SCALE 0 — 20 — 40 FEET

FIGURE 1-22
TNT AREA C
BUILDING 686
WASH HOUSE LINE 8
ANALYTICAL RESULTS AND ESTIMATED AREA/VOLUME OF SOIL REQUIRING REMEDIATION

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw Environmental, Inc.

cbentley 10/01/03 10:36:59 AM p:\cadd\design\807112es.061



Location		TNTC-S0249	
Sample No.		AB0249	
Sample Date		18-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.32	
2A-4,6-DNT	mg/kg	0.26	
4A-2,6-DNT	mg/kg	0.27	

Location		TNTC-S0002	
Sample No.		AB0002	
Sample Date		25-Jul-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.27	

Location		TNTC-S0005	
Sample No.		AB0005	
Sample Date		25-Jul-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.24	
2,4-DNT	mg/kg	0.3	
2A-4,6-DNT	mg/kg	0.37	
4A-2,6-DNT	mg/kg	0.39	

Location		TNTC-S0001	
Sample No.		AB0401	
Sample Date		16-SEP-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	1.67	
2,4-DNT	mg/kg	**14.3**	
2A-4,6-DNT	mg/kg	**4.57**	
4A-2,6-DNT	mg/kg	**3.34**	
Tetryl	mg/kg	0.615	
3-NT	mg/kg	0.643	
2-NT	mg/kg	2.5	
4-NT	mg/kg	0.746	

Location		TNTC-S0001	
Sample No.		AB0001	
Sample Date		25-Jul-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2A-4,6-DNT	mg/kg	**3.29**	
4A-2,6-DNT	mg/kg	**6.08**	
TNT	mg/kg	2.04	
2,4-DNT	mg/kg	**4.17**	
Tetryl	mg/kg	1.86	
2-NT	mg/kg	0.57	

Location		TNTC-S0001	
Sample No.		AB0460	
Sample Date		28-SEP-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	0.436	
DNT	mg/kg	**3.65**	
2-NT	mg/kg	3.27	
3-NT	mg/kg	0.45	
4-NT	mg/kg	2.86	
TNT	mg/kg	1.96	
Dinitrotoluene, 2,4-	mg/kg	0.689	
Dinitrotoluene, 2,6-	mg/kg	0.0977	J
Volatiles			
Acetone	mg/kg	0.0307	J
Carbon disulfide	mg/kg	0.00398	J
Methylene chloride	mg/kg	0.00198	B
Semivolatiles	mg/kg		
Benzo(a)anthracene	mg/kg	0.0465	J
Benzo(a)pyrene	mg/kg	0.0413	J
Chrysene	mg/kg	0.0535	J
PCBs			
Aroclor 1260	mg/kg	0.183	
Metals			
Aluminum	mg/kg	1420	J
Antimony	mg/kg	0.757	J
Arsenic	mg/kg	**3.64**	
Barium	mg/kg	56.5	
Beryllium	mg/kg	0.178	J
Cadmium	mg/kg	0.281	J
Calcium	mg/kg	252000	
Chromium	mg/kg	3.86	
Cobalt	mg/kg	1.94	
Copper	mg/kg	8.19	
Iron	mg/kg	9790	
Lead	mg/kg	**76.4**	
Magnesium	mg/kg	18700	
Manganese	mg/kg	713	
Mercury	mg/kg	0.059	
Nickel	mg/kg	7.55	
Potassium	mg/kg	510	
Sodium	mg/kg	235	B
Vanadium	mg/kg	5.87	
Zinc	mg/kg	56.9	

Location		TNTC-S0001	
Sample No.		AB0426	
Sample Date		12-OCT-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	**6.93**	
2A-4,6-DNT	mg/kg	**3.76**	
DNT	mg/kg	**8.33**	
TNT	mg/kg	4.76	
Dinitrotoluene, 2,4-		**1.01**	
Dinitrotoluene, 2,6-	mg/kg	0.458	
Volatiles	mg/kg		
Acetone	mg/kg	0.456	J
Ethylbenzene	mg/kg	0.00207	J
Methylene chloride	mg/kg	0.0355	J
Styrene	mg/kg	0.00197	J
Toluene	mg/kg	0.0264	J
Xylene, o-	mg/kg	0.00307	J
Xylenes, m,p-	mg/kg	0.0075	J
Semivolatiles	mg/kg		
Benzo(a)anthracene	mg/kg	0.0753	J
Benzo(a)pyrene	mg/kg	**0.0787**	J
Benzo(b)fluoranthene	mg/kg	0.176	J
Bis(2-ethylhexyl)phthalate	mg/kg	0.0493	J
Chrysene	mg/kg	0.114	J
Diethyl phthalate	mg/kg	0.425	B
Fluoranthene	mg/kg	0.189	J
Phenanthrene	mg/kg	0.0543	J
Pyrene	mg/kg	0.131	J
PCBs			
Aroclor 1260	mg/kg	**1.42**	
Metals			
Aluminum	mg/kg	4560	J
Arsenic	mg/kg	**10.5**	
Barium	mg/kg	141	
Beryllium	mg/kg	0.442	J
Cadmium	mg/kg	1.15	
Calcium	mg/kg	38300	J
Chromium	mg/kg	8.13	
Cobalt	mg/kg	4.79	
Copper	mg/kg	21.3	
Iron	mg/kg	18100	
Lead	mg/kg	**355**	J
Magnesium	mg/kg	11300	J
Manganese	mg/kg	512	J
Mercury	mg/kg	0.173	J
Nickel	mg/kg	21.1	
Potassium	mg/kg	858	J
Sodium	mg/kg	182	B
Vanadium	mg/kg	12.7	
Zinc	mg/kg	199	

Location		TNTC-S0247	
Sample No.		AB0247	
Sample Date		18-Aug-00	
Sample Depth (ft)		0.5 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.56	
2A-4,6-DNT	mg/kg	0.4	
4A-2,6-DNT	mg/kg	0.34	

Location		TNTC-S0402	
Sample No.		AB0402	
Sample Date		16-SEP-00	
Sample Depth (ft)		6.0 - 7.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.147	J
2-NT	mg/kg	0.411	J
4-NT	mg/kg	0.253	J

LEGEND:

- △ ABO-001 — SCREENING SOIL SAMPLING LOCATION
- □ ABO-426 — CONFIRMATION SOIL SAMPLE LOCATION
- ○ GW-03 — GROUNDWATER SAMPLING LOCATION
- FORMER TANK LOCATION
- FORMER BUILDING LOCATION
- POTENTIAL NITROAROMATIC REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 REMEDIATION GOAL OBJECTIVES SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLING DEPTHS

SAMPLE	DEPTH (FT)
AB0001	0.0 - 1.0
AB0002	0.0 - 1.0
AB0003	0.0 - 1.0
AB0004	0.0 - 1.0
AB0005	0.0 - 1.0
AB0006	0.5 - 1.5
AB0246	2.5 - 3.0
AB0247	0.5 - 1.0
AB0248	0.5 - 1.0
AB0249	1.0 - 2.0
AB0250	2.5 - 3.5
AB0275	3.0 - 3.5
AB0276	2.0 - 2.5
AB0401	4.0 - 6.0
AB0402	6.0 - 7.0
AB0426	1.0 - 2.0
AB0460	4.0 - 6.0

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	400	8	119

8. GROUNDWATER AND BEDROCK ENCOUNTERED IN SEPTEMBER 2000 BORING C-401/402 AT 8 FEET (IT, 2001a).
9. AUGUST 2001 PROBE REFUSAL FOR TEMPORARY PIEZOMETER GW-31 AT 6 FEET. GROUNDWATER NOT ENCOUNTERED.

FIGURE 1-23
TNT AREA C
BUILDING 689 ACID & FUME RECOVERY
ANALYTICAL RESULTS AND ESTIMATED AREA/VOLUME OF SOIL REQUIRING REMEDIATION

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw® Shaw Environmental, Inc.

STARTING DATE: 10/22/02 | DATE LAST REV.: | DRAFT. CHCK. BY: C. TUMLIN | INITIATOR: T. SIARD | DWG. NO.: 807112es.064
DRAWN BY: B.VANDERGRIFF | DRAWN BY: | ENGR. CHCK. BY: T. SIARD | PROJ. MGR.: S. DOWNEY | PROJ. NO.: 807112

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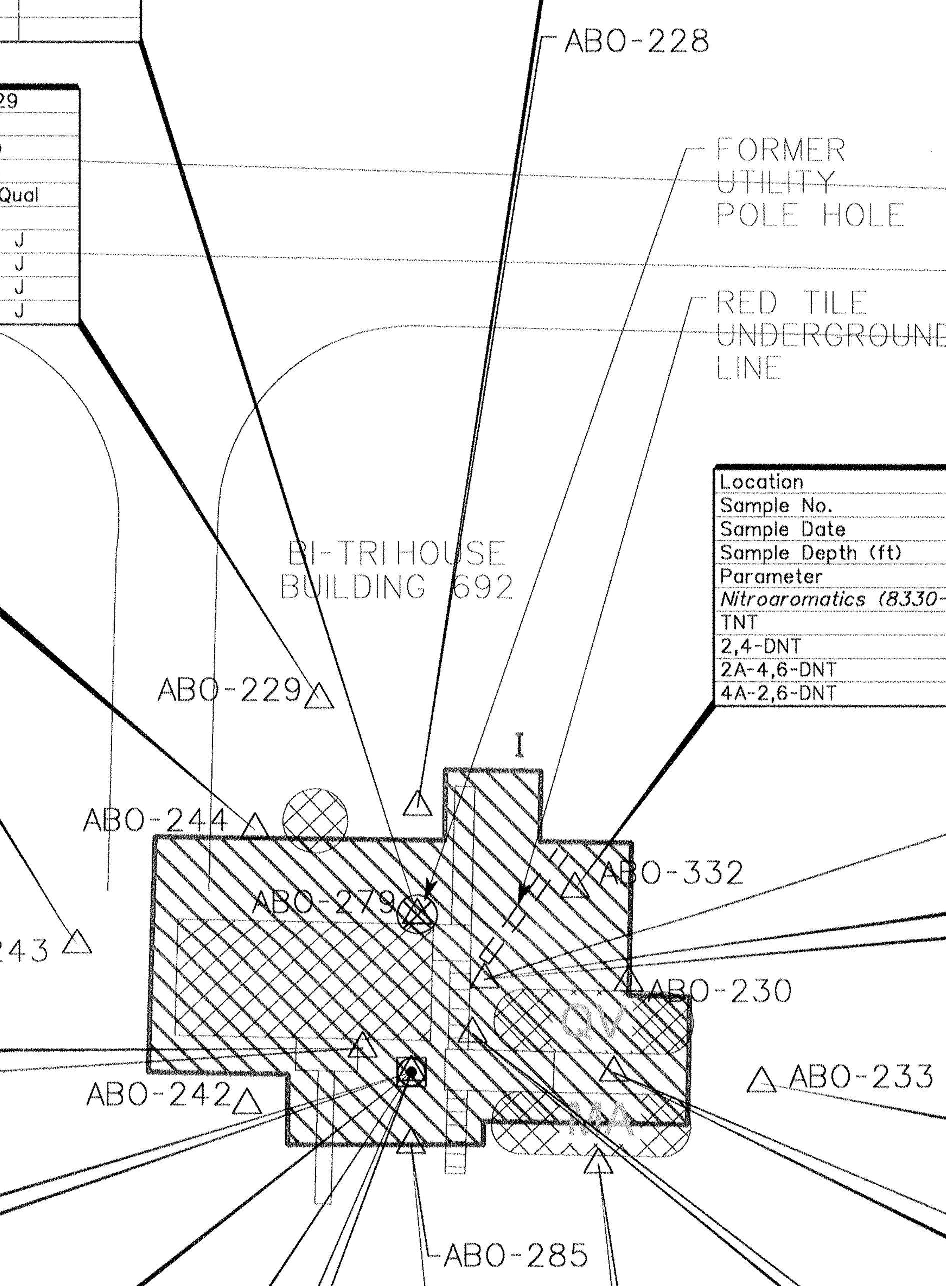
STARTING DATE: 10/22/02 | DATE LAST REV.: | DRAFT. CHCK. BY: C. TUMLIN | INITIATOR: T. SIARD | DWG. NO.: 807112es.065
DRAWN BY: B.VANDERGRIFF | DRAWN BY: | ENGR. CHCK. BY: T. SIARD | PROJ. MGR.: S. DOWNEY | PROJ. NO.: 807112



Location		TNTC-S0279	
Sample No.		AB0279	
Sample Date		19-Aug-00	
Sample Depth (ft)		2.5 - 3.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.63	
2,4-DNT	mg/kg	0.14	J
2A-4,6-DNT	mg/kg	0.36	
4A-2,6-DNT	mg/kg	0.39	

Location		TNTC-S0229	
Sample No.		AB0229	
Sample Date		11-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.17	J
2,4-DNT	mg/kg	0.13	J
2A-4,6-DNT	mg/kg	0.11	J
4A-2,6-DNT	mg/kg	0.21	J

Location		TNTC-S0244	
Sample No.		AB0244	
Sample Date		11-Aug-00	
Sample Depth (ft)		1.0-2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.23	J
2,4-DNT	mg/kg	0.58	
2A-4,6-DNT	mg/kg	0.56	
4A-2,6-DNT	mg/kg	0.40	

Location		TNTC-S0243	
Sample No.		AB0243	
Sample Date		11-Aug-00	
Sample Depth (ft)		1.0-2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.13	J
2A-4,6-DNT	mg/kg	0.19	J
4A-2,6-DNT	mg/kg	0.16	J

Location		TNTC-S0284	
Sample No.		AB0284	
Sample Date		19-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
DNB	mg/kg	0.13	J
TNT	mg/kg	**489**	
2,4-DNT	mg/kg	**986**	
4A-2,6-DNT	mg/kg	**4.78**	

Location		TNTC-S0241	
Sample No.		AB0405	
Sample Date		16-SEP-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.149	J
DNB	mg/kg	0.211	J
TNT	mg/kg	2.55	
2,4-DNT	mg/kg	**0.975**	
2A-4,6-DNT	mg/kg	**5.35**	
4A-2,6-DNT	mg/kg	**5.01**	
Tetryl	mg/kg	0.458	J
3-NT	mg/kg	0.323	J

Location		TNTC-S0241	
Sample No.		AB0469	
Sample Date		27-SEP-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	0.589	
2A-4,6-DNT	mg/kg	0.911	
DNT	mg/kg	0.257	
TNB	mg/kg	0.0616	J
TNT	mg/kg	0.213	
Volatiles			
Acetone	mg/kg	0.0519	
Methylene chloride	mg/kg	0.0162	B
Semivolatiles			
Dinitrotoluene, 2,4-	mg/kg	0.0493	J
PCBs			
Aroclor 1260	mg/kg	0.0196	J
Metals			
Aluminum	mg/kg	5360	J
Arsenic	mg/kg	**3.43**	
Barium	mg/kg	28.3	
Beryllium	mg/kg	0.325	
Calcium	mg/kg	7710	J
Chromium	mg/kg	6.49	
Cobalt	mg/kg	2.41	
Copper	mg/kg	4.46	B
Iron	mg/kg	9180	
Lead	mg/kg	9.27	J
Magnesium	mg/kg	3030	J
Manganese	mg/kg	263	
Mercury	mg/kg	0.024	J
Nickel	mg/kg	6	
Potassium	mg/kg	304	
Sodium	mg/kg	173	J
Vanadium	mg/kg	11	
Zinc	mg/kg	29.3	

Location		TNTC-S0241	
Sample No.		AB0241	
Sample Date		11-Aug-00	
Sample Depth (ft)		1.0-2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	3.88	
DNB	mg/kg	0.32	
TNT	mg/kg	**1319**	
2,4-DNT	mg/kg	**640**	
NB	mg/kg	0.37	
Tetryl	mg/kg	1.29	
3-NT	mg/kg	2.14	
4-NT	mg/kg	1.30	

Location		TNTC-S0241	
Sample No.		AB0283	
Sample Date		19-Aug-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.87	
2,4-DNT	mg/kg	0.28	
2A-4,6-DNT	mg/kg	0.91	
4A-2,6-DNT	mg/kg	1.00	

Location		TNTC-S0241	
Sample No.		AB0448	
Sample Date		11-OCT-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	**11.5**	
2A-4,6-DNT	mg/kg	**17.3**	
DNT	mg/kg	**2.75**	
TNB	mg/kg	2.6	
TNT	mg/kg	**900**	
Volatiles			
Acetone	mg/kg	0.0503	J
Methylene chloride	mg/kg	0.00505	B
Semivolatiles			
Dinitrotoluene, 2,4-	mg/kg	**5.68**	
Dinitrotoluene, 2,6-	mg/kg	**10.7**	
PCBs			
Aroclor 1260	mg/kg	**0.517**	
Metals			
Aluminum	mg/kg	5570	
Arsenic	mg/kg	**9.38**	
Barium	mg/kg	81.6	
Beryllium	mg/kg	0.46	
Cadmium	mg/kg	1.19	
Calcium	mg/kg	24000	J
Chromium	mg/kg	9.87	J
Cobalt	mg/kg	4.5	
Copper	mg/kg	14.2	
Iron	mg/kg	**28800**	
Lead	mg/kg	**58.1**	J
Magnesium	mg/kg	5900	J
Manganese	mg/kg	1400	
Mercury	mg/kg	0.043	J
Nickel	mg/kg	15.4	
Potassium	mg/kg	506	J
Silver	mg/kg	0.455	J
Sodium	mg/kg	228	
Vanadium	mg/kg	17.3	
Zinc	mg/kg	359	J

Location		TNTC-S0228	
Sample No.		AB0228	
Sample Date		11-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.59	
2A-4,6-DNT	mg/kg	0.66	
HMX	mg/kg	0.37	

Location		TNTC-S0332	
Sample No.		AB0332	
Sample Date		13-OCT-00	
Sample Depth (ft)		2.0 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.0884	J
2,4-DNT	mg/kg	0.134	
2A-4,6-DNT	mg/kg	0.614	
4A-2,6-DNT	mg/kg	0.62	

Location		TNTC-S0320	
Sample No.		AB0477	
Sample Date		12-OCT-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	2.6	
2A-4,6-DNT	mg/kg	**6.23**	
TNB	mg/kg	3.24	
TNT	mg/kg	**38.7**	
Volatiles			
Methylene chloride	mg/kg	0.0514	J
Toluene	mg/kg	0.0139	J
Xylenes, m,p-	mg/kg	0.00389	J
Semivolatiles			
Bis(2-ethylhexyl)phthalate	mg/kg	0.0335	J
Di-n-butyl phthalate	mg/kg	0.169	J
Dinitrotoluene, 2,4-	mg/kg	0.176	J
Dinitrotoluene, 2,6-	mg/kg	0.386	
PCBs			
Aroclor 1260	mg/kg	0.0237	J
Metals			
Aluminum	mg/kg	4170	J
Arsenic	mg/kg	**9.88**	
Barium	mg/kg	52.8	
Beryllium	mg/kg	0.42	J
Cadmium	mg/kg	0.159	J
Calcium	mg/kg	45900	J
Chromium	mg/kg	8.08	
Cobalt	mg/kg	3.77	
Copper	mg/kg	10.5	
Iron	mg/kg	**28500**	
Lead	mg/kg	9.46	J
Magnesium	mg/kg	13200	J
Manganese	mg/kg	1120	J
Nickel	mg/kg	14	
Potassium	mg/kg	680	J
Sodium	mg/kg	152	B
Vanadium	mg/kg	14.8	
Zinc	mg/kg	94.6	

Location		TNTC-S0320	
Sample No.		AB0320	
Sample Date		23-SEP-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	2.04	
TNT	mg/kg	**399**	
2,4-DNT	mg/kg	**1.67**	
2A-4,6-DNT	mg/kg	**9.42**	
4A-2,6-DNT	mg/kg	**8.15**	
Tetryl	mg/kg	0.437	J

Location		TNTC-S0233	
Sample No.		AB0233	
Sample Date		11-Aug-00	
Sample Depth (ft)		1.5-2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2A-4,6-DNT	mg/kg	0.29	
4A-2,6-DNT	mg/kg	0.25	J

Location		TNTC-S0231	
Sample No.		AB0231	
Sample Date		11-Aug-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	15.6	
2A-4,6-DNT	mg/kg	0.14	J

Location		TNTC-S0232	
Sample No.		AB0232	
Sample Date		11-Aug-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	0.17	J

Location		TNTC-S0285	
Sample No.		AB0285	
Sample Date		19-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.75	
2,4-DNT	mg/kg	0.36	

Location		TNTC-S0286	
Sample No.		AB0286	
Sample Date		19-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	**41.1**	
2A-4,6-DNT	mg/kg	**4.45**	
4A-2,6-DNT	mg/kg	**4.01**	
Tetryl	mg/kg	0.24	J
3-NT	mg/kg	0.45	

LEGEND:

- △ ABO-228 SCREENING SOIL SAMPLING LOCATION
- • ABO-283 SURFACE SOIL SAMPLE (0-2 FT)
- ○ GW-06 GROUNDWATER SAMPLING LOCATION
- □ ABO-448 CONFIRMATION SOIL SAMPLING LOCATION
- FORMER TANK LOCATION
- FORMER BUILDING LOCATION
- POTENTIAL NITROAROMATIC REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 REMEDIATION GOAL OBJECTIVES SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLING DEPTHS

SAMPLE	DEPTH (FT)
AB0228	1.0 - 2.0
AB0229	1.0 - 2.0
AB0230	0.5 - 1.5
AB0231	1.5 - 2.5
AB0232	1.5 - 2.5
AB0233	1.5 - 2.5
AB0241	1.0 - 2.0
AB0242	1.0 - 2.0
AB0243	1.0 - 2.0
AB0244	1.0 - 2.0
AB0279	2.5 - 3.5
AB0283	0.0 - 1.0
AB0284	1.0 - 2.0
AB0285	1.0 - 2.0
AB0286	1.0 - 2.0
AB0320	1.5 - 2.5
AB0332	2.0 - 2.5
AB0405	4.0 - 6.0
AB0406	8.0 - 10.0
AB0448	1.0 - 2.0
AB0469	4.0 - 6.0
AB0477	1.5 - 2.5

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	2851	8	845

8. GROUNDWATER ENCOUNTERED IN SEPTEMBER 2000 BORING C-405/406 AT 8 FEET, BEDROCK AT 15 FEET.

   GROUNDWATER MEASURED IN TEMPORARY PIEZOMETER GW-06 AT 9.50 FEET (SEPTEMBER 2000).

SCALE
0 30 60 FEET

FIGURE 1-24
TNT AREA C
BUILDING 692 BI-TRIHOUSE
ANALYTICAL RESULTS AND
ESTIMATED AREA/VOLUME OF
SOIL REQUIRING REMEDIATION

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw® Shaw Environmental, Inc.

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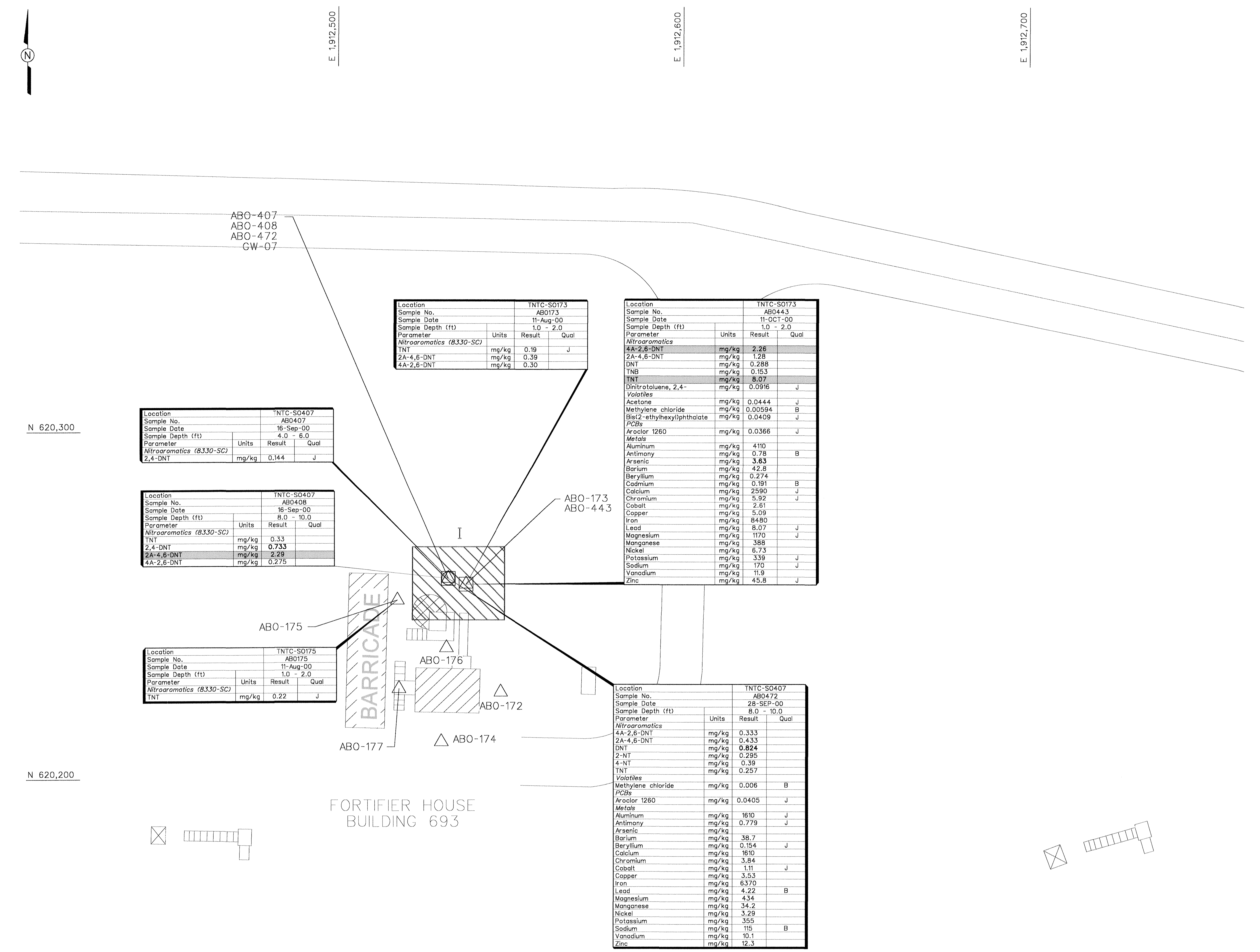


Location		TNTC-S0173	
Sample No.		AB0173	
Sample Date		11-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.19	J
2A-4,6-DNT	mg/kg	0.39	
4A-2,6-DNT	mg/kg	0.30	

Location		TNTC-S0407	
Sample No.		AB0407	
Sample Date		16-Sep-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.144	J

Location		TNTC-S0407	
Sample No.		AB0408	
Sample Date		16-Sep-00	
Sample Depth (ft)		8.0 - 10.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.33	
2,4-DNT	mg/kg	**0.733**	
2A-4,6-DNT	mg/kg	2.29	
4A-2,6-DNT	mg/kg	0.275	

Location		TNTC-S0175	
Sample No.		AB0175	
Sample Date		11-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.22	J

Location		TNTC-S0173	
Sample No.		AB0443	
Sample Date		11-OCT-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	2.26	
2A-4,6-DNT	mg/kg	1.28	
DNT	mg/kg	0.288	
TNB	mg/kg	0.153	
TNT	mg/kg	8.07	
Dinitrotoluene, 2,4-	mg/kg	0.0916	J
Volatiles			
Acetone	mg/kg	0.0444	J
Methylene chloride	mg/kg	0.00594	B
Bis(2-ethylhexyl)phthalate	mg/kg	0.0409	J
PCBs			
Aroclor 1260	mg/kg	0.0366	J
Metals			
Aluminum	mg/kg	4110	
Antimony	mg/kg	0.78	B
Arsenic	mg/kg	**3.63**	
Barium	mg/kg	42.8	
Beryllium	mg/kg	0.274	
Cadmium	mg/kg	0.191	B
Calcium	mg/kg	2590	J
Chromium	mg/kg	5.92	J
Cobalt	mg/kg	2.61	
Copper	mg/kg	5.09	
Iron	mg/kg	8480	
Lead	mg/kg	8.07	J
Magnesium	mg/kg	1170	J
Manganese	mg/kg	388	
Nickel	mg/kg	6.73	
Potassium	mg/kg	339	J
Sodium	mg/kg	170	J
Vanadium	mg/kg	11.9	
Zinc	mg/kg	45.8	J

Location		TNTC-S0407	
Sample No.		AB0472	
Sample Date		28-SEP-00	
Sample Depth (ft)		8.0 - 10.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	0.333	
2A-4,6-DNT	mg/kg	0.433	
DNT	mg/kg	**0.824**	
2-NT	mg/kg	0.295	
4-NT	mg/kg	0.39	
TNT	mg/kg	0.257	
Volatiles			
Methylene chloride	mg/kg	0.006	B
PCBs			
Aroclor 1260	mg/kg	0.0405	J
Metals			
Aluminum	mg/kg	1610	J
Antimony	mg/kg	0.779	J
Arsenic	mg/kg		
Barium	mg/kg	38.7	
Beryllium	mg/kg	0.154	J
Calcium	mg/kg	1610	
Chromium	mg/kg	3.84	
Cobalt	mg/kg	1.11	J
Copper	mg/kg	3.53	
Iron	mg/kg	6370	
Lead	mg/kg	4.22	B
Magnesium	mg/kg	434	
Manganese	mg/kg	34.2	
Nickel	mg/kg	3.29	
Potassium	mg/kg	355	
Sodium	mg/kg	115	B
Vanadium	mg/kg	10.1	
Zinc	mg/kg	12.3	

LEGEND:

- △ ABO-172 — SCREENING SOIL SAMPLING LOCATION
- ○ GW-07 — GROUNDWATER SAMPLING LOCATION
- □ ABO-443 — CONFIRMATION SOIL SAMPLING LOCATION
- FORMER TANK LOCATION
- BUILDING FOUNDATION
- POTENTIAL REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 REMEDIATION GOAL OBJECTIVES SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLING DEPTHS

SAMPLE	DEPTH (FT)
AB0172	1.5 - 2.5
AB0173	1.0 - 2.0
AB0174	1.0 - 2.0
AB0175	1.0 - 2.0
AB0176	1.0 - 2.0
AB0177	1.0 - 2.0
AB0407	4.0 - 6.0
AB0408	8.0 - 10.0
AB0443	1.0 - 2.0
AB0472	8.0 - 10.0

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	567	7	147

8. ENCOUNTERED GROUNDWATER AT 7 FEET IN SEPTEMBER 2000 BORING C-407/408. BEDROCK NOT DETECTED IN THE 10 FOOT BORING.
9. DRILLING CONDUCTED IN AUGUST 2001 NOT APPLICABLE. BOREHOLE DRILLED APPROXIMATELY 220 FOOT DOWNGRADIENT OF SITE.

SCALE
0 20 40 FEET

FIGURE 1-25
TNT AREA C
BUILDING 693 FORTIFIER HOUSE
ANALYTICAL RESULTS AND
ESTIMATED AREA/VOLUME OF
SOIL REQUIRING REMEDIATION

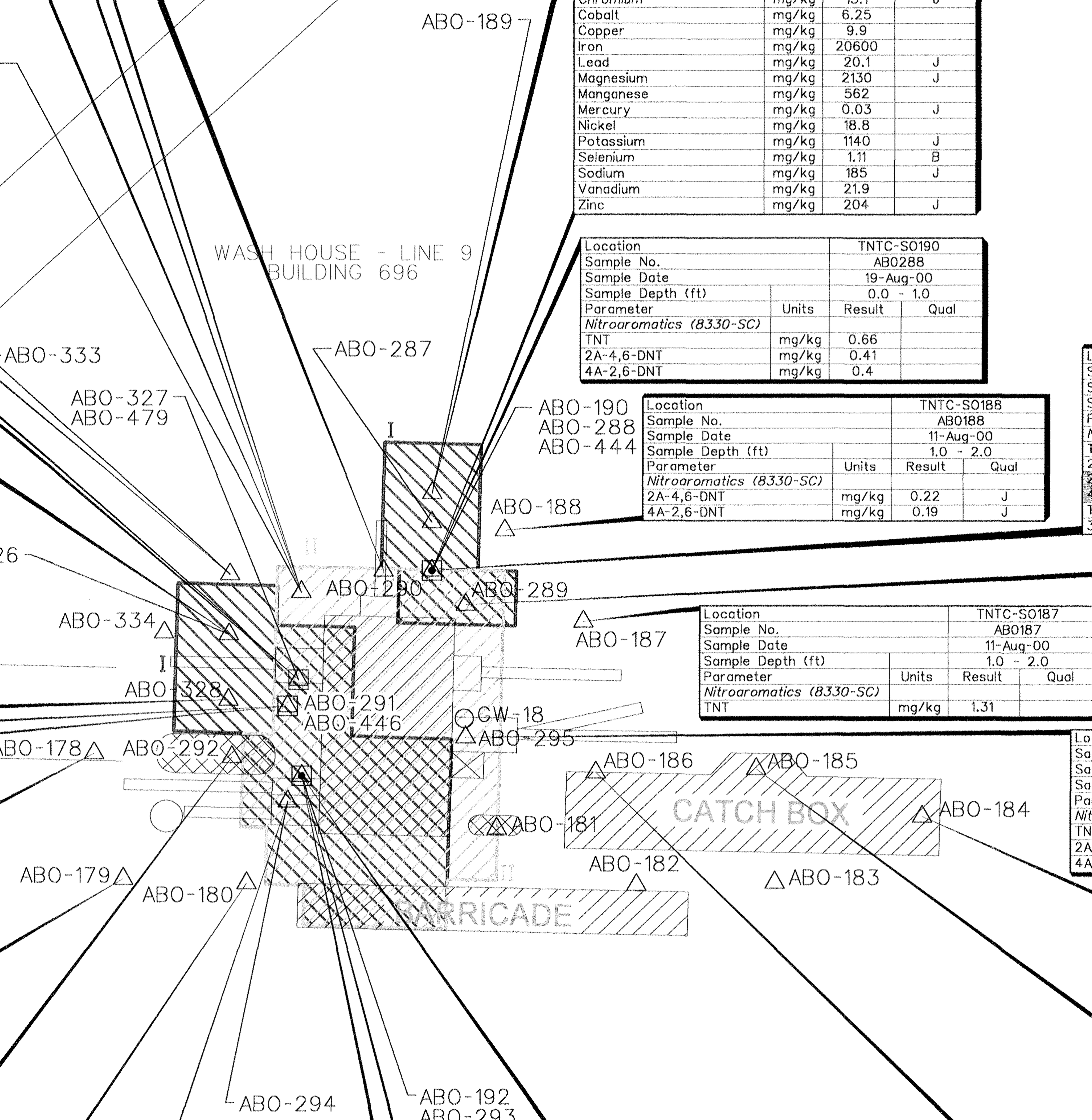
PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw Environmental, Inc.

STARTING DATE: 01/21/02 | DATE LAST REV.: | DRAFT. CHCK. BY: | INITIATOR: T. SIARD | DWG. NO.: 807112ES.057
DRAWN BY: B.VANDERGRIFF | DRAWN BY: | ENGR. CHCK. BY: D. KESSLER | PROJ. MGR.: S. DOWNEY | PROJ. NO.: 807112

c:\cadd\design\807112es.057 02:03:39 PM 09/04/03 cbentley

DWG. NO.: 807112ES.066 | PROJ. NO.: 807112
INITIATOR: T. SIARD | PROJ. MGR.: S. DOWNEY
DRAFT. CHCK. BY: C. TUMLIN | ENGR. CHCK. BY: T. SIARD
DATE LAST REV.: | DRAWN BY:
STARTING DATE: 10/22/02 | DRAWN BY: B.VANDERGRIFF
jwaters 08/26/03 01:53:47 PM
c:\cadd\data\proj\807112es.066



Location		TNTC-S0191	
Sample No.		AB0373	
Sample Date		14-SEP-00	
Sample Depth (ft)		4.0 - 6.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2A-4,6-DNT	mg/kg	0.159	J
2-NT	mg/kg	0.31	J
4-NT	mg/kg	0.324	J

Location		TNTC-S0191	
Sample No.		AB0191	
Sample Date		11-Aug-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.24	
2A-4,6-DNT	mg/kg	1.19	
4A-2,6-DNT	mg/kg	1.23	

Location		TNTC-S0191	
Sample No.		AB0374	
Sample Date		14-SEP-00	
Sample Depth (ft)		8.0 - 10.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.125	J
2-NT	mg/kg	0.21	J

Location		TNTC-S0290	
Sample No.		AB0290	
Sample Date		19-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.83	
2A-4,6-DNT	mg/kg	0.39	
4A-2,6-DNT	mg/kg	0.56	

Location		TNTC-S0327	
Sample No.		AB0327	
Sample Date		23-SEP-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	2.92	
2A-4,6-DNT	mg/kg	2.75	
4A-2,6-DNT	mg/kg	2.06	
3-NT	mg/kg	0.775	

Location		TNTC-S0333	
Sample No.		AB0333	
Sample Date		13-OCT-00	
Sample Depth (ft)		2.0 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.273	
2,4-DNT	mg/kg	0.0713	J
2A-4,6-DNT	mg/kg	0.981	
4A-2,6-DNT	mg/kg	1.07	
3-NT	mg/kg	0.137	J

Location		TNTC-S0189	
Sample No.		AB0189	
Sample Date		11-Aug-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	**13.9**	
2A-4,6-DNT	mg/kg	1.27	
4A-2,6-DNT	mg/kg	1.41	

Location		TNTC-S0190	
Sample No.		AB0444	
Sample Date		11-OCT-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	0.99	
2A-4,6-DNT	mg/kg	1.24	
TNT	mg/kg	0.634	
Volatiles			
Acetone	mg/kg	0.109	J
Carbon disulfide	mg/kg	0.00598	
Methylene chloride	mg/kg	0.00731	B
Toluene	mg/kg	0.00302	J
Semivolatiles			
Benzo(a)anthracene	mg/kg	0.0648	J
Benzo(a)pyrene	mg/kg	0.0596	J
Benzo(b)fluoranthene	mg/kg	0.102	J
Bis(2-ethylhexyl)phthalate	mg/kg	0.0302	J
Chrysene	mg/kg	0.0656	J
Fluoranthene	mg/kg	0.11	J
Pyrene	mg/kg	0.0873	J
Metals			
Aluminum	mg/kg	7340	
Arsenic	mg/kg	**5.58**	
Barium	mg/kg	50.3	
Beryllium	mg/kg	0.482	
Cadmium	mg/kg	0.693	
Calcium	mg/kg	25000	J
Chromium	mg/kg	13.1	J
Cobalt	mg/kg	6.25	
Copper	mg/kg	9.9	
Iron	mg/kg	20600	
Lead	mg/kg	20.1	J
Magnesium	mg/kg	2130	J
Manganese	mg/kg	562	
Mercury	mg/kg	0.03	J
Nickel	mg/kg	18.8	
Potassium	mg/kg	1140	J
Selenium	mg/kg	1.11	B
Sodium	mg/kg	185	J
Vanadium	mg/kg	21.9	
Zinc	mg/kg	204	J

Location		TNTC-S0327	
Sample No.		AB0479	
Sample Date		12-OCT-00	
Sample Depth (ft)		2.0 - 3.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	2.2	
TNT	mg/kg	**9.91**	
Volatiles			
Acetone	mg/kg	0.0696	
Benzene	mg/kg	0.00185	J
Carbon disulfide	mg/kg	0.0272	
Ethylbenzene	mg/kg	0.00119	J
Methylene chloride	mg/kg	0.00583	B
Xylenes, m,p-	mg/kg	0.00114	J
Pesticides/PCBs			
Aroclor 1260	mg/kg	0.00951	J
Metals			
Aluminum	mg/kg	6190	J
Antimony	mg/kg	0.633	B
Arsenic	mg/kg	**4.07**	
Barium	mg/kg	46	
Calcium	mg/kg	6520	J
Chromium	mg/kg	10.1	
Cobalt	mg/kg	4.59	
Copper	mg/kg	7.22	
Iron	mg/kg	18000	
Lead	mg/kg	8.61	J
Magnesium	mg/kg	1640	J
Manganese	mg/kg	424	J
Mercury	mg/kg	0.031	J
Nickel	mg/kg	14.3	
Sodium	mg/kg	109	B
Vanadium	mg/kg	18	
Zinc	mg/kg	29.5	

Location		TNTC-S0190	
Sample No.		AB0288	
Sample Date		19-Aug-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.66	
2A-4,6-DNT	mg/kg	0.41	
4A-2,6-DNT	mg/kg	0.4	

Location		TNTC-S0326	
Sample No.		AB0326	
Sample Date		23-SEP-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.196	J
TNT	mg/kg	**46.2**	
2A-4,6-DNT	mg/kg	**3.21**	
4A-2,6-DNT	mg/kg	**4.04**	

Location		TNTC-S0188	
Sample No.		AB0188	
Sample Date		11-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2A-4,6-DNT	mg/kg	0.22	J
4A-2,6-DNT	mg/kg	0.19	J

Location		TNTC-S0190	
Sample No.		AB0190	
Sample Date		11-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	1.28	
2,4-DNT	mg/kg	0.19	J
2A-4,6-DNT	mg/kg	**7.21**	
4A-2,6-DNT	mg/kg	**4.25**	
Tetryl	mg/kg	0.23	J
3-NT	mg/kg	1.4	

Location		TNTC-S0291	
Sample No.		AB0291	
Sample Date		19-Aug-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.52	
TNT	mg/kg	**33.1**	
2A-4,6-DNT	mg/kg	2.48	
4A-2,6-DNT	mg/kg	2.22	
3-NT	mg/kg	0.62	

Location		TNTC-S0328	
Sample No.		AB0328	
Sample Date		23-SEP-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
4A-2,6-DNT	mg/kg	1.51	
2A-4,6-DNT	mg/kg	2.76	
TNT	mg/kg	0.243	J

Location		TNTC-S0289	
Sample No.		AB0289	
Sample Date		19-Aug-00	
Sample Depth (ft)		0.5 - 1.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	2.75	
2A-4,6-DNT	mg/kg	1.52	
4A-2,6-DNT	mg/kg	1.38	

Location		TNTC-S0187	
Sample No.		AB0187	
Sample Date		11-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	1.31	

Location		TNTC-S0295	
Sample No.		AB0295	
Sample Date		19-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.16	J
2A-4,6-DNT	mg/kg	0.36	
4A-2,6-DNT	mg/kg	0.28	

Location		TNTC-S0291	
Sample No.		AB0446	
Sample Date		11-OCT-00	
Sample Depth (ft)		2.0 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	**4.76**	
2A-4,6-DNT	mg/kg	3.27	
DNT	mg/kg	0.705	
NB	mg/kg	0.212	
TNB	mg/kg	0.811	
TNT	mg/kg	**251**	
Volatiles			
Benzene	mg/kg	0.00291	J
Carbon disulfide	mg/kg	0.00423	J
Methylene chloride	mg/kg	0.00443	B
Toluene	mg/kg	0.00692	
Semivolatiles			
Anthracene	mg/kg	4.14	
Benzo(a)anthracene	mg/kg	**11.1**	
Benzo(a)pyrene	mg/kg	**8.2**	
Benzo(b)fluoranthene	mg/kg	**10.2**	
Benzo(ghi)perylene	mg/kg	3.4	J
Benzo(k)fluoranthene	mg/kg	4.38	
Chrysene	mg/kg	8.74	
Dibenz(a,h)anthracene	mg/kg	**1.4**	J
Dinitrotoluene, 2,4-	mg/kg	**1.64**	J
Fluoranthene	mg/kg	20.3	
Indeno(1,2,3-cd)pyrene	mg/kg	**3.64**	
Phenanthrene	mg/kg	5.21	
Pyrene	mg/kg	17.1	
Pesticides/PCBs			
Aroclor 1260	mg/kg	**0.3**	
Metals			
Aluminum	mg/kg	2820	
Arsenic	mg/kg	**2.58**	
Barium	mg/kg	398	
Beryllium	mg/kg	0.205	J
Cadmium	mg/kg	0.913	
Calcium	mg/kg	46800	J
Chromium	mg/kg	202	J
Cobalt	mg/kg	3.69	
Copper	mg/kg	16.4	
Iron	mg/kg	8120	
Lead	mg/kg	**228**	J
Magnesium	mg/kg	5360	J
Manganese	mg/kg	374	
Mercury	mg/kg	0.085	J
Nickel	mg/kg	90.8	
Potassium	mg/kg	492	J
Sodium	mg/kg	146	J
Vanadium	mg/kg	19.9	
Zinc	mg/kg	170	J

Location		TNTC-S0178	
Sample No.		AB0178	
Sample Date		11-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2,4-DNT	mg/kg	0.11	J
2A-4,6-DNT	mg/kg	0.12	J

Location		TNTC-S0179	
Sample No.		AB0179	
Sample Date		11-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	1.37	
2A-4,6-DNT	mg/kg	0.14	J

Location		TNTC-S0292	
Sample No.		AB0292	
Sample Date		19-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	3.31	
2,4-DNT	mg/kg	0.31	
2A-4,6-DNT	mg/kg	0.59	
4A-2,6-DNT	mg/kg	0.74	

Location		TNTC-S0180	
Sample No.		AB0180	
Sample Date		11-Aug-00	
Sample Depth (ft)		1.6 - 2.6	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2A-4,6-DNT	mg/kg	0.19	J
4A-2,6-DNT	mg/kg	0.15	J

Location		TNTC-S0192	
Sample No.		AB0192	
Sample Date		11-Aug-00	
Sample Depth (ft)		1.6 - 2.6	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.45	
TNT	mg/kg	**20.3**	
2,4-DNT	mg/kg	0.28	
2A-4,6-DNT	mg/kg	0.69	
4A-2,6-DNT	mg/kg	0.6	

Location		TNTC-S0294	
Sample No.		AB0294	
Sample Date		19-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.21	J

Location		TNTC-S0192	
Sample No.		AB0293	
Sample Date		19-Aug-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	**24.7**	
2A-4,6-DNT	mg/kg	1.89	
4A-2,6-DNT	mg/kg	1.97	

Location		TNTC-S0192	
Sample No.		AB0445	
Sample Date		11-OCT-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	**6.62**	
2A-4,6-DNT	mg/kg	**5.14**	
1,3-DNT	mg/kg	0.751	
DNT	mg/kg	**3.7**	
TNB	mg/kg	0.723	
TNT	mg/kg	**878**	
Volatiles			
Acetone	mg/kg	0.0975	J
Benzene	mg/kg	0.00601	
Methylene chloride	mg/kg	0.0054	B
Toluene	mg/kg	0.00258	J
Semivolatiles			
Benzo(a)anthracene	mg/kg	**1**	J
Benzo(a)pyrene	mg/kg	**0.704**	J
Benzo(b)fluoranthene	mg/kg	**0.929**	J
Chrysene	mg/kg	0.831	J
Dinitrotoluene, 2,4-	mg/kg	**2.41**	J
Fluoranthene	mg/kg	2.05	J
Phenanthrene	mg/kg	1.35	
Pyrene	mg/kg	1.54	J
Pesticides/PCBs			
Aroclor 1260	mg/kg	**0.373**	J
Metals			
Aluminum	mg/kg	5580	
Arsenic	mg/kg	**7.12**	
Barium	mg/kg	89.8	
Beryllium	mg/kg	0.394	
Cadmium	mg/kg	2.19	
Calcium	mg/kg	45900	J
Chromium	mg/kg	16.2	J
Cobalt	mg/kg	4.36	
Copper	mg/kg	52.2	
Iron	mg/kg	21400	
Lead	mg/kg	**934**	J
Magnesium	mg/kg	4660	J
Manganese	mg/kg	614	
Mercury	mg/kg	0.107	J
Nickel	mg/kg	22.1	
Potassium	mg/kg	878	J
Selenium	mg/kg	0.948	B
Sodium	mg/kg	403	
Vanadium	mg/kg	28.8	
Zinc	mg/kg	708	J

Location		TNTC-S0184	
Sample No.		AB0184	
Sample Date		11-Aug-00	
Sample Depth (ft)		1.5 -2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.16	J
2A-4,6-DNT	mg/kg	0.14	J
4A-2,6-DNT	mg/kg	0.16	J

Location		TNTC-S0185	
Sample No.		AB0185	
Sample Date		11-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.25	

Location		TNTC-S0186	
Sample No.		AB0186	
Sample Date		11-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.14	J
2A-4,6-DNT	mg/kg	0.73	
4A-2,6-DNT	mg/kg	0.5	

LEGEND:

- △ ABO-178 SCREENING SOIL SAMPLING LOCATION
- • ABO-288 SURFACE SOIL SAMPLE (0-2 FT)
- □ ABO-444 CONFIRMATION SOIL SAMPLING LOCATION
- ○ GW-18 GROUNDWATER SAMPLING LOCATION
- FORMER TANK LOCATION
- FORMER BUILDING LOCATION
- POTENTIAL NITROAROMATIC REMEDIATION AREA
- POTENTIAL LEAD REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 REMEDIATION GOAL OBJECTIVES SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLING DEPTHS

SAMPLE	DEPTH (FT)
AB0178	1.0 - 2.0
AB0179	1.0 - 2.0
AB0180	1.6 - 2.6
AB0181	1.0 - 2.0
AB0182	1.6 - 2.6
AB0183	1.0 - 2.0
AB0184	1.5 - 2.5
AB0185	1.0 - 2.0
AB0186	1.0 - 2.0
AB0187	1.0 - 2.0
AB0188	1.0 - 2.0
AB0189	1.5 - 2.5
AB0190	1.0 - 2.0
AB0191	0.5 - 1.5
AB0192	1.6 - 2.6
AB0287	1.0 - 2.0
AB0288	0.0 - 1.0
AB0289	0.5 - 1.5
AB0290	1.0 - 2.0
AB0291	1.5 - 2.5
AB0292	1.0 - 2.0
AB0293	0.0 - 1.0
AB0294	1.0 - 2.0
AB0295	1.0 - 2.0
AB0326	1.5 - 2.5
AB0327	2.0 - 3.0
AB0328	1.0 - 2.0
AB0333	2.0 - 2.5
AB0334	1.0 - 2.0
AB0373	4.0 - 6.0
AB0374	8.0 - 10.0
AB0444	1.0 - 2.0
AB0445	0.0 - 1.0
AB0446	2.0 - 2.5
AB0479	2.0 - 3.0

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	3301	12	1467
II	1476	5	273
TOTAL	4777		1740

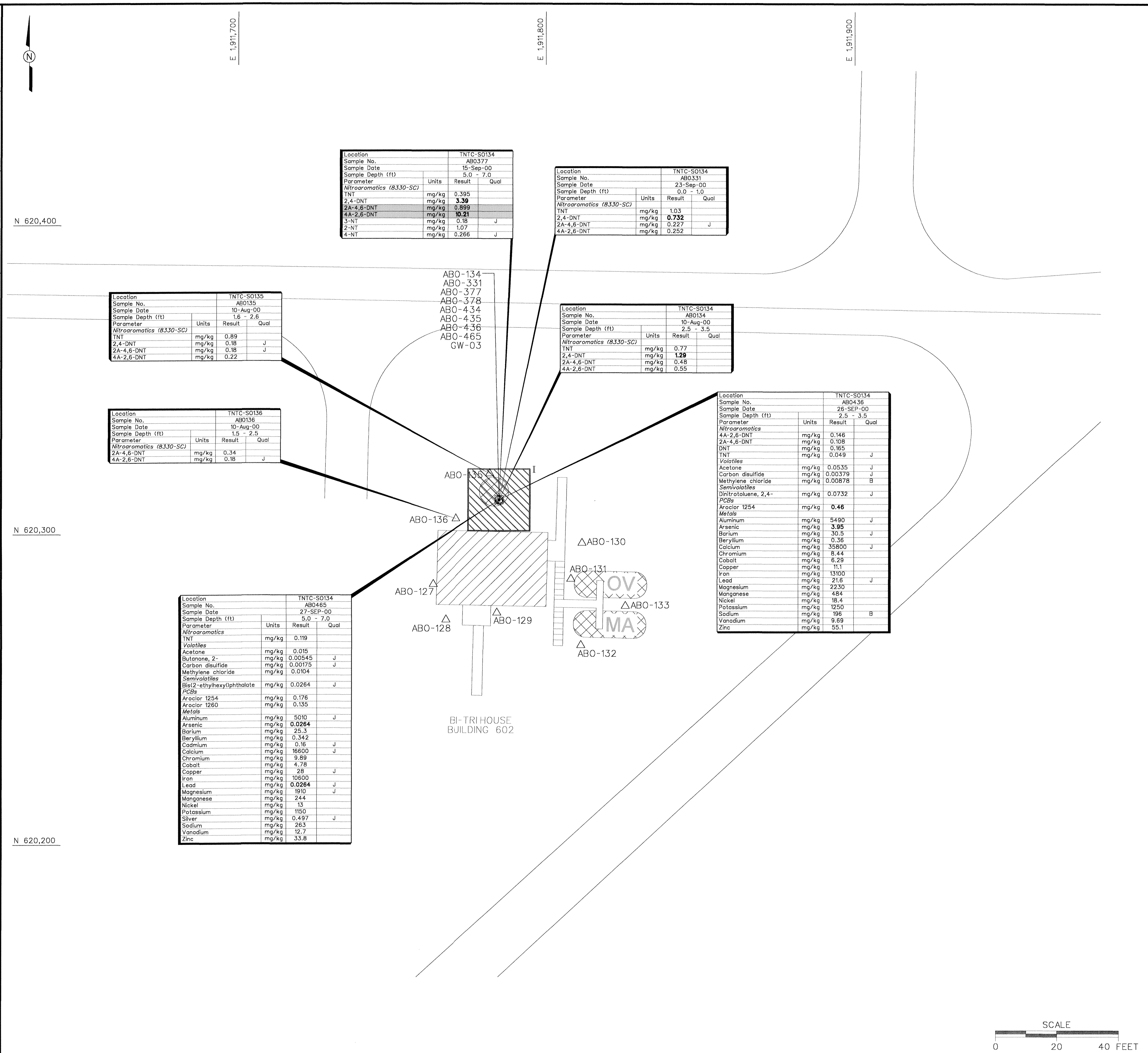
8. GROUNDWATER AND BEDROCK WERE NOT ENCOUNTERED IN SEPTEMBER 2000 C-373/374 BORING. TOTAL DEPTH WAS 10 FEET.
9. GROUNDWATER WAS NOT ENCOUNTERED IN AUGUST 2001 TEMPORARY PIEZOMETER GW-18. BEDROCK ENCOUNTERED AT 12 FEET.

FIGURE 1-26
TNT AREA C BUILDING 696 WASH HOUSE LINE 9 ANALYTICAL RESULTS AND ESTIMATED AREA/VOLUME OF SOIL REQUIRING REMEDIATION

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

SCALE
0 30 60 FEET

Shaw Environmental, Inc.



Location		TNTC-S0134	
Sample No.		AB0377	
Sample Date		15-Sep-00	
Sample Depth (ft)		5.0 - 7.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.395	
2,4-DNT	mg/kg	**3.39**	
2A-4,6-DNT	mg/kg	0.899	
4A-2,6-DNT	mg/kg	**10.21**	
3-NT	mg/kg	0.18	J
2-NT	mg/kg	1.07	
4-NT	mg/kg	0.266	J

Location		TNTC-S0134	
Sample No.		AB0331	
Sample Date		23-Sep-00	
Sample Depth (ft)		0.0 - 1.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	1.03	
2,4-DNT	mg/kg	**0.732**	
2A-4,6-DNT	mg/kg	0.227	J
4A-2,6-DNT	mg/kg	0.252	

Location		TNTC-S0135	
Sample No.		AB0135	
Sample Date		10-Aug-00	
Sample Depth (ft)		1.6 - 2.6	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.89	
2,4-DNT	mg/kg	0.18	J
2A-4,6-DNT	mg/kg	0.18	J
4A-2,6-DNT	mg/kg	0.22	

Location		TNTC-S0134	
Sample No.		AB0134	
Sample Date		10-Aug-00	
Sample Depth (ft)		2.5 - 3.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.77	
2,4-DNT	mg/kg	**1.29**	
2A-4,6-DNT	mg/kg	0.48	
4A-2,6-DNT	mg/kg	0.55	

Location		TNTC-S0136	
Sample No.		AB0136	
Sample Date		10-Aug-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
2A-4,6-DNT	mg/kg	0.34	
4A-2,6-DNT	mg/kg	0.18	J

Location		TNTC-S0134	
Sample No.		AB0436	
Sample Date		26-SEP-00	
Sample Depth (ft)		2.5 - 3.5	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	0.146	
2A-4,6-DNT	mg/kg	0.108	
DNT	mg/kg	0.165	
TNT	mg/kg	0.049	J
Volatiles			
Acetone	mg/kg	0.0535	J
Carbon disulfide	mg/kg	0.00379	J
Methylene chloride	mg/kg	0.00878	B
Semivolatiles			
Dinitrotoluene, 2,4-	mg/kg	0.0732	J
PCBs			
Aroclor 1254	mg/kg	**0.46**	
Metals			
Aluminum	mg/kg	5490	J
Arsenic	mg/kg	**3.95**	
Barium	mg/kg	30.5	J
Beryllium	mg/kg	0.36	
Calcium	mg/kg	35800	J
Chromium	mg/kg	8.44	
Cobalt	mg/kg	6.29	
Copper	mg/kg	11.1	
Iron	mg/kg	13100	
Lead	mg/kg	21.6	J
Magnesium	mg/kg	2230	
Manganese	mg/kg	484	
Nickel	mg/kg	18.4	
Potassium	mg/kg	1250	
Sodium	mg/kg	196	B
Vanadium	mg/kg	9.69	
Zinc	mg/kg	55.1	

Location		TNTC-S0134	
Sample No.		AB0465	
Sample Date		27-SEP-00	
Sample Depth (ft)		5.0 - 7.0	
Parameter	Units	Result	Qual
Nitroaromatics			
TNT	mg/kg	0.119	
Volatiles			
Acetone	mg/kg	0.015	
Butanone, 2-	mg/kg	0.00545	J
Carbon disulfide	mg/kg	0.00175	J
Methylene chloride	mg/kg	0.0104	
Semivolatiles			
Bis(2-ethylhexyl)phthalate	mg/kg	0.0264	J
PCBs			
Aroclor 1254	mg/kg	0.176	
Aroclor 1260	mg/kg	0.135	
Metals			
Aluminum	mg/kg	5010	J
Arsenic	mg/kg	**0.0264**	
Barium	mg/kg	25.3	
Beryllium	mg/kg	0.342	
Cadmium	mg/kg	0.16	J
Calcium	mg/kg	16600	J
Chromium	mg/kg	9.89	
Cobalt	mg/kg	4.78	
Copper	mg/kg	28	J
Iron	mg/kg	10600	
Lead	mg/kg	**0.0264**	J
Magnesium	mg/kg	1910	J
Manganese	mg/kg	244	
Nickel	mg/kg	13	
Potassium	mg/kg	1150	
Silver	mg/kg	0.497	J
Sodium	mg/kg	263	
Vanadium	mg/kg	12.7	
Zinc	mg/kg	33.8	

LEGEND:

- △ ABO-127 — SCREENING SOIL SAMPLING LOCATION
- • ABO-331 — SURFACE SOIL SAMPLE (0 - 1FT)
- ○ GW-03 — GROUNDWATER SAMPLING LOCATION
- □ ABO-465 — CONFIRMATION SOIL SAMPLING LOCATION
- FORMER TANK LOCATION
- FORMER BUILDING LOCATION
- POTENTIAL NITROAROMATIC REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 PRELIMINARY REMEDIATION GOALS ARE SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLING DEPTHS

SAMPLE	DEPTH (FT)
AB0127	2.6 - 3.6
AB0128	2.0 - 3.0
AB0129	2.0 - 3.0
AB0130	2.5 - 3.5
AB0131	1.8 - 2.8
AB0132	1.5 - 2.0
AB0133	2.0 - 3.0
AB0134	2.5 - 3.5
AB0135	1.6 - 2.6
AB0136	1.5 - 2.5
AB0331	0.0 - 1.0
AB0377	5.0 - 7.0
AB0378	8.0 - 10.0
AB0434	2.5 - 3.5
AB0435	2.5 - 3.5
AB0436	2.5 - 3.5
AB0465	5.0 - 7.0

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	400	6	89

8. GROUNDWATER ENCOUNTERED AT 6 FEET IN SEPTEMBER 2000 BORING C-377/378.

FIGURE 1-27
TNT AREA C
BUILDING 602 BI-TRI HOUSE
ANALYTICAL RESULTS AND
ESTIMATED AREA/VOLUME OF
SOIL REQUIRING REMEDIATION

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw Environmental, Inc.

STARTING DATE: 10/22/02 | DATE LAST REV.: | DRAFT. CHCK. BY: C. TUMLIN | INITATOR: T. SIARD | DWG. NO.: 807112ES.071
DRAWN BY: B. VANDERGRIFF | DRAWN BY: | ENGR. CHCK. BY: T. SIARD | PROJ. MGR.: S. DOWNEY | PROJ. NO.: 807112

g:\cadd\design\807112es.071 01:57:05 PM 08/26/03 jwaters

E 1,911,500

E 1,911,600

E 1,911,700

N 620,400

N 620,300

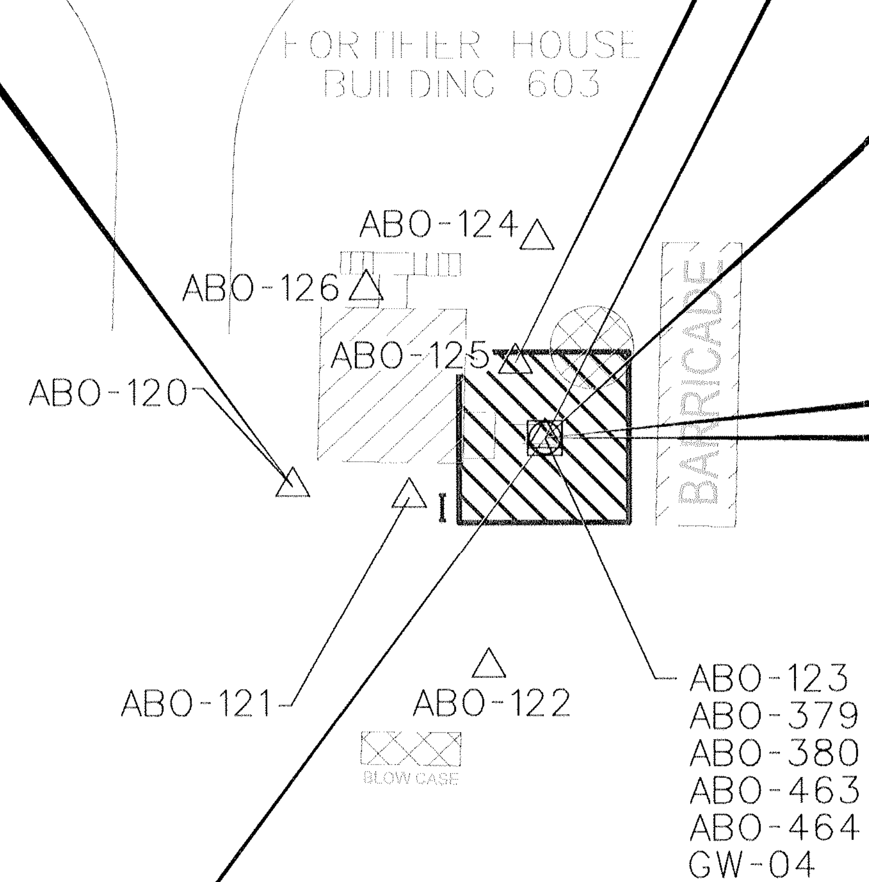
N 620,200

Location		TNTC-S0125	
Sample No.		AB0125	
Sample Date		10-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	0.499	

Location		TNTC-S0123	
Sample No.		AB0123	
Sample Date		10-Aug-00	
Sample Depth (ft)		1.0 - 2.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	2.73	

Location		TNTC-S0120	
Sample No.		AB0120	
Sample Date		10-Aug-00	
Sample Depth (ft)		1.5 - 2.5	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNT	mg/kg	1.38	
2,4-DNT	mg/kg	0.302	
2A-4,6-DNT	mg/kg	0.614	
4A-2,6-DNT	mg/kg	0.402	

Location		TNTC-S0123	
Sample No.		AB0464	
Sample Date		27-SEP-00	
Sample Depth (ft)		8.0 - 10.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	0.896	
2A-4,6-DNT	mg/kg	**10.3**	
DNT	mg/kg	**16.8**	
2-NT	mg/kg	2.8	
3-NT	mg/kg	0.328	
4-NT	mg/kg	1.47	
TNB	mg/kg	0.507	
TNT	mg/kg	15.1	
Volatiles			
Acetone	mg/kg	0.034	
Carbon disulfide	mg/kg	0.00215	J
Methylene chloride	mg/kg	0.00272	B
Semivolatiles			
Dinitrotoluene, 2,4-	mg/kg	**8.19**	
Dinitrotoluene, 2,6-	mg/kg	**6.83**	
Metals			
Aluminum	mg/kg	6950	J
Arsenic	mg/kg	**2.90**	
Barium	mg/kg	21.5	
Beryllium	mg/kg	0.515	
Calcium	mg/kg	126000	J
Chromium	mg/kg	14.1	
Cobalt	mg/kg	8.38	
Copper	mg/kg	11.5	J
Iron	mg/kg	14000	
Lead	mg/kg	4.05	J
Magnesium	mg/kg	3960	J
Manganese	mg/kg	764	
Nickel	mg/kg	23.1	
Potassium	mg/kg	2640	
Sodium	mg/kg	355	
Vanadium	mg/kg	9.79	
Zinc	mg/kg	17.3	



Location		TNTC-S0123	
Sample No.		AB0379	
Sample Date		15-Sep-00	
Sample Depth (ft)		5.0 - 7.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.807	
TNT	mg/kg	5.44	
2,4-DNT	mg/kg	**8.9**	
4A-2,6-DNT	mg/kg	1	
Tetryl	mg/kg	0.828	
2-NT	mg/kg	0.219	J

Location		TNTC-S0123	
Sample No.		AB0380	
Sample Date		15-Sep-00	
Sample Depth (ft)		8.0 - 10.0	
Parameter	Units	Result	Qual
Nitroaromatics (8330-SC)			
TNB	mg/kg	0.449	
TNT	mg/kg	7.39	
2,4-DNT	mg/kg	**56.1**	
4A-2,6-DNT	mg/kg	0.479	
3-NT	mg/kg	1.09	
2-NT	mg/kg	7.71	
4-NT	mg/kg	6.75	

Location		TNTC-S0123	
Sample No.		AB0463	
Sample Date		27-SEP-00	
Sample Depth (ft)		5.0 - 7.0	
Parameter	Units	Result	Qual
Nitroaromatics			
4A-2,6-DNT	mg/kg	0.934	
2A-4,6-DNT	mg/kg	**3.61**	
DNT	mg/kg	**3.5**	
2-NT	mg/kg	0.27	
3-NT	mg/kg	0.275	
TNB	mg/kg	0.205	
TNT	mg/kg	5.26	
Volatiles			
Acetone	mg/kg	0.0081	J
Methylene chloride	mg/kg	0.00443	B
Semivolatiles			
Dinitrotoluene, 2,4-	mg/kg	0.617	J
Dinitrotoluene, 2,6-	mg/kg	**7.21**	
Metals			
Aluminum	mg/kg	4310	J
Arsenic	mg/kg	**2.99**	
Barium	mg/kg	24.4	
Beryllium	mg/kg	0.321	
Cadmium	mg/kg	0.136	J
Calcium	mg/kg	65300	J
Chromium	mg/kg	7.13	
Cobalt	mg/kg	3.62	
Copper	mg/kg	11.2	J
Iron	mg/kg	10100	
Lead	mg/kg	27.9	J
Magnesium	mg/kg	1160	J
Manganese	mg/kg	361	
Nickel	mg/kg	10.4	
Potassium	mg/kg	897	
Sodium	mg/kg	288	
Vanadium	mg/kg	8.95	
Zinc	mg/kg	41.2	

SCALE

0 30 60 FEET

LEGEND:

- △ ABO-120 — SCREENING SOIL SAMPLING LOCATION
- ○ GW-04 — GROUNDWATER SAMPLING LOCATION
- □ ABO-464 — CONFIRMATION SOIL SAMPLING LOCATION
- FORMER TANK LOCATION
- FORMER BUILDING LOCATION
- POTENTIAL NITROAROMATIC REMEDIATION AREA

NOTES:

1. ANALYTICAL RESULTS EXCEEDING REGION 9 REMEDIATION GOAL OBJECTIVES SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLING DEPTHS

SAMPLE	DEPTH (FT)
AB0120	1.5 - 2.5
AB0121	1.0 - 2.0
AB0122	2.5 - 3.5
AB0123	1.0 - 2.0
AB0124	1.0 - 2.0
AB0125	1.0 - 2.0
AB0126	0.0 - 1.0
AB0379	5.0 - 7.0
AB0380	8.0 - 10.0
AB0463	5.0 - 7.0
AB0464	8.0 - 10.0

6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:

AREA NO.	AREA (FT^2)	DEPTH (FEET)	VOLUME (YD^3)
I	400	8	119

8. GROUNDWATER ENCOUNTERED AT 8 FEET IN SEPTEMBER 2000, C-379/380 BORING (IT, 2001a)

   GROUNDWATER MEASURED IN GW-04 AT 6.9 FEET.

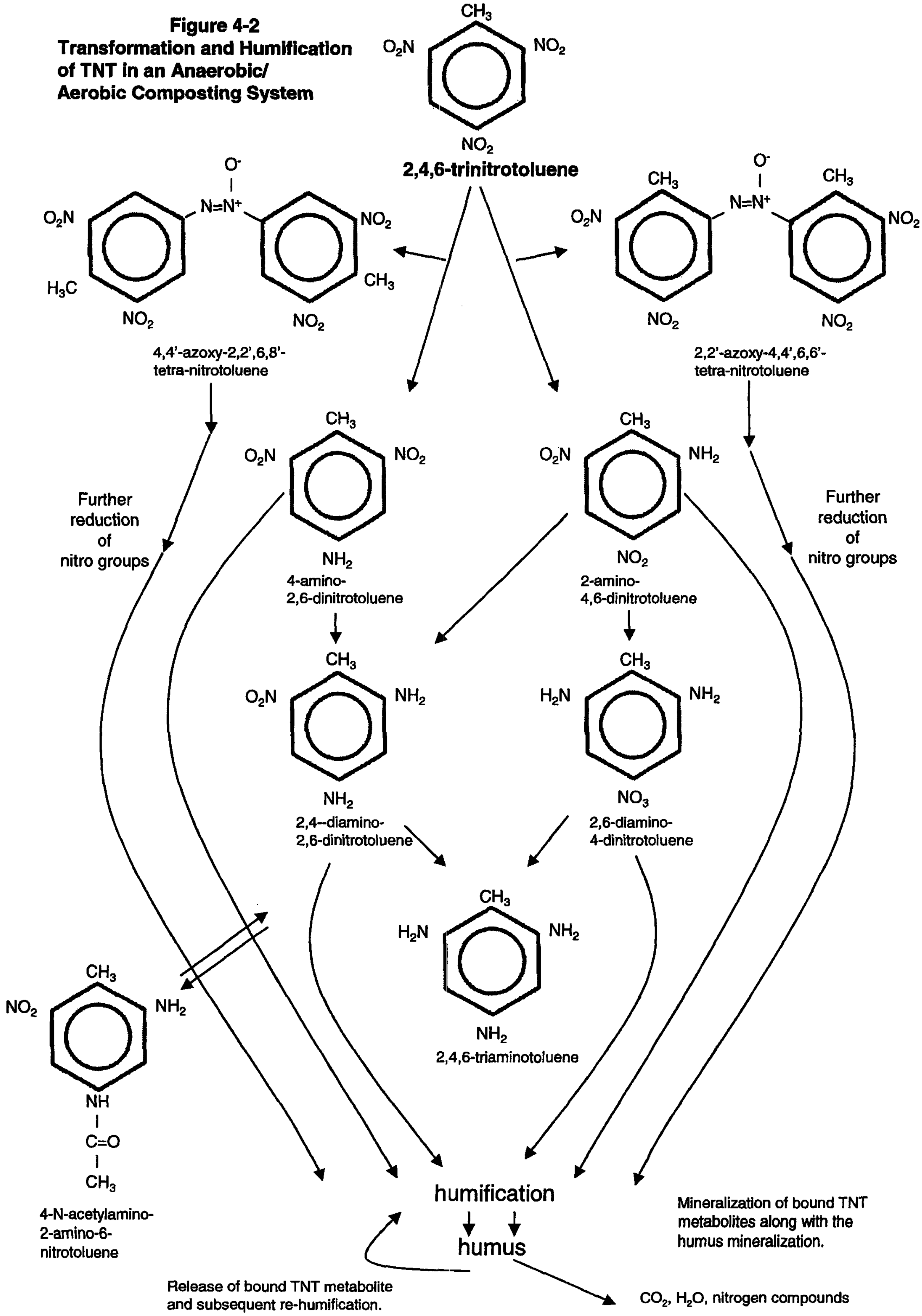
FIGURE 1-28
TNT AREA C
BUILDING 603 FORTIFIER HOUSE ANALYTICAL RESULTS AND ESTIMATED AREA/VOLUME OF SOIL REQUIRING REMEDIATION

PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw Environmental, Inc.

DWG. NO.: ...\80712es.068
PROJ. NO.: 80712
INITIATOR: T. SIARD
PROJ. MGR.: S. DOWNEY
DRAFT. CHCK. BY: C. TUMLIN
ENGR. CHCK. BY: T. SIARD
DATE LAST REV.:
DRAWN BY:
STARTING DATE: 10/22/02
DRAWN BY: S. VANDERGRIFF
12:01:12 PM
09/04/03
cbentley
c:\cadd\design\80712es.068

Figure 4-2
Transformation and Humification of TNT in an Anaerobic/ Aerobic Composting System



APPENDIX A

RISK ESTIMATIONS FOR SELECTED AREAS WITH REMEDIAL GOAL OPTION EXCEEDANCES

Appendix A

Risk Estimations for Selected Areas with RGO Exceedances
TNTA and TNTC
Former Plum Brook Ordnance Works
Sandusky, Ohio

Risks associated with TNT Area A (TNTA) and TNT Area C (TNTC) at the former Plum Brook Ordnance Works (PBOW) were evaluated in the baseline human health risk assessment (BHHRA) (IT, 2001) based on validated confirmation samples. Nonvalidated screening samples, which were analyzed at a fixed-base laboratory using a modified Method 8330, were not evaluated in the BHHRA. The BHHRA further addressed human health risks by building area. Tables 1-2 and 1-4 of the focused feasibility study (FFS) for TNT A&C soil and sediment indicate which building areas have estimated risks that exceed Ohio Environmental Protection Agency (OEPA) cancer (incremental lifetime cancer risk [ILCR] >1E-5) or noncancer (hazard index [HI]>1) risk management criteria based on the results of the BHHRA. Each of these building areas is proposed for remediation in the FFS.

Separate remedial goal options (RGO) are proposed in Section 2.2 of the FFS as respective cleanup standards for TNTA and TNTC. A comparison of all analytical results to RGOs was performed; particular focus was accorded those building areas that were either identified as being within OEPA risk management criteria or for which only screening samples were collected. These building areas can be characterized by one of the following descriptions:

1. Areas identified by Tables 1-2 and 1-4 of the FFS (based on the BHHRA results) as being within OEPA risk management criteria, but having specific samples that exceed RGOs.

2. Areas not evaluated in the BHHRA because only screening samples were collected.

Some building areas, characterized by No. 1 or No. 2 above, were observed to have exceedances of RGOs in either confirmation or screening samples that clearly would result in noncancer and/or cancer risks that exceed the OEPA risk management criteria. These building areas were proposed for remediation and are not further addressed herein. These include the following:

- Building 111
- Building 116
- Building 129
- Building 133
- Building 142
- Building 143
- Building 148
- Building 182
- Building 602

Building Areas Evaluated. Four building areas are described, based on the BHHRA, as being within OEPA risk management criteria but having individual marginal-to-moderate RGO exceedances such that OEPA risk management criteria were not obviously exceeded. These are:

- Building 611
- Building 626
- Building 657
- Building 693.

Because Building Area 657 had an exceedance of the polynuclear aromatic hydrocarbon RGO that is based on OEPA policy rather than risk, Building Area 657 was proposed for remediation and is not evaluated in this appendix.

Building areas not evaluated in the BHHRA but having screening samples with marginal RGO exceedances are:

- Building 113
- Building 123
- Building 128
- Building 132
- Building 691.

The remainder of this appendix presents the risk evaluation of confirmation and screening samples that marginally exceed RGOs in the eight building areas (not including Building Area 657) identified in the two sets of bullets above.

Method. RGOs for TNTA and TNTC soils were derived based on the residential receptor described in the BHHRA. Only noncancer risks are estimated in this appendix because the only COCs with marginal exceedances are 2-amino-4,6-dinitrotoluene (2-ADNT), 4-amino-2,6-dinitritoluene (4-ADNT), and 2,4,6-trinitrotoluene (TNT). The ADNT isomers are not known to be carcinogenic, and the risks associated with noncancer effects of a given concentration of TNT make a greater contribution toward exceeding the respective OEPA risk management criterion than do the cancer effects. For example, assuming residential exposure, a TNT soil concentration (assuming no other contaminants) at 100 mg/kg (hazard quotient [HQ] = 3) clearly exceeds the OEPA noncancer risk management criterion ($HI \leq 1$), but the cancer risk of TNT at 100 mg/kg (ILCR = 7E-6) is still within the OEPA risk management range (1E-6 to 1E-5). The following equation, which takes advantage of the fact that each RGO was back-calculated from the BHHRA and has an associated HQ, was used to estimate risks associated with 2-ADNT, 4-ADNT, and TNT in TNTA&C total soil.

$$HQ_s = C_s/RGO \times HQ_{RGO} \qquad \text{Eq. A-1}$$

Where:

HQ_s	=	hazard quotient associated with COC in the sample
C_s	=	concentration of COC in the sample (mg/kg)
RGO	=	remedial goal option of the COC (mg/kg) (from Appendix B of the FFS)
HQ_{RGO}	=	hazard quotient associated with the RGO (from Appendix B of the FFS).

The HI associated with the COCs in a sample is estimated by summing the HQs of that sample:

$$HI_s = HQ_{s\text{-}2\text{-}ADNT} + HQ_{s\text{-}4\text{-}ADNT} + HQ_{s\text{-}TNT} \qquad \text{Eq. A-2}$$

Where:

HI_s	=	hazard index of the sample
$HQ_{s\text{-}(COC)}$	=	hazard quotient for each of the three relevant noncancer COCs in the sample

Table A-1 shows the input and results of the calculations for each building area evaluated. A brief discussion of the results follows.

Discussion of Results

- ***Building Area 113*** – Only screening samples were collected at Building Area 113. TNT at 10.8 mg/kg marginally exceeds the RGO (8 mg/kg) in 1 of 9 samples. The detected concentrations of 2-ADNT and 4-ADNT in this sample (AA0121) (0.52 mg/kg and 1.05 mg/kg, respectively) are the MDCs for Building Area 113. The HI associated with these concentrations of TNT and the ADNT isomers would be 0.7.

- ***Building Area 123*** - Only screening samples were collected at Building Area 123. 2-ADNT at 1.69 mg/kg marginally exceeds the RGO (1.3 mg/kg) in 1 of 6 samples. The detected concentrations of 4-ADNT and TNT in this sample (AA0167) (1.01 mg/kg and 0.451 mg/kg, respectively) are the MDCs for Building Area 123. The HI associated with these concentrations of TNT and the ADNT isomers would be 0.7.

- ***Building Area 128*** - Only screening samples were collected at Building Area 128. 2-ADNT at 1.50 mg/kg marginally exceeds the RGO (1.3 mg/kg) in 1 of 5 samples. The detected concentrations of 4-ADNT and TNT in this sample (AA0146) (0.912 mg/kg and 1.24 mg/kg, respectively) are the MDCs for Building Area 128. The HI associated with these concentrations of TNT and the ADNT isomers would be 0.6.

- ***Building Area 132*** - Only screening samples were collected at Building Area 132. 2-ADNT marginally exceeded the RGO (1.3 mg/kg) in 2 of 12 samples, AA0052 (at 1.65 mg/kg) and AA0054 (at 1.57 mg/kg). TNT and 4-ADNT were detected in Sample AA0052 at 5.04 and 1.18 mg/kg, respectively. The HI associated with concentrations of TNT and the ADNT isomers in sample AA0052 would be 0.8; all three of the concentrations in this sample are MDCs for Building Area 132. TNT and 4-ADNT were detected in Sample AA0054 at 4.08 and 1.07 mg/kg, respectively. The HI associated with concentrations of TNT and the ADNT isomers in sample AA0054 would also be 0.8

- ***Building Area 611*** - 2-ADNT (1.97 mg/kg) and 4-ADNT (1.46 mg/kg) marginally exceeded the respective RGOs (1.7 and 1.3 mg/kg) in 1 of 9 confirmation and screening samples. This screening sample, AB0383, had an associated TNT concentration of 0.662 mg/kg. Each of these concentrations is the MDC for Building Area 611. The HI associated with these MDC values would be 0.9, which is less than the OEPA risk management criterion of 1. A confirmation sample was also collected from the same depth and location as Sample AB0383. The concentrations of 2-ADNT (0.182 mg/kg), 4-ADNT (0.192 mg/kg), and TNT (0.0956 mg/kg) in this confirmation sample (AB0470) were far less than the RGO values. It is noted that no HI could be calculated in the BHHRA because no noncancer site-related chemicals of potential concern were identified for Building Area 611 based on the confirmation samples alone.

- ***Building Area 626*** - 2-ADNT is the only COC that exceeded its RGO. The RGO (1.7 mg/kg) for 2-ADNT was exceeded in 1 of 18 confirmation and screening samples at a concentration of 2.67 mg/kg. It was detected in only one other Building Area 626 sample and at a much lower concentration (0.237 mg/kg). The single exceedance (Sample AB0431) of 2-ADNT (2.67 mg/kg) was collocated with the only Building Area 626 detection of 4-ADNT (0.784 mg/kg). If these concentrations are combined with the TNT concentration detected in this sample (1.41 mg/kg), the resultant hazard index (HI) equals 0.9, which is less than the OEPA risk management criterion of 1. It is noted that the HI of Building Area 626 as calculated in the BHHRA (including all chemicals evaluated, not just the COCs) is equal to the OEPA risk management criterion.

- ***Building Area 691*** - Only screening samples were collected at Building Area 691. 4-ADNT marginally exceeded the RGO (1.3 mg/kg) at 1.72 mg/kg in 1 of 8 screening samples. 2-ADNT was not detected in this sample (AB0021), and TNT was not detected in any Building Area 691 samples. The HI associated with Sample AB0021 is, therefore, 0.4. 2-ADNT was detected in only one screening sample, at a concentration of 0.156 mg/kg. If this concentration of 2-ADNT is combined with the exceedance of 4-ADNT found at AB0021, the resulting HI would be 0.5.

- ***Building Area 693*** - 2-ADNT, 4-ADNT, and TNT were each detected at concentrations exceeding the respective RGOs in 1 of 9 confirmation and screening samples. The 4-ADNT (2.26 mg/kg) and TNT (8.07 mg/kg) exceedances were both detected in the same sample (AB0443), with an associated 2-ADNT concentration of 1.28 mg/kg. The resultant HI for Sample AB0443 of 1 (1.1 prior to rounding) equals the OEPA risk management criterion. 2-ADNT exceeded its RGO only in Sample AB0408, at a concentration of 2.29 mg/kg. 4-ADNT (0.275 mg/kg) and TNT (0.33 mg/kg) were also detected in Sample AB0408, but at concentrations below the respective RGOs. The resultant HI for Sample AB0408 is 0.6, which is less than the OEPA risk management criterion. The HI values for these two individual samples are consistent with the BHHRA, in which an HI of 0.9 was calculated.

References

IT Corporation (IT), 2001, ***TNT Areas A&C Remedial Investigation, Volume II, Human Health Risk Assessment,*** Plum Brook Ordnance Works, Sandusky, Ohio, November.

U.S. Environmental Protection Agency (EPA), 1989, ***Risk Assessment Guidance for Superfund, Volume 1 - Human Health Evaluation Manual (Part A),*** Office of Emergency and Remedial Response, December (EPA/540/1-89/002).

Table A-1

Estimated Noncancer Risks Associated with Samples Marginally Exceeding Remedial Goal Options
TNTA and TNTC
Former Plum Brook Ordnance Works
Sandusky, Ohio

TNT Area A

COC	RGO (mg/kg)	HQ Associated with RGO	Concentration in Building Area 113 - Sample AA0121 (mg/kg)	HQ & HI of Building Area 113 - Sample AA0121	Concentration in Building Area 123 - Sample AA0167 (mg/kg)	HQ & HI of Building Area 123 - Sample AA0167	Concentration in Building Area 128 - Sample AA0146 (mg/kg)	HQ & HI of Building Area 128 - Sample AA0146	Concentration in Building Area 132 - Sample AA0052 (mg/kg)	HQ & HI of Building Area 132 - Sample AA0052	Concentration in Building Area 132 - Sample AA0054 (mg/kg)	HQ & HI of Building Area 132 - Sample AA0054
2-Amino-4,6-dinitrotoluene	1.3	0.32	0.52	**0.13**	1.69	**0.42**	1.5	**0.37**	1.65	**0.41**	1.57	**0.39**
4-Amino-2,6-dinitrotoluene	1.7	0.42	1.05	**0.26**	1.01	**0.25**	0.912	**0.23**	1.18	**0.29**	1.07	**0.26**
2,4,6-Trinitrotoluene	8	0.24	10.8	**0.32**	0.451	**0.01**	1.24	**0.04**	5.04	**0.15**	4.08	**0.12**
HI				**0.7**		**0.7**		**0.6**		**0.8**		**0.8**

TNT Area C

COC	RGO (mg/kg)	HQ Associated with RGO	Concentration in Building Area 611 - Sample AB0383 (mg/kg)	HQ & HI of Building Area 611 - Sample AB0383	Concentration in Building Area 626 - Sample AB0431 (mg/kg)	HQ & HI of Building Area 626 - Sample AB0431	Concentration in Building Area 693 - Sample AB0408 (mg/kg)	HQ & HI of Building Area 693 - Sample AB0408	Concentration in Building Area 693 - Sample AB0443 (mg/kg)	HQ & HI of Building Area 693 - Sample AB0443	Concentration in Building Area 691 - Sample AB0021 (mg/kg)	HQ & HI of Building Area 691 - Sample AB0021
2-Amino-4,6-dinitrotoluene	1.7	0.42	1.97	**0.49**	2.67	**0.66**	2.29	**0.57**	1.28	**0.32**	ND	**NA**
4-Amino-2,6-dinitrotoluene	1.3	0.32	1.46	**0.36**	0.784	**0.19**	0.275	**0.07**	2.26	**0.56**	1.72	**0.42**
2,4,6-Trinitrotoluene	8	0.24	0.662	**0.02**	1.41	**0.04**	0.33	**0.01**	8.07	**0.24**	ND	**NA**
HI				**0.9**		**0.9**		**0.6**		**1.1**		**0.4**

RGO=remedial goal option; mg/kg=milligram per kilogram; HQ=hazard quotient; HI=hazard index; ND=not detected; NA=not applicable

APPENDIX B

SUM OF RATIOS APPROACH FOR DERIVING RISK-BASED REMEDIATION CONCENTRATIONS AS PROPOSED REMEDIAL GOAL OPTIONS

Appendix B

Sum-of-Ratios Approach for Deriving Risk-Based Remediation Concentrations (RBRC) as Proposed Remedial Goal Options (RGO) TNTA and TNTC Former Plum Brook Ordnance Works Sandusky, Ohio

A sum-of-ratios approach (SRA) was used to develop RBRCs for chemicals of concern (COC) in total soil at TNTA and TNTC. RBRCs are COC-, receptor-, and medium-specific concentrations, and for the former Plum Brook Ordnance Works (PBOW), are based on a cumulative target cancer risk level of 1E-5 and a cumulative target HI value of 1 for each target organ. They are typically used for consideration as cleanup criteria, referred to in the Plum Brook TNTA&C Focused Feasibility Study (FFS) as remedial goal options (RGO). The RBRCs incorporate all the exposure and toxicity assumptions and data used in the TNTA&C baseline human health risk assessment (BHHRA) (IT, 2001).

The only noncancer COCs identified in TNTA are nitroaromatics, all of which have a common target organ, the erythrocyte. At TNTC, Aroclor 1254 was also identified as a noncancer COC, in addition to nitroaromatics, but Aroclor 1254 (target organs: skin and immune system) does not affect the same target organs as nitroaromatics. Thus, the effects of Aroclor 1254 are not regarded as additive with those of nitroaromatics. More details about assumptions regarding the additivity of noncancer hazards are provided in the BHHRA.

Where multiple COCs are identified, such as for TNTA soil, TNTC soil, and TNTC sediment, a virtually limitless number of combinations of RBRCs for the set of COCs could be proposed. The SRA provides the flexibility necessary to derive RBRCs so that the target cumulative risk values (i.e., ILCR = 1E-5; HI = 1) are divided among the COCs in appropriate proportions, considering both cancer and noncancer effects. Various project-specific considerations may affect the proportions selected, notably spatial distribution of detected concentrations of the COCs. The SRA often requires ongoing balancing of the contributions of individual COCs to cumulative cancer and noncancer cancer risks until a set of RBRCs is derived that is considered the "best possible" combination to recommend in the feasibility study. Ultimately, RBRCs are selected such that the remediation effort, costs, and/or time required to meet the remedial action objectives (RAO) are minimized.

The basic SRA methodology and the specific derivation of TNTA and TNTC RBRCs are described in the following paragraphs.

B.1 SRA Methodology

A first step to derive RBRCs using the SRA addresses the relative contributions to risk of the various site-related chemicals. This method is typically applied where the risks associated with site-related chemicals exceed the risk management range. For example, if COPCs have a combined HI of 5.0 in a single medium, a noncancer RBRC for each chemical may be calculated by the following equation:

$$RBRC_a = C_a \times (\text{Target HI}/HI_m) \qquad \text{Eq. B-1}$$

Where:

$RBRC_a$	=	Site-specific risk-based remedial concentration for chemical "a" (mg/kg for soil)
C_a	=	Concentration of chemical "a" in site medium (mg/kg for soil)
Target HI	=	The HI value targeted for overall risks (usually 1, as used for Plum Brook)
HI_m	=	The HI calculated for the medium based on site-specific risks (in this example = 5.0)

The resulting RBRC in this case would be the original concentration of chemical "a" multiplied by 0.2 (i.e., 1/5.0).

A similar equation can be used for calculating RGOs for carcinogens:

$$RBRC_a = C_a \times (\text{Target ILCR}/ILCR_m) \qquad \text{Eq. B-2}$$

$RBRC_a$	=	Site-specific remedial goal option for chemical "a" (mg/kg for soil)
C_a	=	Concentration of chemical "a" in site medium (mg/kg for soil)
Target ILCR	=	The ILCR value targeted for overall risks (1E-5 for Plum Brook)
$ILCR_m$	=	The ILCR calculated for the medium based on site-specific risks

The resultant values may be accepted as derived directly from Equations B-1 and B-2. More often, the RBRCs are further adjusted for chemicals that exhibit both cancer and noncancer health effects, chemicals that contribute only minimally to risk, spatial distribution of the COCs, or other pertinent concerns as deemed necessary by the project team. As mentioned, RBRCs should be ultimately selected in relative concentrations such that the remediation effort, costs, and/or time required to meet the RAOs are minimized.

B.2 TNTA Total Soil RBRCs

Equations B-1 and B-2 were applied directly to TNTA total soil COCs (Table B-1), based on the BHHRA.

Table B-1
Preliminary RBRC Calculations for TNTA Total Soil COCs

COC	EPC (mg/kg)	HQ	ILCR	Noncancer-based Concentration from Eq. B-1 (mg/kg)	Cancer-based Concentration from Eq. B-2 (mg/kg)
2-ADNT	33.6	8.3	NA	0.15 (HQ=0.04)	NA
4-ADNT	9.77	2.4	NA	0.045 (HQ=0.01)	NA
2-Nitrotoluene	582	0.80	NA	2.7 (HQ=0.004)	NA
4-Nitrotoluene	484	0.67	NA	2.2 (HQ=0.003)	NA
TNT	259	7.7	1.8E-5	1.2 (HQ=0.04)	0.10 (ILCR=7E-9)
2,4-DNT	8912	60	1.2E-2	40.7 (HQ=0.27)	3.5 (ILCR=4.6E-6)
2,6-DNT	10274	139	1.4E-2	46.9 (HQ=0.63)	4.0 (ILCR=5.3E-6)
Aroclor 1260	69.8	NA	2.4E-4	NA	0.027 (ILCR=9E-8)
Total HI/ILCR		219	2.6E-2	1	1E-5

COC = chemical of concern; EPC = exposure point concentration; mg/kg = milligrams per kilogram; HQ = hazard quotient; ILCR = incremental lifetime cancer risk; RBRC = risk-based remediation concentration; NA = not applicable

Both noncancer and cancer risks in TNTA total soil were dominated by 2,4-dinitrotoluene (2,4-DNT) and 2,6-dinitrotoluene (2,6-DNT). As a result, concentration values used directly as output from Equations B-1 and B-2, other than those associated with the DNT isomers, are at de minimis risk levels (i.e., HQ<0.1; ILCR<1E-6) and several are less than reporting limits. Therefore, these low concentration levels could not reasonably be proposed as RGOs for TNTA soil COCs.

As mentioned in Section B.1, the derivation of RBRCs often requires ongoing balancing. Their derivation follows a logical progression, based on site-specific considerations and an understanding of the interconnectedness of the values (i.e., if the concentration of one COC is changed, it affects the values of other COCs), to provide the most appropriate set of concentration values to propose as RGOs. The following progression was followed in deriving a set of values to propose as RGOs for TNTA soil COCs. Note that because of the interconnectedness of the values, these items are not necessarily discrete "steps." Instead, a number of these were performed simultaneously, as appropriate, and the RBRCs balanced accordingly.

- The noncancer concentration values from Table B-1 for the DNT isomers would result in cancer risks exceeding the upper bound of the target risk range (1E-5).

Therefore, focus was placed on the cancer-based values for 2,4- and 2,6-DNT in deriving RBRCs.

- If a combined value of 7.5 mg/kg were selected as the RBRC for the two DNT isomers, then the resulting HQ value would be *de minimis* (<0.1). Therefore, the combined DNT isomers would have essentially no effect on noncancer risks at a concentration associated with an ILCR of 1E-5.

- The exposure point concentrations (EPC) used in the BHHRA for 2-nitrotoluene (2-NT) and 4-nitrotoluene (4-NT) are the maximum detected concentrations (MDC) (582 and 484 mg/kg, respectively, in Sample AA0466 from Building 119). The combined 2-NT and 4-NT concentrations exceeded 40 mg/kg in only one other confirmation sample (2-NT at 152 and 4-NT at 98.4 mg/kg in Sample AA0462 collected from Building 131). Similarly, among the screening samples (not used in the BHHRA), only samples collected from these two building areas (Buildings 119 and 131) had combined 2NT and 4-NT analytical results exceeding 40 mg/kg. Other nitroaromatic COCs (ADNT isomer, DNT isomers, and TNT) co-occur with 2- and 4-NT at relatively high concentrations in each of these building areas (Buildings 119 and 131) and represent a greater potential risk than the NTs. Therefore, the derivation of noncancer RBRCs for TNTA soil COCs focused on the ADNT isomers and TNT.

- If ADNTs were the only noncancer COCs present, then the RBRC for combined ADNTs would be 4 mg/kg (HI=1.0). Based on the analytical results of confirmation and screening samples, as well as the nitroaromatic analytical results of TNTB confirmation samples associated with the remediation of the PBOW TNTB site, it was observed that relatively many samples exhibited combined ADNT concentrations in the range of 1 to 4 mg/kg. Therefore, emphasis was placed on maximizing the RBRCs to be proposed as RGOs for 2-ADNT and 4-ADNT, yet still maintain a reasonable RBRC for TNT. This would be consistent with the overall goal of minimizing the volume of soil to be remediated, yet still be protective of human health.

- A quantitative and spatial review of all the confirmation and screening analytical results was performed. The following set of noncancer-based RBRCs, which would result in an HI of 1.0, was derived as the set that would likely minimize the volume of TNTA soil to be remediated: 2-ADNT – 1.3 mg/kg; 4-ADNT – 1.7 mg/kg; TNT – 8.0 mg/kg; 2-NT – 31 mg/kg; 4-NT – 9 mg/kg. The ILCR associated with the noncancer-based TNT RBRC of 8.0 mg/kg for TNTA total soil is estimated as 6E-7, which is regarded as *de minimis*. Therefore, none of the noncancer RBRCs would contribute appreciably to cancer risk.

- If soil were remediated to noncancer-based concentrations listed in the preceding bullet with a combined DNT concentration of 7.5 mg/kg based on carcinogenicity, the maximum Aroclor 1260 concentration among the remaining TNTA total soil samples would be 0.014 mg/kg. This represents a *de minimis* ILCR of 5E-8.

Therefore, the potential contribution of Aroclor 1260 to the cumulative ILCR was not further considered in the derivation of RBRCs.

- A chemical-specific ARAR of 1 mg/kg exists for PCB-containing soil released for nonrestricted use. As mentioned, the MDC for Aroclor 1260 among the remaining soil samples is nearly two orders of magnitude lower than this value. However, even if soil at 1 mg/kg total PCBs were to be left in place, the ILCR associated with this concentration would be 3E-6. This means if PCBs at this concentration were to co-occur with DNT isomers at a combined concentration of 7.5 mg/kg, the resulting ILCR would round to 1E-5.

- A quantitative and spatial review of all the confirmation and screening analytical results was performed with regard to 2,4-DNT and 2,6-DNT. 2,4-DNT is far more prevalent in the remaining samples and occurs at relatively higher concentrations than 2,6-DNT. Based on this review, it was determined that the volume of soil for remediation would be minimized if the 2,4-DNT RBRC were set at 6.0 mg/kg and the 2,6-DNT RBRC were set at 1.5 mg/kg.

B.3 Proposed TNTA Total Soil RGOs

Based on the considerations, analysis and discussions included in the above bullets, the RGOs proposed for TNTA total soil are listed in Table B-2. To avoid possible confusion, all COCs are included in this table, even those for which the development of RBRCs was determined as not applicable.

Table B-2
Proposed RGOs for TNTA Total Soil COCs

COC	Proposed RGO (mg/kg)	Basis	HQ	ILCR
2-ADNT	1.3 mg/kg	RBRC	0.32	NA
4-ADNT	1.7 mg/kg	RBRC	0.42	NA
TNT	8.0 mg/kg	RBRC	0.24	5.6E-7
2-NT	31 mg/kg	RBRC	0.04	NA
4-NT	9 mg/kg	RBRC	0.01	NA
2,4-DNT	6.0 mg/kg	RBRC	0.04	8.0E-6
2,6-DNT	1.5 mg/kg	RBRC	0.02	2.0E-6
Aroclor 1260	1.0 mg/kg	ARAR	NA	3.5E-6 (4.9E-8)[a]
Lead	400 mg/kg	TBC	NA	NA
Total HI/ILCR			1.0	1.0E-5 (1.3E-5)[b]

RGO = remedial goal option; COC = chemical of concern; mg/kg = milligrams per kilogram; HQ = hazard quotient; ILCR = incremental lifetime cancer risk; RBRC = risk-based remediation concentration; ARAR = applicable or reasonable and appropriate requirement; TBC = to be considered criterion; NA = not applicable

[a] Value shown in parentheses is the ILCR for the highest detected concentration among the areas not proposed for remediation based on the nitroaromatic RGOs; this value is *de minimis* (i.e., <1E-6).
[b] Value outside of parentheses is for nitroaromatics and the maximum detected concentration among the remaining samples for residual PCBs; value shown in parentheses is the total ILCR assuming the combined Aroclor 1254 and 1260 concentration is equal to the RGO.

It is noted that the ARAR proposed for Aroclor 1260 is based on total polychlorinated biphenyls (PCB). This ARAR will be applied to both Aroclor 1260 and Aroclor 1254; therefore, combined Aroclor 1254/1260 will be treated as a COC. Aroclor 1254 was not detected at the site, but has been detected at other PBOW sites (including TNTC). The lead RGO value is based on the average soil screening concentration, which is regarded as a "to be considered" (TBC) criterion (refer to Section 2.2.2 of the FFS text).

B.4 TNTC Total Soil RBRCs

Equations B-1 and B-2 were applied directly to TNTC total soil RBRCs (Table B-3), based on the BHHRA (IT, 2001).

Table B-3
Preliminary RBRC Calculations for TNTC Total Soil COCs

COC	EPC (mg/kg)	HQ	ILCR	Noncancer-based Concentration from Eq. B-1 (mg/kg)	Cancer-based Concentration from Eq. B-2 (mg/kg)
2-ADNT	38.0	9.4	NA	0.031 (HQ=0.008)	NA
4-ADNT	11.3	2.8	NA	0.009 (HQ=0.002)	NA
2,4-DNT	275	1.9	3.7E-4	0.22 (HQ=0.001)	0.79 (ILCR=1.1E-6)
2,6-DNT	19.4	0.26	2.6E-5	0.016 (HQ=0.0002)	0.056 (7E-8)
TNT	41261	1230	2.9E-3	33 (HQ=0.99)	119 (ILCR=8.3E-6)
Aroclor 1254[a]	0.745	0.48	2.6E-6	1.6 (HQ=1)	0.002 (ILCR=7E-9)
Aroclor 1260	4.88	NA	1.7E-5	NA	0.014 (ILCR=5E-8)
Benzo(a)anthracene	6.94	NA	1.3E-5	NA	0.020 (ILCR=4E-8)
Benzo(a)pyrene	6.33	NA	1.2E-4	NA	0.018 (ILCR=3E-7)
Benzo(b)fluoranthene	8.43	NA	1.6E-5	NA	0.024 (ILCR=4E-8)
Dibenz(a,h)anthracene	1.40	NA	2.2E-5	NA	0.004 (ILCR=6E-8)
Indeno(1,2,3-cd)pyrene	2.05	NA	3.8E-6	NA	0.006 (ILCR=1E-8)
Total HI/ILCR		1244	3.5E-3	1	1E-5

COC = chemical of concern; EPC = exposure point concentration; mg/kg = milligrams per kilogram; HQ = hazard quotient; ILCR = incremental lifetime cancer risk; RBRC = risk-based remediation concentration; NA = not applicable

[a] Noncancer effects of Aroclor 1254 were regarded as nonadditive with those of nitroaromatics.

Noncancer risks in TNTC total soil were dominated by TNT, which accounts for 99 percent of the cumulative nitroaromatic HI value. As a result, concentration values used directly as output from Equation B-1, other than for TNT, are at *de minimis* risk levels (i.e., HQ<0.1; ILCR<1E-6) and are less than reporting limits. Therefore, these low concentration levels could not reasonably be proposed as RGOs for TNTC soil COCs.

TNT in TNTC total soil also accounts for over 80 percent of the cancer risks in the BHHRA. The contribution of TNT to cumulative cancer risk results in output from Equation B-2 for the other COCs that are at or near *de minimis* risk levels (i.e., ILCR<1E-6) and are too low to be useful for proposing as RGOs.

As mentioned, the derivation of RBRCs often requires ongoing balancing. Their derivation follows a logical progression, based on site-specific considerations and an understanding of the interconnectedness of the values, to provide the most appropriate set of concentration values to propose as RGOs. The following progression was used in deriving a set of values to propose as RGOs for TNTC total soil COCs. As mentioned above for TNTA, these bulleted items are not necessarily discrete "steps"; rather, a number of these were performed simultaneously.

- The noncancer values from Table B-3 for the DNT isomers would result in cancer risks exceeding the upper bound of the target risk range (1E-5). Therefore, focus was placed on the cancer-based values for 2,4- and 2,6-DNT in deriving RBRCs.

- If a combined value of 7.5 mg/kg were selected as the RBRC for the two DNT isomers (at an ILCR of 1E-5), then the resulting HQ value would be *de minimis* (<0.1). Therefore, this combined DNT isomer RBRC would have essentially no effect on noncancer risks.

- The high contributions of TNT to estimated cancer and noncancer risks for TNTC soil are associated with the MDC.

- A preliminary spatial and quantitative evaluation of analytical results was performed for TNT in the confirmation and screening sample results. Forty-five percent of the confirmation samples had TNT concentrations that exceeded the proposed TNTA RGO of 8 mg/kg; however, most of these concentrations were much higher than 8 mg/kg. If, for instance, the RGO were doubled to 16 mg/kg, the remediation area would change relatively little (based solely on the change in the TNT RGO and ignoring the corresponding changes resultant to the ADNT RGOs). Fewer than 10 percent of screening samples had TNT concentrations exceeding 8 mg/kg. Note that confirmation sample locations were selected based on screening sample results and were generally biased toward areas of higher nitroaromatics concentrations; therefore, higher concentrations and greater prevalence of TNT in the confirmation samples than the screening samples is expected.

- If ADNTs were the only noncancer COCs present in TNTC soil, then the RBRC for combined ADNTs would be 4 mg/kg (HI=1.0). Based on the analytical results of confirmation and screening samples, as well as the nitroaromatic analytical results of TNTB confirmation samples associated with the remediation of the PBOW TNTB site, it was observed that relatively many samples exhibited combined ADNT concentrations in the range of 1 to 4 mg/kg. Therefore, emphasis was placed on maximizing the RBRCs to be proposed as RGOs for 2-ADNT and 4-ADNT, yet still maintain a reasonable RBRC for TNT. This would be consistent with the overall goal of minimizing the volume of soil to be remediated, yet still be protective of human health.

- A quantitative and spatial review of all the confirmation and screening analytical results was performed. The proposed TNTA RBRC of 8 mg/kg for TNT and a combined ADNT of 3 mg/kg were used as a basis for comparison in an effort to meet the goal of minimizing the volume of soil to be remediated. The following set of noncancer-based RBRCs, which would result in an HI of 1.0, was derived as the set judged most likely to minimize the volume of soil to be remediated: 2-ADNT – 1.7 mg/kg; 4-ADNT – 1.3 mg/kg; TNT – 8.0 mg/kg.

- The ILCR associated with the noncancer-based TNT RBRC of 8.0 mg/kg for TNTC total soil is estimated as 6E-7, which is regarded as *de minimis*. Therefore, none of the noncancer RBRCs would contribute appreciably to cancer risk

- If soil were remediated to noncancer-based concentrations listed in the preceding bullet and a combined DNT concentration of 7.5 mg/kg based on carcinogenicity (discussed above), the maximum Aroclor 1260 concentration among the remaining TNTA total soil samples would be 0.15 mg/kg. This represents a *de minimis* ILCR of 5E-7. Therefore, the potential contribution of Aroclor 1260 to the cumulative ILCR was not further considered in the derivation of RBRCs.

- A chemical-specific ARAR of 1 mg/kg exists for PCB-containing soil released for nonrestricted use. As mentioned, the MDC for Aroclor 1260 among the remaining soil samples is nearly an order of magnitude lower than this value. (Note that PCB 1254 was not detected in any of the remaining TNTC soil samples.) However, even if soil at 1 mg/kg combined Aroclor 1254/1260 were left in place, the ILCR associated with this concentration is 3E-6. This means that if PCBs at this concentration were to co-occur with DNT isomers at a combined concentration of 7.5 mg/kg, the resulting ILCR would nonetheless round to 1E-5.

Five PAHs were also identified as COCs. However, RBRCs were not developed for these because of the following reasons: (1) PAHs are less prevalent than the nitroaromatic COCs, especially in subsurface soil; (2) PAHs are not known to have been used at the site other than presumably in paving materials, lubricants and fuels for vehicles; (3) Controlled vegetation burning may provide an ongoing source of PAHs in surficial soils (note that PAHs are more prevalent in TNTC surface soil than TNTC subsurface soil); (4) Naturally occurring petroliferous rock may be a natural source of PAHs in TNTC soil; (5) Given the contribution of the DNT isomers to cancer risk associated with TNTC soils, RBRCs for the individual PAHs would have been less than the analytical reporting limits and could not be regarded as reliable quantifications.

B.5 Proposed TNTC Total Soil RGOs

Based on the considerations, analysis and discussions included in the above bullets, the RGOs proposed for TNTC total soil are listed in Table B-4. To avoid possible confusion as to the list of RGOs, all COCs are included in this table, even those for which the development of RBRCs was determined as not applicable.

Table B-4
Proposed RGOs for TNTC Total Soil COCs

COC	Proposed RGO (mg/kg)	Basis	HQ	ILCR
2-ADNT	1.7 mg/kg	RBRC	0.42	NA
4-ADNT	1.3 mg/kg	RBRC	0.32	NA
TNT	8.0 mg/kg	RBRC	0.24	5.6E-7
2,4-DNT	6.5 mg/kg	RBRC	0.04	8.7E-6
2,6-DNT	1.0 mg/kg	RBRC	0.01	1.3E-6
Aroclor 1254[a]	1.0 mg/kg	ARAR	0.64 (0.11)[c]	3.5E-6 (6.1E-7)[d]
Aroclor 1260[a]	1.0 mg/kg	ARAR	NA	3.5E-6 (5.2E-7)[b]
PAHs	1.0 mg/kg	TBC	NA	NA[e]
Lead	400 mg/kg	TBC	NA	NA
Total HI/ILCR			1.0[f]	1.0E-5 (1.3E-5)[g]

RGO = remedial goal option; COC = chemical of concern; mg/kg = milligrams per kilogram; HQ = hazard quotient; ILCR = incremental lifetime cancer risk; RBRC = risk-based remediation concentration; ARAR = applicable or reasonable and appropriate requirement; TBC = to be considered criterion; NA = not applicable

[a] ARAR value of 1.0 mg/kg is for combined Aroclor 1254 and 1260 concentrations.
[b] Value shown in parentheses is the ILCR for the highest detected concentration (0.15 mg/kg) among the areas not proposed for remediation based on the nitroaromatic RGOs; this value is *de minimis* (i.e., <1E-6).
[c] HQ value shown in parentheses is for the highest detected concentration (0.176 mg/kg) among the areas not proposed for remediation based on the nitroaromatic RGOs.
[d] ILCR value shown in parentheses is for the highest detected concentration (0.176 mg/kg) among the areas not proposed for remediation based on the nitroaromatic RGOs; this value is *de minimis* (i.e., <1E-6).
[e] Although the PAH COCs are carcinogenic, the ILCR would be based on the specific combination of PAHs present in a specific sample or post-remediation area.
[f] Total HI reflects the additive effects of the nitroaromatics. The effects of Aroclor 1254 are not regarded as additive with those of the nitroaromatics, so its HQ is not added into the HI for nitroaromatic effects.
[g] Value outside of parentheses is for nitroaromatics and the maximum detected concentration among the remaining samples for residual PCBs; value shown in parentheses is the total ILCR assuming the combined Aroclor 1254 and 1260 concentration is equal to the RGO.

It is noted that the ARAR of 1.0 mg/kg is based on total PCBs. The lead RGO value is based on the average soil screening concentration, which is regarded as a "to be considered" (TBC) criterion (refer to Section 2.2.2 of the FFS text). The RGO for PAHs is based on a TBC criterion provided by OEPA. This RGO is for the five carcinogenic PAH COCs: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene.

B.6 TNTC Sediment RBRCs

Equation B-1 was applied directly to TNTC sediment COCs (Table B-5), based on the resident and construction worker scenarios as described in the BHHRA (IT, 2001). No cancer-based RBRCs were needed for TNTC sediment because the ILCR values associated with TNT for the resident (1E-5) and the construction worker (1E-6) were within the OEPA risk management range (i.e., 1E-6 to 1E-5).

Table B-5
Preliminary RBRC Calculations for TNTC Sediment COCs

COC	EPC (mg/kg)	HQ Resident	HQ Construction Worker	Noncancer-based Concentration from Eq. B-1 Resident (mg/kg)	Noncancer-based Concentration from Eq. B-1 Construction Worker (mg/kg)
2-ADNT	11.2	0.308	0.754	2.0 (HQ=0.055)	0.82 (HQ=0.055)
4-ADNT	12.8	0.352	0.862	2.3 (HQ=0.063)	0.93 (HQ=0.063)
TNT	1496	4.94	12.1	267 (HQ=0.88)	109 (HQ=0.88)
Total HI		5.6	13.7	1	1

COC = chemical of concern; EPC = exposure point concentration; mg/kg = milligrams per kilogram; HQ = hazard quotient; RBRC = risk-based remediation concentration; NA = not applicable

Because noncancer risks in TNTC sediment were dominated by TNT, the concentration values derived directly from Equation B-1 output are relatively high for TNT and relatively low for the ADNT isomers. Therefore, the RBRCs for the three COCs were recalculated using Equation B-3 assuming an HQ value of 0.333 (i.e., equal noncancer risk contributions) for each COC.

$$RBRC_a = C_a \times (\text{Target HQ}/HQ_{Ca}) \qquad \text{Eq. B-3}$$

Where:

$RBRC_a$ = Site-specific risk-based remedial concentration for chemical "a" (mg/kg for soil)

C_a = Concentration of chemical "a" in site medium (mg/kg for soil)

Target HQ = The HQ value targeted for chemical-specific risks (0.333 for the TNTC sediment COCs)

HQ_{Ca} = The HQ calculated for the COC at C_a based on site-specific risks

B.7 Proposed TNTC Sediment RGOs

The RBRCs for the COCs resulting from the output of Equation B-3, assuming the residential and construction worker receptors and an HQ of 0.333, are presented in Table B-6. For conservativeness, the construction worker RBRCs were selected as the proposed RGOs.

Table B-6 Proposed RGOs for TNTC Sediment COCs				
COC	RBRC Based on Resident (mg/kg)	RBRC Based on Construction Worker (mg/kg)	Proposed RGO[a] (mg/kg)	HQ of Proposed RGO[b]
2-Amino-4,6-Dinitrotoluene	12.1	5.0	5.0	0.3
4-Amino-2,6-Dinitrotoluene	12.1	5.0	5.0	0.3
2,4,6-Trinitrotoluene	101	41	41	0.3
Total HI/ILCR				1.0

RGO = remedial goal option; COC = chemical of concern; HQ = hazard quotient; RBRC = risk-based remediation concentration; NA = not applicable

[a] RGO derived on the basis of noncancer effects; cancer risk is *de minimis* (<1E-6).
[b] Based on the construction worker scenario.

B.8 Discussion

Implementation of the RBRCs as RGOs for TNTA soil (Section B.3), TNTC soil (Section B.5), and TNTC sediment (Section B.7) ought to consider the implications of the risk-based approach used in the SRA. In a risk assessment, an EPC (in conjunction with other exposure and toxicity assumptions/values) is used to estimate the potential level of risk. Generally the EPC in a risk assessment is based on a conservative estimate of average concentration (EPA, 1989). To be completely consistent with the risk assessment approach, the RBRC-based RGO should not be applied as not-to-exceed concentrations. Instead, an application of these RGOs should consider the overall risk posed by the resulting (conservative estimate of) average concentration. It is possible that a number of individual samples may exceed an RGO and the average exposure level still meet the RAO. Under these circumstances, theoretically, further remediation should not be required. It is noted that "a conservative estimate of average concentration" is sometimes difficult to ascertain because of high variability in the data set and/or considerable uncertainty as to how well the data set defines the actual distribution of soil concentrations (i.e., the data "population") present at the site. In such situations the MDC may not be an unreasonable approximation of the average concentration, though it is still often likely to be very conservative.

A further consideration is the additive risks associated with multiple COCs on a spatial basis. It is possible that the COC in a given post-remediation confirming sample may exceed a given RBRC-based RGO, yet pose no apparent human health risk. For example, suppose that 2-NT and 4-NT were each detected at 200 mg/kg in TNTA total soil; this concentration is 6 times and 22 times the respective proposed RGOs. However, the resulting HI would round to 0.5, which is less than the noncancer health-based criterion of 1. Seemingly, an area with these concentrations of NT isomers (given the lack of detections of other COCs) should not be remediated on the basis of human health risk.

TNTC sediment is known to be impacted at a single sampling location (AB1009). It is anticipated that during remediation activities this area will be confirmed as spatially very limited. The other 14 TNTC sediment sample locations had concentrations well below the proposed RGOs; 13 of the 15 samples had TNT less than 0.8 mg/kg and combined ADNT concentrations less than 0.7 mg/kg. Therefore, concentrations that approximate the RGOs, if left in place, are likely to represent a very limited area; the vast majority of the TNTC sediment would appear to be at concentrations far less than the respective RGOs.

B.9 References

IT Corporation (IT), 2001, ***TNT Areas A&C Remedial Investigation, Volume II, Human Health Risk Assessment,*** Plum Brook Ordnance Works, Sandusky, Ohio, November.

U.S. Environmental Protection Agency (EPA), 1989, ***Risk Assessment Guidance for Superfund, Volume 1 - Human Health Evaluation Manual (Part A)***, Office of Emergency and Remedial Response, December (EPA/540/1-89/002).

APPENDIX C

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Table C-1

Location-Specific Applicable or Relevant and Appropriate Requirements
Feasibility Study
TNT Area A and C, Former Plum Brook Ordnance Works
Sandusky, Ohio

Location Characteristics	Requirement(s)	Prerequisite(s)	Federal Citation	Ohio Citation	Alternatives Applicable	Comments
Floodplains/Wetlands						
Presence of floodplain [as defined in 40 CFR 6, Appendix A, Section 4.0(d)]	Avoid, as practicable, the long- and short-term adverse effects associated with occupancy and modification of floodplain include, but are not limited to: minimum grading requirements, runoff controls, design and construction constraints, and protection of ecologically sensitive areas.	Federal actions with potential to impact or occur within flood plains - **Applicable**	40 CFR 6, Appendix A	NA	NA	No floodplains were identified at TNT Area A or C
	Potential effects of any action taken in a floodplain shall be evaluated. Identify, evaluate, and implement alternative actions that may avoid or mitigate adverse impacts or floodplains.		40 CFR 6, Appendix A			
	Design or modify selected alternatives to minimize harm to or within floodplains and restore and preserve floodplain values.		40 CFR 6, Appendix A			
Presence of wetlands as defined in 40 CFR 6, Appendix A, Section 4.0(j).	Avoid, to the extent possible, the long- and short-term adverse effects associated with destruction, occupancy and modification of wetlands. Measures to mitigate adverse effects or actions in a wetland include, but are not limited to: minimum grading requirements, runoff controls, design and construction constraints, and protection of ecology-sensitive areas.	Federal actions that involve potential impacts to, or take place within wetlands - **Applicable**	40 CFR 6, Appendix A	NA	NA	No Wetlands were identified at TNT Area A or C
	Take action, to the extent practicable, to minimize destruction, loss or degradation of wetlands, and to preserve, restore, and enhance the natural and beneficial values of wetlands.		40 CFR 6, Appendix A			
	Potential effects of any new construction in wetlands that are not in a floodplain shall be evaluated. Identify, evaluate, and as appropriate, implement alternatives actions that may avoid or mitigate adverse impacts on wetlands.		10 CFR 1022.3 (c) and (d)			

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Location-Specific Applicable or Relevant and Appropriate Requirements
Feasibility Study
TNT Area A and C, Former Plum Brook Ordnance Works
Sandusky, Ohio

Location Characteristics	Requirement(s)	Prerequisite(s)	Federal Citation	Ohio Citation	Alternatives Applicable	Comments
Aquatic Resources						
Within area impacting stream or any other body of water – and – presence of wildlife resources (e.g., fish)	The effects of water-related projects on fish and wildlife resources and their habitat should be considered with a view to the conservation of fish and wildlife resources by preventing loss of and damage to such resources.	Action that impounds, modifies, diverts, or controls waters including navigation and drainage activities **-Relevant and appropriate**	Fish and Wildlife Coordination Act (16 USC 661 et seq.)	NA	NA	Remedial activities are not anticipated to impact fish and wildlife resources.
Location encompassing aquatic ecosystem as defined in 40 CFR 230.3(c)	Except as provided under Section 404(b)2 of the Clean Water Act, no discharge of dredged or fill material into an aquatic ecosystem is permitted if there is a practicable alternatives that would have less adverse impact. No discharge of dredged or fill material shall be permitted unless appropriate and practicable steps per 40 CFR 230.70 et seq. Have been taken which will minimize potential adverse impacts of the discharge on the aquatic ecosystem.	Action that involves the discharge of dredged or fill material into waters of the U.S. including jurisdictional wetlands – **Applicable**	40 CFR 230.10(a) 40 CFR 230.10(d)		NA	No wetlands were identified at TNT Area A or C.

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Location-Specific Applicable or Relevant and Appropriate Requirements
Feasibility Study
TNT Area A and C, Former Plum Brook Ordnance Works
Sandusky, Ohio

Location Characteristics	Requirement(s)	Prerequisite(s)	Federal Citation	Ohio Citation	Alternatives Applicable	Comments
Cultural Resources						
Presence of archaeological resources	May not excavate, remove, damage, or otherwise alter or deface such resources unless by permit or exception	Action that would impact archaeological resources on public land – **Applicable**	43 CFR 7.4(a)		NA	Cultural resources have not been discovered within PBOW.
	Must protect any such archaeological resources if discovered.	Excavation activities that inadvertently discover archaeological resources – **Applicable**	40 CFR 7.5(b)(1)		NA	Cultural resources have not been discovered within PBOW.
	Must stop activities in the area of discovery and make a reasonable effort to secure and protect the objects discovered.	Excavation activities that inadvertently discover such resources on federal lands or under federal control – **Applicable**	43 CFR 10.4 (C)		NA	Cultural resources have not been discovered within PBOW.
	Must consult with Indian tribe likely to be affiliated with the objects to determine further disposition per 40 CFR 10.5(b)	Same as above – **Applicable**	43 CFR 10.4(d)		NA	Cultural resources have not been discovered within PBOW.
Within area where action may cause irreparable harm, loss, or destruction of significant artifacts.	Must take action to recover and preserve artifacts.	Alteration of terrain that threatens significant scientific, prehistoric, or archaeological data.	National Archaeological and Historical Preservation Act (16 USC Section 469); 35 CFR Part 65	NA	NA	Cultural resources have not been discovered within PBOW.

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Location-Specific Applicable or Relevant and Appropriate Requirements
Feasibility Study
TNT Area A and C, Former Plum Brook Ordnance Works
Sandusky, Ohio

Location Characteristics	Requirement(s)	Prerequisite(s)	Federal Citation	Ohio Citation	Alternatives Applicable	Comments
Endangered, threatened or rare species						
Areas harboring Endangered species	Current conditions and potential remedial activities at PBOW must not destroy or adversely critical habitat	Threatened and endangered species were identified at PBOW, but not at TNT Area A	16 USC 1531 et seq., 50 CFR 17.21, 17.31, 17.61, 17.71, 17.94, 50 CFR 402.	NA	NA	No endangered species identified at TNT Area A or C.
	May not knowingly destroy the habitat of such wildlife species.	Same as above – **Relevant and Appropriate**		NA	NA	No endangered species identified at TNT Area A or C.
	Upon good cause shown and where necessary to protect human health or safety, endangered or threatened species may be removed, captured, or destroyed.	Same as above – **Relevant and Appropriate**		NA	NA	

CFR - Code of Federal Regulations.
NA - Not applicable.
PBOW - Plumb Brook Ordnance Works.
TNT - Trinitrotoluene.
USC - U.S. Code.

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Action-Specific Applicable or Relevant and Appropriate Requirements
Feasibility Study
TNT Area A and C, Former Plum Brook Ordnance Works
Sandusky, Ohio

Action/Requirement	Requirement(s)	Prerequisite(s)	Federal Citation	Ohio Citation	Alternative Applicable	Comments
Waste Generation/Management						
Characterization of solid waste (e.g., contaminated PPE, equipment, wastewater)	Must determine if the waste is hazardous or if waste is excluded under 40 CFR 261.4; and	Generation of solid waste as defined in 40 CFR 261.2 – **Applicable**	40 CFR 262.11(a)	3745-52-11(a)	2-5	Remedial activities might generate hazardous waste.
	Must determine if waste is listed under 40 CFR Part 261; or		40 CFR 262.11(b)	3745-52-11(b)	2-5	Excavated contaminated soil is not classified as a listed hazardous waste because there is not definite documentation regarding the dates of disposal.
	Must characterize waste by using prescribed testing methods or applying generator knowledge based on information regarding material or processes used. If waste is determined to be hazardous, it must be managed in accordance with pertinent provisions of 40 CFR 261 through 268.		40 CFR 262.11(c) and (d)	3745-52-11(c) through (e)	2-5	Remedial activities might generate hazardous waste.
Characterization of hazardous waste	Must obtain a detailed chemical and physical analysis of a representative sample of the waste(s) which at a minimum contains all of the information which must be known to treat, store, or dispose of the waste in accordance with 40 CFR 264 and 268.	Generation of RCRA hazardous waste for storage, treatment or disposal - **Applicable**	40 CFR 264.13(a)(1)	3745-59-07	2-5	Remedial activities might generate hazardous waste.
	Must determine if the waste is restricted from land disposal under 40 CFR 268 et seq. by testing in accordance with prescribed methods or use of generator knowledge of waste.		40 CFR 268.7	3745-59-07	2-5	Remedial activities might generate hazardous waste.
	Must determine alternative land disposal restrictions under 40 CFR 268.49 by treating soil to 10 x UTS levels prior to land disposal.	Generation of RCRA hazardous waste for storage, treatment or disposal – **Applicable**	40 CFR 268.49		2-5	Remedial activities might generate hazardous waste.

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Action-Specific Applicable or Relevant and Appropriate Requirements
Feasibility Study
TNT Area A and C, Former Plum Brook Ordnance Works
Sandusky, Ohio

Action/Requirement	Requirement(s)	Prerequisite(s)	Federal Citation	Ohio Citation	Alternative Applicable	Comments
Storage						
Accumulation of hazardous waste in containers (e.g. PPE, rags, etc.)	A generator may accumulate hazardous waste at the facility provided that: • Waste is placed in containers that comply with 40 CFR 265.171 through 173 (Subpart 1); and • container is marked with the words [hazardous waste] or; • container may be marked with other words that identify the contents.	Accumulation of RCRA hazardous waste on site as defined in 40 CFR 260.10 – **Applicable** Accumulation of 55 gallons or less of RCRA hazardous waste at or near any point of generation – **Applicable**	40 CFR 262.34(a) 40 CFR 262.34(c)(1)	3745-52-34(a) 3745-52-34(c)(1)	2-5	This applies to accumulation in 55-gallon drums at or near the point of generation, before the drum is filled. Upon filling the drum, it must be moved within 3 days to a designated container storage area. Upon a drum placement in the container storage area, if a temporary storage area, it must be disposed within allowed time frame.

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Action-Specific Applicable or Relevant and Appropriate Requirements
Feasibility Study
TNT Area A and C, Former Plum Brook Ordnance Works
Sandusky, Ohio

Action/Requirement	Requirement(s)	Prerequisite(s)	Federal Citation	Ohio Citation	Alternative Applicable	Comments
Temporary storage of hazardous waste in containers	Except noted below, a generator may accumulate(store) hazardous waste on-site for 90 days or less without a permit or without having interim status: • A generator who generates greater than 100 kg but less than 1000 kg of hazardous waste in a calendar month may accumulate hazardous waste on-site for 180 days or less without need to meet long-term storage requirements (40 CFR 262.34(d)). • A generator who generates greater than 100 kg but less than 1000 kg of hazardous waste in a calendar month and who must transport his waste, or offer his waste for transportation, over a distance of 200 miles or more for off-site treatment, storage or disposal may accumulate hazardous waste on-site for 270 days without need to meet long-term storage requirements (40 CFR 262.34(d)) • A generator who generates greater than 100 kg but less than 1000 kg of hazardous waste in a calendar month and who accumulates hazardous waste in quantity less than 6000 kg or for fewer than 180 days (or for less than 270 days if he must transport his waste, or offer his waste for transportation, over a distance of 200 miles or more), is not required to meet long-term storage requirements (40 CFR 262.34(f)).	A generator providing temporary storage pending off-site treatment, storage, and disposal.	40 CFR 262.34	3745-52-34	2-5	Remedial activities might generate hazardous waste. On-site storage prior to disposal/treatment might be necessary.

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Action-Specific Applicable or Relevant and Appropriate Requirements
Feasibility Study
TNT Area A and C, Former Plum Brook Ordnance Works
Sandusky, Ohio

Action/Requirement	Requirement(s)	Prerequisite(s)	Federal Citation	Ohio Citation	Alternative Applicable	Comments
Requirements for temporary storage of hazardous waste in containers	Except as noted above, a generator may accumulate hazardous waste on-site for 90 days or less without the need to meet requirements for long-term storage, provided than:	Temporary storage of RCRA hazardous waste pending off-site treatment, storage, and disposal.	40 CFR 262.34(a)(1)(I)	3745-52-34(a)(1)(a)	2-5	Remedial activities might generate hazardous waste.
	The waste is placed in containers and the generator complies with Subpart I of 40 CFR Part 265.		40 CFR 262.34(a)(2)	3745-52-34(a)(1)(a)	2-5	Remedial activities might generate hazardous waste.
	The date upon which each period of accumulation begins is clearly marked and visible for inspection on each container.		40 CFR 262.34(a)(2)	3745-52-34(a)(2)	2-5	Remedial activities might generate hazardous waste.
	While being accumulated on-site, each container and tank is labeled or marked clearly with the words, [hazardous waste] and		40 CFR 262.34(a)(3)	3745-52-34(a)(3)	2-5	Remedial activities might generate hazardous waste.
	The generator complies with the requirements for owners and operators in Subpart C (Emergency Prepardness), and Subpart D (Contingency Plan), and with 268.7(a)(4) [testing and documentation for disposal]		40 CFR 262.34(a)(4)	3745-52-34(a)(4)	2-5	Remedial activities might generate hazardous waste.
Use and management of hazardous waste in containers	If container is not in good condition (e.g., severe rusting, structural defects) or if it begins to leak, must transfer waste into container in good condition.	Storage of RCRA hazardous waste in containers – **Applicable**	40 CFR 264.171	3745-55-71	2-5	Remedial activities might generate hazardous waste.
	Use container made or line with materials compatible with waste to be stored so that the ability of the container is not impaired.		40 CFR 264.172	3745-55-72	2-5	Remedial activities might generate hazardous waste.
	Keep containers closed during storage, except to add/remove waste.		40 CFR 264.173(a)	3745-55-73(a)	2-5	Remedial activities might generate hazardous waste.
	Open handle and store containers in a manner that will not cause containers to rupture or leak.		40 CFR 264.173(b)	3745-55-73(b)	2-5	Remedial activities might generate hazardous waste.

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Action-Specific Applicable or Relevant and Appropriate Requirements
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TNT Area A and C, Former Plum Brook Ordnance Works
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Action/Requirement	Requirement(s)	Prerequisite(s)	Federal Citation	Ohio Citation	Alternative Applicable	Comments
Design and operation of a RCRA container storage area (no free liquids).	Area must be sloped or otherwise designed and operated to drain liquid from precipitation, or containers must be elevated or otherwise protected from contact with a accumulated liquid.	Long-term storage of RCRA hazardous waste in containers that do not contain free liquids – **Applicable**	40 CFR 264.175(c)	3745-55-75(c)	2-5	Remedial activities might generate hazardous waste.
Design and operation of a RCRA container storage area (contains free liquids)	Area must have a containment system designed and operated as follows: • A base must underlie the containers that is free of cracks or gaps and is sufficiently impervious to contain leaks, spills and accumulated precipitation until the collected material is detected and removed. • Base must be sloped or the containment system must be otherwise designed and operated to drain and remove liquids resulting from the leaks spills or precipitation, unless the containers are elevated or are otherwise protected from contact with accumulated liquids. • Must have sufficient capacity to contain 10% of the volume of containers or the volume of the largest container, whichever is greater. • Runoff into the system must be prevented unless the collection system has sufficient capacity to contain along with volume required for containers.	Long-term storage of RCRA hazardous waste with free liquids – **Applicable**	40 CFR 264.175(a)	3745-55-75(a)	2-5	Remedial activities might generate hazardous waste.

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Action-Specific Applicable or Relevant and Appropriate Requirements
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TNT Area A and C, Former Plum Brook Ordnance Works
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Action/Requirement	Requirement(s)	Prerequisite(s)	Federal Citation	Ohio Citation	Alternative Applicable	Comments
Storage of Remediation Waste in Staging Piles	A staging pile must comply with the following design criteria: • The staging pile must facilitate a reliable, effective, and protective remedy. • The staging pile must be designed so as to prevent or minimize releases of hazardous wastes and hazardous constituents into the environment, and minimize or adequately control cross-media transfer, as necessary to protect human health and the environment (for example, through the use of liners, covers, run-off/run-on controls, as appropriate). • The staging pile must not operate for more than two years, except when the EPA grants an operating term extension under 40 CFR 264.554(i). The operator must maintain a record of when remediation waste was first placed into the staging pile.	Storage of RCRA hazardous remediation waste – **Relevant and Appropriate.**	40 CFR 264.554(d)(1)	NA	2-5	Remedial activities might generate hazardous waste.
Waste Treatment						
On-site treatment of RCRA hazardous waste in a NPDES treatment system	Wastewater treatment units (WWTUs), as defined in 260.10, are exempt from the requirements for permitting and interim status treatment, storage, and disposal facilities, which are codified in 40 CFR Parts 264 and 265. All applicable hazardous waste management standards apply to the waste prior to treatment in the WWTU and to any residue generated by the treatment of the waste. In other words, solid waste resulting from the treatment of a listed waste, and solid waste resulting from the treatment of a characteristic hazardous waste in an exempt wastewater treatment unit will remain hazardous as long as the solid waste continues to exhibit a characteristic as defined in 261.3 (3) and (d).	Treatment of RCRA hazardous wastewater.	40 CFR 264.1(g)(6), 251.1 (c)(10), and 270.1(c)(2)(v)	3745-54(g)(5) and 3745-65(c)(8)	NA	Remedial activities are not expected to generate wastewater.

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Action-Specific Applicable or Relevant and Appropriate Requirements
Feasibility Study
TNT Area A and C, Former Plum Brook Ordnance Works
Sandusky, Ohio

Action/Requirement	Requirement(s)	Prerequisite(s)	Federal Citation	Ohio Citation	Alternative Applicable	Comments
Classification of local water bodies for discharge of treated waters.	Discharge quality of treated waters from the site must attain the criteria for which the segment of the water body is classified.	Point source discharge of treated wastewater.	NA	3745-1-01	NA	Remedial activities are not expected to generate wastewater.
Discharge of Toxic Pollutants identified by the State of Ohio pursuant to Section 307(a)(1) of the Federal Water Pollution Control Act.	Concentrations of identified toxic pollutants in Ohio waters shall not exceed the criteria indicated in this regulation.	Point source discharge of treated wastewater.	NA	3745-1-07	NA	Remedial activities are not expected to generate wastewater.
Land Disposal Restrictions (LDRs)						
Land disposal restrictions (LDRs) for contaminated soil.	Must comply with LDRs prior to placing soil that exhibits a characteristic of hazardous waste, or exhibited a characteristic of hazardous waste at the time it was generated, into a land disposal unit.	Hazardous waste – 40 CFR 268.49 - **Applicable**	40 CFR 268.49(a)	3745-270-49(A)	2-5	Remedial activities might generate soil contaminated by a RCRA hazardous waste.
	Prior to land disposal, contaminated soil must be treated according to the applicable treatment standards specified according to the Universal Treatment Standards specified in 40CFR268.48 applicable to the contaminating listed hazardous waste and/or the applicable characteristic of hazardous waste if the soil is characteristic.		40 CFR 268.49(b)	3745-270-49(B)	2-5	
	Treatment standards for contaminated soils. Prior to land disposal, contaminated soil must be treated according to all standards specified in the Universal Treatment Standards specified in 40CFR268.48.		40 CFR 268.49(c)	3745-270-49(C)	2-5	

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Action-Specific Applicable or Relevant and Appropriate Requirements
Feasibility Study
TNT Area A and C, Former Plum Brook Ordnance Works
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Action/Requirement	Requirement(s)	Prerequisite(s)	Federal Citation	Ohio Citation	Alternative Applicable	Comments
PCB Wastes						
Characterization and cleanup of solid waste contaminated with PCBs	Waste containing PCB concentrations greater than or equal to 50 ppm are defined by USEPA as a PCB remediation waste.	Generation of a PCB remediation waste through excavation - **Applicable**	40 CFR 761.3	NA	2-5	Remedial activities might generate PCB remediation waste.
	Cleanup and disposal options for PCB remediation waste. Any person cleaning up and disposing of PCBs under section 40 CFR 761.61 shall do so based on the concentration at which the PCBs are found.		40 CFR 761.61			Generator has the option of selecting (a) self-implementing cleanup, (b) performance-based cleanup, or (c) risk-based cleanup per 40 CFR 761.61.
	Any person may conduct self-implementing cleanup and disposal of PCB remediation waste in accordance with the requirements of 40 CFR 761.61(a) without prior written approval from EPA.	Self-implementing on-site cleanup and disposal of PCB remediation waste.	40 CFR 761.61(a)	NA	NA	USACE will not perform self-implementing cleanup.
	Self-implementing cleanups shall not be binding upon cleanups conducted under other authorities, including but not limited to, actions conducted under section 104 or section 106 of CERCLA, or section 3004(u) or section 3008(h) of RCRA.	Self-implementing on-site cleanup and disposal of PCB remediation waste.	40 CFR 761.61(a)(ii)	MA	NA	USACE will not perform self-implementing cleanup.
	The cleanup level for bulk PCB remediation waste in high occupancy areas (residential exposure scenario) is <= 1 ppm without further conditions.	Self-implementing on-site cleanup and disposal of PCB remediation waste.	40 CFR 761.61 (a)(4)(i)(A)	NA	NA	USACE will not perform self-implementing cleanup.
	Any person disposing of non-liquid PCB remediation waste shall do so by one of the following methods: • Dispose of it in a high-temperature incinerator approved under 40 CFR 761.70(b), an alternate disposal method approved under 40 CFR 761.60(e), a chemical waste landfill approved under 40 CFR 761.75, or in a facility with a coordinated approval under issued under 40 CFR 761.77. • Decontaminate it in accordance with 40 CFR 761.79	Performance-based disposal of PCB remediation waste.	40 CFR 761.61(b) 40 CFR 761.61(c)	NA	2-5	

Table C-2

Action-Specific Applicable or Relevant and Appropriate Requirements
Feasibility Study
TNT Area A and C, Former Plum Brook Ordnance Works
Sandusky, Ohio

Action/Requirement	Requirement(s)	Prerequisite(s)	Federal Citation	Ohio Citation	Alternative Applicable	Comments
Characterization and cleanup of solid waste contaminated with PCBs (continued)	Any person wishing to sample, cleanup, or dispose of PCB remediation waste in a manner other than prescribed in 40 CFR 761.61(a) or (b) or store PCB remediation waste in a manner other than prescribed in 761.65, must apply in writing to the EPA Regional Administrator. Each application must contain information described in the notification required by 40 CFR 761(a)(3).	Risk-based cleanup and disposal of PCB remediation waste – **Applicable.**	40 CFR 761.61(a)(3)	NA	2-5	
	Notification and certification. At least 30 days prior to the date that site cleanup begins, the person in charge of the cleanup or the property owner shall notify in writing the EPA regional Administrator and the Director of the county or local environmental protection agency. Notification requirements are prescribed in 40 CFR 761.61(a)(3).	PCB remediation waste cleanup - **Applicable.**	40 CFR 761.65(c)(9)	NA	2-5	
	PCB remediation waste may be stored at the cleanup site or site of generation for 180 days subject to the following conditions: • The waste is placed in a pile designed and operated to control dispersal by the wind, where necessary, by means other than wetting. • The waste must not generate leachate through decomposition or other reactions. • The storage site must have: (a) a liner to prevent any migration of wastes off or through the liner into the adjacent subsurface soil, groundwater, or surface water, (b) a cover that meets the requirements of 40 CFR 761.65(c)(9)(iii)(A), is installed to cover all the stored waste likely to be contacted with precipitation, and is secured so as not to be functionally disabled by winds, and (c) a run-on control system designed, constructed, operated, and maintained according to the requirements of 40 CFR 761.65(c)(9)(iii)(C).	Storage for disposal of PCBs at concentrations of 50 ppm or greater – **Applicable.**				

Table C-2

Action-Specific Applicable or Relevant and Appropriate Requirements
Feasibility Study
TNT Area A and C, Former Plum Brook Ordnance Works
Sandusky, Ohio

Action/Requirement	Requirement(s)	Prerequisite(s)	Federal Citation	Ohio Citation	Alternative Applicable	Comments
General Facility Requirements						
Emissions of hazardous air pollutants from TNT Area A operations	The steps necessary to indicate that the remediation systems are in compliance with the Ohio Environmental Protection Agency requirements are as follows: • Model each new or modified source of an air toxic using the SCREEN 3 model. • Compare predicted 1-hour concentrations against 1/40 of the Threshold Limit Value (TLV). The guidance specifically calls for evaluation against the time-weighted average (TWA). TLVs published by the American Conference of Governmental Industrial Hygenist (ACGIH) and Biological Exposure Indices; Threshold Limit Values and Biological Exposure Indices, ACGIH, 1998. • If this comparison shows that the predicted 1-hour concentration is greater than 1/40 of the TLV, further assessment is required. • Applies to controlled or uncontrolled sources	Emissions of potentially toxic air containments	Clean Air Act Amendments of 1990, Appendix G	3745-15 et. Seq.	NA	Remedial activities are not expected to result in the emission of hazardous air pollutants.
Security system	Must prevent the unknowing entry and minimize the possibility for unauthorized entry of persons or livestock onto active portion of the facility or comply with provisions of 40 CFR 264.14(b) and (c)	Operation of long-term (>90) container storage —**Relevant and Appropriate**	40 CFR 264.14	3745-54-14	2-5	Land use restrictions will be implemented as part of remedial activities.
General Inspections	Must inspect facility for malfunctions and deterioration, operator errors, and discharges, often enough to identify and correct any problems.	Operation of long-term (>90 day) container storage – **Relevant and Appropriate**	40 CFR 264.15(a)	3745-15(a)	2-5	Inspections are part of O&M activities.
Personal Training	Must ensure personnel adequately trained in hazardous waste, emergency response, monitoring equipment maintenance, alarm system procedures, etc.	Operation of long-term (>90 day) container storage – **Relevant and Appropriate**	40 CFR264.16	3745-54-16	2-5	

Table C-2

Action-Specific Applicable or Relevant and Appropriate Requirements
Feasibility Study
TNT Area A and C, Former Plum Brook Ordnance Works
Sandusky, Ohio

Action/Requirement	Requirement(s)	Prerequisite(s)	Federal Citation	Ohio Citation	Alternative Applicable	Comments
Contingency Plan	Must have a contingency plan, designed to minimize hazards to human health and the environment from fires, explosions, or other unplanned sudden releases of hazardous waste to air, soil, or surface water in accordance with 40 CFR 264.52	Operation of long-term (>90 day) container storage – **Relevant and Appropriate**	40 CFR264.51	3745-51	2-5	Requirement for both temporary and long-term storage
	Must be at least one emergency coordinator on facility premises responsible for coordinating emergency response measures in accordance with 40 CFR 264.30 et seq.	Operation of long-term (>90 day) container storage – **Relevant and Appropriate**	40 CFR264.55	3745-55	2-5	Contingency plan can refer to PBOW site wide, not TNT Area A alone
Preparedness and Prevention	Facilities must be designed, constructed, maintained, and operated to prevent any unplanned release of hazardous waste of hazardous waste constituents into the environment and minimize the possibility of fire explosion. All facilities must be equipped with communication and fire suppression equipment and undertake additional measures as specified in 40 CFR 264.30 et seq.	Operation of long-term (>90 day) container storage – **Relevant and Appropriate**	40 CFR264.30-264.37	3745-54-30 through 37	2-5	Requirement for both temporary and long-term storage of hazardous waste
Closure of RCRA Container Storage						
Clean closure of RCRA container storage area	Must close the facility in a manner that: • Minimize the need for further maintenance • Controls, minimizes or eliminates potential hazards to human health and the environment, post-closure escape of hazardous waste, hazardous constituents, contaminated runoff or hazardous waste decomposition products to ground or surface waters or to the atmosphere; and • Complies with closure requirements of 40 CFR 264.178	Management of RCRA hazardous waste in long-term storage (>90 days) facility – **Relevant and Appropriate**	40 CFR264.111	3745-66-11	2-5	
Monitoring and Extraction Wells						
Monitoring/Extraction well construction	Monitoring and extraction wells shall be constructed in accordance with EPA Region V Standard Operating Procedures	Installation of groundwater monitoring or extraction wells	EPA Region V SOPs		NA	No additional monitoring wells or extraction wells are anticipated
Monitoring/Extraction Well Abandonment	Monitoring and extraction wells shall be abandoned in accordance with requirements specified in EPA Region V Standard Operating Procedures.	Closure or abandonment of groundwater monitoring or extraction wells	EPA Region V SOPs		NA	No action alternative results in monitoring well abandonment.

Table C-2

Action-Specific Applicable or Relevant and Appropriate Requirements
Feasibility Study
TNT Area A and C, Former Plum Brook Ordnance Works
Sandusky, Ohio

Action/Requirement	Requirement(s)	Prerequisite(s)	Federal Citation	Ohio Citation	Alternative Applicable	Comments
Transportation of Hazardous Materials and Wastes						
Transportation of hazardous waste off-site	Must comply with the generator requirements of 40 CFR 262.20-23 for manifesting. Section 262.30 for packaging, Section 262.31 for labeling, Section 262.32 for marking, Section 262.33 for placarding, and Section 262.40, 262.41(a) for record keeping requirements and Section 262.12 to obtain EPA ID number.	Off-site transportation of RCRA hazardous waste- **Applicable**	40 CFR 262.10(h)	3745-52-10(f)	2-5	Off-site disposal of hazardous waste might be part of remedial alternative.
	Must comply with the requirements of 40 CFR 263.11-263.31.	Transportation of hazardous waste within United States requiring a manifest – **Applicable**	40 CFR 263.10(a)	3745-53-10(a)	2-5	Off-site disposal of hazardous waste might be part of remedial alternative.
	A transporter who meets all applicable requirements of 49 CFR 171-179 and the requirements of 40 CFR 263.11 and 263.31 will be deemed in compliance with 40 CFR 263.	Transportation of hazardous waste within United States requiring a manifest – **Applicable**	40 CFR 263.10(a)	3745-53-10(a)	2-5	Off-site disposal of hazardous waste might be part of remedial alternative.
Transportation of hazardous material	Shall be subject to and must comply with all applicable provisions of the HMTA and HMR (49 CFR 171-180).	Any person, who under contract with a department or agency of the federal government, transport [in commercial] or causes to be transported or shipped, a hazardous material – **Applicable**	49 CFR171.1 (c)	NA	2-5	Transportation of hazardous waste might be part of remedial alternative.

APPENDIX D

SUPPORTING CALCULATIONS

Table D-2

Stabilization Calculations
Alternative 3
TNTA and TNTC
Plum Brook Ordnance Works
Sandusky, Ohio

	Units	Soil	Portland Cement	Granular Activated Carbon	Water	Stabilization Mix
Mass of stabilization mix (dry soil basis)	tons	1.00	0.08	0.02	0.032	1.132
Component mass fraction		0.883	0.071	0.018	0.028	1.000
Bulk density of components	lbs/cf		94	97	62.4	
Bulk density of components	tons/cy	1.20	1.27	1.31	0.84	1.242
Volume of stabilization mix (dry soil basis)	cy	0.833	0.063	0.015	0.038	0.950
Component volume fraction		0.914	0.069	0.017	0.040	1.000
Component volume in 10 cy batch	cy	9.141	0.692	0.168	0.400	10.000
Component mass in 10 cy batch	tons	10.97	0.88	0.22	0.34	12.40
Stockpile height	ft	9.0				
TNTA:						
Volume of hazardous soil (consolidated)	cy	3871				
Volume of hazardous soil (unconsolidated)	cy	5032				
Volume of stabilization agents required	cy	5032	381	92	229	5734
Volume of stabilization agents required	gal				46252	
Mass of stabilization agents required	tons	6038	483	121	193	6642
Area of stockpile	sf	15096				
No. of treatment cycles						550
Batch treatment cycle	hr					0.25
Treatment duration	hr					138
Treatment duration	days					18
TNTC:						
Volume of hazardous soil (consolidated)	cy	2310				
Volume of hazardous soil (unconsolidated)	cy	3003				
Volume of stabilization agents required	cy	3003	227	55	137	3422
Volume of stabilization agents required	gal				27670	
Mass of stabilization agents required	tons	3604	288	72	115	3964
Area of stockpile	sf	9009				
No. of treatment cycles						329
Batch treatment cycle	hr					0.25
Treatment duration	hr					82
Treatment duration	days					11

Table D-3

Stabilization Calculations
Alternative 5
TNTA and TNTC
Plum Brook Ordnance Works
Sandusky, Ohio

	Units	Soil	Portland Cement	Granular Activated Carbon	Water	Stabilization Mix
Mass of stabilization mix (dry soil basis)	tons	1.00	0.08	0.02	0.032	1.132
Component mass fraction		0.883	0.071	0.018	0.028	1.000
Bulk density of components	lbs/cf		94	97	62.4	
Bulk density of components	tons/cy	1.20	1.27	1.31	0.84	1.242
Volume of stabilization mix (dry soil basis)	cy	0.833	0.063	0.015	0.038	0.950
Component volume fraction		0.914	0.069	0.017	0.040	1.000
Component volume in 10 cy batch	cy	9.141	0.692	0.168	0.400	10.000
Component mass in 10 cy batch	tons	10.97	0.88	0.22	0.34	12.40
TNTA:						
Volume of hazardous soil (consolidated)	cy	217				
Volume of hazardous soil (unconsolidated)	cy	282				
Volume of stabilization agents required	cy	282	21	5	13	321
Volume of stabilization agents required	gal				2626	
Mass of stabilization agents required	tons	338	27	7	11	372
No. of treatment cycles						31
Batch treatment cycle	hr					0.25
Treatment duration	hr					8
Treatment duration	days					1
TNTC:						
Volume of hazardous soil (consolidated)	cy	400				
Volume of hazardous soil (unconsolidated)	cy	520				
Volume of stabilization agents required	cy	520	39	9	24	592
Volume of stabilization agents required	gal				4847	
Mass of stabilization agents required	tons	624	50	12	20	686
No. of treatment cycles						57
Batch treatment cycle	hr					0.25
Treatment duration	hr					14
Treatment duration	days					2

APPENDIX E

RESPONSE TO COMMENTS

Response to Comments
Draft-Final Feasibility Study, TNT Areas A and C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Dated August 2003)

Comments from Jim Beaujon, CELRN-EC-R-D:

Comment 1: **Last paragraph on page 1-2 and middle paragraph on page 1-3: I believe all our PBOW documents use the term "overburden groundwater" rather than "residual groundwater". Please make this change. Also, in the next sentence for clarity change "Depth to the groundwater" to "Depth to the overburden groundwater."**

Response 1: The suggested changes will be made.

Comment 2: **Sections 4.3 through 4.6: As each alternative is discussed the "economies of scale" relative to cost are pointed out and briefly detailed. When the period of time to complete the alternative is discussed (last paragraph of Short-Term Effectiveness subsection) apparently only the economized time is presented with no comparison to the time for each TNT area if done separately. Please revise the discussion of "time to complete" to include an "economies of scale" comparison.**

Response 2: The Short-Term Effectiveness section of Alternatives 2 through 5 will include a discussion of the remediation time frame for both TNTA and TNTC individually. A new table (Table 5-3) will be added that compares the individual remediation times to the combined time if both areas are remediated in one field event. Old Table 5-3 in the report will be renamed Table 5-4.

Comment 3: **Table 5-3: Please add a footnote explaining that the numbers in the "Total" row represent the "economies of scale" costs.**

Response 3: A footnote will be added to the table.

Comment 4: **Following along with the "economies of scale" comparison relative to time that was requested above, please consider adding a Table 5-4 that presents the individual times and then the economized time similar to what is done in Table 5-3 for cost. (Table 5-1 and 5-2 correctly present only the time to complete the individual TNT area.)**

Response 4: A new table will be added that compares the individual remediation times to the combined time if both areas are remediated in one field event.

Comments from Doug Mullendore, CELRN-EC-R-D:

Comment 1: **General Comment. It seems that the cumulative RGO for the two DNT compounds in both manufacturing areas is 7.5 mg/kg. Why is it necessary to set individual action levels for each DNT compound in each manufacturing area? Wouldn't it be acceptable to set the action level, in both areas, for total DNT to 7.5 mg/kg? Couldn't the same be done for the ADNT compounds?**

Response 1: Shaw had previously proposed combining the DNT isomers into one RGO and taking this same approach for the ADNT isomers. It is Shaw's position that combining the isomers, which share the same toxicity values and have virtually the same physical properties, is technically appropriate. However, during the November 2002 meeting between OEPA, EPA, and USACE, it was agreed that separate RGOs would be developed for the separate DNT and ADNT isomers. Apparently, this is an OEPA policy.

Comment 2: **Page 1-4, Section 1.3, 2nd Paragraph, 7th Sentence. I compared the results from the screening and confirmation sampling. During this review I noticed that it wasn't unusual for confirmation samples collected from areas that exceeded the action levels for screening samples to not exceed the action levels in the confirmation samples. As a matter of fact I believe this happened approximately 60% of the time (reference page 1-19, Section 1.5.2.1). I am concerned that our volume estimates are not accurate. Please add some discussion regarding the difference in results between the screening and confirmation sampling to the report.**

Response 2: Discussion will be added to acknowledge the difference in screening and confirmation samples collected from the same locations. Prior to submittal of the FS, Shaw internally performed an informal review to determine whether the screening samples were consistently greater (or less) than the confirmation samples. Our finding was that there were a number of sampling locations where a screening sample yielded higher concentrations than the corresponding confirmation sample. However, we also found a nearly equal number of times where the confirmation sample yielded higher concentrations of nitroaromatics than the screening sample collected at the same location. Based on this information, and the characteristic of nitroaromatics to generally have a heterogeneous distribution in soil, the differences observed between the screening and confirmation sampling results were assumed to be associated with heterogeneity of actual conditions rather than only an artifact of the analytical protocol.

Therefore, both screening and confirmation data were used to estimate remediation volumes in the areas where both types of samples were collected, so that the remedial volumes would not be underestimated. Although the screening method may give some false positives because of the lack of a second column to confirm the result, the variation between the screening and confirmation results are thought to be potentially associated with the heterogeneous nature of the soil contamination. For this reason, screening samples were used to delineate areas to be remediated, even in areas where a confirmation sample indicated considerably lower concentrations of nitroaromatics.

Comment 3: **Page 1-8. For CoCs, other then nitroaromatics, the volumes for remediation are based on a small number of samples suggest this be clarified in the text. Although I am less concerned about the PAH contamination because it can be remediated by composting and is less of a cost driver, I recommend further PCB and PAH screening sampling be performed before excavation to determine if estimates of these contaminants are accurate.**

Response 3: The following sentence will be added to the end of Section 2.4:

"It is important to note that there is significantly more analytical data for the nitroaromatic COCs than for lead, PAHs, or PCBs. As a result, there is a greater degree of uncertainty about the accuracy of the remedial volumes concerning these constituents."

PCBs and PAHs will be added to the list of analytical parameters for the pre-excavation sampling for each remedial alternative.

Comment 4: **Page 1-22, Process Line 12, 1st Sentence. Suggest editing this sentence to say *two buildings and the wastewater settling basins*.**

Response 4: The sentence will be reworded as suggested.

Comment 5: **Page 2-2, Section 2.2, 2nd Paragraph, 4th Line. Suggest adding a citation for the PCB ARAR referenced in this sentence.**

Response 5: The following sentence will be added after the third sentence in this paragraph: "Section 2.5.3 discusses the pertinent PCB regulations and how they apply to remedial actions at TNTA and TNTC."

Comments from Lannae Long, CELRN-EC-R-D:

Comment 1: **General Comment. With lessons learned from TNT B remedial action, such that subsurface contamination is of concentrations greater than RAOs and is found in non-standard pattern, should the volume estimate of each hole be increased?**

Response 1: Based on earlier discussions with the USACE and the lessons learned during remediation of TNTB, a more aggressive approach for soil removal was suggested in the draft-final FS for TNTA&C than was used in the FS for TNTB or the draft FS for TNTA&C. This change in methodology has resulted in a significant increase in the estimated remedial volume of contaminated soil from 5,695 cubic yards in the draft FS to 24,623 cubic yards in the draft-final FS report.

Due to the uncertainty associated with the volume estimates, it may be appropriate to further increase the estimated cost of each alternative to account for a potentially higher volume of contaminated soil than was previously estimated. It is recommended that this be accomplished by increasing the contingency added to each cost estimate. This will provide an additional allowance for higher volumes without requiring significant revisions to the document. Currently, the contingency is 20 percent; an increase in the contingency to 30 percent is thus recommended to meet this objective.

Comment 2: **General Comment. If certain constituents in TNT A and C soils are considered hazardous and post-compost concentrations are still designated hazardous, should the excavated soils be transferred to a hazardous waste landfill directly, instead of composting and adding more volume to a hazardous waste?**

Response 2: This is a feasible option for handling soil that does not pass confirmation testing. This option would be most appropriate for treated soil when confirmation results are significantly above the cleanup levels. If confirmation results are close to the cleanup levels, it may be more appropriate to allow the treatment to continue for an additional short period of time. Although the disposal approach is mentioned in the "Implementability" sections of Alternatives 2 (Section 4.3.6) and 5 (Section 4.6.7), it is suggested only after additional treatment has failed. The last sentence of the fifth paragraph of each section will be reworded as follows: "Alternatively, the compost could be disposed of off site at an approved TSDF if the compliance results of the treated compost are significantly elevated above the RGOs such that further biological treatment would not be cost-effective."

Comment 3: **Page 1-4, 1st line: Change "wee" to "were."**
Page 1-5, last line: Delete one of the "as the" in "as the as the."
Page 1-10, Building Area 693, 2nd line: Add a space between "9" and "Building."
Page 1-17, Building 131, 3rd line: Change "of the 10 the soil" to "of the 10 soil."
Page 5-2, Section 5.5, 4th to 5th line: Delete one of the "is not" from "is not is not."
Page 1-5, 4th Line. Suggest changing target analyte list metals (total) to target analyte list metals.
Page 1-7, 4th Bullet. Please correct 4-Nitrotoluene (4-NT).

Response 3: All changes will be made as requested.

Comments from Dave Becker, HTRW Center of Expertise:

Comment 1: **General. Thank you for the extensive revisions that addressed previous comments. The only issue I still see is the approach to excavate soils above the PRGs rather than looking at the specific site average concentrations**

following excavation of the hot spots. I realize the limited data prevents you from easily defining these "hot spots" that could be excavated to bring site 95% UCL on the mean to within the PRGs. Perhaps this is an issue for design, but I would preposition the Corps to propose this excavation approach in design with language in the FS. I defer to comments from the risk assessors, however.

Response 1: As stated in the previous response to A. Meyer Comment No. 20, a remediation such that the 95% UCL of the mean concentration does not exceed the RGO is generally preferable to a not-to-exceed (NTE) RGO. However, the lack of definitive data, coupled with the distribution of the nitroaromatics in site soils, results in 95% UCL estimates of the mean that exceed the maximum detected concentrations. The high level of heterogeneity of nitroaromatics in soil further complicates this issue and would necessitate that a correspondingly high number of additional samples be collected (due to high statistical variability associated with the heterogeneity). The result may be that a large number of "hot spots" would be identified.

The issue of RGOs as either NTE or 95% UCL levels has been previously discussed by the USACE and OEPA. The agreement reached was that remediation design would be based on the data collected thus far (and possibly additional data) and the RGOs would be treated as NTE concentrations. It was also agreed that professional judgment would be used during remediation, and that individual post-excavation soil samples modestly exceeding the RGOs would not necessarily be a basis for further remediation in the corresponding area.

Comments from Anita Meyer, HTRW Center of Expertise:

Comment 1: **Many of my comments on the previous version of the FS were incorporated in their entirety, or the text modified to acknowledge my general concern. Thank you for your attention on those issues. Below are some comments on the draft FS that were not incorporated. I retain the same technical opinion and believe that incorporation of these comments would have improved the document and would have added value to the project.**

Response 1: No response necessary.

Comment 2: **Comment 9 from Draft FS - Section 2.2. Given the current, and I assume likely future land use at the site, cleanup goals should not have been developed solely for residential reuse. Cleanup goals consistent with the current use of the property need to be presented and remedial alternatives developed to achieve these goals. Remedial alternatives need to be developed consistent with the non-residential cleanup goals that address soils and include land use restrictions to prohibit future residential use. Subsurface soils would be able to be addressed for impacts to groundwater and could be covered in the groundwater operable unit.**

Response 2: The stakeholders (NASA, OEPA, the RAB) have made it clear that they are interested only in releasing the site without restriction. Text will be added to Section 2.2 to state this. Cleanup levels based on alternative land uses were not of interest to the stakeholders and thus only residential RGOs were included in the draft-final FS. Groundwater at PBOW is being addressed separately; it is anticipated that remedial actions associated with soil will be consistent with the remedial goals for groundwater.

Comment 3: Comment 20 from Draft FS - Section 4.5.1. Excavation approach should not be to remove all areas above PRGs, but rather to excavate soils so that remaining concentrations do not exceed PRGs. An iterative hot spot removal could very well achieve this goal at the site. See Schulz T. and Griffin, S., Practical Methods for Meeting Remediation Goals at Hazardous Waste Sites, Risk Analysis 21:43, 2001. If you need a copy of the paper I will send you one.

Response 3: The USACE agrees that the iterative approach is valid, and it was used in identifying and estimating the area and volume of the remedial area for the Pentolite Road Red Water Pond Site at PBOW. However, the USACE considers a lack of validated sample results coupled with a high level of heterogeneity to be problematic in implementing the iterative approach at TNTA&C. Please also refer to the response to D. Becker Comment No. 1. As mentioned in that response, it was agreed that RGOs at TNTA&C would be used as NTE levels, partly due to a lack of definitive data, and that professional judgment would be used in determining whether exceedances of RGOs in the post-excavation samples require additional remediation.

Comments from Ron Nabors, Ohio EPA:

Comment 1: The U.S. Army Corps has already developed cleanup levels for soil at TNT Area B. The U.S. Army Corps should compare the proposed Remediation Goal Options (RGOs) to see if the levels are comparable. If they compare, a statement should be included indicating the consistency. If they do not compare then the U.S. Army Corps should briefly discuss why the numbers are different.

Response 1: The attached Table 1 compares RGOs for TNTB to those of TNTA and TNTC. The RGOs for TNTA and TNTC are virtually identical with respect to one another; the slight differences reflect an attempt to minimize excavation efforts necessary to protect human health and the environment. Although the RGOs for TNTB differ somewhat from TNTA&C, all are protective.

The reason for the differences between TNTB and the other two areas is that the RGOs for TNTB are based on the lower of an incremental lifetime cancer risk (ILCR) of 1E-5 or a noncancer hazard index (HI) of 0.1, *for each individual chemical*. The RGOs for nitroaromatics at TNTA and TNTC are based on the lower of a *cumulative* ILCR of 1E-5 or noncancer HI of 1.0. As mentioned, the RGO for each nitroaromatic at TNTA and TNTC was established to minimize the

Table 1

Comparison of Remedial Goal Options for TNTB with TNTA and TNTC
Former Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	TNTB[a] (mg/kg)	TNTA[b] (mg/kg)	TNTC[b] (mg/kg)
2-amino-4,6-dinitrotoluene	0.4	1.3	1.7
4-amino-2,6-dinitrotoluene	0.4	1.7	1.3
2,4-dinitrotoluene	7.5	6.0	6.5
2,6-dinitrotoluene	2.75	1.5	1.0
2-nitrotoluene	74	31	-
4-nitrotoluene	-	9	-
2,4,6-trinitrotoluene	3.36	8.0	8.0
Aroclor-1254	0.16	-	1.0[c]
Aroclor-1260	2.87	1.0[c]	1.0[c]
Lead	-	400[d]	400[d]
Benzo(a)anthracene	5.4	-	1.0[e]
Benzo(a)pyrene	0.54	-	1.0[e]
Benzo(b)fluoranthene	5.4	-	1.0[e]
Dibenzo(a,h)anthracene	0.65	-	1.0[e]
Indeno(1,2,3-cd)pyrene	5.4	-	1.0[e]

Notes:

[a] The RGO was based on a cancer risk of 1E-05 or a non-cancer hazard of 0.1, whichever was lower.

[b] RGOs for nitroaromatics based on a cummulative cancer risk of 1E-5 and hazard index of 1.

[c] ARAR for total PCBs per 40 CFR 761.3.

[d] EPA soil screening value for average lead concentration.

[e] RGO for total carcinogenic PAHs based on OEPA policy

total volume of soil requiring remediation for all nitroaromatics, while complying with the cumulative cancer and noncancer limits. As a result, the RGO for a particular chemical is not the same for the three areas.

The RGOs for PCBs are not the same at TNTB and TNTA&C because the RGOs for TNTB are based on the TNTB human health risk assessment, whereas the RGOs for TNTA and TNTC are based on the ARAR in 40 CFR 761.3. Both approaches are acceptable under the Toxic Substances and Control Act (TSCA).

The RGO for each PAH at TNTB is based on the TNTB human health risk assessment and represents the lower of an ILCR of 1E-5 or a noncancer HI of 0.1. The RGOs for total carcinogenic PAHs at TNTA and TNTC are set at 1.0 mg/kg per OEPA policy.

A statement indicating the TNTA&C RGOs differ from but are comparable to the TNTB RGOs will be added to the text in Chapter 2.0.

Comments from Lisa Humphries, CELRH-EC-CE:

Comment 1: **The following comments are offered for your consideration and are based on some of the lessons learned from our construction activities at WVOW composting project as well as the PBOW TNT B Interim Soil Removal Efforts. I have not had the time to thoroughly review the FS and associated alternative cost estimates, but felt these comments should at least be offered in case the estimates have not adequately reflected or addressed some of the issues outlined below. Also, here's some "food for thought". While some of the issues listed below may seem trivial and thoughts to cover them under a contingency of 5 – 10% may seem adequate, these little "trivial" issues really did add a lot of expense to the job and are necessary for project completion so you may want to address them fully rather than just blindly under "contingency".**

Response 1: The additional cost elements identified below will be added to the remedial cost estimates.

Comment 2: **Lessons learned from WVOW composting efforts, a concrete pad/foundation should be constructed under the building.**

Response 2: A concrete pad and foundation will be added to the cost estimate for the treatment area of each remedial estimate.

Comment 3: **Additional costs for road repair should be included due to the truck's heavy weight and high traffic and additional duration required due to weight limits on the access roads within the PBOW gates. Also, having to work in the different seasons also took a toll on the roads that was not anticipated for TNT B.**

Response 3: A lump sum line item of $50,000 will be added to TNTA and TNTC remedial alternatives to account for road repair costs over the duration of each project.

Comment 4: **Additional costs should be included for disposal of groundwater/rainwater that enters the pit excavations. The pits for TNT A & C will remain open longer than TNT B because the composting material will be used as backfill rather than bringing it in as on TNT B. This additional timeframe for composting will allow more rain and surface runoff to enter the pits and we can't rely on NASA's good graces to let us always "dispose of on site."**

Response 4: Additional costs will be added to pump, transport, treat, and dispose of pit excavation water. Rental costs for a trash pump, transportable poly tank, flatbed truck, sand filter, and carbon adsorber will be added to the excavation section of each remedial alternative.

Comment 5: **Is the issue of "composting timeframe" adequate if we run into hazardous levels (higher level other than what's noted in the FS as we did on TNT B). IF you increase the timeframe, the contractor's labor, materials, per diem, analytical costs, etc. will increase as well.**

Response 5: The composting batch cycle time was estimated based on previous experience on a similar project at the Naval Surface Warfare Center in Crane, Indiana. It is believed that the estimated remedial duration is reasonable given the volume of contaminated soil currently estimated.

Comment 6: **Make sure an adequate amount for field sampling kits have been included as a screening tool for confirmation.**

Response 6: The cost of field sampling kits for nitroaromatic compounds and lead will be added to the excavation task of the remedial cost estimates.

Comment 7: **Additional quantities for confirmation sampling based on Ohio EPA protocol for sampling various sizes of holes (i.e., 20' walls vs. 50' walls, number of samples required by Ohio EPA for confirmation doubles and triples based on length).**

Response 7: The number of confirmation samples will be increased to be consistent with the OEPA requirement of one sample per 20 lineal foot of excavation floor and sidewall. A 1.1 multiplier will be used in calculating the number of samples required to account for resampling areas that failed the initial confirmatory sampling.

Comment 8: **Additional quantities for the excavation efforts in case the FS assumptions not pan out (as in TNT B). This would also increase your costs for confirmation analytical efforts because you'll have to keep re-sampling the walls for closure.**

Response 8: The areas of contamination will be redrawn to combine areas that are closely adjacent. These increased areas will be factored into the excavation, treatment, disposal, and confirmation sampling and analytical costs. The estimated remedial volumes at TNTA and TNTC were increased from 5,695 cubic yards in the draft FS to 24,623 cubic yards in the draft-final FSreport.

Comment 9: Additional costs for backfill material (adequate for seeding and of the same consistency/type as what was excavated (clay material vs. sand type) and include adequate analytical costs for borrow sites prior to obtaining backfill.

Response 9: In-place costs for backfill will be increased from $6.00 to $12.00 per cubic yard based on previous work at TNTB. Analytical costs for backfill are already included in the cost estimates.

Comment 10: Adequate quantities used in cost estimate should include "swell factors."

Response 10: A factor of 1.3 was used in the estimate of excavated soil to account for the increased volume of unconsolidated soil.

Comment 11: Adequate landfill costs for disposal (TNT B was at $31 for Erie County landfill) and also take into account that we have to go to them because of the flow-control regulations. However, we may be able to go elsewhere (i.e., Ottowa) once Erie's daily maximum limit is met.

Response 11: Nonhazardous soil disposal costs will be increased from $30 per ton to $31 per ton in the remedial estimates.

Comment 12: Adequate downtime included due to the fact that analytical cannot always be turned around as quickly as we anticipate. There may be charges for equipment on site while contractor is not there (i.e., trailer, generator, dozer, excavator, composting equipment).

Response 12: An efficiency factor has already been applied to the excavation task that adequately accounts for downtime.

Comment 13: Include additional time for contractor to have meetings with EPA/NASA and trips prior to construction activities for coordination efforts.

Response 13: Four trips will be budgeted for 2 contractor employees to attend coordination meetings prior to the commencement of site activities.

Comment 14: Include adequate time for contractor to do closure report at end of job.

Response 14: A $20,000 line item will be added to last task of each alternative to include the cost of preparing a remediation closure report.

Comment 15: Include PBOSG guard costs because we are not using front gate for access into and out of the site. This turned into quite a problem because we had to

really coordinate with the PBOSG guard services and get them to work overtime because they don't bring in additional guards (they use those you meet at the front gate). Also, the time to actually arrange all of this with them as well as getting them the money for the guard services was unbelievable. It's not as simple as requesting a few guards, you have to work around their schedule.

Response 15: A line item for additional security will be added to the excavation task. Additional security will be estimated at $600 per week based on past experience for the TNTB area remediation at PBOW.

Comment 16: Adequate number of field men as well as QC officer and Safety officer (had anywhere from 5 - 8 guys/gals on site at all times, not to mention USACE people helping out with oversite).

Response 16: For the excavation task of each alternative, a full-time quality assurance coordinator and health and safety coordinator will be added to the crew. A part-time chemist will also be added at 20 hours per week. During the treatment and/or disposal tasks of each alternative, a full-time quality assurance coordinator will be added to the crew.

Comment 17: May require stabilization of metals if those are encountered.

Response 17: On-site chemical stabilization is included as a component of Alternative 3 and Alternative 5 for soil contaminated with metals at levels that could fail the TCLP test. Disposal costs for those alternatives without on-site treatment include the cost of off-site treatment for those constituents that would not pass the TCLP test.

Comment 18: Possible use of level C (respirators) and additional costs associated with slower working conditions and increased PPE.

Response 18: Based on past experience at TNTB, only a limited amount of excavation was performed in Level C PPE. The excavation cost estimates will assume that 10 percent of the excavation work will be performed using Level C PPE. Labor productivity for Level C work will be adjusted to 67 percent of Level D. Equipment productivity for Level C work will be adjusted to 75 percent of Level D. Costs for Level D PPE ($10.00 per worker per day) and Level C PPE ($35.00 per worker per day) will be added to the cost estimates.

Comment 19: Air monitoring requirements for excavation as well as composting efforts.

Response 19: Equipment rental costs for a photoionization detector (PID) and a combustible gas indicator (CGI) will be added to the excavation and treatment cost estimates.

Comment 20: Adequate decon provisions/procedures and amount of time in going from pit to pit as well as costs for disposal and where the water's going to (may or may not be able to spray on compost pile).

Response 20: Equipment rental costs for a steam cleaner will be added to the cost estimates. Excavation productivity has already been adjusted to 67 percent of normal to account for the additional time required to decon and move equipment from one building area to the next.

Comment 21: Adequate contractor time for staging/stockpiling excavated material and moving to composting building as well as sampling for clean confirmation below stockpiles once done.

Response 21: Costs for the excavation task in each alternative already includes time to stage and stockpile contaminated soil, and move untreated and treated soil to and from the treatment area. Sampling and analytical costs will be added to test soil under stockpiles after remediation is complete.

Comment 22: Adequate seeding efforts (RAB requirements) once we're complete.

Response 22: Costs to reseed the excavation and staging areas with fescue will be added to the remedial estimates.

Comment 23: Adequate clearing and grubbing efforts since A&C are so overgrown.

Response 23: The remedial estimates already assume 5 acres will be cleared for remediation in each area at a cost of $2,300 per acre.

Comment 24: Adequate costs for sump pumps to collect composting runoff and circulate back onto piles.

Response 24: Pump rental for collecting contact water from the treatment and staging areas is already included in the cost estimates.

Comment 25: Time included for the contractor to coordinate everything prior to mobilization to site (quite a few trips were required to get everything in place (borrow and sampling, truck rentals, coordination with NASA, pre-construction meeting, etc.).

Response 25: Four trips will be budgeted for 2 contractor employees to attend coordination meetings prior to the commencement of site activities.

Comment 26: Surveying efforts of the pits (initial to locate and final survey for closure) and composting building foundation.

Response 26: Surveying costs of $24,000 will be added under site preparation to complete pre- and post-remediation surveying at each site (TNTA/TNTC).

Comment 27: Allow contractor time for building installation as well as maintenance on it throughout the composting process (will have downtime associated with tightening of building, securing/adjusting tarps/roof, etc.).

Response 27: Costs are already included in the remedial estimates for building construction. Previous experience with this type of structure at WVOW demonstrated that no significant costs were incurred for maintenance of the fabric structure.

Comment 28: Adequate costs for sampling of compost efforts.

Response 28: Compost sampling and analysis is already incorporated into the remedial cost estimates.

Comment 29: Adequate travel costs for contractor (daily crews for composting requirements as well as QC and Safety Officers).

Response 29: The current remedial estimates include travel for a site superintendent and field technician only. Based on previous experience at TNTB, it will be assumed that all remediation workers will travel to the site from outside the local area. Travel costs for remediation workers will be increased accordingly in the remedial estimates.

Comment 30: Adequate trailer costs (required for field screening efforts, can't be done from back of truck).

Response 30: The remedial cost estimates already include costs for an on-site office trailer. An additional trailer will be added to the cost estimate for sampling and analytical requirements.

Response to Shaw Environmental Internal Comments
Final Feasibility Study, TNT Areas A and C
Former Plum Brook Ordnance Works, Sandusky, Ohio
August 2003

Comments from Mary Hall:

Comment 1: **See minor changes in the redline text file.**

Response 1: The suggested changes will be made.

Comment 2: **Tables 5-3 and 5-4: Suggest removing the number "1" in front of the note. The reader may interpret this as a reference to Alternative 1, not all the alternatives in the table.**

Response 2: The number will be removed from the note in each table.

Comments from Mike Gunderson:

Comment 1: **Sections to J. Beaujon comment #2 – Suggest changing last sentence in response to "A new table (Table 5-4) will be added that compares..."**

Response 1: The table reference will be added to the response.

Comment 2: **Table 5-4 is not listed in the Table of Contents.**

Response 2: The table will be added to the Table of Contents.

Comment 3: **Response to Anita Meyer comment #3 - The first sentence makes no sense. It states that the "USACE agrees that the iterative approach is a valid and was the selected in the remediation of the Pentolite Road Red Water Pond Site at PBOW." Should this read " USACE agrees that the iterative approach is a valid and was the selected *alternative* in the remediation of the Pentolite Road Red Water Pond Site at PBOW."**

Response 3: The first sentence in the response will be reworded as follows: "The USACE agrees that the iterative approach is valid, and it was used in identifying and estimating the area and volume of the remedial area for the Pentolite Road Red Water Pond Site at PBOW."

Comment 4: **Response to L. Humphries comment #14: The cost for the Closure Report is in Task 8.0, not 1.0 as indicated.**

Response 4: The response will be restated to indicate the cost of the closure report will be added to the last task of each alternative.

Comment 5: **Response to L. Humphries comment #19: I did not find costs associated with the CGI in the cost tables.**

Response 5: The CGI rental costs will be added to the appropriate tasks of each alternative in the cost tables.

Comments from Steve Downey:

Comment 1: **No comments.**

Response 1: No response necessary.

Comments from David Kessler:

Comment 1: **Response to Jim Beaujon comment No. 2 - Table 5-4 is not listed in the TOC.**

Response 1: The table will be added to the Table of Contents.

Comment 2: **The title block of Table 5-4 should be the same as the other tables (i.e., add "Former" in front of Plum ...).**

Response 2: The title of the table will be corrected.

Comment 3: **Are the pre-excavation costs (subcontractor/oversight labor, excavation equipment, lead, PCB, PAH analytical costs, etc....) included the capital cost summary?**

Response 3: The pre-excavation sampling and analysis are included in Task 3.0 of each alternative. Costs for excavation equipment are included in Task 5.0. The total cost for each alternative in the cost summary table (Table 5-4) includes all costs itemized in the individual cost tables.

Comment 4: **A hyphen "-" should be added between off and site (i.e., off-site) in the report text.**

Response 4: The version of the report circulated for internal review had not been edited. The report will be edited after all internal comments have been incorporated.

Comment 5: **Ron Nabors comment No. 1 - No Table 1 was attached to the RTCs (comparison TNTB RGOs to those of TNTA and TNTC).**

Response 5: Table 1 was prepared but inadvertently omitted from the internal review distribution. It will be included in the response to comments for the revised report.

Comment 6: Table 5-1, the page numbering needs to be corrected.

Response 6: The pagination for the table will be corrected during editing.

Comments from Tom Siard:

Comment 1: On pages 2-4 and 2-6 where respective TNTA and TNTC RGOs are being compared to TNTB RGOs, the statement is made that, "The RGOs for TNTC differ slightly but are comparable to the RGOs previously developed for TNTB." I suggest either removing the word "slightly" or replacing it with "somewhat."

Response 1: The word "slightly" will be changed to "somewhat" in both sentences.

Comments from Tarek Ladaa:

Comment 1: No comments.

Response 1: No response necessary.

Comments from Mark Weisberg:

Comment 1: No comments.

Response 1: No response necessary.