HAFB 04

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RESPONSIVENESS – INTEGRITY - TEAMWORK

February 8, 2006

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NMED Hazardous Waste Bureau

New Mexico Environment Department
Hazardous Waste Bureau
Permits Management Program
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505-6303

Attention: Mr. John E. Kieling
Program Manager

Subject: Voluntary Corrective Measures Work Plan for Disposal Pit 63 (DP-63)
Holloman Air Force Base, New Mexico. February 2006

Dear Mr. Kieling:

Bhate Environmental Associates, Inc. (Bhate) is pleased to submit the enclosed plan for investigative and/or removal activities at the above referenced site.

If you have any questions, please feel free to call me at 303-386-6454.

Sincerely,
Bhate Environmental Associates, Inc.

Frank Gardner, PG
Program Manager

cc w/enclosures: Cornelius Amindyas, Holloman AFB Team Lead, NMED/Hazardous Waste Bureau, 5500 San Antonio NE, Albuquerque, NM 87109.

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VOLUNTARY CORRECTIVE MEASURES WORK PLAN

DISPOSAL PIT 63 (DP-63)

Holloman Air Force Base
New Mexico

February 2006

Contract No.: DACA45-03-D-0023
Delivery/Task Order: 0008
Bhate Project No.: 9050044

Headquarters, Air Combat Command
Langley Air Force Base, Virginia

49 CES/CEV
Holloman Air Force Base, New Mexico

VOLUNTARY CORRECTIVE MEASURES WORK PLAN

DISPOSAL PIT 63 (DP-63)

HOLLOMAN AIR FORCE BASE, NEW MEXICO

Prepared for:

49 CES/CEV
Holloman Air Force Base
New Mexico

Under Contract To:

U.S. Army Corps of Engineers
Omaha District
Omaha, Nebraska

Contract No.
DACA45-03-D0023
Delivery/Task Order No. 008

February 2006

Prepared by:

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Bhate Project No.: 9050044

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VOLUNTARY CORRECTIVE MEASURES WORK PLAN

DISPOSAL PIT 63 (DP-63)

HOLLOMAN AIR FORCE BASE, NEW MEXICO

REVIEW SHEET

This Work Plan has been reviewed and approved by:

		February 3, 2006
John Hymer Site Manager	Signature	Date:
		February 3, 2006
Karen J. Niebuhr, P.E. Senior Project Manager	Signature	Date:
		February 3, 2006
Frank Gardner, P.G. Program Manager	Signature	Date:

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VOLUNTARY CORRECTIVE MEASURES WORK PLAN

DISPOSAL PIT 63 (DP 63)

HOLLOMAN AIR FORCE BASE, NEW MEXICO

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- Tables 2-1, 4-1, 4-2, and 4-3
- Figure 4-1
- Boring Logs

B NMED Soil Screening Levels Revision 3.0, November 2005

C Section 5.0 *Draft Report for the Remedial Investigation of DP-63 – Disposal Pit 63,* Foster Wheeler Environmental Corporation, December 2002
- Boring Logs
- Well Construction Diagrams

D Geophysical Results *Final Report for Preliminary Assessment/Site Inspection of DP-63 – Disposal Pit 63,* Foster Wheeler Environmental Corporation, January 2001

E Base Civil Engineer Work Request Air Force Form 332

F Portions of Bhate Standard Operating Procedure No. 10

G Site-Specific Addendum to the Basewide Quality Assurance Project Plan

H UFGS Section 02111 *Excavation and Handling of Contaminated Material*, September 2003

I Portions of USEPA Innovative Technology Verification Report: *Field Measurement Technologies for Total Petroleum Hydrocarbons in Soil*

J NMED TPH Screening Guidelines June 24, 2003

K Accutest Laboratories, USACE Laboratory Validation Approval, US Department of Army, July 9, 2004

L Site-Specific Addendum to the Basewide Health and Safety Plan

ACRONYMS AND ABBREVIATIONS

AAF	Army Air Field
AFCESA	Air Force Civil Engineer Support Agency
AF Fm	Air Force Form
amsl	Above mean sea level
ANSI	American National Standards Institute
ARB	Anomaly Review Board
bgs	Below ground surface
Bhate	Bhate Environmental Associates, Inc.
BMP	Best management practices
BSOP	Bhate Standard Operating Procedure
BTEX	Benzene, toluene, ethylbenzene, and xylenes
CDW	Construction-derived waste
CES/CEV	Civil Engineering Squadron/Combat Engineer Vehicle
COC	Chain-of-custody
CRZ	Contamination reduction zone
cu yds	Cubic yards
DMM	Discarded Military Munitions
DPT	Direct push technology
DRMO	Defense Reutilization and Marketing Office
DRO	Diesel-range organics
DQO	Data quality objective
EMM	Earth moving machinery
EOD	Explosive Ordnance Disposal
ERPIMS	Environmental Restoration Program Information Management System

ACRONYMS AND ABBREVIATIONS (CONTINUED)

EZ	Exclusion zone
°F	Degrees Fahrenheit
FID	Flame-ionization detector
ft	feet
GC	Gas chromatographic
GPS	Global Positioning System
GRO	Gasoline-range organics
HAFB	Holloman Air Force Base
HASP	Health and Safety Plan
HSA	Hollow stem auger
ln ft	Linear feet
MEC	Munitions and Explosives of Concern
µg/kg	Micrograms per kilogram
mg/kg	Milligrams per kilogram
µg/L	Micrograms per liter
mg/L	Milligrams per liter
MPPEH	Military Debris, or Material Potentially Presenting an Explosive Hazard
MS/MSD	Matrix spike/matrix spike duplicate
NAVFAC	Naval Facilities Engineering Command
NFA	No Further Action
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMWQCC	New Mexico Water Quality Control Commission

ACRONYMS AND ABBREVIATIONS (CONTINUED)

ORO	Oil-range organics
OSHA	Occupational Safety and Health Administration
OVA	Organic vapor analyzer
PA/SI	Preliminary Assessment/Site Inspection
PCB	Polychlorinated biphenyl
PCS	Petroleum-contaminated soils
PID	Photo-ionization detector
PPE	Personal protective equipment
PVC	Polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RA	Remedial Action
RI	Remedial Investigaion
SCH	Schedule
SCP	Sediment Control Plan
SOP	Standard Operating Procedure
SSHO	Site Safety and Health Officer
SSL	Soil Screening Level
SWPPP	Storm Water Pollution Prevention Plan
SVOC	Semi-volatile organic compound
SZ	Support zone
TAL	Target Analyte List
TAZ	Tractor-Accessorized Zierrist
TDS	Total dissolved solids

ACRONYMS AND ABBREVIATIONS (CONTINUED)

TPH	Total petroleum hydrocarbons
UFGS	Unified Facilities Guide Specifications
USACE	United States Corps of Engineers
USAESCH	United States Army Engineering and Support Center Huntsville
USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit
UVF	Ultraviolet Fluorometer
UXO	Unexploded ordnance
VCMs	Voluntary Corrective Measures
VOC	Volatile organic compound
WRCC	Western Regional Climate Center
WSMR	White Sands Missile Range
WWTP	Wastewater treatment plant

1 INTRODUCTION

Bhate Environmental Associates, Inc., (Bhate) has been retained by the U.S. Army Corps of Engineers (USACE), under contract DACA45-03-D0023, Delivery/Task Order No. 008, to conduct Voluntary Corrective Measures (VCMs) at Disposal Pit 63 (DP-63) at Holloman Air Force Base (HAFB), New Mexico. The VCMs include tasks as outlined in the USACE Scope of Services dated November 29, 2004. This document is to provide a work plan that will serve as the primary working document for the excavation activities at DP-63.

The VCM Work Plan provides the relevant site specific information and requirements as outlined in the Scope of Services for remedial activities at DP-63. The primary objective of this VCM is to remove, through excavation, and properly dispose of petroleum-contaminated soils (PCS). During this process, required data will be collected to support the closure of the site based on guidance from the New Mexico Environment Department (NMED). The ultimate objective is to achieve No Further Action (NFA) approval for site closure from NMED.

This document has been written to provide relevant information on the geologic, hydrologic, and other environmental conditions for HAFB and DP-63 as well as the procedures by which the VCM will be completed. Information is provided for HAFB and its surrounding environment as well as DP-63. This VCM Work Plan calls for the removal of PCS at the site through excavation, with verification of complete PCS removal via confirmation sampling from the excavation.

1.1 HAFB Site Description

HAFB is located in southeastern New Mexico in Otero County, New Mexico, approximately 100 miles north-northeast of El Paso, Texas and six miles west of Alamogordo, New Mexico (Figure 1). HAFB was first established in 1942 as Alamogordo Army Air Field (AAF). From 1942 through 1945, Alamogordo AAF served as the training grounds for over 20 different flight groups, flying primarily B-17s, B-24s, and B-29s. After World War II, most operations had ceased at the base. In 1947, Air Material Command announced the air field would be its primary site for the testing and development of un-manned aircraft, guided missiles, and other research programs. On January 13, 1948, the Alamogordo installation was renamed Holloman Air Force Base, in honor of the late Col. George V. Holloman; a pioneer in guided missile research. In 1968, the 49th Tactical Fighter Wing arrived at HAFB and has remained since. Today, HAFB also serves as the training center for the German Air Force's Tactical Training Center.

1.2 DP-63 Site Description

The DP-63 site is located in the northern portion of the Ammunition Storage Facility on the eastern side of HAFB (Figure 2). There are three disposal areas associated with DP-63. The total area of the DP-63 site is approximately 1,291 acres. Two separate disposal pits (East and West Areas) were originally identified by HAFB Explosive Ordnance Disposal (EOD) personnel. HAFB EOD personnel previously referred to DP-63 as the bomb dump. The North

Area location was identified during the preliminary assessment/site inspection (PA/SI) conducted by Foster Wheeler Environmental Incorporated (Foster Wheeler) in 2000. Originally, the disposal pit areas were located immediately north and outside of the facility, but during an expansion of the storage yard in the 1960s, DP-63 became part of the Ammunition Storage Facility (with the exception of the North Area).

Descriptions of the three disposal areas, according to the PA/SI are as follows:

- East Area: Located on the east side of DP-63, this site covers an area approximately 15,000 square feet and may contain several distinct disposal pits that extend to depths ranging from 6 to 8 feet below ground surface (ft bgs). Miscellaneous small arms (30 to 50-caliber cartridges and bullets) are scattered throughout the area on the land surface. During the PA/SI geophysical survey, an anomaly was detected in an area of subsurface disposal less than 2 ft bgs and containing the metallic equivalent of two or three 55-gallon drums.

- West Area: Located on the west side of DP-63, this small disposal feature covers an area up to 100 square feet and extends to a depth of 6 ft bgs. Miscellaneous small arms (30 to 50-caliber cartridges and bullets) are scattered throughout the area on the land surface. A shallow anomaly (<1 ft bgs) equivalent in metal content to a 55-gallon drum was detected during the PA/SI geophysical survey.

- North Area: Located on the north side of DP-63, this disposal feature covers an area of approximately 90,000 square feet and may extend to 6 ft bgs. Large amounts of scrap metal and munitions debris are scattered throughout the area on the land surface. A geophysical anomaly equivalent in metallic content to five or more 55-gallon drums coincides with a high concentration of scrap metal and fragments at the surface. A low berm (approximately 6 inches high) surrounds the area.

1.3 Physiography

HAFB is located within the Sacramento Mountains Physiographic Province on the western edge of the Sacramento Mountains. HAFB is approximately 59,600 acres in area, and is located at a mean elevation of 4,093 feet above mean sea level (amsl). The region is characterized by high tablelands with rolling summit plains; cuesta-formed mountains dipping eastward and of west-facing escarpments with the wide bracketed basin forming the basin and range complex. The Base is located in the Tularosa Sub-basin which is part of the Central Closed Basins. The San Andres Mountains bound the basin to the west (about 30 miles) with the Sacramento Mountains approximately 10 miles to the east. At its widest, the basin is about 60 miles east to west and stretches approximately 150 miles north to south.

The ground surface at DP-63 is relatively flat and sparsely covered with native vegetation.

1.4 Surface Water

The Tularosa Basin contains all of the surface flow in its boundaries. The nearest inflow of surface waters to the Base comes from the Lost River, located in the north-central region of the Base. The upper reaches of the Three Rivers and the Sacramento River are perennial in the basin. HAFB is dissected by several southwest trending arroyos that control the surface drainage. Hay Draw arroyo is located in the far north. Malone and Rita's Draw, which drain into the Lost River, and Dillard Draw arroyos are located along the eastern perimeter of the Base. Approximately 10,000 years ago, indications are of a much wetter climate. The present day Lake Otero encompassed a much larger area, possibly upwards of several hundred square miles. Its remains are the Alkali Flat and Lake Lucero. Lake Lucero is a temporary feature of merely a few inches in depth during the rainy season.

Ancient lakes and streams deposited water bearing deposits over the older bedrock basement material. Fractures, cracks, and fissures in the Permian and Pennsylvanian bedrock yield small quantities of relatively good quality water in the deeper peripheral. Potable water is only found from a handful of wells near the edges of the basin with more saline water towards the center. Two of the principal sources of potable water are a long narrow area on the upslope sides of Tularosa and Alamogordo with the other in the far southwestern part of the basin. Alamogordo's water, as well as the Base's, is supplied from Lake Bonito (which is in the Pecos River Basin).

There are no apparent surface water features at DP-63. The area is relatively flat with a slightly discernable slope to the east. Dillard Draw is the closest surface water feature, located approximately one-half mile to the east of DP-63. Ritas Draw is located to the northwest, approximately 1 mile.

1.5 Groundwater

The predominance of the groundwater occurs as an unconfined aquifer in the unconsolidated deposits of the central basin, with the primary source of recharge as rainfall percolation and minor amounts of stream run-off along the western edge of the Sacramento Mountains. Surface water/rainfall migrates downward into the alluvial sediments at the edge of the shallow aquifer near the ranges, and flows downgradient through progressively finer-grained sediments towards the central basin. Because the Tularosa Basin is a closed system, water that enters the area only leaves either through evaporation or percolation. This elevated amount of percolation results in a fairly high water table. Beneath HAFB, groundwater ranges from 5 to 50 feet. Flow for the Base is generally towards the southwest with localized influences from the variations in the topography of the Base. Near the arroyos, groundwater flows directly toward the surface drainage feature.

The approximate depth to the water table at DP-63 is reported at 41 ft bgs (bgs) in the West Area to 46 ft bgs in the East Area. These measurements were taken from temporary wellpoints installed in these two areas. Therefore, an accurate direction of groundwater flow in the area of DP-63 cannot be readily determined.

1.6 Climate

As a whole, New Mexico has a mild, arid to semi-arid continental climate characterized by light precipitation totals, abundant sunshine, relatively low humidity, and relatively large annual and diurnal temperature range (Western Regional Climate Center (WRCC), 2003). The climate of the Central Closed Basins varies with elevation. The Base is found in the low areas and is characterized by warm temperatures and dry air. Daytime temperatures often exceed 100 degrees Fahrenheit (°F) in the summer months and are in the middle 50s in the winter. A preponderance of clear skies and relatively low humidity permits rapid night time cooling resulting in average diurnal temperature ranges of 25 to 35°F. Potential evapotranspiration, at 67 inches per year, significantly exceeds annual precipitation, usually less than 10 inches (Foster Wheeler/Radian, 1995). The very low rainfall amounts resulting in the arid conditions, which with the topographically induced wind patterns combining with the sparse vegetation, tend to cause localized "dust devils". Much of the precipitation falls during the mid-summer monsoonal period (July and August) as brief, yet frequent, intense thunderstorms culminating to 30 – 40% of the annual total rainfall.

1.7 Geology

The sedimentary rocks which make up the adjacent mountain ranges are between 500 and 250 million years old (White Sands Missile Range (WSMR), 2003). During the period when the area was submerged under the shallow intra-continental sea, the layers of limestone, shale, gypsum, and sandstone were deposited. In time, these layers were pushed upward through various tectonic forces forming a large bulge on the surface. Approximately 10 million years ago the center began to subside resulting in a vertical drop of thousands of feet leaving the edges still standing (the present day Sacramento and San Andres mountain ranges). In the millions of years following, rainfall, snowmelt, and wind eroded the mountain sediments depositing them in the valley (i.e. Tularosa Basin). Water carrying eroded gypsum, gravel, and other matter continues to flow into the basin.

As the Tularosa Basin is a bolson, which is a basin with no surface drainage outlet, sediments carried by surface water into a closed basin are bolson deposits. The overlying alluvium generally consists of unconsolidated gravels, sands, and clays. Soils in the basin are derived from the adjacent ranges as erosional deposits of limestone, dolomite, and gypsum. A fining sequence from the ranges towards the basin's center characterizes the area with the near surface soils as alluvial, eolian, and lacustrine deposits. The alluvial fan deposits are laterally discontinuous units of interbedded sand, silt, and clay while the eolian deposits consist primarily of gypsum sands. The eolian and alluvial deposits are usually indistinguishable due to the reworking of the alluvial sediment by eolian processes. The playa, or lacustrine deposits, consist of clay containing gypsum and are contiguous with the alluvial fan and eolian deposits throughout HAFB. There has been the identification of stiff caliche layers, varying in thickness, at different areas of the Base. At the site, soils are predominantly silty sands and interbedded clays.

The area of DP-63 is underlain by silts, clays, and silty clays that contain an abundance of gypsum crystals within the unsaturated vadose zone. The lithologies are laterally discontinuous over the distance between the West and East Areas.

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2 HISTORICAL DATA REVIEW

Three disposal areas (East Area, West Area, and North Area) are associated with DP-63 (Figure 2). Two of the three areas were reported by HAFB EOD personnel as the bomb dump. During past operations, munitions were placed into the disposal pits. Diesel fuel and wood pallets were added to the pits and ignited to incinerate the charges and render the ordnance inert.

2.1 Preliminary Assessment/Site Inspection

Foster Wheeler conducted interviews with base personnel, performed a records search, and conducted a geophysical survey of the three disposal areas to determine the presence of buried metal debris and other potential sources during the PA/SI conducted in 2000. Three areas were investigated within DP-63 during the PA/SI field activities: East Area, West Area, and North Area. The North Area was discovered as a potential disposal site during this investigation.

Geophysical surveys were performed in each area to locate and determine the extent of any buried metal debris. Based on the records search, a review of utility data, and the geophysical survey, four direct push technology (DPT) sampling locations were selected in the West and East Areas. Subsurface soil samples were collected from these four DPT borings in order to assess the impact of site activities at DP-63 on the soil, and impacts to groundwater through leaching from the surrounding soil.

Results of the PA/SI were presented in the *Final Report for Preliminary Assessment/Site Inspection of DP-63-Disposal Pit 63,* by Foster Wheeler dated January 2001. Analytical results presented in Tables 2-1, 4-1, 4-2, and 4-3 of the PA/SI report, along with Figure 4-1 showing the soil boring locations and the boring logs, are included as Appendix A.

2.1.1 Soil Boring Samples

Subsurface soil samples were collected at three distinct depths at each soil boring location. The deepest samples from these boring locations were collected below the soil-water interface. Analytical results for the subsurface soil samples collected at DP-63 showed detections of total petroleum hydrocarbons (TPH), volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), cyanide, polychlorinated biphenyls (PCBs), pesticides, explosives, and Target Analyte List (TAL) metals (totals). Data reported in the PA/SI are results that were validated using U.S. Environmental Protection Agency (USEPA) protocols as presented in Appendix A of that report. Many VOC and SVOC constituents were reported as estimated values and were rejected during the data validation. The only VOC concentrations reported in samples from location DP02 were also detected in the associated blanks. Therefore, these results were not presented in the PA/SI.

2.1.1.1 Total Petroleum Hydrocarbons

TPH was detected in each sample except for three of the shallowest soil samples. TPH concentrations reported ranged from 37.7 milligrams per kilogram (mg/kg) to a maximum of 263 mg/kg. This level is below the allowable NMED Soil Screening Level (SSL) for jet fuel of 940 mg/kg and diesel fuel of 880 mg/kg for residential soils (Appendix B). Generally, concentrations of TPH increased with depth.

2.1.1.2 Volatile Organic Compounds

VOCs were detected in soil samples from locations DP01, DP03, and DP04. The only benzene, toluene, ethylbenzene, and xylenes (BTEX) constituent detected was toluene at two locations. Toluene concentrations ranged from 308 micrograms per kilogram (µg/kg) in the sample collected from DP03 at 12 to 13 feet bgs, to 440 µg/kg in the sample duplicate collected from 44 to 45 feet bgs at location DP01. Carbon disulfide and 2-butanone were detected in two samples collected. At location DP01, they were detected at 4,497 µg/kg and 1,526 µg/kg, respectively, in the sample from 44 to 45 feet bgs and in the duplicate at 8,876 µg/kg and 4,356 µg/kg, respectively. At location DP03, carbon disulfide and 2-butanone were detected in each of the three samples. In the sample collected from 12 to 13 feet bgs, they were detected at 7,904 µg/kg and 2,705 µg/kg, respectively. In the sample collected from 21 to 22 feet bgs, carbon disulfide was detected at 7,406 µg/kg and 2-butanone was detected at 2,752 µg/kg. In the deepest sample collected, 45 to 46 feet bgs, carbon disulfide and 2-butanone were detected at 7,242 µg/kg and 2,946 µg/kg, respectively. Concentrations of each VOC detected were not above the NMED respective SSL for residential soils.

2.1.1.3 Semi-Volatile Organic Compounds

Two SVOC constituents were reported above detection limits: diethyl-phthalate and bis (2-ethylhexyl) phthalate. None of these constituents were detected at concentrations above the NMED SSLs for residential soils.

In the East Area, in the sample collected from location DP03 from 12 to 13 feet, diethyl-phthalate and bis (2-ethylhexyl) phthalate were detected at concentrations of 750 µg/kg and 1,500 µg/kg, respectively. Diethyl-phthalate was also detected at a concentration of 100 µg/kg in the sample collected from 45 to 46 feet bgs.

2.1.1.4 PCBs and Pesticides

PCBs and pesticides were not detected in any of the soil samples analyzed.

2.1.1.5 Metals

In the PA/SI, concentrations of metals were compared to background levels established for HAFB. These levels were presented in the *Basewide Background Study – Sewage Lagoons and Lakes Characterization Report*, Radian Corporation, 1993. The background level for metals at

DP-63 were determined as the 95 percent upper tolerance limit (UTL) for data collected in areas of HAFB that have not been impacted by site activities.

Aluminum was detected at a concentration of 19,600 mg/kg which is above the background of 8,760 mg/kg in the sample collected from 20 to 21 feet bgs at location DP04. This was the only sample in which aluminum was above the established background. Arsenic was also above the background concentration in this sample. It was detected at 7.3 mg/kg which is above the background of 6.88 mg/kg.

Barium was detected in four samples above the background of 84.4 mg/kg, two from location DP04; 227 mg/kg in the sample from 20 to 21 feet bgs and 120 mg/kg in the sample from 44 to 45 feet bgs. The remaining samples were DP01 from 44 to 55 feet (94.4 mg/kg) and DP02 from 46 to 47 feet bgs (334 mg/kg).

Beryllium was detected at a concentration of 1.3 mg/kg in the sample from 20 to 21 feet bgs at location DP04, which is above the background of 0.40 mg/kg. Cobalt was detected above its background limit of 2.49 mg/kg in the sample collected from 46 to 47 feet bgs at location DP02. The concentration of cobalt in this sample was 75.7 mg/kg.

The established background for chromium is 6.60 mg/kg; however, chromium was detected in four samples above this concentration. At location DP01, it was reported at a concentration of 7.4 mg/kg in the sample collected from 44 to 45 feet bgs. In the sample collected from 20 to 21 feet bgs at location DP04, it was detected at a concentration of 22.4 mg/kg. At location DP02, it was reported in two samples: 7.3 mg/kg in the sample from 17 to 18 feet bgs and 8.3 mg/kg in the sample from 46 to 47 feet bgs.

Copper was reported above the background of 4.84 mg/kg in four samples collected from three locations. At location DP02, it was reported at 21.2 mg/kg in the sample from 46 to 47 feet bgs. In the sample collected from 21 to 22 feet bgs at location DP03, it was reported at 6.2 mg/kg. In two samples from DP04, 20 to 21 feet bgs and 44 to 45 feet bgs, copper was detected at concentrations of 13.6 mg/kg and 4.9 mg/kg, respectively.

Background for iron at HAFB is established at 6,360 mg/kg. Concentrations of iron in three samples from two locations exceeded this concentration. In the sample from 46 to 47 feet bgs at location DP02, iron was reported at 8,890 mg/kg. At DP04, it was reported as 17,800 mg/kg in the sample from 20 to 21 feet bgs and 8,050 mg/kg in the sample from 44 to 45 feet bgs. Also at this location in these samples, nickel was reported at 19.5 mg/kg and 7.3 mg/kg, respectively. Nickel was also reported in this DP02 sample above the background of 5.61 mg/kg. It was reported at 33.2 mg/kg.

Concentrations of lead were above the background of 8 mg/kg in samples from two locations, DP02 and DP04. Lead was reported at 10.5 mg/kg in the sample from 46 to 47 feet bgs and 12.3 mg/kg in the sample from 20 to 21 feet bgs.

At location DP02, manganese was reported above the background of 165 mg/kg at 4,930 mg/kg in the sample from 46 to 47 feet bgs. In the sample from 20 to 21 feet bgs at location DP04, manganese was reported at a concentration of 308 mg/kg.

Potassium was reported above the background of 2,500 mg/kg in the sample from DP04 at 20 to 21 feet bgs. It was detected at a concentration of 3,700 mg/kg.

The established background for vanadium is 15.5 mg/kg. The concentration was exceeded in three samples from two locations. At DP02, it was reported at 45.9 mg/kg in the sample collected at 46 to 47 feet bgs. In the sample collected from 20 to 21 feet bgs at DP04, it was reported at 37.3 mg/kg and in the sample collected from 44 to 45 feet bgs, vanadium was reported at 38.4 mg/kg.

Zinc was reported above the background concentration of 20.2 mg/kg in the sample from 46 to 47 feet bgs at location DP02. It was reported at 22.1 mg/kg. At DP03, it was reported at 29 mg/kg in the sample from 21 to 22 feet bgs. For DP04, zinc was reported in two samples: 20 to 21 feet bgs and 44 to 45 feet bgs. The concentrations were reported as 58.4 mg/kg and 22.8 mg/kg, respectively.

2.1.2 Groundwater Samples

Analytical results confirmed that groundwater samples at DP-63 contained no explosives and that free-phase fuel was not observed at any groundwater sampling locations; however, the presence of organic constituents in the saturated soil samples that were collected indicates that groundwater may potentially be impacted by dissolved constituents. The North Area Disposal Pit was not found until after the soil and groundwater sampling for the East and West Area was conducted; therefore, no analytical samples were collected from the North area during the PA/SI.

2.2 Remedial Investigation

Foster Wheeler conducted a Remedial Investigation (RI) of the three disposal areas at DP-63 in 2002. DPT borings were advanced at 15 locations and five monitoring wells were installed. Results of the field work, the human health risk assessment, and the ecological risk assessment were presented in the *Draft Report for the Remedial Investigation of DP-63 – Disposal Pit 63*, (draft RI), Foster Wheeler, December 2002.

2.2.1 Nature and Extent of Contamination

The evaluation of the nature and extent of contamination of the three disposal areas presented in the draft RI was based on the results presented in the PA/SI, field observations, and analytical results from the groundwater/soil samples collected during the RI. A copy of Section 5 from the draft RI, associated figures, and associated data tables are attached as Appendix C.

2.2.1.1 Soils

A total of 15 surface soil and DPT soil boring locations were selected to assess the presence and extent of soil impacts from past site activities. Eight of the borings were shallow and were completed to depths of 21 feet below ground surface (bgs). Seven borings were deep borings that extended below the water table. Total depths of these borings ranged from 48.5 feet to 58.5 feet bgs. Three of the deep borings were completed with temporary piezometers to establish the hydraulic gradient. Soil samples were analyzed for VOCs, SVOCs, explosives, TAL metals, cyanide, and TPH as oil-range organics (ORO), diesel-range organics (DRO), and gasoline-range organics (GRO).

Surface soil samples were collected at each of the DPT soil boring locations, with the exception of SS09 and DP11. DP11 did not have a corresponding surface soil sample.

Three borings were completed in the West Area, six borings were completed in the East Area, and six borings were completed in the North Area. Soil samples were collected from depths of approximately 4 to 5 feet bgs, 9 to 10 feet bgs, 20 to 25 feet bgs, and 43 to 48 feet bgs. Based on interviews with facility personnel, the pits were reported as being 6 to 10 feet deep. Therefore, the 4 to 5-foot samples and the 9 to 10-foot samples were collected to bracket the pit depth. Samples were collected from the 20 to 25-foot interval because this was half the distance to groundwater. The remaining interval, 43 to 48 feet bgs, was selected based on the depth to groundwater and the potential presence of contamination at the capillary fringe. A total of 67 samples were collected.

Total Petroleum Hydrocarbons

Petroleum hydrocarbons were detected in samples collected from each of the study areas, from surface soils down to 21 feet. Ten samples contained concentrations of TPH; however, concentrations were not above the action level of 940 mg/kg in any of the samples analyzed. Concentrations of ORO, DRO, and GRO ranged from 0.068 mg/kg to 390 mg/kg.

The highest concentration detected in a sample from the East area was 0.16 mg/kg as GRO in the sample collected from 0 to 0.5 feet at location DP06. In the West Area, the highest concentration was a total of 530 mg/kg, with 140 mg/kg ORO and 390 mg/kg DRO, detected in the sample collected from 20 to 21 feet bgs at location DP12. For the North Area, the highest concentration was a total of 7.6 mg/kg. DRO was detected at a concentration of 7.5 B mg/kg in the sample collected from 0 to 0.5 feet bgs at location DP19, and GRO was detected in this sample at a concentration of 0.076 mg/kg.

Volatile Organic Compounds

Methylene chloride was detected in three surface soil samples collected in the East Area: DP07, DP08, and DP09. Concentrations were 3.8 mg/kg, 2.8 mg/kg, and 2.5 mg/kg, respectively. Each reported detection was qualified with a "B", indicating that the analyte was also detected in the laboratory method blank.

Semi-Volatile Organic Compounds

Two SVOCs were detected in the soil boring samples. Bis (2-ethylhexyl) phthalate and diethyl-phthalate were detected in eight soil samples collected from the North, East, and West Areas. The detection of bis (2-ethylhexyl) phthalate was also in the method blank which suggested laboratory contamination. Foster Wheeler also suggested that the presence of diethylphthalate was the result of cross contamination from the disposable sampling tools and the acetate sleeves from the DPT samplers.

Cyanide

Cyanide was above detection limits in two samples: The 24 to 25-foot sample at location DP08 and the 4 to 5-foot sample at location DP09. Concentrations were 0.199 B mg/kg and 0.266 B mg/kg, respectively.

Metals

In soil samples collected during the RI, each of the 20 metals analyzed for was detected. Seventeen of these metals were detected above background values established for HAFB: aluminum, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, potassium, sodium, vanadium, and zinc. Soil samples where these background concentrations were exceeded, were collected from either the surface soils or the deeper horizons, 19 feet to 25 feet or 39 feet to 48 feet. Metal concentrations in soils collected from the depths of 4 feet to 5 feet or 9 feet to 10 feet did not exceed background values.

Concentrations of metals appeared to increase with depth. The distinguishing feature between the shallow and deeper soils is lithology. The shallow soils are predominantly sand while the deeper soils are predominantly clay. In the case of aluminum, the average concentration increased from 2,849 mg/kg in the shallow soils to 11,835 mg/kg in the deeper soils. Foster Wheeler calculated correlation coefficients to relate the increased clay content with depth to the increase in metals concentrations. Positive correlations with aluminum were obtained for barium, chromium, cobalt, iron, magnesium, manganese, potassium, thallium, and vanadium for the entire set of samples collected. Aluminum correlated positively with barium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, potassium, sodium, vanadium, and zinc for the deeper soil horizons. The results indicated that with increased clay content, most metal concentrations increase, either due to incorporation into the clay structure or absorption onto the surface of the clay minerals.

2.2.1.2 Groundwater

Five monitoring wells were installed to assess the groundwater quality in the North and East Areas. An upgradient well was installed to establish background concentrations for the site. This well was placed northeast of the North Area. Two monitoring wells installed corresponded to the two deep borings with the temporary piezometers. One well was completed inside the North and the East Areas. The remaining two monitoring wells were installed 200 feet to 250

feet down gradient of the North and East Areas. Groundwater samples collected were analyzed for VOCs, SVOCs, explosives, TAL metals, and total dissolved solids (TDS).

Volatile Organic Compounds

VOCs detected in groundwater samples included acetone, benzene, carbon disulfide, chloroform, ethylbenzene, and xylenes. Of the VOCs detected, only benzene exceeded the New Mexico Water Quality Control Commission (NMWQCC) standards. In the sample collected from MW02, benzene was reported at a concentration of 15 micrograms per liter (μg/L).

Semi-Volatile Organic Compounds and Explosives

No SVOCs or explosive constituents were above detection limits in any of the groundwater samples collected at the site.

Total Dissolved Solids

TDS concentrations in all the groundwater samples collected exceeded the NMWQCC standard of 1,000 mg/L and was above the 10,000 mg/L for potable water. TDS ranged from 17,600 mg/L to 22,800 mg/L. The sample collected from the upgradient monitoring well contained 20,400 mg/L TDS.

Metals

NMWQCC standards were exceeded for two metals detected in groundwater samples. Iron concentrations ranged from 1.02 milligrams per liter (mg/L) to 2.53 mg/L, which was above the standard of 1.0 mg/L. The lowest concentration of iron, 1.02 mg/L, was detected in the sample collected from MW05 which is located downgradient of the East Area. The highest concentration of iron, 2.53 mg/L, was detected in the sample from MW04 located in the East Area.

Manganese was the second metal detected at a concentration above the NMWQCC standard of 0.2 mg/L. The lowest concentration of manganese was detected in the sample from the upgradient well, MW01, at a level of 0.604 mg/L. The highest concentration was detected in the sample collected from the North Area well, MW02. Manganese was reported at a concentration of 2.2 mg/L.

In the draft RI, Foster Wheeler attributed the elevated levels of metals in the groundwater to the saline conditions of the upper water-bearing zone and the high turbidity associated with a saturated zone comprised mainly of fine sand and sandy silts with some clays.

2.3 Previous MEC Clearances and Magnetic Survey

There had been no previous Munitions and Explosives of Concern (MEC) surface or subsurface sweeps performed in the three areas of concern. There currently remains a large amount of small

arms casings in the East and West Areas, and a large amount of munitions debris on the surface in all three areas.

A geophysical survey of each of the three areas was performed during the PA/SI in 2000. The objective of the geophysical investigations at the East Area, West Area, and the North Area was to detect, locate, and characterize the extent of metal debris associated with the suspected munitions disposal site. Results of the geophysical investigation were presented in the PA/SI report (Foster Wheeler, January 2001) and are attached in Appendix D.

2.4 Remedial Action for MEC Removal

A Remedial Action (RA) for MEC removal will be conducted prior to the implementation of this VCM Work Plan. The purpose of the RA is to detect, identify, and remove Discarded Military Munitions (DMM) within the three areas at DP-63. The types of DMM included munitions ranging from 20 caliber small arms to grenades. Currently, the ground surface of all three areas is littered with metal fragments and casings that have been exposed as a result of erosion.

The MEC removal action will be conducted on the three suspected munitions disposal pits. This will entail locating the three areas, performing a surface sweep, and removing subsurface munitions debris by excavating each disposal pit, and identifying and disposing of all MEC (surface and subsurface) within the footprint of the disposal pits. Additionally there may be excavation of subsurface anomalies following a geophysical survey that will be performed by the Omaha District USACE. Based on the results of an Anomaly Review Board (ARB), there may be intrusive investigation of selected anomalies. The RA will be conducted in accordance with the *Remedial Action-Construction Work Plan MEC Removal at Disposal Pits 63 (DP-63),* Bhate Environmental Associates, Inc. and USA Environmental Inc., August 2005. The intended RA is summarized below.

2.4.1 Surface Clearance

A visual surface clearance will be performed by the unexploded ordnance (UXO) team prior to the excavation of each disposal pit. Surface clearance will be performed within 100 feet surrounding each of the three disposal pits. If there any MEC, Military Debris, or Material Potentially Presenting an Explosive Hazard (MPPEH) located within the 100-foot boundary, than an additional 50 feet will be cleared. If at the increased sweep area more MEC, Military Debris, or MPPEH are located, the procedure will be repeated until no MEC, Military Debris, or MPPEH is found on the surface.

2.4.2 Subsurface Investigation

Under the RA, an investigation will be conducted of the subsurface metallic contacts to the depth determined to be undisturbed soil. The excavation will be accomplished by utilizing earth moving machinery (EMM). Soil excavated from each disposal pit will be mechanically screened. EMM identified for this task will be armored to United States Army Engineering and

Support Center Huntsville (USAESCH) specifications to ensure operator personnel protection from unintentional detonation.

2.4.3 Subsurface Excavation of DP-63 Disposal Pits

Excavation of the three disposal pits will be performed using a Tractor-Accessorized Zierrist (TAZ) on a Caterpillar 325BL carrier. Soil from each disposal pit will be excavated using the dimensional bucket. Soil from each excavation will be placed in an area established to contain the soils from the excavation. Throughout the excavation activity, the TAZ will be reconfigured to utilize a Trommex head. The Trommex head is a screening mechanism with a rotating head. Screening of soils will be performed in a separate location in order to keep the screened soil separate from the soils to be screened. After each cycle, the remaining contents will be placed in a separate location for inspection and separation of MEC, Military Debris, MPPEH, or other material (rocks, vegetation etc.) for inspection and separation by qualified UXO technicians.

Once all the material of concern has been removed from the disposal pit, the disposal pit will be checked using a Schonstedt GA-52CX and/or the White Eagle Spectrum to check that all metallic material has been removed.

2.4.4 Intrusive Investigation of Selected Anomalies

Based on the findings of the geophysical survey performed by the Omaha District USACE and comments of the ARB, the UXO Team will locate suspected anomaly locations identified for investigation. Anomaly locations will be located using Trimble Pro XR GPS (sub-meter accuracy). The planned approach is to locate the selected subsurface anomalies and excavate the anomalies to a depth of no greater than one foot. Once the anomaly has been removed, the UXO Team will recheck the excavation to ensure that the target anomaly has been removed.

After the probable source of the anomaly is identified and removed, an approved geophysical instrument should be used to validate the process. If the Schonstedt GA-52CX, and/or the White Eagle Spectrum do not continue to detect an anomaly, then the excavation may be back-filled and restored.

2.4.5 Removal and Disposal of Scrap Metal

Within or adjacent to the disposal pit areas, the UXO Team will establish temporary MPPEH and small arms collection points. During operations, items that are free of explosive contamination will be placed into these collection points. MEC or MPPEH items that require venting to determine if they are explosives free will be included in demolition operations to be performed by the Base EOD Unit. Upon completion of daily operations in that disposal pit area, the material in these temporary collection points will be collected and a second inspection will take place. Once this inspection is complete, the MPPEH will be transported to locked containers located at the site within the Munitions Storage Facility. MPPEH that is determined free from explosives will be annotated in the Daily Operations Summary and include a description of the material that is free from explosives.

At project completion, or when on-site scrap containers are full, the scrap will be sent to the Defense Reutilization and Marketing Office (DRMO) or a local scrap dealer for disposal.

3 VCM ASSESSMENT SAMPLING

Work conducted under this VCM Work Plan will be conducted in a phased approach. The first phase is to collected additional soil boring samples from the East, West, and North Areas to further investigate the impacts of past site practices. Once this has been completed, if results from the soil boring samples indicate significant impacts to the area from TPH, VOCs, SVOCs, and/or metals, then the second phase, soil excavation, will be conducted.

Sampling activities for DP-63 have been designed to augment information from the original site PA/SI . The following activities will be performed:

- Collect soil samples to characterize the presence of constituents within the three areas of DP-63
- Analyze the soil samples for VOCs, SVOCs, TPH, and TAL metals
- Install three additional groundwater monitoring wells
- Analyze groundwater samples for VOCs, SVOCs, TPH, and TAL metals
- Perform physical survey of soil borings and monitoring wells with survey grade Global Positioning System (GPS)

The following subsections provide detailed descriptions for completing each activity.

3.1 Pre-Sampling Activities

Prior to the initiation of any sampling activities, Air Force Form (AF Fm) 332 and utility clearance permitting will need to be completed.

3.1.1 AF Form 332

AF Fm 332, included as Appendix E, authorizes construction work at HAFB and is required for the initiation of any construction work. This work order will describe the activities to take place at the location. Also, the AF Fm 332 is the mechanism by which the utility clearance/dig permit is authorized. Both the AF Fm 332 and dig permit will be reviewed by the appropriate HAFB utility group for approval prior to the initiation of work. Prior to the submittal of AF Fm 332, the locations of the soils borings and monitoring wells will be clearly identified with marker flags, stakes, or paint, as appropriate to the surface material.

3.1.2 Dig Permit/Utility Clearances

As noted above, utility clearance approvals will need to be completed by the appropriate HAFB utility office. Upon receipt of the approved dig permit with the utility clearances, the Bhate Site

Manager or other authorized project personnel will complete a site walk-through confirming the dig permit authorizations and make any required changes.

Any utilities adjacent to the planned excavation boundary noted during the site reconnaissance will be properly identified and located. All necessary measures to secure the utility from potential damage and/or service interruption will be implemented prior to excavation.

3.2 DPT Soil Assessment

The field work for the VCM will be conducted in accordance with HAFB Standard Operating Procedures (SOPs) provided in the *Basewide Quality Assurance Project Plan* (QAPP) (Bhate, November 2003). These SOPs outline methodologies for soil boring advancement, soil sampling, soil sample description, field screening, sample management, equipment decontamination, and chain-of-custody procedures.

Nine DPT soil borings (Figure 2) will be advanced at the site to an anticipated depth of 48 feet bgs to groundwater using DPT methodology in accordance with HAFB SOP No. 4. Continuous soil samples will be collected from these borings with lithologic descriptions per HAFB SOP No. 7. A total of 29 soil samples, including two field duplicate samples, will be submitted to the laboratory for analysis. The samples will be placed on ice and shipped under strict chain-of-custody to Acutest Laboratories located in Orlando, Florida.

Soils will be field screened in accordance with HAFB SOP No. 6 using an organic vapor analyzer (OVA) utilizing soil-headspace screening techniques. Notation will also be made of any visual (discoloration) and/or aromatic indicative of potential contamination.

Based on headspace screening results, three soil samples from each soil boring with the highest OVA readings will be selected for laboratory analyses. Should the screening not identify one or more intervals in which to select, then the lower most interval at the soil-water interface, a mid-range sample, and uppermost, or single OVA detection shall be retained for laboratory analysis.

3.3 Groundwater Assessment

During the PA/SI, groundwater samples were collected, observed for the presence of free product, and analyzed for explosives. Analyses conducted during the RI included explosives but also VOCs, SVOCs, TAL metals, and TDS. Monitoring wells were not installed in the West Area during the RI. The proposed locations of the new wells are shown on Figure 3. Two wells will be installed in the West Area, and one will be installed side-gradient of MW02, in the North Area.

3.3.1 Monitoring Well Installation

Three permanent monitoring wells will be installed in DP-63 based on information obtained from the RI. The wells will be advanced and installed using hollow stem auger (HSA) drilling

technology. The monitoring wells will be constructed of 2-inch Schedule (SCH) 40 polyvinyl chloride (PVC) casing and screen with a slot opening of 0.10 inch. The portion of Bhate Standard Operating Procedure (BSOP) No. 10, *Subsurface Water Investigation*, regarding well construction and development is provided in Appendix F of this VCM Work Plan. The wellpoints will be located and elevations taken using GPS.

Continuous soil samples will be collected from these borings with lithologic descriptions per HAFB SOP No. 7. Since one of the DPT locations will be completed as a monitoring well, only two samples, one from each of the remaining monitoring wells (plus one duplicate), will be submitted to the laboratory for analysis, making a total of three soil samples. Soil samples will be placed on ice and shipped under strict chain-of-custody to Accutest Laboratories in Orlando, Florida.

3.3.2 Groundwater Sampling

The three new monitoring wells and the five existing monitoring wells will be sampled two times per year for a period of 2 years. A total of 10 groundwater samples, including one field duplicate sample and a matrix spike/matrix spike duplicate (MS/MSD) will be submitted to the laboratory for analysis from each sampling event. All samples for VOC analysis will require a trip blank. The samples will be placed on ice and shipped under strict chain-of-custody to Accutest Laboratories in Orlando, Florida.

3.4 Laboratory Analysis

During the sampling, a total of 32 soil samples (including the field duplicates) and 10 groundwater samples (including the field duplicate and MS/MSD) will be analyzed for VOCs by Method 8260B, SVOCs by Method 8270C, TPH by Method 8015M, and TAL metals by 6010B/7000 series. Each soil and groundwater sample (including the field duplicates) will be analyzed for their respective analytes in accordance with Table 3-1. Groundwater will also be analyzed for TDS by Method 160.1 and field filtration will be performed for the fraction of groundwater samples submitted for metals analysis.

Appendix G details the method detection limits by method for chemical constituents indicated for DP-63. Table 3-2 is a matrix indicating the analytical requirements for DP-63.

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4 EXCAVATION PROCEDURES

The objective of the soil excavation at DP-63 is to excavate, transport, and dispose of impacted subsurface soils that either have TPH levels exceeding 880 mg/kg (the NMED SSL for diesel-crankcase oil) or soils posing a risk due to exposure to VOCs, SVOCs, and/or metals as established by the NMED soil screening guidance. The depth of removal of contaminated soils will be based on the results of the DPT samples collected during the first phase of work under this VCM Work Plan. Horizontally, the excavation will be completed based upon TPH levels greater than 880 mg/kg as determined by confirmation soil samples collected from the excavation and analyzed by Accutest Laboratories.

The excavation activities will prescribe to the procedures outlined in Unified Facilities Guide Specifications (UFGS) Section 02111 *Excavation and Handling of Contaminated Material,* September 2003 (Appendix H). The UFGS are a joint effort of the USACE, the Naval Facilities Engineering Command (NAVFAC), and the Air Force Civil Engineer Support Agency (AFCESA). The UFGS are for use in providing construction specifications and guidelines for the military services.

4.1 Pre-Excavation Activities

The construction general permit requires a project *Storm Water Pollution Prevention Plan* (SWPPP) to be submitted for excavation sites which will disturb greater than one acre of surface soils.

Currently, should excavation of the areas be necessary, the total area of disturbance and/or excavation is estimated at 2.4 acres. As part of the construction SWPPP for the area, a site-specific Sediment Control Plan (SCP) will be required. The SCP and sediment control activities at the site will be developed in accordance with the *Draft Master Sediment Control Plan*, Bhate, September 2005.

4.1.1 AF FM 332 and Utility Clearance

Before excavation and other site activities can begin, pre-construction documents and approval requirements are necessary, including: AF Fm 332 approval, dig permit with utility clearances in accordance with Section 3.1, site security measures, and facility manager notification of the intended operations. Bhate will coordinate project requests for Base installation support services through the 49th Civil Engineering Squadron/Combat Engineer Vehicle (CES/CEV). Pertinent to the start of activities, a pre-construction meeting and site walk-through will be conducted with the USACE Resident Engineer, HAFB personnel, and the Bhate Site Manager to inspect site conditions for site/equipment access, equipment staging area(s), soil stockpile areas, potential site hazards, and emergency evacuation routes. Also reviewed at this time will be project procedures in accordance with the schedule and planned activities.

4.1.2 Geophysical Survey

A remedial action of DP-63 will be conducted in accordance with the *Remedial Action-Construction Work Plan MEC Removal at Disposal Pits 63 (DP-63),* Bhate Environmental Associates, Inc. and USA Environmental Inc., August 2005. An UXO surface sweep of all three areas will be conducted before any subsurface clearance operations are conducted during the remedial action. Once the remedial action is completed, USACE Omaha Division will conduct a geophysical survey of the area to verify the removal of munitions debris and any MEC prior to the implementation of this VCM Work Plan.

4.2 Decontamination Procedures

Small equipment, such as sampling tools, will be decontaminated in accordance with the Basewide QAPP (Bhate, November 2003). Heavy equipment, such as the DPT rig, backhoe, trackhoe, etc., will be decontaminated at a temporary decontamination pad set up at the site.

4.3 Excavation Activities

4.3.1 Excavation Boundary

The approximate limit of the area to be excavated will be determined from the first phase of investigative activities outlined under this VCM Work Plan. After the first phase is completed, the horizontal extent of contamination and amount of overburden required to be removed will be estimated. This material will be directly loaded into a dump truck for immediate delivery to the FT-31 Landfarm for treatment or stockpiling.

4.3.2 Soil Excavation

Excavation activities will utilize the appropriate excavation equipment and a wheel loader to assist with soil management. Overburden soils may be stockpiled onsite or directly loaded into a dump truck and hauled to the FT-31 overburden stockpile. Soil (backfill) stockpiles will be managed as to not allow for any material to be removed or transported off-site via wind or precipitation (see Section 7 of this VCM Work Plan, *Waste Management*).

Contaminated soils will be directly loaded and transported to the FT-31 Landfarm for management. Applicable procedures and safety measures for completing the excavation are located in the *Basewide Health and Safety Plan* (Bhate, December 2003). Applicable HAFB SOPs for completing the sampling associated with this excavation are located in Appendix A of the Basewide QAPP (Bhate, November 2003).

4.3.2.1 Soil Screening

Throughout the excavation, observation of MEC will be conducted. At any sign of MEC, the operations will cease and the appropriate HAFB personnel will be notified as described in the

Remedial Action-Construction Work Plan MEC Removal at Disposal Pits 63 (DP-63) (Bhate USA Environmental Inc., August 2005). Once the all clear is given, excavation of soils will continue.

Discoloration and unusual odors of soils will be documented. Potential PCS will be field screened for petroleum hydrocarbon contamination using the SiteLAB® Analytical Test Kit Ultraviolet Fluorometer (UVF) 3100A in accordance with the U.S. Environmental Protection Agency (USEPA) Innovative Technology Verification Report: *Field Measurement Technologies for Total Petroleum Hydrocarbons in Soil* guideline, attached as Appendix I. Excavated soil will be segregated in the field based on visual observation, headspace readings, and onsite analysis of TPH with laboratory confirmation. Soils that demonstrate a field screened TPH concentration above 880 mg/kg exceed the action limit for PCS and will be managed in accordance with Section 7 of this Work Plan. Soils demonstrating a concentration below 880 mg/kg will be stockpiled for backfill once the excavation is complete. Excavation sampling quantities and analyses are summarized in Table 4-1.

The field screening incorporates the initial screening for the segregation of the excavated soils between contaminated and un-contaminated and the corresponding Quality Assurance/Quality Control (QA/QC) confirmation and validation analyses. The soil screening is comprised of three phases: 1) initial field screening, 2) field confirmatory, and 3) laboratory validation. These steps are detailed in Section 5, *Soil Sampling and Analysis,* of this Work Plan.

4.3.2.2 Soil Segregation

The 880 mg/kg action level for PCS is found listed in Table 2 of the residential direct exposure limit for diesel fuel in the *NMED TPH Screening Guidelines*, June 24, 2003 (Appendix J). This cleanup level is part of a previous agreement between HAFB and NMED. The concentrations for the TPH carbon fractions will be summed for the total TPH value as the comparison to the NMED TPH allowable limit of 880 mg/kg for diesel contaminated PCS.

The un-impacted soils are the overburden soils which have historically demonstrated no contamination and the source of the contamination is not from past activities. These soils will be determined during the first phase of work conducted under this VCM Work Plan. Suspected contaminated soils are those primarily within the smear zone. These are typically contained in a 1 to 2 foot zone above the contaminated soils. The contaminated soils are those that are definitively contaminated as validated by laboratory analytical data. Suspected contaminated soils will be handled as though they are contaminated, directly loaded, and transported to the FT-31 Landfarm for treatment or stockpiling.

4.3.2.3 Confirmation Soil Sampling

After the excavation is complete and suspected petroleum contaminated soils have been removed, sidewall confirmation samples will be collected. Samples will be collected using the bucket of the back-hoe. A soil sample will be obtained from the interior of the bucket to minimize the potential for outside source contamination. Samples will be collected at a

frequency of 1 per 20 linear feet (ln ft) per side wall at mid-depth of the contamination zone. At a minimum, 1 sample per side wall will be collected.

4.3.3 Excavation Backfilling and Compaction

Clean overburden soils removed from the site will be emplaced into the excavation with periodic compaction using the loader. Because there will be a void space, soils will be transported onsite from the HAFB borrow area or clean soils from the FT-31 Landfarm. It is not anticipated that the site is to be reused for any future construction activities (buildings, structures, etc.) due to its location.

4.3.4 Soil Disposal

Contaminated soils will be transported to the permitted FT-31 Landfarm for treatment/processing or stockpiling. Soils will be handled, transported, and managed in accordance with NMED guidelines and the facility's requirements.

4.3.5 Site Restoration

Upon completion of site excavation and backfill activities, the site will be restored to its original appearance. Construction equipment and debris will be removed. The site will be canvassed for trash, debris, etc. Final grade for areas of the site which will not have a surface improvement upon them will allow for positive drainage in accordance with the surrounding area.

5 SAMPLING AND ANALYSIS

The excavation soil sampling requirements, detailed in Table 4-1, include field screening samples, soil borings, stockpile samples, and confirmation samples. Table 5-1 provides the sample collection information inclusive of the container type, quantity, and holding times for soil samples.

5.1 Field Screening Sampling

During the DPT sampling and the excavation, soils will be periodically field screened using soil-headspace screening techniques via a field OVA. Confirmatory field TPH analysis of the OVA headspace samples will be performed with the field fluorometer in accordance with the USEPA *Innovative Technology Verification Report: Field Measurement Technologies for Total Petroleum Hydrocarbons in Soil*, September 2001 guideline (see Appendix I of this VCM Work Plan). From these samples, final QA confirmation analysis in accordance with the NMED specified gas chromatographic (GC) methods will be accomplished via a fixed-base laboratory.

5.1.1 Initial Field Screening

For the DPT sampling activities, soils cores retrieved by the Macrocore tubes will be screened by headspace analysis. Samples with the highest headspace readings will be collected, for a maximum of three samples per boring.

HAFB excavation guidelines for PCS require initial field screening via headspace analysis every 100 cubic yards. Therefore, one sample will be screened per 100 cubic yards of soil removed via the OVA.

5.1.2 Field Confirmatory Sampling

For excavation confirmation samples, a field confirmatory frequency of 10% with the SiteLAB® Analytical Test Kit UVF-3100A will be implemented per the USACE and USEPA (SW846) guidelines for QA/QC requirements of site investigations for contamination. The samples will be field checked with the SiteLAB®. This test uses a 10-gram sample of soil where petroleum compounds are extracted with methanol. The extract is decanted into a quartz cuvette and placed in the chamber of the UVF and the TPH concentration is displayed. Although the NMED clean-up level is 880 mg/kg, soils resulting in a headspace reading with the UVF above 790 mg/kg will be designated TPH contaminated, allowing for a 10% instrument error and variability between the screening method and the USEPA Method analyses.

5.1.3 Laboratory Validation

Laboratory validation frequency of the UVF screening samples will be at 10%, or 1 sample per site minimum. Laboratory validation will be completed using USEPA Method 8015M for TPH-

GRO [C_6-C_{10}], TPH-DRO [C_{10}-C_{22}], and TPH-ORO [C_{22}-C_{36}]. Laboratory analyses will be completed at an expedited turn-around-time of 24 hours.

5.2 Soil Borings

Soil boring data collected will adhere to project data quality objective (DQO) requirements, method reporting limits, duplicate field samples, and QC samples as established within the Basewide QAPP (Bhate, November 2003). Sample quantities, containers, methods of preservation, and holding times will be consistent with the requirements of associated method protocols. Laboratory analyses will be completed at a rush turn-around-time, 24-hours.

At the soil boring locations where the initial screening does not indicate VOCs, three discreet samples will be collected, with the deepest sample collected from the soil/water interface.

5.3 Groundwater

Groundwater data collected will adhere to project DQO requirements, method reporting limits, duplicate field samples, and QC samples as established within the Basewide QAPP (Bhate, November 2003). Sample quantities, containers, methods of preservation, and holding times will be consistent with the requirements of associated method protocols. Laboratory analyses will be completed at a rush turn-around-time, 24-hours.

5.4 Excavation Confirmation Sampling

Excavation confirmation samples will be collected at the frequency of one per 20 linear feet of each sidewall within the contamination zone at mid-depth. Analytical confirmation sampling from the bottom of the excavation is not required because excavation will be terminated at one foot below the water table. Samples will be analyzed by a fixed-base laboratory for TPH, TPH-DRO, and TPH-GRO, using USEPA Method 8015M, VOCs (USEPA Method 8260B), SVOCs (USEPA Method 8270C), and TAL metals. If any single sample demonstrates a TPH level above the NMED soil value for TPH of 880 mg/kg, excavation will continue along that face until field screening deems termination with re-evaluation via laboratory confirmation analysis.

Soil data collected will adhere to project DQO requirements, method reporting limits, duplicate field samples, and QC samples as established within the Basewide QAPP (Bhate, November 2003). Sample quantities, containers, methods of preservation, and holding times will be consistent with the requirements of associated method protocols. Laboratory analyses will be completed at standard turnaround time of 7 days.

5.4.1 Stockpile Sampling

Stockpiled overburden soils will be sampled every 500 cu yds. Laboratory analyses will be completed at an expedited turn-around-time, 24 hours with analysis for TPH, -DRO and -GRO,

using USEPA Method 8015M, VOCs (USEPA Method 8260B), and SVOCs (USEPA Method 8270C).

5.4.2 Analytical Methods

Each laboratory soil sample (including the field duplicates) will be analyzed for their respective analytes in accordance with Table 5-2. Samples will be analyzed for VOCs by Method 8260B, SVOCs by Method 8270C, TPH and carbon fractions (Table 5-3) by Method 8015M, and TAL metals by 6010/7000 series.

Laboratory analyzed samples will be completed by Accutest Laboratories in Orlando, Florida. A copy of their USACE validation is included in Appendix K of this VCM Work Plan.

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6 RISK BASED CLEAN-UP APPROACH

The objective of the excavation activities presented is to remove contaminated soil from the site to support closure of the site. Data collected as a result of field screening will be evaluated based on the DQOs of the project. The results from the off-site laboratory confirmation samples from the sidewalls of the excavation will be evaluated to determine whether excavation activities at the site have removed the contaminated soil to the point where there is an acceptable risk given possible exposure at the site. If the completed evaluation indicates an acceptable risk, then no further excavation will be required and the site can be considered for closure with no further action.

6.1 Evaluation of TPH

Based on the direction provided by NMED pertaining to the remediation of petroleum-impacted sites at HAFB, a TPH screening level of 880 mg/kg will be used to evaluate the data provided by the off-site analytical laboratory. As discussed in Section 5 of this VCM Work Plan, *Sampling and Analysis*, the 880 mg/kg action level for PCSs is the Residential Direct Exposure Limit for diesel fuel, listed in Table 2 of the *NMED TPH Screening Guidelines*, June 24, 2003 (see Appendix J of this VCM Work Plan).

6.2 Evaluation of VOCs and SVOCs

For any VOCs or SVOCs that are detected in soil, the concentration will be evaluated against the screening levels provided in Appendix A of the revised NMED guidance document *Technical Background Document for Development of Soil Screening Levels, Revision 3.0*, November 2005 (NMED, 2005). Tables containing the SSLs from this guidance document are provided in Appendix B of this VCM Work Plan. The laboratory data for each collected soil sample will be compared to these SSLs.

For VOCs and SVOCs detected in groundwater, the results will be compared to the New Mexico Water Quality Control Commission (NMWQCC) published groundwater quality standards. The NMWQCC standards for aquifers with TDS concentrations less than or equal to 10,000 mg/L [20.6.2.3101 New Mexico Administrative Code (NMAC)]. The TDS concentration is a direct measure of the presence of total ions in the aquifer and is one of the primary criteria for classifying the aquifer based on its use as a potential drinking water source. Under the NMWQCC regulations, if TDS in groundwater is more than 10,000 mg/L, the aquifer is classified as non-potable.

6.3 Evaluation of Metals

For metals detected in soil, the concentrations will be evaluated against the background levels presented in the *Basewide Background Study – Sewage Lagoons and Lakes Characterization Report*, Radian Corporation, 1993. The concentrations of metals at DP-63 will be compared to

the 95 percent UTL. Groundwater metals concentrations will be compared to the NMWQCC standards.

7 WASTE MANAGEMENT

Construction-derived waste (CDW) generated by the activities of this VCM may include soil boring cuttings, excavated soil, decontamination residuals, and personal protective equipment (PPE) (see Table 7-1). Each of these waste streams will be managed and characterized according to the guidelines discussed below. Waste containers and the decontamination pad will be managed in a secure area.

7.1 Excavated Soil

7.1.1 Clean Soils – Stockpiles

The clean soil stockpiles will be constructed in accordance with best management practices (BMPs) to mitigate soil loss due to erosion, wind, and run-off in accordance with the site specific SCP as developed from the Draft Master SCP (Bhate, September 2005) and the site-specific SWPPP. These BMPs may include the use of a plastic liner, straw bales for berms or silt fencing, and a cover. Soils will be placed on thick plastic sheeting within a constructed berm for protection from off-site transportation by wind and rain until characterization is complete. If laboratory analysis indicates concentrations are below the SSL for TPH of 880 mg/kg, and the SSL for each individual VOC and SVOC constituent, the stockpiled soil will be used as backfill once the excavation activities are complete.

7.1.2 Contaminated Soils – Base Landfarm

Excavated contaminated soils will be handled in accordance with Sections 4 and 5 of this Work Plan. Contaminated soils will be directly loaded and transported to the selected location for treatment and/or disposal at either the FT-31 Landfarm or an off-site subcontractor location.

7.2 Decontamination Water

Decontamination water is anticipated to be non-hazardous and as such, can be disposed of through the HAFB wastewater treatment plant (WWTP). When feasible, decontamination water will be allowed to evaporate from the decontamination pad area. Sediment remaining in the decontamination pad area after the water has either evaporated or has been discharged to the WWTP will be combined with the excavated contaminated soil for disposal.

7.3 Personal Protective and Disposable Sampling Equipment

PPE and other site non-hazardous debris/waste shall be placed in plastic trash bags and disposed in a standard trash dumpster or receptacle as directed by HAFB personnel.

7.4 Construction Debris

Unless visibly stained, all construction debris will be assumed to be uncontaminated and non-hazardous and will be disposed of accordingly at the HAFB re-use facility. Stained construction debris will be disposed of in accordance with HAFB procedures.

8 PROJECT QUALITY ASSURANCE

The laboratory performing the chemical sample analysis will follow the Site Specific Addendum to the Basewide QAPP (Bhate, September 2005) provided in Appendix G of this VCM Work Plan.

8.1 Standard Operating Procedures

Applicable SOPs for completing the sampling associated with excavation at DP-63 are located in Appendix A of the Basewide QAPP (Bhate, November 2003).

8.2 Sample Identification

Each sample will be identified on the sample label and chain-of-custody (COC) records for each sample collected, regardless of type. Field duplicates will be paired with another sample and will be classified as blind samples. The duplicate samples will appear in sequence with the regular samples. Sample nomenclature will adhere to the procedures and guidelines established in the Basewide QAPP. Sample labeling will adhere to the format provided in the QAPP project addendum.

8.3 Project Documentation

The field operations documentation will provide consistent procedures and formats for documentation and management of field records and collected samples.

8.3.1 Sample Documentation

Sample documentation, identification, and tracking will adhere to the prescribed methods found in the Basewide QAPP project-specific addendum. All sampling activities will include documentation of significant activities, potential environmental influences during sampling, field variances, and sample identification information. At a minimum, field logbooks will be utilized to record dates and times, sampling protocols, project numbers, and sampler's name. Daily Quality Assurance Reports will be completed and submitted weekly to the HAFB Project Manager. Other pertinent information will include COC numbers and air bill tracking numbers. COC forms will be completed and included with each sample shipment; one COC per cooler.

At a minimum, the following sample collection information will be logged in the field book:

- Date and time
- Sample identification number
- Project number
- Sampler name
- Preservative (if any)

- Analysis
- Map or schematic of sampling location

If no map of sampling locations is available prior to sampling, a drawing of the site will be sketched on the left page of the field logbook to provide an illustration of all sampling points. Measured distances from sampling points to a fixed reference point will be recorded.

8.3.2 Field Logbook

Personnel will use only bound field logbooks for field records. The Project Manager will ensure that all field notes can be efficiently traced, filed, and retrieved. All entries will be recorded in indelible, waterproof ink. If errors are made, corrections will be made by crossing a single line through the error, correcting the information, and initialing and dating the correction. Entries will be made as described below.

Documentation and reporting of events and activities will be made in chronological order on the right page of the logbook. All entries will be dated and time of entry recorded. At the beginning of each day, the first two entries will be "personnel/contractors on site" and "weather". At the end of each day's entry, the personnel will draw a diagonal line originating from the bottom left corner of the page to the conclusion of the entry and sign along the line indicating the conclusion of the entry or the day's activity. Once completed, the field logbooks become documents that can be used to account for project activities and will be maintained as part of the project files.

The following general requirements apply to field logbooks:

- The left page of the logbook will be used for auxiliary reporting such as sketches, tables, etc.

- The date will be recorded in the top, left-hand corner of each right page.

The time of entry recordings will be in columnar form down the left-hand side of the right page.

8.3.3 Field Analytical Data

The field analytical data collected at the site will include the field screening readings for selection of PPE, as well as field screening for headspace analysis. The breathing zone of the site will be screened for VOCs in the field at the time of sample collection utilizing an OVA. If a high humidity condition exists at the time of sample collecting, a flame-ionization detector (FID) is recommended since a photo-ionization detector (PID) is not a completely reliable screening instrument under these conditions. The field screening data will be recorded in the field logbook.

8.3.4 Data Reporting

Data obtained during the excavation, through confirmation or field screening samples, will be reported according to the Basewide QAPP (Bhate, November 2003). In accordance with USACE EM200-1-6, the investigative data is classified as definitive data. The data will be generated using rigorous, analyte-specific analytical methods where analyte identifiers and quantitations are confirmed and QA/QC requirements have been satisfied. For this project, regular, field duplicate and MS/MSD samples are to be collected concurrently. The data must meet the objectives of the project for level of accuracy and precision required, intended use of the data, analytical methods, time constraints, and allowable decision errors. Risk evaluation and sampling results will be tabulated and summarized in the VCM report for the site. An Environmental Restoration Program Information Management System (ERPIMS) submittal is not required for this project.

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9 HEALTH AND SAFETY REQUIREMENTS

Because this site was used as a munitions disposal site, extreme care and caution will be exercised during the field activities conducted under this VCM.

Project health and safety practices during the field activities will adhere to the *Basewide Health and Safety Plan* (HASP) (Bhate, December 2003) and the Site Specific Addendum to the Basewide HASP, included in Appendix L of this VCM Work Plan. It is anticipated that no greater than modified level D PPE will be required to complete the site inspection and sampling activities. This includes: Occupational Safety and Health Administration (OSHA)-approved safety shoes, American National Standards Institute (ANSI) approved safety glasses (Z87.1) and hard hat (Z89.1-1997: Type I), long-sleeved shirt and long pants, and as required, hearing protection, leather work gloves, and/or nitrile gloves.

The site must also be secured to further ensure safety at the site. Of concern is the proper designation and demarcation of the excavation boundaries (i.e., Support Zone (SZ), Contamination Reduction Zone (CRZ), and Exclusion Zone (EZ)), as appropriate. Likewise, compliance with any intrusive work requirements, posting of potential hazards, and control of unauthorized site personnel will be completed as directed in the Basewide HASP. At a minimum, the site will be secured with caution tape surrounding the perimeter of the site and delineating the outer boundary of the SZ. This is essential in the utility clearance process and it serves as the demarcation of the site for both project and non-project-related individuals. A CRZ and/or EZ will be established as guided by the HASP and site prevailing conditions.

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10 ORGANIZATION AND SCHEDULE

During the corrective measures activities at the site, Mr. John Hymer will serve as the Bhate Site Manager overseeing and directing all investigation sampling activities. Mr. Hymer will also provide on-site management of any subcontractors for the project. Mr. Frank Gardner is the Bhate Program Manager and will ensure required project documents, permits, contractual agreements, and other program tasks are completed. Key project personnel are listed in Table 10-1. Activities associated with this VCM Work Plan are anticipated to begin March 2006.

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11 REFERENCES

Bhate Environmental Associates, Inc. December 2003. *Basewide Health and Safety Plan.* Holloman Air Force Base, New Mexico.

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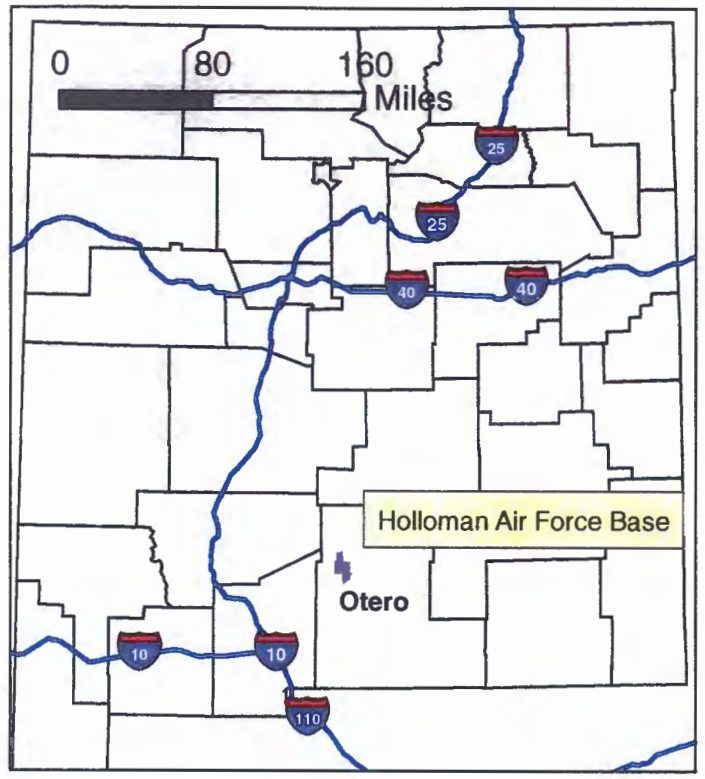
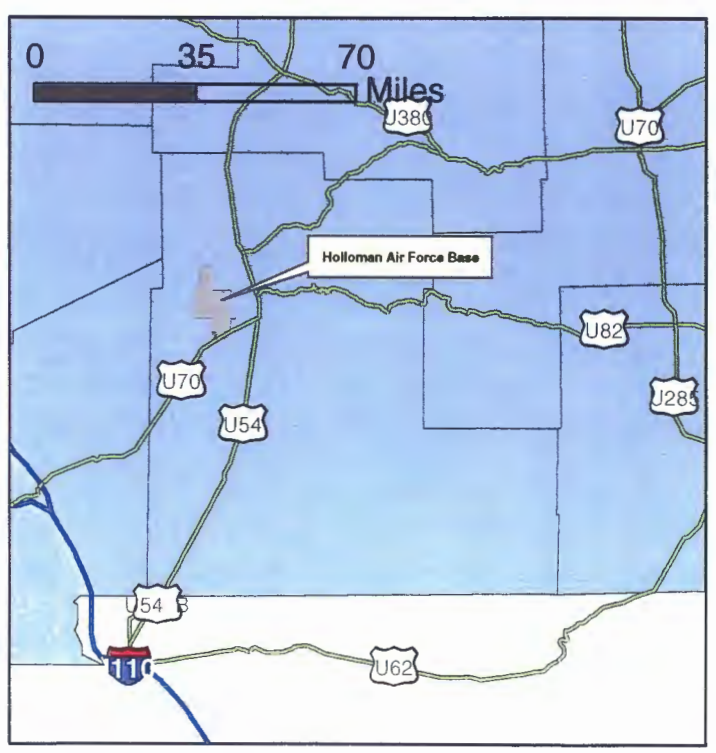
FIGURES

New Mexico



Otero County, New Mexico



Disposal Pit 63 (DP-63)
Voluntary Corrective Measures Work Plan
Holloman Air Force Base, New Mexico

Figure 1

Site Location Map

PROJECT NO.	SCALE	DATE	DRAWN BY:	DRAWING NO:
9050044	1"=200'	9/20/05	cm	fig2

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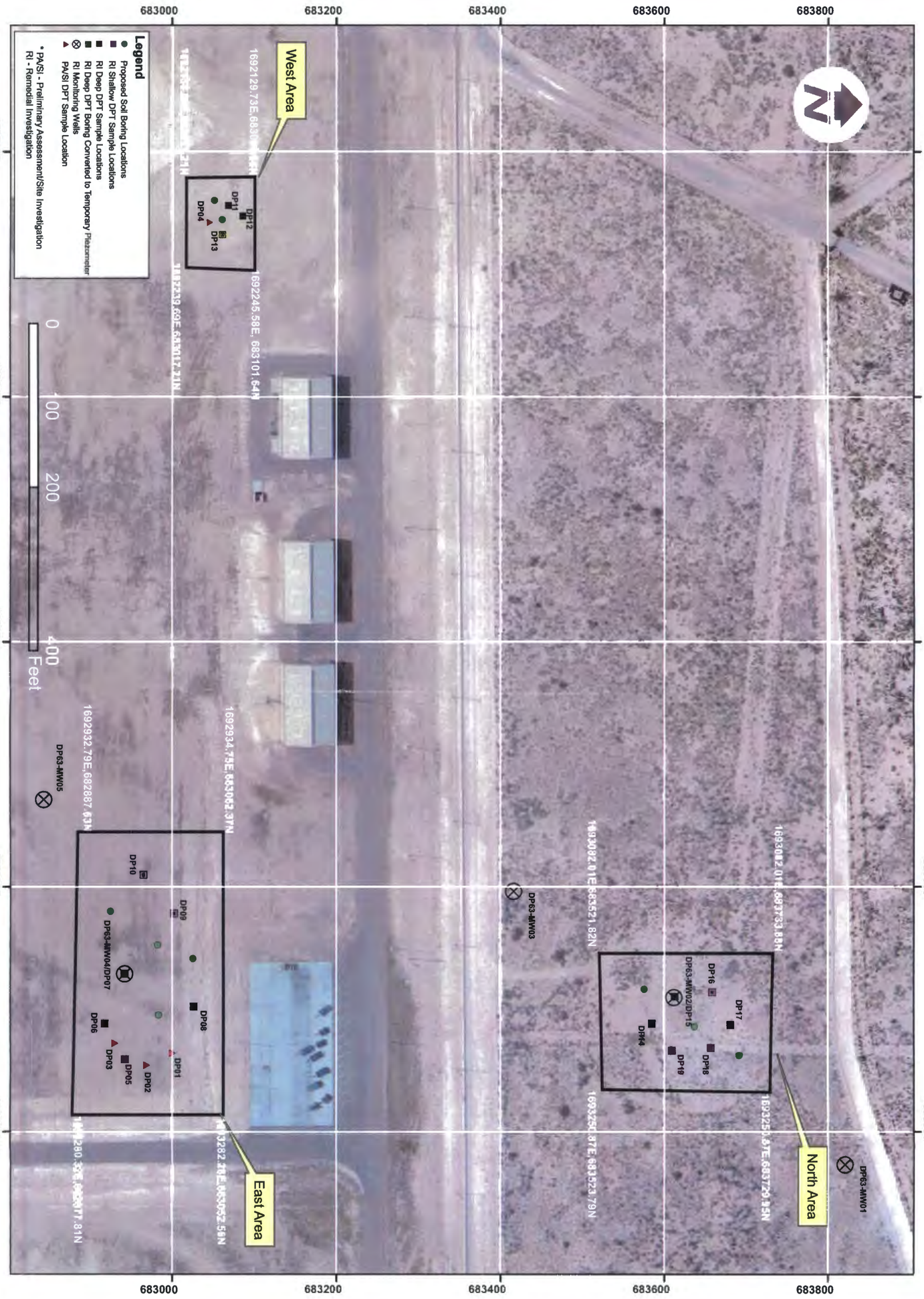

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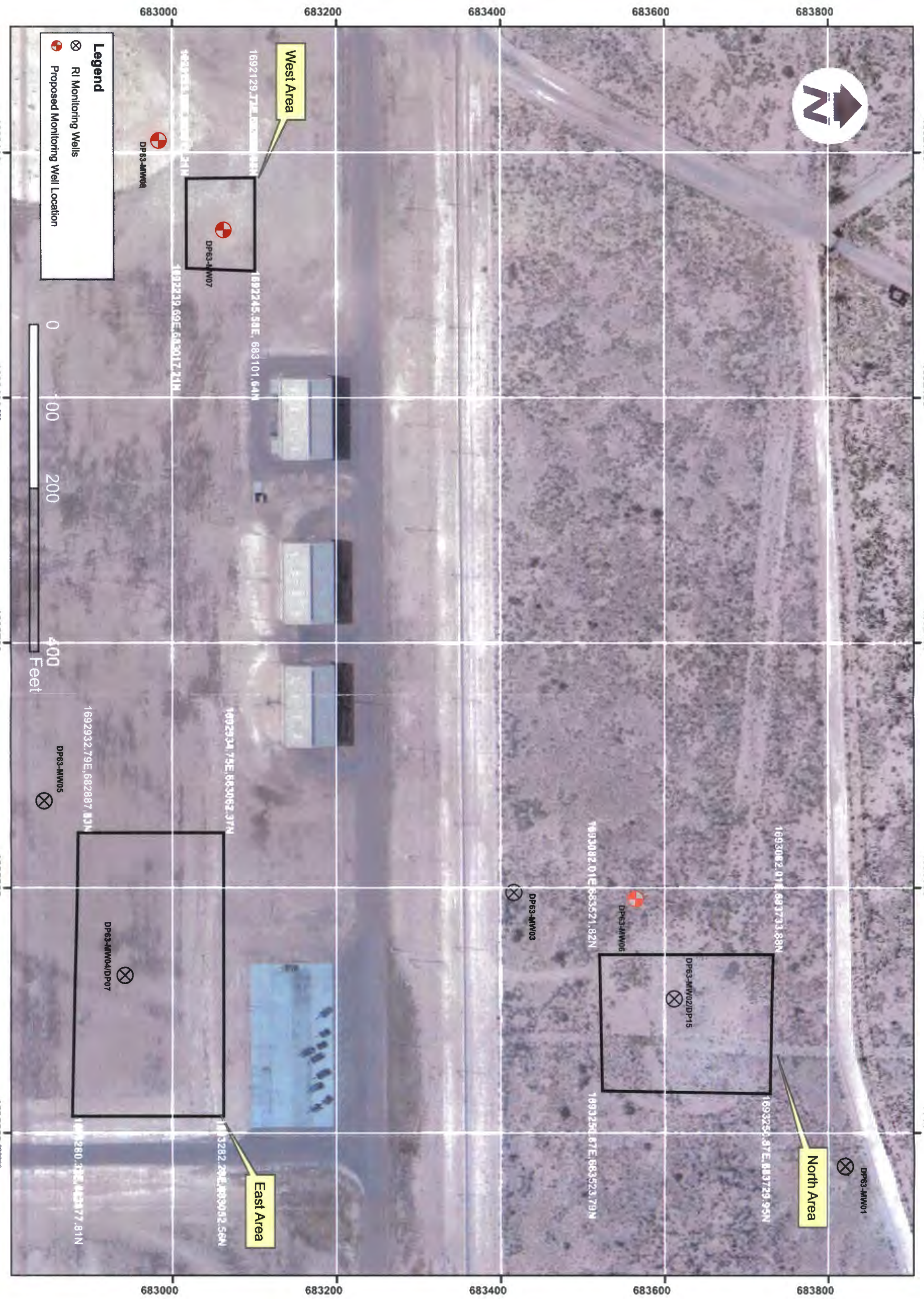
Proposed Soil Boring Locations

PROJECT NO.	SCALE	DATE	DRAWN BY:
9050044	Shown	2/3/06	cm
			DRAWING NO: fig2

Disposal Pit 63 (DP-63)
Voluntary Corrective Measures Work Plan
Holloman Air Force Base, New Mexico

Figure 2



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Proposed Monitoring Well Locations

PROJECT NO.	SCALE	DATE	DRAWN BY: cm
9050044	Shown	2/3/06	DRAWING NO: fig3

Disposal Pit 63 (DP-63)
Voluntary Corrective Measures Work Plan
Holloman Air Force Base, New Mexico

Figure 3

TABLES

Table 3-1. Sample Analytes and Methodologies for VCM Sampling

Analysis	Water	Soil
TPH	EPA Method 8015M	EPA Method 8015M
VOC	EPA Method 8260B	EPA Method 8260B
SVOC	EPA Method 8270C	EPA Method 8270C
TAL Metals	EPA Methods 6010B/7470A	EPA Methods 6010B/7471A
Total Dissolved Solids	EPA Method 160.1	Not Applicable

Notes:
TPH – Total Petroleum Hydrocarbons
VOC – Volatile Organic Compounds
SVOC – Semi-volatile Organic Compounds
TAL – Target Analyte List
EPA – Environmental Protection Agency

Table 3-2. Summary of Analytical Parameters for VCM Sampling

Analytical Constituents	Soil Samples	Water Samples[1]
Total Petroleum Hydrocarbons Method 8015M	33 samples (including 3 duplicates and MS/MSD)	10 samples (including 1 duplicate and 1 MS/MSD)
Volatile Organic Compounds Method 8260B	36 samples (including 3 duplicates, 3 trip blanks, MS/MSD)	11 samples (including 1 duplicate, 1 MS/MSD, and 1 trip blank)
Semi-Volatile Organic Compounds Method 8270C	33 samples (including 1 duplicates and MS/MSD)	10 samples (including 1 duplicate and 1 MS/MSD)
TAL Metals Methods 6010B and 7470A/7471A (mercury)	33 samples (including 3 duplicates and MS/MSD)	10 samples (including 1 duplicate and 1 MS/MSD)
Total Dissolved Solids Method 160.1	Not Applicable	9 samples (including 1 duplicate)

Notes:
MS/MSD – matrix spike/matrix spike duplicate
TAL – Target Analyte List
[1] Per sampling event

Table 4-1. Excavation Sampling Quantities and Analysis

Sample Type	Contamination Profile	Purpose	Frequency	Estimated Quantity	Method/ Analyses	Requested Analyses Time
Field Screening	Un-impacted Soils	Initial Field Screening	Every 50 cu yds	6	OVA: VOCs	24 hrs
		Field Confirmatory	Every 100 cu yds	3	UVF: TPH	
		Laboratory Validation	Every 100 cu yds	1	Laboratory: TPH, VOCs, and SVOCs	
	Suspected Contaminated and Contaminated Soils (contamination zone)	Initial Field Screening	Every 50 cu yds	6	OVA: VOCs	
		Field Confirmatory	Every 100 cu yds	3	UVF: TPH	
		Laboratory Validation	Every 300 cu yds	1	Laboratory: TPH	
Stock Pile	Un-impacted Soils	Backfill Characterization	Every 500 cu yds	2	Laboratory: TPH, VOCs, and SVOCs	24 hrs
Excavation Confirmation	Un-impacted Soils	Closure	Every 20 ln ft, at mid-depth within contamination zone, minimum of 1 per side wall	4	Laboratory: TPH, VOCs, and SVOCs	7 days

Notes:
cu yds - Cubic yards
ln ft - Linear feet
TPH - Total Petroleum Hydrocarbons
VOCs - Volatile organic compounds; SVOCs = Semi-volatile organic compounds
hrs - Hours
UVF - Ultraviolet fluorometer
OVA - Organic vapor analyzer

Table 5-1. Soil Sample Collection Information

Soil Collection Information	ANALYTE METHOD			
	VOC (8260B)	SVOC (8270C)	TPH (8015M)	Soil Moisture
Container	Encore	4 oz glass jar	Non-preserved 40-mL vial (Terra-core)	8 oz glass jar
Container Quantity	3	1	1	1
Holding Time	24 hrs	7 days	7 days	14 days

Notes:
hrs - Hours
oz - Ounce
mL - Milliliter
TPH - Total petroleum hydrocarbons
VOC - Volatile organic compound
SVOC - Semi-volatile organic compound

Table 5-2. Sample Analytes and Methodologies

Analysis	Soil
VOCs	EPA Method 8260B
SVOCs	EPA Method 8270C
TPH (GRO/DRO/ORO)	EPA Method 8015M
TAL Metals	Methods 6010B and 7470A/7471A (mercury)

Notes:
TPH - Total petroleum hydrocarbons
VOCs - Volatile organic compounds
SVOCs - Semi-volatile organic compounds
GRO - Gasoline range organics
DRO - Diesel range organics
ORO - Oil range organics
EPA - Environmental Protection Agency
TAL - Target Analyte List

Table 5-3. Carbon Fractions for Petroleum Hydrocarbons

Aliphatics	Aromatics
C6	C7-C8
C6-C8	C8-C10
C8-C10	C10-C12
C10-C12	C12-C16
C12-C16	C16-C21
C16-C35*	C21-C35*

Notes:
Aliphatics are compounds containing only carbon and hydrogen which do not contain a benzene ring and they can be straight-chain, branched chain, or cyclic molecules
Aromatics are any of a large class of hydrocarbon compounds, that includes benzene and compounds that resemble benzene in certain of their chemical properties, that have one or more benzene rings. Common aromatic compounds other than benzene include toluene, naphthalene, and anthracene (the polynuclear aromatic hydrocarbons).

Table 7-1. Construction-Derived Wastes

Activity	Waste Stream			
	PPE	Soil	Water	Debris
Assessment Sampling	✓	✓	✓	
Equipment Decontamination	✓	✓	✓	
Excavation	✓	✓		✓

Table 10-1. Key Personnel and Responsibilities

Name	Project Title/Assigned Role	Phone Numbers
Mr. John Hymer	Site Manager/SSHO	Work: (505) 679-2100 Cell: (505) 491-9171
To be determined	Field Team Leader	
Mr. Frank Gardner	Bhate Program Manager	Work: (970) 216-7819
Ms. Karen Niebuhr	Senior Engineer/Project Manager	Work: (205) 918-4024
Ms. Judy McBride	Health and Safety Specialist	Home: (205) 871-9215 Cell: (205) 586-6200

Note:

SSHO - Site Safety and Health Officer

APPENDIX A

TABLES FROM *FINAL REPORT FOR PRELIMINARY ASSESSMENT/SITE INSPECTION OF DP-63 DISPOSAL PIT 63*

FOSTER WHEELER ENVIRONMENTAL CORPORATION

JANUARY 2001

Tables 2-1, 4-1, 4-2, and 4-3
Figure 4-1
Boring Logs

Table 2-1. Samples Collected during the PA/SI Field Investigation at DP-63

Site ID	Location	Sampling Rationale	Samples Collected	
			Groundwater	Soil
DP63-DP01	East Area of DP-63 at disposal pit Site 1	Determine impact to soil and groundwater	1	7 - 8 ft, 21 - 22 ft, 44 - 45 ft, 44 - 45 (D)
DP63-DP02	East Area of DP-63 at disposal pit Site 1	Determine impact to soil and groundwater	1 (plus field duplicate)	7 - 8 ft, 17 - 18 ft, 46 - 47 ft
DP63-DP03	East Area of DP-63 at disposal pit Site 1	Determine impact to soil and groundwater	1	12 - 13 ft, 21 - 22 ft, 45 - 46 ft
DP63-DP04	West Area of DP-63 at disposal pit Site 2	Determine impact to soil and groundwater	1	5 - 6 ft, 20 - 21 ft, 44 - 45 ft

* The following analyses were performed on groundwater and soil samples:

Groundwater: Explosives by EPA SW-846 Method 8330

Soil: VOCs by EPA SW-846 Methods 5035/8260B
SVOCs by EPA SW-846 Method 8270C
Pesticides/PCBs by EPA SW-846 Methods 8081A/8082
TRPH by EPA SW-846 Method 9071/418.1
Metals by EPA SW-846 Methods 6010B/7471A
Cyanide by EPA SW-846 Method 9013

D - field duplicate sample collected

ft - feet

Table 4-1. Analytical Results for Organic Compounds Detected in Soil Samples Collected at DP-63

Location	Depth Interval (ft)	TRPH (mg/kg)	Explosives (µg/kg)	VOCs (µg/kg)			SVOCs (µg/kg)		Pesticides/ PCBs (µg/kg)
				Carbon disulfide	2-Butanone	Toluene	Diethyl-phthalate	bis(2-Ethylhexyl) phthalate	
DP63-DP01	7 - 8	ND	NA	ND	ND	ND	ND	ND	ND
DP63-DP01	21 - 22	**62.5**	NA	ND	ND	ND	ND	ND	ND
DP63-DP01	44 - 45 *	**41.4**	NA	**4497**	**1526**	ND	ND	ND	ND
DP63-DP01 (dup)	44 - 45 *	**38.5**	NA	**8876**	**4356**	**440**	ND	ND	ND
DP63-DP02	7 - 8	ND	NA	ND	ND	ND	ND	ND	ND
DP63-DP02	17 - 18	**37.7**	NA	ND	ND	ND	ND	ND	ND
DP63-DP02	46 - 47 *	**71.4**	NA	ND	ND	ND	ND	ND	ND
DP63-DP03	12 -13	**38.5**	NA	**7904**	**2705**	**308**	**750**	**1500**	ND
DP63-DP03	21 - 22	**79**	NA	**7406**	**2752**	**328**	ND	ND	ND
DP63-DP03	45 - 46 *	**263**	NA	**7242**	**2946**	ND	**100**	ND	ND
DP63-DP04	5 - 6	ND	NA	ND	ND	ND	ND	ND	ND
DP63-DP04	20 - 21	**39.7**	NA	ND	ND	ND	ND	ND	ND
DP63-DP04	44 - 45 *	**70.7**	NA	ND	ND	ND	ND	ND	ND

* Sample collected below the water table

NOTE: Pesticides and PCBs were analyzed for but not detected

dup - field duplicate sample
ft - feet
mg/kg - milligrams per kilogram
µg/kg - micrograms per kilogram
NA - not analyzed
ND - analyte not detected above the method reporting limit
PCBs - polychlorinated biphenyls
SVOCs - semivolatile organic compounds
VOCs - volatile organic compounds

Table 4-2. Analytical Results for Cyanide and Metals Detected in Soil Samples Collected at DP-63

Location	Depth Interval (ft)	Cyanide (mg/kg)	TAL Metals (mg/kg)							
			Aluminum	Arsenic	Barium	Beryllium	Calcium	Cobalt	Chromium	Copper
DP63-DP01	7 - 8	ND	2,070	ND	ND	ND	213,000	ND	2.3	ND
DP63-DP01	21 - 22	ND	4,240	ND	65.8	ND	88,300	ND	6.4	ND
DP63-DP01	44 - 45 [1]	ND	5,650	ND	94.4	ND	170,000	ND	7.4	ND
DP63-DP01 (dup)	44 - 45 [1]	ND	3,650	ND	52.8	ND	203,000	ND	4.9	ND
DP63-DP02	7 - 8	ND	1,360	ND	ND	ND	196,000	ND	ND	ND
DP63-DP02	17 - 18	ND	4,960	ND	ND	ND	190,000	ND	7.3	ND
DP63-DP02	46 - 47 [1]	ND	6,930	5.2	334	ND	108,000	75.7	8.3	21.2
DP63-DP03	12 -13	ND	4,560	ND	53.5	ND	142,000	ND	6.2	ND
DP63-DP03	21 - 22	0.26	5,970	ND	50.4	ND	190,000	ND	6.3	6.2
DP63-DP03	45 - 46 [1]	ND	1,940	ND	ND	ND	76,700	ND	3.9	ND
DP63-DP04	5 - 6	ND	4,090	ND	ND	ND	177,000	ND	4.4	ND
DP63-DP04	20 - 21	ND	19,600	7.3	227	1.3	135,000	ND	22.4	13.6
DP63-DP04	44 - 45 [1]	ND	7,970	2.6	120	ND	98,800	ND	ND	4.9
Background Value [2]		NB	8,760	6.88	84.4	0.400	250,000	2.49	6.60	4.84

[1] Sample collected below the water table

[2] Background values are 95 percent upper tolerance limits as presented in the Basewide Background Study (Radian 1993)

Note: Metals detections above background values are shaded and are the only detections presented on Figure 4-1.

dup - field duplicate sample
ft - feet
mg/kg - milligrams per kilogram
NB - no background value established
ND - analyte not detected above the method reporting limit
TAL - target analyte list

Table 4-2. Analytical Results for Cyanide and Metals Detected in Soil Samples Collected at DP-63

Location	Depth Interval (ft)	TAL Metals (mg/kg)								
		Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Sodium	Vanadium	Zinc
DP63-DP01	7 - 8	1,940	0.69	1,260	25.7	ND	ND	ND	ND	5.1
DP63-DP01	21 - 22	6,140	3.6	4,410	91.7	ND	ND	1,500	14	14.7
DP63-DP01	44 - 45 1	5,510	3	3,270	77.8	ND	ND	2,600	ND	18.8
DP63-DP01 (dup)	44 - 45 [1]	3,200	2.1	2,290	36.9	ND	ND	2,240	ND	10.3
DP63-DP02	7 - 8	1,280	2.8	1,270	21	ND	ND	ND	ND	ND
DP63-DP02	17 - 18	4,920	3.5	2,970	74.5	ND	1,260	1,540	ND	15.1
DP63-DP02	46 - 47 [1]	8,890	10.5	4,340	4,930	33.2	1,270	2,480	45.9	22.1
DP63-DP03	12 -13	5,130	3.5	3,950	102	ND	ND	1,390	11.4	15.1
DP63-DP03	21 - 22	5,890	3.5	3,770	67.1	ND	1,520	2,290	ND	29
DP63-DP03	45 - 46 [1]	2,690	2.8	1,610	59.6	ND	ND	1,560	ND	9.5
DP63-DP04	5 - 6	3,640	1.8	2,300	62	ND	1,180	ND	ND	10.7
DP63-DP04	20 - 21	17,800	12.3	9,370	308	19.5	3,700	3,900	37.3	58.4
DP63-DP04	44 - 45 [1]	8,050	5.7	4,570	122	7.3	1,510	2,190	38.4	22.8
Background Value [2]		6,360	8	14,700	165	5.61	2,500	5,000	15.5	20.2

[1] Sample collected below the water table

[2] Background values are 95 percent upper tolerance limits as presented in the Basewide Background Study (Radian 1993)

Note: Metals detections above background values are shaded and are the only detections presented on Figure 4-1.

dup - field duplicate sample
ft - feet
mg/kg - milligrams per kilogram
NB - no background value established
ND - analyte not detected above the method reporting limit
TAL - target analyte list

Table 4-3. Analytical Results for Groundwater Water Samples Collected at DP-63

Location	Groundwater Depth (feet bgs)	TRPH (mg/L)	VOCs (µg/L)	SVOCs (µg/L)	Explosives (µg/L)	Pesticides/PCBs (µg/L)	TAL Metals (mg/L)
DP63-DP01	45	NA	NA	NA	ND	NA	NA
DP63-DP02	46	NA	NA	NA	ND	NA	NA
DP63-DP02 (dup)	46	NA	NA	NA	ND	NA	NA
DP63-DP03	46	NA	NA	NA	ND	NA	NA
DP63-DP04	41	NA	NA	NA	ND	NA	NA

bgs - below ground surface
dup - field duplicate sample
mg/L - milligrams per liter
NA - not analyzed
ND - analyte not detected above method reporting limit
PCB - polychlorinated biphenyl
SVOC - semivolatile organic compound
TAL - target analyte list
TRPH - total recoverable petroleum hydrocarbons
VOC - volatile organic compound
µg/L - micrograms per liter

Notes:

TRPH units are mg/kg.

Organic units are ug/kg.

Inorganic units are mg/kg.

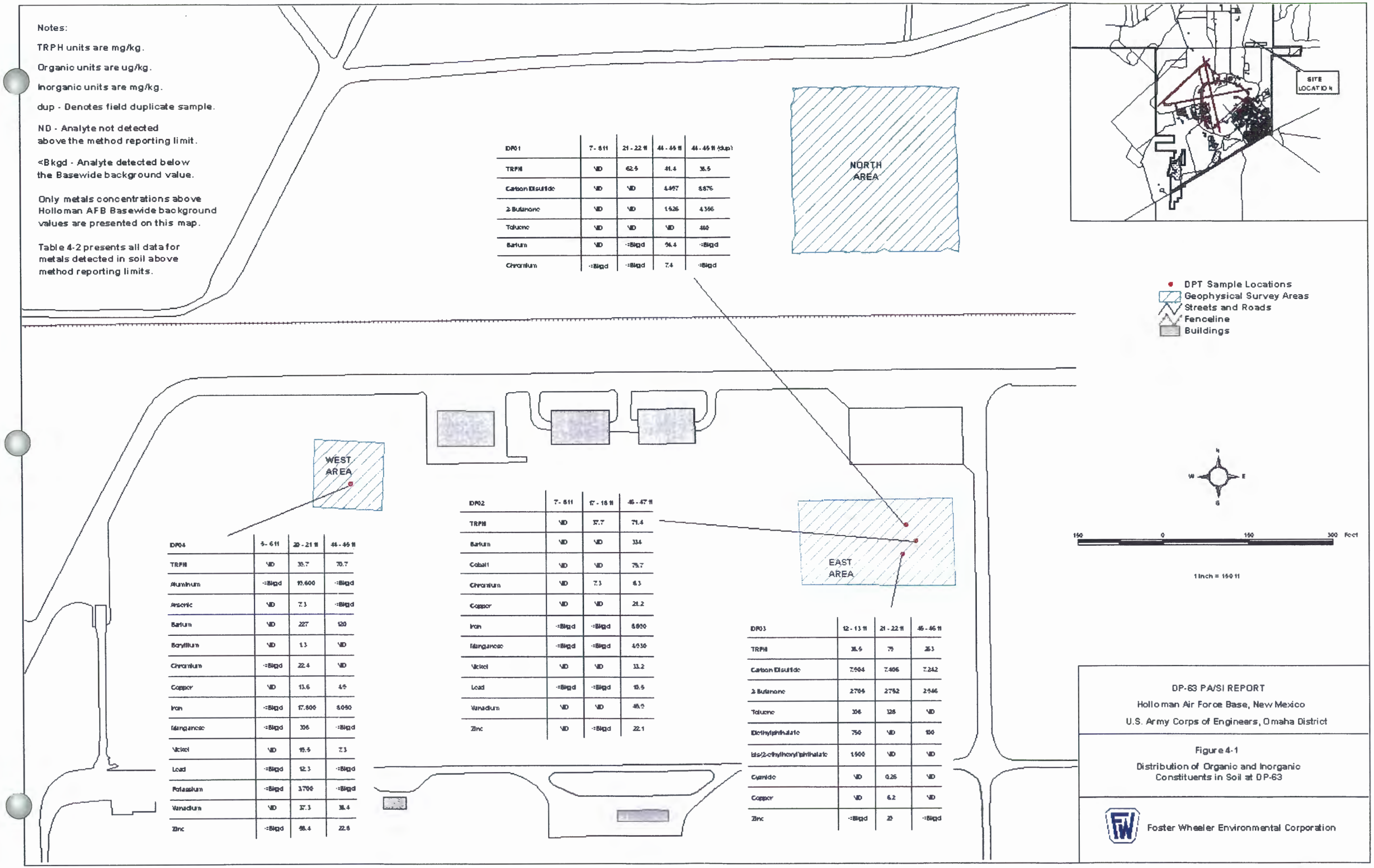
dup - Denotes field duplicate sample.

ND - Analyte not detected above the method reporting limit.

<Bkgd - Analyte detected below the Basewide background value.

Only metals concentrations above Holloman AFB Basewide background values are presented on this map.

Table 4-2 presents all data for metals detected in soil above method reporting limits.



DP01	7 - 8 ft	21 - 22 ft	44 - 45 ft	44 - 45 ft (dup)
TRPH	ND	62.5	41.4	38.5
Carbon Disulfide	ND	ND	4.497	5.875
2-Butanone	ND	ND	1.526	4.356
Toluene	ND	ND	ND	440
Barium	ND	<Bkgd	94.4	<Bkgd
Chromium	<Bkgd	<Bkgd	7.4	<Bkgd

DP02	7 - 8 ft	17 - 18 ft	46 - 47 ft
TRPH	ND	37.7	71.4
Barium	ND	ND	334
Cobalt	ND	ND	79.7
Chromium	ND	7.3	6.3
Copper	ND	ND	21.2
Iron	<Bkgd	<Bkgd	8,800
Manganese	<Bkgd	<Bkgd	4,030
Nickel	ND	ND	33.2
Lead	<Bkgd	<Bkgd	10.5
Vanadium	ND	ND	45.0
Zinc	ND	<Bkgd	22.1

DP03	12 - 13 ft	21 - 22 ft	45 - 46 ft
TRPH	38.5	75	253
Carbon Disulfide	7.504	7.406	7.242
2-Butanone	2.704	2.752	2.546
Toluene	306	328	ND
Diethylphthalate	750	ND	190
bis(2-ethylhexyl)phthalate	1,500	ND	ND
Cyanide	ND	0.26	ND
Copper	ND	6.2	ND
Zinc	<Bkgd	23	<Bkgd

DP04	5 - 6 ft	20 - 21 ft	44 - 45 ft
TRPH	ND	35.7	70.7
Aluminum	<Bkgd	15,600	<Bkgd
Arsenic	ND	7.3	<Bkgd
Barium	ND	227	120
Beryllium	ND	1.3	ND
Chromium	<Bkgd	22.4	ND
Copper	ND	13.6	4.5
Iron	<Bkgd	17,600	8,050
Manganese	<Bkgd	336	<Bkgd
Nickel	ND	15.5	7.3
Lead	<Bkgd	12.3	<Bkgd
Potassium	<Bkgd	3,700	<Bkgd
Vanadium	ND	37.3	38.4
Zinc	<Bkgd	48.4	22.8

DP-63 PA/SI REPORT

Holloman Air Force Base, New Mexico

U.S. Army Corps of Engineers, Omaha District

Figure 4-1

Distribution of Organic and Inorganic Constituents in Soil at DP-63

Foster Wheeler Environmental Corporation

HTRW DRILLING LOG

DISTRICT OMAHA		HOLE NUMBER DP63-DP03
1.COMPANY NAME Foster Wheeler Environmental Corp.	2.DRILL SUBCONTRACTOR Indian Fire and Safety	SHEET 1 OF SHEETS 4
3.SITE Holloman AFB, NM	4.LOCATION DP63	
5.NAME OF DRILLER Rafe Jones	6.MANUFACTURER'S DESIGNATION OF DRILL Geoprobe	
7.SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT Geoprobe 66DT Track Rig	8.HOLE LOCATION Site 1 - East Area	
	9.SURFACE ELEVATION N/A	
	10.DATE STARTED 4-25-2000	11.DATE COMPLETED 4-28-2000
12.OVERBURDEN THICKNESS 51.0 ft.	15.DEPTH GROUNDWATER ENCOUNTERED approx. 45 ft.	
13.DEPTH DRILLED INTO ROCK N/A	16.DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED 46.5 ft. / 0.5 hour	
14.TOTAL DEPTH OF HOLE 51.0 ft.	17.OTHER WATER LEVEL MEASUREMENTS (SPECIFY) 46.53 prior to abandonment on 5-2-00	

18.GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19.TOTAL NUMBER OF CORE BOXES
None	N/A	N/A	N/A

20.SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	SVOC	Pest/PCB	Cyanide/TRPH	21.TOTAL CORE RECOVERY %
	X	X	X	X	X	
	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23.SIGNATURE OF INSPECTOR		
	X					

22.DISPOSITION OF HOLE Well casing removed and hole plugged with hydrated bentonite	SCALE 1 in. = 250 ft.

LOCATION SKETCH/COMMENTS

DP03

PROJECT Holloman AFB DP-63 PA/SI	HOLE NO. DP63-DP03

ENG FORM 5056A-R, AUG 94 (Proponent: CECW-EG)

HTRW DRILLING LOG

SITE	LOCATION	HOLE NUMBER
Holloman AFB, NM	DP-63	DP63-DP03

PROJECT #	DISTRICT	INSPECTOR	SHEET	SHEETS
5155.0022.0001.H2000	OMAHA	Carol Bieniulis/Luke Darragh	2 OF	4

ELEV. (a)	DEPTH (ft.) (b)	DESCRIPTION OF MATERIALS (c)	USCS CLASS. (d)	FIELD SCREEN RESULTS (e)	REMARKS (f)
	1, 2, 3	Silty sand, grey, dry, medium dense some subrounded gravel 0-15 mm in size fine sand, some medium sand and some coarse sand	SM	ND	no odor, no staining sample depth 0.0 ft. - 4.0 ft.
	4, 5	Silt, tan/reddish brown, soft, dry, traces of very fine sand	ML	0.95 ppm ND	in borehole headspace no odor, no staining sample depth 4.0 ft. - 6.0 ft.
	6, 7	Silty sand, tan/brown, dry, dense, very fine sand, some medium sand	SM	0.56 ppm ND	in borehole headspace sample depth 6.0 ft. - 8.0 ft.
	8, 9	same as above - with some fine rounded gravel	SM	ND	headspace no odor, no staining sample depth 8.0 ft. - 10.0 ft.
	10, 11, 12, 13	Sandy silt, tan/brown, dry, soft, fine sand	ML	0.50 ppm	headspace continued drilling after UXO clearance 4-28-00 sample depth 10.0 ft. -13.0 ft. sample recovery 3.0 ft. sample for lab analysis 12.0 ft. - 13.0 ft.
	14, 15, 16	same as above	ML	1.00 ppm	sample depth 13.0 ft. -16.5 ft. sample recovery 3.5 ft.
	17, 18, 19	Sandy silt, tan, dry, soft, fine sand, trace of medium sand	ML	0.75 ppm	sample depth 16.5 ft. - 19.5 ft.
		same as above	ML		sample depth 19.5 ft. - 20.0 ft.

PROJECT Holloman AFB DP-63 PA/SI

HOLE NO. DP63-DP03

HTRW DRILLING LOG

SITE	LOCATION	HOLE NUMBER
Holloman AFB, NM	DP-63	DP63-DP03

PROJECT #	DISTRICT	INSPECTOR	SHEET	SHEETS
5155.0022.0001.H2000	OMAHA	Luke Darragh	3 OF	4

ELEV. (a)	DEPTH (ft.) (b)	DESCRIPTION OF MATERIALS (c)	USCS CLASS. (d)	FIELD SCREEN RESULTS (e)	REMARKS (f)
	21 22	Clayey silt, reddish brown, dry, stiff, fine sand with traces of medium sand	ML	0.75 ppm	sample depth 19.5 ft. - 22.5 ft. sample recovery 3.0 ft. sample from 21.0 ft. - 22.0 ft. for lab analysis
	23 24	Silty clay, reddish brown, dry, stiff, white sand lenses throughout (caliche?) low plasticity	CL	0.64 ppm	sample depth 22.5 ft. - 25.0 ft. sample recovery 2.5 ft.
	25 26 27	same as above	CL	0.35 ppm	sample depth 25.0 ft. - 27.5 ft. sample recovery 2.5 ft.
	28	Sandy silt, reddish brown, dry, soft, fine sand, traces of medium sand	ML		sample depth 27.5 ft. - 30.5 ft. sample recovery 3.0 ft.
	29 30	Silty clay, reddish brown, dry, stiff, slight plasticity, some fine to medium sand	CL	0.89 ppm	
	31 32 33	Silty clay, reddish brown, dry, hard, white sand lenses (some oxide staining), (caliche), small white crystals	CL	0.85 ppm	sample depth 30.5 ft. - 33.5 ft. sample recovery 3.0 ft.
	34	same as above			
	35 36	Sandy silt, reddish brown, dry, stiff, some clay, fine sand, traces of medium sand		4.55 ppm	sample depth 33.5 ft. - 36.5 ft. sample recovery 3.0 ft.
	37	Silty clay, reddish brown, dry, stiff, some fine sand		ND	sample depth 36.5 ft. - 39.5 ft. sample recovery 3.0 ft.
	38 39	Silty sand, brown/grey, dry, loose, fine to medium sand			
		same as above			sample depth 39.5 ft. - 40.0 ft.

PROJECT Holloman AFB DP-63 PA/SI | HOLE NO. DP63-DP03

HTRW DRILLING LOG

SITE	LOCATION	HOLE NUMBER
Holloman AFB, NM	DP-63	DP63-DP03

PROJECT #	DISTRICT	INSPECTOR	SHEET	SHEETS
5155.0022.0001.H2000	OMAHA	Luke Darragh	4 OF	4

ELEV. (a)	DEPTH (ft.) (b)	DESCRIPTION OF MATERIALS (c)	USCS CLASS. (d)	FIELD SCREEN RESULTS (e)	REMARKS (f)
		Silty clay, reddish brown, dry, hard, low plasticity, snad lenses (caliche)	CL		sample depth 39.5 ft. - 42.0 ft. sample recovery 2.5 ft.
	41	Clayey silt, tan, dry, soft, traces of fine sand	ML	3.65 ppm	
	42	Silty clay, reddish brown, dry, soft, some fine sand, white crystals, sand lenses (caliche) low plasticity	CL	2.25 ppm	sample depth 42.0 ft. - 44.5 ft. sample recovery 2.5 ft.
	43				
	44	same as above	CL		
	45	Silty sand, grey, wet, fine to medium sand, loose, trace coarse sand	SM	3.75 ppm	sample depth 44.5 ft. - 46.0 ft. sample recovery 1.5 ft.
	46	same as above - saturated	SM		
	47			3.30 ppm	sample depth 46.0 ft. - 49.0 ft. sample recovery 3.0 ft.
	48	Clayey silt with sand, tan, wet, stiff, fine sand	ML		
	49	same as above			
	50				
	51	Total Depth 51.0 ft. Depth to water 45 ft.			
	52				
	53				
	54				
	55				

PROJECT Holloman AFB DP-63 PA/SI

HOLE NO. DP63-DP03

ENG FORM 5056A-R, AUG 94

(Proponent: CECW-EG)

HTRW DRILLING LOG

DISTRICT **OMAHA**		HOLE NUMBER **DP63-DP04**
1.COMPANY NAME **Foster Wheeler Environmental Corp.**	2.DRILL SUBCONTRACTOR **Indian Fire and Safety**	SHEET 1 OF SHEETS 4
3.SITE **Holloman AFB, NM**	4.LOCATION **DP-63**	
5.NAME OF DRILLER **Rafe Jones**	6.MANUFACTURER'S DESIGNATION OF DRILL **Geoprobe**	
7.SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT **Geoprobe 66DT Track Rig**	8.HOLE LOCATION **Site 2 - West Area**	
	9.SURFACE ELEVATION **N/A**	
	10.DATE STARTED **4-24-2000**	11.DATE COMPLETED **4-28-2000**
12.OVERBURDEN THICKNESS **48.0 ft.**	15.DEPTH GROUNDWATER ENCOUNTERED **approx. 43.5 ft. bgs**	
13.DEPTH DRILLED INTO ROCK **N/A**	16.DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED **N/A**	
14.TOTAL DEPTH OF HOLE **48.0 ft.**	17.OTHER WATER LEVEL MEASUREMENTS (SPECIFY) **42.78 prior to abandonment on 5-2-00**	

18.GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19.TOTAL NUMBER OF CORE BOXES
None			**N/A**

20.SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	SVOC	Pest/PCB	Cyanide/TRPH	21.TOTAL CORE RECOVERY %
	X	X	X	X	X	
	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23.SIGNATURE OF INSPECTOR		
	X					

22.DISPOSITION OF HOLE **Temp well removed and hole plugged with hydrated bentonite**	SCALE **1 in. = 250 ft.**

LOCATION SKETCH/COMMENTS

PROJECT **Holloman AFB DP-63 PA/SI**	HOLE NO. **DP63-DP04**

ENG FORM 5056A-R, AUG 94 (Proponent: CECW-EG)

HTRW DRILLING LOG

SITE	LOCATION	HOLE NUMBER
Holloman AFB, NM	DP-63	DP63-DP04

PROJECT #	DISTRICT	INSPECTOR	SHEET	SHEETS
5155.0022.0001.H2000	OMAHA	Carol Bieniulis/Luke Darragh	2 OF	4

ELEV. (a)	DEPTH (ft.) (b)	DESCRIPTION OF MATERIALS (c)	USCS CLASS. (d)	FIELD SCREEN RESULTS (e)	REMARKS (f)
	1	White to tan silt, dry, no cementation, well graded, medium density	ML	0.24 ppm	sample depth 0.0 ft. - 4.0 ft. sample recovery 4.0 ft.
	2, 3	Light tan silt with some sand and clay, dry, poor cementation, low plasticity, medium density	ML	0.23 ppm	
	4, 5, 6, 7	same as above	ML	0.19 ppm 0.27 ppm	sample depth 4.0 ft. - 8.0 ft. sample recovery 4.0 ft. sample collected for lab analysis 5.0 ft. - 6.0 ft.
	8, 9	White silt, dry, no cementation, well graded, low density	ML	1.61 ppm	
	10, 11	Tan sand with some silt, trace moisture, well graded, low density, poor cementation	SM	1.41 ppm	sample depth 10.0 ft. - 12.0 ft. sample recovery 2.0 ft. UXO clearance to 12.0 ft.
	12, 13, 14	Silt, reddish brown, dry, soft, some fine sand	ML	1.00 ppm 1.12 ppm	headspace sample depth 12.0 ft. - 15.0 ft. sample recovery 3.0 ft.
	15, 16, 17	same as above	ML	0.50 ppm	headspace sample depth 15.0 ft. - 18.0 ft. sample recovery 3.0 ft.
	18, 19	Clayey silt, reddish brown, dry, medium stiffness, traces of fine sand	ML		sample depth 18.0 ft. - 21.5 ft. sample recovery 3.5 ft.

PROJECT Holloman AFB DP-63 PA/SI HOLE NO. DP63-DP04

HTRW DRILLING LOG

SITE	LOCATION	HOLE NUMBER
Holloman AFB, NM	DP-63	DP63-DP04

PROJECT #	DISTRICT	INSPECTOR	SHEET
5155.0022.0001.H2000	OMAHA	Luke Darragh	3 OF 4

ELEV. (a)	DEPTH (ft.) (b)	DESCRIPTION OF MATERIALS (c)	USCS CLASS. (d)	FIELD SCREEN RESULTS (e)	REMARKS (f)
	21	Silty clay, reddish brown, dry, hard, no plasticity, caliche, trace fine sand	CL	1.53 ppm	sample depth 18.0 ft. - 21.5 ft. sample recovery 3.5 ft. sample from 20.0 ft. - 21.0 ft. for lab analysis
	22	same as above	CL	ND	sample depth 21.5 ft. - 25.0 ft. sample recovery 3.5 ft.
	23	Silty sand, brown, slight moisture, loose, fine sand, some medium sand	SM		
	24	Silty clay, brown, dry, hard, no plasticity, caliche	CL		
	25	Silty clay, olive grey, dry, stiff, white sand lenses throughout, caliche, low plasticity	CL	ND	sample depth 25.0 ft. - 28.5 ft. sample recovery 3.5 ft.
	26				
	27				
	28				
	29	same as above	CL	ND	sample depth 28.5ft. - 31.5 ft. sample recovery 3.0 ft.
	30				
	31				
	32	Silty clay, reddish brown, dry hard, sand lenses, caliche	CL	ND	sample depth 31.5 ft. - 34.0 ft. sample recovery 2.5 ft.
	33	Silt, grey, dry, soft, trace coarse, rounded sand	ML	1.00 ppm	headspace slight odor
		same as above	ML		no odor
	34	Silty clay, grey, dry, hard, sand lenses (fine), caliche			sample depth 34.0 ft. - 36.5 ft. sample recovery 2.5 ft.
	35				
	36				
	37	Silty clay, reddish brown, moist, medium stiffness, high plasticity, large clear crystals throughout, white sand lenses throughout			sample depth 36.5 ft. - 38.5 ft. sample recovery 2.0 ft.
	38				
	39	same as above			sample depth 38.5 ft. - 40.5 ft. sample recovery 2.0 ft.

PROJECT	HOLE NO.
Holloman AFB DP-63 PA/SI	DP63-DP04

HTRW DRILLING LOG

SITE	LOCATION	HOLE NUMBER
Holloman AFB, NM	DP-63	DP63-DP04

PROJECT #	DISTRICT	INSPECTOR	SHEET	OF	SHEETS
5155.0022.0001.H2000	OMAHA	Luke Darragh	4	OF	4

ELEV. (a)	DEPTH (ft.) (b)	DESCRIPTION OF MATERIALS (c)	USCS CLASS. (d)	FIELD SCREEN RESULTS (e)	REMARKS (f)
		same as above - color change to grey, large crystals	CL	ND	headspace
	41	Silty clay, greenish grey, moist, soft, high plasticity, trace fine sand	CL		sample depth 40.5 ft. - 43.5 ft. sample recovery 3.0 ft.
	42	Clayey gravel with sand, greenish grey, subrounded gravel 20 mm in size, coarse rounded sand	GC		
	43	same as above silty clay	CL		
	44	Silty clay, reddish brown, wet, high plasticity, some subrounded gravel 10 mm in size, some coarse sand	CL		sample depth 43.5 ft. - 45.5 ft. sample recovery 2.0 ft. sample from 44.0 ft. - 45.0 ft. for lab analysis
	45	Sandy silt, tan, wet, soft, fine sand, traces of clay			
	46	same as above			sample depth 45.5 ft. - 48.0 ft. sample recovery 2.5 ft.
	47	Silty sand, dark grey, wet, dense, some rounded gravel 0-10 mm in size, fine sand			
	48	Total Depth 48.0 ft.			
	49				
	50				
	51				
	52				
	53				
	54				
	55				

PROJECT	HOLE NO.
Holloman AFB DP-63 PA/SI	DP63-DP04

APPENDIX B

NMED SOIL SCREENING LEVELS REVISION 3.0

NOVEMBER 2005

Appendix A

State of New Mexico Soil Screening Levels

Table A-1 provides State of New Mexico Soil Screening Levels (SSLs), as developed by the New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB) and the Ground Water Quality Bureau Voluntary Remediation Program for 208 chemicals most commonly associated with environmental releases within the state. These NMED SSLs are derived using default exposure parameter values (as presented in Table A-2) and chemical- and State of New Mexico-specific physical parameters (as presented in Table B-1 of Appendix B). These default values are assumed to be appropriately conservative in the face of uncertainty and are likely to be protective for the majority of site conditions relevant to soil exposures within New Mexico.

However, the NMED SSLs are not necessarily protective of all known human exposure pathways, reasonable land uses or ecological threats. Thus, before applying NMED SSLs at a site, it is extremely important to compare the conceptual site model (CSM) with the assumptions upon which the NMED SSLs are predicated to ensure that the site conditions and exposure pathways match those used to develop the NMED SSLs. If this comparison indicates that the site at issue is more complex than the corresponding SSL scenarios, or that there are significant exposure pathways not accounted for by the NMED SSLs, then the NMED SSLs are insufficient for use in a defensible assessment of the site. A more detailed site-specific approach will be necessary to evaluate the additional pathways or site conditions.

Table A-1

Column 1:	The first column in Table A-1 presents the names of the chemicals for which NMED has developed SSLs.
Column 2:	The second column presents NMED SSLs predicated on residential soil exposures.
Column 3:	The third column presents indicator categories for the NMED SSL residential basis, whether predicated on carcinogenic effects (ca), noncarcinogenic effects (nc), soil saturation limits (sat) or a non-risk based "max" determination. NMED SSLs predicated on a carcinogenic endpoint reflect age-adjusted child-to-adult exposures. NMED SSLs predicated on a noncarcinogenic endpoint reflect child-only exposures. Detected concentrations above the "sat" value may indicate the presence of nonaqueous phase liquid (NAPL). For certain inorganic and semivolatile organic compounds (SVOCs) that exhibit relatively low toxicity, a non risk-based maximum concentration of 10^5 mg/kg is given when the risk-based SSL exceeds that level. These are noted as "max" in the tables.
Columns 4 and 6:	The fourth and sixth columns present NMED SSLs analogous to Column 1, with the exception that these values correspond to Industrial/Occupational and Construction worker (adult-only) exposures, respectively.
Columns 5 and 7:	The fifth and seventh columns present endpoint bases analogous to Column 3 for the Industrial/Occupational and Construction worker receptor

populations, respectively. Unlike the Residential population, noncarcinogenic endpoint notes for these receptor populations are predicated on adult-only exposures.

Column 8: The eighth column notes which chemicals are considered VOCs (for inhalation considerations). Those chemicals not considered VOCs are evaluated within the SSLs relative to inhalation of particulate emissions.

Column 9: Presents the tap water SSL for the residential scenario.

Columns 10 and 11: The ninth column presents NMED SSLs for the migration to groundwater pathway developed using a default dilution attenuation factor (DAF) of 1, which assumes no effective dilution or attenuation. These values can be considered at sites where little or no dilution or attenuation of soil leachate concentrations is expected (e.g., shallow water tables, karst topography). Column 10 presents NMED SSLs for the migration to groundwater pathway developed using a DAF of 20 to account for natural processes that reduce contaminant concentrations in the subsurface.

As noted above, separate NMED SSLs are presented for use in evaluating three discrete potential receptor populations: Residential, Industrial/Occupational, and Construction. Each NMED SSL considers incidental ingestion of soil, inhalation of volatiles (limited to those chemicals noted as volatile organic compounds [VOCs] within Table A-1) or particulate emissions from impacted soil, and dermal contact with soil.

Generally, if a contaminant is detected at a level in soil exceeding the most relevant NMED SSL, and the site-specific CSM is in general agreement with the underlying assumptions upon which the NMED SSLs are predicated, this result indicates the potential for adverse human health effects to occur. Conversely, if no contaminants are detected above the most relevant NMED SSL, this tends to indicate to the user that environmental conditions may not necessitate remedial action of the surface soil or the vadose zone.

A detection above an NMED SSL does not indicate that unacceptable exposures are, in fact, occurring. The NMED SSLs are predicated on relatively conservative exposure assumptions and an exceedance only tends to indicate the potential for adverse effects. The NMED SSLs do not account for additive exposures, whether for carcinogenic or noncarcinogenic endpoints. Section 5 of Part A addresses a methodology by which an environmental manager may determine whether further site-evaluation is warranted, however, this methodology does not replace the need for defensible risk assessment where indicated.

The NMED SSLs address a basic subset of exposures fundamental to the widest array of environmentally-impacted sites within the State of New Mexico. The NMED SSLs cannot address all relevant exposure pathways associated with all sites. The utility of the NMED SSLs depends heavily upon the understanding of site conditions as accurately reflected in the CSM and nature and extent of contamination determinations. Consideration of the NMED SSLs does not preclude the need for site-specific risk assessment in all instances

Table A-1
NMED Soil Screening Levels

Chemical	Residential Soil (mg/kg)	End-point	Industrial/ Occupational Soil (mg/kg)	End-point	Construction Worker Soil (mg/kg)	End-point	VOC	Tap Water (ug/L)	End-point	DAF 1 (mg/kg)	DAF 20 (mg/kg)
Acenaphthene	3.19E+01	sat	3.19E+01	sat	3.19E+01	sat	x	3.65E+02	nc	2.75E+00	5.49E+01
Acetaldehyde	3.39E+01	nc	1.23E+02	nc	1.11E+02	nc	x	1.72E+01	ca		
Acetone	1.26E+04	nc	5.30E+04	nc	4.26E+04	nc	x	5.48E+03	nc	9.55E-01	1.91E+01
Acrylonitrile	1.81E+00	ca	4.70E+00	ca	2.10E+01	nc	x	3.81E-01	ca	6.68E-05	1.34E-03
Acetophenone	1.48E+03	sat	1.48E+03	sat	1.48E+03	sat	x	3.65E+03	nc	8.86E-01	1.77E+01
Acrolein	6.51E-02	nc	2.37E-01	nc	2.13E-01	nc	x	4.16E-02	nc	8.55E-06	1.71E-04
Aldrin	2.84E-01	ca	1.12E+00	ca	6.99E+00	nc		3.87E-02	ca	1.42E-01	2.84E+00
Aluminum	7.78E+04	nc	1.00E+05	max	1.44E+04	nc		3.65E+04	nc	5.48E+04	1.10E+06
Anthracene	1.93E+00	sat	1.93E+00	sat	1.93E+00	sat	x	1.83E+03	nc	8.11E+01	1.62E+03
Antimony	3.13E+01	nc	4.54E+02	nc	1.24E+02	nc		1.46E+01	nc	6.61E-01	1.32E+01
Arsenic	3.90E+00	ca	1.77E+01	ca	8.52E+01	nc		4.42E-01	ca	1.46E-02	2.92E-01
Barium	5.45E+03	nc	7.83E+04	nc	1.44E+03	nc		2.56E+03	nc	1.06E+02	2.11E+03
Benzene	3.32E+00	ca	8.08E+00	ca	5.83E+01	nc	x	3.49E+00	ca	1.01E-03	2.02E-02
Benzidine	2.11E-02	ca	8.33E-02	ca	7.09E-01	ca		2.89E-03	ca	1.24E-05	2.47E-04
Benzo(a)anthracene	6.21E+00	ca	2.34E+01	ca	2.12E+02	ca		9.09E-01	ca	5.43E-01	1.09E+01
Benzo(a)pyrene	6.21E-01	ca	2.34E+00	ca	2.12E+01	ca		9.09E-02	ca		2.78E+00
Benzo(b)fluoranthene	6.21E+00	ca	2.34E+01	ca	2.12E+02	ca		9.09E-01	ca	1.68E+00	3.35E+01
Benzo(k)fluoranthene	6.21E+01	ca	2.34E+02	ca	2.12E+03	ca		9.09E+00	ca	1.68E+01	3.35E+02
Beryllium	1.56E+02	nc	2.25E+03	nc	5.62E+01	nc		7.30E+01	nc	5.77E+01	1.15E+03
a-BHC	9.02E-01	ca	3.99E+00	ca	3.00E+01	ca		1.05E-01	ca	2.13E-04	4.25E-03
b-BHC	3.16E+00	ca	1.40E+01	ca	5.39E+01	nc		3.69E-01	ca	7.61E-04	1.52E-02
g-BHC	4.37E+00	ca	1.93E+01	ca	8.09E+01	nc		5.10E-01	ca	9.08E-04	1.82E-02
1,1-Biphenyl	8.91E+01	sat	8.91E+01	sat	8.91E+01	sat	x	3.04E+02	nc	3.61E+00	7.22E+01
Bis(2-chloroethyl) ether	1.05E+00	ca	2.76E+00	ca	5.09E+01	ca	x	9.65E-02	ca	1.90E-05	3.80E-04
Bis(2-chloroisopropyl) ether	4.53E+02	sat	4.53E+02	sat	4.53E+02	sat	x	2.43E+02	nc	6.48E-02	1.30E+00
Bis(2-ethylhexyl) phthalate	3.47E+02	ca	1.37E+03	ca	4.66E+03	nc		4.74E+01	ca	1.07E+03	2.15E+04
Bis(chloromethyl) ether	1.64E-03	ca	4.05E-03	ca	8.55E-02	ca	x	5.09E-04	ca	8.96E-08	1.79E-06
Boron	1.22E+04	nc	1.00E+05	max	2.69E+04	nc		7.30E+03	nc	2.40E+01	4.81E+02
Bromobenzene	1.14E+01	nc	4.16E+01	nc	3.72E+01	nc	x	2.06E+01	nc	1.07E-02	2.15E-01
Bromodichloromethane	4.36E+00	ca	1.07E+01	ca	2.29E+02	ca	x	1.78E+00	ca	4.70E-04	9.41E-03
Bromomethane	2.73E+00	nc	1.01E+01	nc	8.95E+00	nc	x	8.66E+00	nc	1.88E-03	3.77E-02
1,3-Butadiene	3.04E-01	ca	7.27E-01	ca	1.40E+00	nc	x	1.26E+00	ca		

Chemical	Residential Soil (mg/kg)	End-point	Industrial/ Occupational Soil (mg/kg)	End-point	Construction Worker Soil (mg/kg)	End-point	VOC	Tap Water (ug/L)	End-point	DAF 1 (mg/kg)	DAF 20 (mg/kg)
2-Butanone (MEK)	4.86E-03	sat	4.86E-03	sat	4.86E-03	sat	x	7.06E+03	nc	1.27E+00	2.54E+01
tert-Butyl methyl ether (MTBE)	6.67E-03	sat	6.67E-03	sat	6.67E-03	sat	x	6.26E+03	nc		
n-Butylbenzene	6.21E+01	sat	6.21E+01	sat	6.21E+01	sat	x	2.43E+02	nc	1.08E+00	2.16E+01
sec-Butylbenzene	6.06E+01	sat	6.06E+01	sat	6.06E+01	sat	x	2.43E+02	nc	8.68E-01	1.74E+01
tert-Butylbenzene	1.06E+02	sat	1.06E+02	sat	1.06E+02	sat	x	2.43E+02	nc	8.60E-01	1.72E+01
Cadmium	3.90E+01	nc	5.64E+02	nc	1.54E+02	nc		1.83E+01		1.37E+00	2.75E+01
Carbon disulfide	1.97E+02	nc	4.60E+02	sat	4.60E+02	sat	x	1.04E+03	nc	4.03E-01	8.06E+00
Carbon tetrachloride	9.65E-01	nc	2.69E+00	ca	3.16E+00	nc	x	1.69E+00	ca	9.88E-04	1.98E-02
Chlordane	1.62E+01	ca	7.19E+01	ca	1.30E+02	nc		1.90E+00	ca	3.42E-01	6.83E+00
2-Chloroacetophenone	1.35E-02	nc	4.97E-02	nc	4.42E-02	nc	x	5.22E-02	nc	4.43E-05	8.85E-04
2-Chloro-1,3-butadiene	1.93E+00	nc	7.00E+00	nc	6.29E+00	nc	x	1.43E+01	nc	5.79E-03	1.16E-01
1-Chloro-1,1-difluoroethane	2.11E+02	sat	2.11E+02	sat	2.11E+02	sat	x	8.66E+04	nc	6.52E+01	1.30E+03
Chlorobenzene	6.44E+01	nc	2.41E+02	nc	2.12E+02	nc	x	1.06E+02	nc	5.51E-02	1.10E+00
1-Chlorobutane	2.99E+02	sat	2.99E+02	sat	2.99E+02	sat	x	2.43E+03	nc	9.84E-01	1.97E+01
Chlorodifluoromethane	2.11E+02	sat	2.11E+02	sat	2.11E+02	sat	x	9.75E+04	nc	7.33E+01	1.47E+03
Chloroethane	1.96E+01	ca	4.71E+01	ca	1.05E+03	ca	x	3.81E+01	ca	9.53E-03	1.91E-01
Chloroform	1.21E+00	ca	2.90E+00	ca	6.53E+01	ca	x	1.65E+00	ca	4.14E-04	8.28E-03
Chloromethane	6.83E+00	ca	1.65E+01	ca	8.63E+01	nc	x	1.49E+01	ca	5.12E-03	1.02E-01
b-Chloronaphthalene	3.09E+01	sat	3.09E+01	sat	3.09E+01	sat	x	4.87E+02	nc	1.25E+00	2.51E+01
o-Chloronitrobenzene	6.72E-01	nc	2.46E+00	nc	2.20E+00	nc	x	1.45E-01	nc	3.94E-05	7.88E-04
p-Chloronitrobenzene	5.37E+00	nc	2.05E+01	nc	1.78E+01	nc	x	1.20E+00	nc	3.25E-04	6.50E-03
2-Chlorophenol	7.25E+01	nc	3.06E+02	nc	2.45E+02	nc	x	3.04E+01	nc	2.36E-02	4.72E-01
2-Chloropropane	9.39E+01	nc	3.52E+02	nc	3.09E+02	nc	x	1.76E+02	nc	4.61E-02	9.21E-01
o-Chlorotoluene	7.15E+01	nc	2.02E+02	sat	2.02E+02	sat	x	1.22E+02	nc	5.23E-02	1.05E+00
Chromium III	1.00E+05	max	1.00E+05	max	1.00E+05	max		5.48E+04	nc	9.86E+07	1.97E+09
Chromium VI	2.34E+02	nc	3.40E+03	nc	2.61E+01	ca		1.10E+02	nc	2.10E+00	4.20E+01
Chrysene	9.55E-01	sat	9.55E-01	sat	9.55E-01	sat	x	2.91E+01	ca	1.74E+01	3.48E+02
Cobalt	1.52E+03	nc	2.05E+04	nc	6.10E+01	nc		7.30E+02	nc	3.31E+01	6.61E+02
Copper	3.13E+03	nc	4.54E+04	nc	1.24E+04	nc		1.46E+03	nc	5.15E+01	1.03E+03
Crotonaldehyde	3.37E+00	ca	1.67E+01	ca	5.27E+01	sat	x	3.49E-01	ca	9.20E-04	1.84E-02
Cumene (isopropylbenzene)	3.41E+01	sat	3.41E+01	sat	3.41E+01	sat	x	6.78E+02	nc	3.79E-01	7.59E+00
Cyanide	1.56E+03	nc	2.27E+04	nc	6.19E+03	nc		7.30E+02	nc	7.35E+00	1.47E+02
Cyanogen	7.68E+01	nc	2.84E+02	nc	2.52E+02	nc	x	2.43E+02	nc	5.78E-02	1.16E+00

Chemical	Residential Soil (mg/kg)	End-point	Industrial/ Occupational Soil (mg/kg)	End-point	Construction Worker Soil (mg/kg)	End-point	VOC	Tap Water (ug/L)	End-point	DAF 1 (mg/kg)	DAF 20 (mg/kg)
Cyanogen bromide	1.73E+02	nc	6.39E+02	nc	5.67E+02	nc	x	5.48E+02	nc	1.30E-01	2.60E+00
Cyanogen chloride	9.60E+01	nc	3.55E+02	nc	3.15E+02	nc	x	3.04E+02	nc	7.22E-02	1.44E+00
DDD	2.44E+01	ca	1.11E+02	ca	8.07E+02	ca		2.77E+00	ca	4.15E+00	8.30E+01
DDE	1.72E+01	ca	7.81E+01	ca	5.70E+02	ca		1.95E+00	ca	1.31E+01	2.62E+02
DDT	1.72E+01	ca	7.81E+01	ca	1.38E+02	nc		1.95E+00	ca	7.70E+00	1.54E+02
Dibenz(a,h)anthracene	6.21E-01	ca	2.34E+00	ca	2.12E+01	ca		9.09E-02	ca	5.18E-01	1.04E+01
Dibenzofuran	3.66E+01	sat	3.66E+01	sat	3.66E+01	sat	x	1.22E+01	nc	1.44E-01	2.87E+00
1,2-Dibromo-3-chloropropane	1.03E+00	nc	4.52E+00	nc	3.51E+00	nc	x	3.47E-01	nc	7.49E-05	1.50E-03
Dibromochloromethane	4.42E+00	ca	1.09E+01	ca	2.30E+02	ca	x	1.32E+00	ca	1.16E-03	2.32E-02
1,2-Dibromoethane	1.82E-01	ca	4.49E-01	ca	9.49E+00	ca	x	5.53E-02	ca	1.33E-05	2.66E-04
1,4-Dichloro-2-butene	4.29E-02	ca	1.06E-01	ca	2.23E+00	ca	x	1.19E-02	ca	2.93E-06	5.87E-05
1,2-Dichlorobenzene	4.30E+01	sat	4.30E+01	sat	4.30E+01	sat	x	3.70E+02	nc	1.02E-01	2.04E+00
1,3-Dichlorobenzene	1.74E+02	sat	1.74E+02	sat	1.74E+02	sat	x	1.83E+02	nc	2.03E-01	4.06E+00
1,4-Dichlorobenzene	1.33E+01	ca	3.28E+01	ca	8.19E+01	sat	x	4.95E+00	ca	5.49E-03	1.10E-01
3,3-Dichlorobenzidine	1.08E+01	ca	4.26E+01	ca	3.63E+02	ca		1.47E+00	ca	1.86E-03	3.71E-02
Dichlorodifluoromethane	4.95E+01	nc	1.80E+02	nc	1.62E+02	nc	x	3.95E+02	nc	2.97E-01	5.94E+00
1,1-Dichloroethane	3.00E+02	nc	1.12E+03	nc	9.88E+02	nc	x	8.11E+02	nc	2.01E-01	4.03E+00
1,2-Dichloroethane	1.82E+00	ca	4.42E+00	ca	1.83E+01	nc	x	1.22E+00	ca	2.48E-04	4.97E-03
cis-1,2-Dichloroethene	2.49E+01	nc	9.24E+01	nc	8.17E+01	nc	x	6.08E+01	nc	1.50E-02	3.00E-01
trans-1,2-Dichloroethene	3.71E+01	nc	1.37E+02	nc	1.22E+02	nc	x	1.22E+02	nc	3.63E-02	7.26E-01
1,1-Dichloroethene	6.41E+01	nc	2.36E+02	nc	2.10E+02	nc	x	3.39E+02	nc	1.33E-01	2.67E+00
2,4-Dichlorophenol	1.83E+02	nc	2.05E+03	nc	6.99E+02	nc		1.10E+02	nc	4.31E-02	8.63E-01
1,2-Dichloropropane	1.90E+00	ca	4.60E+00	ca	1.08E+01	nc	x	1.63E+00	ca	4.11E-04	8.22E-03
1,3-Dichloropropene	4.36E+00	ca	1.08E+01	ca	2.87E+01	nc	x	3.90E+00	ca	1.28E-03	2.57E-02
Dicyclopentadiene	1.98E-01	nc	7.19E-01	nc	6.47E-01	nc	x	4.17E-01	nc	4.50E-04	9.01E-03
Dieldrin	3.04E-01	ca	1.20E+00	ca	1.02E+01	ca		4.15E-02	ca	1.34E-03	2.68E-02
Diethyl phthalate	4.89E+04	nc	1.00E+05	max	1.00E+05	max		2.92E+04	nc	1.77E+01	3.54E+02
Dimethyl phthalate	1.00E+05	max	1.00E+05	max	1.00E+05	max		3.65E+05	nc	8.36E+01	1.67E+03
Di-n-butyl phthalate	6.11E+03	nc	6.84E+04	nc	2.33E+04	nc		3.65E+03	nc	1.86E+02	3.72E+03
2,4-Dimethylphenol	1.22E+03	nc	1.37E+04	nc	4.66E+03	nc		7.30E+02	nc	3.55E-01	7.11E+00
2,4-Dimethylphenol	6.11E+00	nc	6.84E+01	nc	2.33E+01	nc		3.65E+00	nc	3.93E-03	7.85E-02
4,6-Dinitro-o-cresol	1.22E+02	nc	1.37E+03	nc	4.66E+02	nc		7.30E+01	nc	5.25E-02	1.05E+00

Chemical	Residential Soil (mg/kg)	End-point	Industrial/ Occupational Soil (mg/kg)	End-point	Construction Worker Soil (mg/kg)	End-point	VOC	Tap Water (ug/L)	End-point	DAF 1 (mg/kg)	DAF 20 (mg/kg)
2,4-Dinitrotoluene	1.22E+02	nc	1.37E+03	nc	4.66E+02	nc		7.30E+01	nc	2.31E-02	4.62E-01
1,2-Diphenylhydrazine	6.08E+00	ca	2.39E+01	ca	2.04E+02	ca		8.30E-01	ca	4.48E-03	8.95E-02
Endosulfan	3.67E+02	nc	4.10E+03	nc	1.40E+03	nc		2.19E+02	nc	7.41E-01	1.48E+01
Endrin	1.83E+01	nc	2.05E+02	nc	6.99E+01	nc		1.10E+01	nc	2.04E-01	4.08E+00
Epichlorohydrin	6.13E+00	nc	2.29E+01	nc	2.02E+01	nc	x	2.03E+00	nc	3.62E-04	7.25E-03
Ethyl acetate	1.09E+04	nc	2.10E+04	sat	2.10E+04	sat	x	5.48E+03	nc	1.44E+00	2.87E+01
Ethyl acrylate	8.61E-01	ca	2.07E+00	ca	4.62E+01	ca	x	2.30E+00	ca	6.01E-03	1.20E-01
Ethyl chloride	1.96E+01	ca	4.71E+01	ca	1.05E+03	ca	x	3.81E+01	ca	9.53E-03	1.91E-01
Ethyl ether	1.94E+03	sat	1.94E+03	sat	1.94E+03	sat	x	1.22E+03	nc	2.37E-01	4.73E+00
Ethyl methacrylate	5.27E+01	sat	5.27E+01	sat	5.27E+01	sat	x	5.48E+02	nc	1.44E+00	2.88E+01
Ethylbenzene	1.28E+02	sat	1.28E+02	sat	1.28E+02	sat	x	1.34E+03	nc	1.01E+00	2.03E+01
Ethylene oxide	1.18E+00	ca	3.13E+00	ca	5.74E+01	ca	x	2.41E-01	ca	4.27E-05	8.54E-04
Fluoranthene	2.29E+03	nc	2.44E+04	nc	8.73E+03	nc		1.46E+03	nc	2.35E+02	4.69E+03
Fluorene	3.97E+01	sat	3.97E+01	sat	3.97E+01	sat	x	2.43E+02	nc	5.08E+00	1.02E+02
Fluoride	4.68E+03	nc	6.77E+04	nc	1.85E+04	nc		2.19E+03	nc	3.29E+02	6.58E+03
Furan	1.76E+00	nc	6.51E+00	nc	5.78E+00	nc	x	6.08E+00	nc	1.32E-03	2.65E-02
Heptachlor	1.08E+00	ca	4.26E+00	ca	3.63E+01	ca		1.47E-01	ca	3.12E-01	6.24E+00
Hexachlorobenzene	3.04E+00	ca	1.20E+01	ca	1.02E+02	ca		4.15E-01	ca	3.43E-02	6.86E-01
Hexachloro-1,3-butadiene	1.22E+01	nc	1.37E+02	nc	4.66E+01	nc		7.30E+00	nc	5.90E-01	1.18E+01
Hexachlorocyclopentadiene	3.66E+02	nc	4.10E+03	nc	4.31E+02	nc		2.19E+02	nc	6.58E+01	1.32E+03
Hexachloroethane	6.11E+01	nc	6.84E+02	nc	2.33E+02	nc		3.65E+01	nc	1.04E-01	2.09E+00
n-Hexane	3.80E+01	sat	3.80E+01	sat	3.80E+01	sat	x	4.16E+02	nc	8.78E-01	1.76E+01
HMX	3.06E+03	nc	3.42E+04	nc	1.17E+04	nc		1.83E+03	nc	5.39E+00	1.08E+02
Hydrogen cyanide	7.05E+00	nc	2.57E+01	nc	2.30E+01	nc	x	6.20E+00	nc	1.24E-03	2.47E-02
Indeno(1,2,3-c,d)pyrene	6.21E+00	ca	2.34E+01	ca	2.12E+02	ca		9.09E-01	ca	4.73E+00	9.46E+01
Iron	2.35E+04	nc	1.00E+05	max	9.29E+04	nc		1.10E+04	nc	2.77E+02	5.54E+03
Isobutanol	8.44E+03	nc	2.26E+04	sat	2.26E+04	sat	x	1.83E+03	nc	4.86E-01	9.72E+00
Isophorone	5.12E+03	ca	2.02E+04	ca	4.66E+04	nc		6.99E+02	ca	1.70E-01	3.40E+00
Lead	4.00E+02	IEUBK	8.00E+02	IEUBK	8.00E+02	IEUBK					
Lead (tetraethyl-)	6.11E-03	nc	6.84E-02	nc	2.38E-02	nc		3.65E-03	nc	6.33E-07	1.27E-05
Maleic hydrazide	9.30E+02	nc	1.61E+03	sat	1.61E+03	sat	x	3.04E+03	nc	8.17E-01	1.63E+01
Manganese	1.02E+04	nc	1.00E+05	max	1.51E+02	nc		5.11E+03	nc	3.34E+02	6.67E+03

Chemical	Residential Soil (mg/kg)	End-point	Industrial/ Occupational Soil (mg/kg)	End-point	Construction Worker Soil (mg/kg)	End-point	VOC	Tap Water (ug/L)	End-point	DAF 1 (mg/kg)	DAF 20 (mg/kg)
Mercury (elemental)	1.00E+05	max	1.00E+05	max	9.27E+02	nc			ca	1.05E-01	2.09E-03
Mercury (methyl)	6.11E+00	nc	6.84E+01	nc	2.38E+01	nc		3.65E+00	nc	8.37E-04	1.67E-02
Methacrylonitrile	1.83E+00	nc	8.08E+00	nc	6.25E+00	nc	x	1.04E+00	nc	1.83E-04	3.65E-03
Methomyl	2.65E+01	nc	9.72E+01	nc	8.68E+01	nc	x	1.52E+02	nc	5.90E-02	1.18E+00
Methyl acetate	1.94E+04	nc	8.64E+04	nc	6.62E+04	nc	x	6.08E+03	nc	1.08E+00	2.15E+01
Methyl acrylate	2.91E+01	nc	1.06E+02	nc	9.51E+01	nc	x	1.83E+02	nc	4.76E-01	9.52E+00
Methyl isobutyl ketone	4.36E+03	nc	7.01E+03	sat	7.01E+03	sat	x	1.99E+03	nc	7.35E-01	1.47E+01
Methyl methacrylate	1.52E+03	nc	2.92E+03	sat	2.92E+03	sat	x	1.42E+03	nc	2.76E-01	5.52E+00
Methyl styrene (alpha)	2.17E+02	sat	2.17E+02	sat	2.17E+02	sat	x	4.26E+02	nc	3.09E-01	6.17E+00
Methyl styrene (mixture)	5.30E+01	nc	2.10E+02	nc	1.77E+02	nc	x	5.48E+01	nc	3.97E-02	7.93E-01
Methylcyclohexane	7.89E+01	sat	7.89E+01	sat	7.89E+01	sat	x	5.23E+03	nc	2.95E+01	5.89E+02
Methylene bromide	4.22E+01	nc	1.60E+02	nc	1.39E+02	nc	x	6.08E+01	nc	1.31E-02	2.62E-01
Methylene chloride	6.47E+01	ca	1.61E+02	ca	2.63E+03	sat	x	4.22E+01	ca	8.53E-03	1.71E-01
Molybdenum	3.91E+02	nc	5.68E+03	nc	1.55E+03	nc		1.83E+02	nc	3.70E+00	7.41E+01
Naphthalene	2.52E+01	nc	9.25E+01	nc	8.25E+01	nc	x	6.20E+00	nc	1.97E-02	3.94E-01
Nickel	1.56E+03	nc	2.25E+04	nc	5.61E+02	nc		7.30E+02	nc	4.77E+01	9.53E+02
Nitrate	1.00E+05	max	1.00E+05	max	1.00E+05	max		5.84E+04	nc	1.71E+01	3.43E+02
Nitrite	7.82E+03	nc	1.00E+05	max	3.10E+04	nc		3.65E+03	nc	7.63E-01	1.53E+01
Nitrobenzene	1.29E+01	nc	6.24E+01	nc	4.48E+01	nc	x	3.40E+00	nc	9.18E-04	1.84E-02
Nitroglycerin	3.47E+02	ca	1.37E+03	ca	1.17E+04	ca		4.74E+01	ca	2.81E-02	5.63E-01
N-Nitrosodiethylamine	3.24E-02	ca	1.28E-01	ca	1.09E+00	ca		4.42E-03	ca	8.73E-06	1.75E-04
N-Nitrosodimethylamine	9.54E-02	ca	3.76E-01	ca	1.86E+00	nc		1.30E-02	ca	1.22E-05	2.44E-04
N-Nitrosodi-n-butylamine	1.99E-01	ca	5.23E-01	ca	9.53E+00	ca	x	1.99E-02	ca	5.27E-05	1.05E-03
N-Nitrosodiphenylamine	7.40E+01	sat	7.40E+01	sat	7.40E+01	sat		1.35E+02	ca	2.86E-01	5.71E+00
N-Nitrosopyrrolidine	2.32E+00	ca	9.12E+00	ca	7.77E+01	ca		3.16E-01	ca	1.30E-04	2.60E-03
m-Nitrotoluene	4.73E+02	nc	5.69E+02	sat	5.69E+02	sat	x	1.22E+02	nc	3.30E-02	6.59E-01
o-Nitrotoluene	5.11E+00	ca	1.35E+01	ca	2.48E+02	ca	x	4.81E-01	ca	1.30E-04	2.61E-03
p-Nitrotoluene	6.91E+01	ca	1.83E+02	ca	5.69E+02	sat	x	6.51E+00	ca	1.76E-03	3.53E-02
Pentachlorobenzene	4.89E+01	nc	5.47E+02	nc	1.86E+02	nc		2.92E+01	nc	9.38E-02	1.88E+00
Pentachlorophenol	2.98E+01	ca	1.00E+02	ca	1.02E+03	ca		5.53E+00	ca	5.87E-03	1.17E-01
Phenanthrene	1.83E+03	nc	2.05E+04	nc	6.99E+03	nc		1.10E+03	nc	2.32E+01	4.64E+02
Phenol	1.83E+04	nc	1.00E+05	max	6.99E+04	nc		1.10E+04	nc	2.37E+00	4.74E+01

Chemical	Residential Soil (mg/kg)	End-point	Industrial/ Occupational Soil (mg/kg)	End-point	Construction Worker Soil (mg/kg)	End-point	VOC	Tap Water (ug/L)	End-point	DAF 1 (mg/kg)	DAF 20 (mg/kg)
Polychlorinatedbiphenyls											
Aroclor 1016	3.93E+00	nc	4.13E+01	nc	1.50E+01	nc		2.56E+00	nc	1.73E-01	3.45E+00
Aroclor 1221	1.12E+00	nc	8.26E+00	ca	4.28E+00	nc		3.32E-01	ca	2.24E-02	4.47E-01
Aroclor 1232	1.12E+00	nc	8.26E+00	ca	4.28E+00	nc		3.32E-01	ca	2.24E-02	4.47E-01
Aroclor 1242	1.12E+00	nc	8.26E+00	ca	4.28E+00	nc		3.32E-01	ca	2.24E-02	4.47E-01
Aroclor 1248	1.12E+00	nc	8.26E+00	ca	4.28E+00	nc		3.32E-01	ca	2.64E-01	5.28E+00
Aroclor 1254	1.12E+00	nc	8.26E+00	ca	4.28E+00	nc		3.32E-01	ca	2.64E-01	5.28E+00
Aroclor 1260	1.12E+00	nc	8.26E+00	ca	4.28E+00	nc		3.32E-01	ca	2.64E-01	5.28E+00
n-Propylbenzene	6.21E+01	sat	6.21E+01	sat	6.21E+01	sat	x	2.43E+02	nc	1.08E+00	2.16E+01
Propylene oxide	1.63E+01	ca	5.71E+01	ca	3.16E+02	nc	x	2.18E+00	ca	4.60E-04	9.20E-03
Pyrene	2.13E+01	sat	2.13E+01	sat	2.13E+01	sat	x	1.83E+02	nc	2.88E+01	5.76E+02
RDX	4.42E+01	ca	1.74E+02	ca	6.99E+02	nc		6.03E+00	ca	1.68E-03	3.36E-02
Selenium	3.91E+02	nc	5.68E+03	nc	1.55E+03	nc		1.83E+02	nc	9.53E-01	1.91E+01
Silver	3.91E+02	nc	5.68E+03	nc	1.55E+03	nc		1.83E+02	nc	1.57E+00	3.14E+01
Strontium	4.69E+04	nc	1.00E+05	max	1.00E+05	max		2.19E+04	nc	7.73E+02	1.55E+04
Styrene	4.21E+02	sat	4.21E+02	sat	4.21E+02	sat	x	1.62E+03	nc	2.20E+00	4.40E+01
1,2,4,5-Tetrachlorobenzene	1.83E+01	nc	2.05E+02	nc	6.99E+01	nc		1.10E+01	nc	2.14E-02	4.29E-01
1,1,1,2-Tetrachloroethane	1.56E+01	ca	3.86E+01	ca	8.09E+02	ca	x	4.27E+00	ca	1.34E-03	2.68E-02
1,1,2,2-Tetrachloroethane	2.00E+00	ca	4.94E+00	ca	1.04E+02	ca	x	5.46E-01	ca	1.72E-04	3.44E-03
Tetrachloroethene	3.52E+00	ca	8.56E+00	ca	9.93E+01	sat	x	4.32E+00	ca	2.15E-03	4.29E-02
Thallium	5.16E+00	nc	7.49E+01	nc	2.04E+01	nc		2.41E+00	nc	1.72E-01	3.43E+00
Toluene	2.52E+02	sat	2.52E+02	sat	2.52E+02	sat	x	7.23E+02	nc	3.47E-01	6.93E+00
Toxaphene	4.42E+00	ca	1.74E+01	ca	1.48E+02	ca		6.03E-01	ca	2.33E-01	4.65E+00
Tribromomethane	4.11E+02	ca	1.34E+03	ca	2.75E+03	nc		2.44E+01	ca	1.73E-01	3.47E+00
1,1,2-Trichloro-1,2,2-trifluoroethane	3.28E+03	sat	3.28E+03	sat	3.28E+03	sat	x	5.92E+04	nc	1.76E+02	3.53E+03
1,2,4-Trichlorobenzene	2.25E+01	nc	8.34E+01	nc	7.38E+01	nc	x	7.16E+00	nc	2.04E-02	4.08E-01
1,1,1-Trichloroethane	5.63E+02	sat	5.63E+02	sat	5.63E+02	sat	x	3.17E+03	nc	1.34E+00	2.68E+01
1,1,2-Trichloroethane	3.90E+00	ca	9.52E+00	ca	6.60E+01	nc	x	1.97E+00	ca	4.98E-04	9.96E-03
Trichloroethylene	2.26E-01	ca	5.45E-01	ca	1.21E+01	ca	x	2.77E-01	ca	1.31E-04	2.62E-03
Trichlorofluoromethane	1.82E+02	nc	6.65E+02	nc	5.96E+02	nc	x	1.29E+03	nc	1.15E+00	2.30E+01
2,4,5-Trichlorophenol	6.11E+03	nc	6.84E+04	nc	2.33E+04	nc		3.65E+03	nc	7.13E+00	1.43E+02
2,4,6-Trichlorophenol	6.11E+00	nc	6.84E+01	nc	2.33E+01	nc		3.65E+00	nc	7.13E-03	1.43E-01

Chemical	Residential Soil (mg/kg)	End-point	Industrial/ Occupational Soil (mg/kg)	End-point	Construction Worker Soil (mg/kg)	End-point	VOC	Tap Water (ug/L)	End-point	DAF 1 (mg/kg)	DAF 20 (mg/kg)
1,1,2-Trichloropropane	4.08E+01	nc	1.61E+02	nc	1.36E+02	nc	x	3.04E+01	nc	7.65E-03	1.53E-01
1,2,3-Trichloropropane	1.82E-01	ca	4.50E-01	ca	9.50E+00	ca	x	5.53E-02	ca	1.39E-05	2.78E-04
1,2,3-Trichloropropene	2.63E+00	nc	9.58E+00	nc	8.60E+00	nc	x	2.10E+00	nc	5.29E-04	1.06E-02
Triethylamine	1.98E+01	nc	7.94E+01	nc	6.61E+01	nc	x	1.21E+01	nc	2.14E-03	4.29E-02
1,2,4-Trimethylbenzene	1.77E+01	nc	6.45E+01	nc	5.79E+01	nc	x	1.23E+01	nc	7.09E-02	1.42E+00
1,3,5-Trimethylbenzene	7.54E+00	nc	2.74E+01	nc	2.46E+01	nc	x	1.23E+01	nc	1.78E-02	3.55E-01
2,4,6-Trinitrotoluene	3.06E+01	nc	3.42E+02	nc	1.17E+02	nc		1.83E+01	nc	5.34E-02	1.07E+00
Vanadium	7.82E+01	nc	1.14E+03	nc	3.10E+02	nc		3.65E+01	nc	3.65E+01	7.30E+02
Vinyl acetate	3.30E+02	nc	1.20E+03	nc	1.08E+03	nc	x	4.12E+02	nc	7.57E-02	1.51E+00
Vinyl bromide	8.65E-01	ca	2.07E+00	ca	6.15E+00	nc	x	1.18E+00	ca	4.73E-04	9.45E-03
Vinyl chloride (Child)	1.04E+00	ca					x	4.28E-01	ca	1.43E-04	2.86E-03
Vinyl chloride (adult)	2.02E+00	ca	5.48E+00	ca	8.07E+01	nc	x	8.33E-01	ca	2.78E-04	5.57E-03
m-Xylene	1.01E+02	nc	1.32E+02	sat	1.32E+02	sat	x	2.03E+02	nc	1.66E-01	3.33E+00
o-Xylene	1.32E+02	sat	1.32E+02	sat	1.32E+02	sat	x	7.30E+03	nc	5.43E+00	1.09E+02
Xylenes	1.02E+02	nc	1.33E+02	sat	1.33E+02	sat	x	2.03E+02	nc	1.67E-01	3.34E+00
Zinc	2.35E+04	nc	1.00E+05	max	9.29E+04	nc		1.10E+04	nc	6.82E+02	1.36E+04

Table A-2

Default Exposure Factors			
Symbol	**Definition (units)**	**Default**	**Reference**
CSF_o	Cancer slope factor oral $(mg/kg\text{-}day)^{-1}$	Chem.-spec.	IRIS, HEAST, or NCEA
CSF_i	Cancer slope factor inhaled $(mg/kg\text{-}day)^{-1}$	Chem.-spec.	IRIS, HEAST, or NCEA
RfD_o	Reference dose oral (mg/kg-day)	Chem.-spec.	IRIS, HEAST, or NCEA
RfD_i	Reference dose inhaled (mg/kg-day)	Chem.-spec.	IRIS, HEAST, or NCEA
TR	Target cancer risk	1E-05	NMED-specific value
THQ	Target hazard quotient	1	US EPA, 1989
BW	Body weight (kg)		
	-- adult	70	US EPA, 1989
	-- child	15	US EPA, 1991
AT	Averaging time (days)		
	-- carcinogens	25550	US EPA, 1989
	-- noncarcinogens	ED*365	
SA	Exposed surface area for soil/dust (cm^2/day)		US EPA, 1989
	– adult resident	5700	US EPA, 1996a
	– adult worker	3300	US EPA, 1996a
	-- child	2800	US EPA, 1989
AF	Adherence factor, soils (mg/cm^2)		US EPA, 1989
	– adult resident	0.07	US EPA, 1996a
	– adult worker	0.2	US EPA, 1996a
	-- child resident	0.2	US EPA, 1989
	– construction worker	0.3	NMED-specific value
ABS	Skin absorption defaults (unitless):		
	– semi-volatile organics	0.1	US EPA, 1989
	– volatile organics	na	US EPA, 2003a
	– inorganics	na	US EPA, 2000s
IRA	Inhalation rate (m^3/day)		
	-- adult resident	20	US EPA, 1991
	– adult worker	20	US EPA, 2001a
	-- child resident	10	Exposure Factors, (US EPA, 1997)
IRW	Drinking water ingestion rate (L/day)		
	-- adult	2.4	US EPA, 1997
	-- child	1.5	US EPA, 1997
IRS	Soil ingestion (mg/day)		
	-- adult resident	100	US EPA, 1991
	-- child resident	200	US EPA, 1991
	-- commercial/industrial worker	100	US EPA, 2001a
	construction worker	330	US EPA, 1991
EF	Exposure frequency (days/yr)		
	-- residential	350	US EPA, 1991
	-- commercial/industrial	225	US EPA, 2001a
	– construction worker	250	NMED-specific value
ED	Exposure duration (years)		
	-- residential	30[a]	US EPA, 1991)
	-- child	6	(US EPA, 1991)
	-- commercial/industrial	25	(US EPA, 1999)
	– construction worker	1	NMED-specific value
	Age-adjusted factors for carcinogens		
IFSadj	Ingestion factor, soils ([mg-yr]/[kg-day])	114	US EPA, 2001a
SFSadj	Dermal factor, soils ([mg-yr]/[kg-day])	360	US EPA, 2001a
InhFadj	Inhalation factor, air ([m^3-yr]/[kg-day])	11	By analogy to RAGS: Part B, (US
IFWadj	Ingestion factor, water ([L-yr]/[kg-day])	1.1	By analogy to RAGS: Part B, (US
PEF	Particulate emission factor (m^3/kg)	Chem.-spec.	US EPA, 2001a
VFs	Volatilization factor for soil (m^3/kg)	Chem.-spec.	US EPA, 2001a
Csat	Soil saturation concentration (mg/kg)	Chem.-spec.	US EPA, 2001a

[a]Exposure duration for lifetime residents is assumed to be 30 years total. For carcinogens, exposures are combined for children (6 years) and adults (24 years).
Chem.-spec.- Chemical-specific value
na - not applicable
RAGS – Risk Assessment Guidance for Superfund
IRIS – Integrated Risk Information System, USEPA, 2003b
HEAST – Health Effects Assessment Summary Tables, USEPA, 1997
NCEA – National Center for Environmental Assessment, Office of Research and Development (USEPA, 2003c)
NMED – New Mexico Environment Department

APPENDIX C

SECTION 5.0

DRAFT REPORT FOR THE REMEDIAL INVESTIGATION OF DP-63 – DISPOSAL PIT 63

FOSTER WHEELER ENVIRONMENTAL CORPORATION

DECEMBER 2002

Section 5.0 Nature and Extent of Contamination
Figure 2-1
Boring Logs
Well Construction Diagrams

5.0 NATURE AND EXTENT OF CONTAMINATION

An evaluation of the nature and extent of contamination at the East, West, and North areas is based on results of the PA/SI (Foster Wheeler Environmental 2001), field observations, and recent analytical results for soil and groundwater sampling from the RI. A summary of the sample results is presented below for the following media·

- Soil sampled during the PA/SI and RI
- Groundwater collected at DPT locations and from monitoring wells during the PA/SI and RI

Tables 5-1 and 5-4 present a summary of soil and groundwater results for the PA/SI, and Tables 5-2 and 5-5 present a summary of soil and groundwater sample results for the RI Table 5-3 summarizes the lithology and soil metals results by exceeding background area for the RI.

The analytical data were validated according to the EPA's Contract Laboratory Program National Functional Guidelines for Inorganic and Organic Data Review (EPA 1994a, 1994b). The results of the data validation effort are presented in Appendix A. none of the data were rejected based on the results of the validation All data were deemed usable for the purposes of this report.

5.1 FIELD OBSERVATIONS

The presence of metallic shards, shell casings, berms and disturbed ground was consistent with descriptions presented in the PA/SI.

No free product or sheen was observed in samples or cuttings from any of the DP-63 boring or drilling locations (Figure 2-1). Staining was noted on boring log forms (Appendix B) and its presence is summarized here. Minor amounts of black (organic) material or staining were noted in four borings: black "spots" were noted at DP06 at approximately 15 ft bgs, black lenses of organic material less than 5 millimeters (mm) thick were noted at DP08 at approximately 48 5 ft bgs, black organic patches ("flecks" or "spots") were noted at approximately 9 ft at DP-13 and at approximately 19 ft bgs and 37 ft bgs at DP14, and black patches less than 2 mm in diameter were noted at 19 ft bgs at DP17. Rust-colored oxidation patches were common at depth in samples throughout the area These examples of staining could all be the result of naturally occurring organic material and localized oxidizing conditions

None of the samples or cuttings at DP-63 had a distinctive odor that would indicate contamination Headspace photoionization detector/flame ionization detector (PID/FID) readings were taken multiple times (at 3- to 10-ft intervals) at each DPT location. Headspace, breathing zone, and cutting readings were

also taken during auger drilling operations PID/FID readings are presented in Appendix B. Headspace PID/FID readings ranged from background to a maximum of 15.4 parts per million above background between 37 and 38 ft bgs at DP13.

5.2 SOIL ANALYTICAL RESULTS

Analytical data for soil samples collected during the RI in July 2002 were evaluated in a manner consistent with previous investigations at Holloman AFB Comparative baseline values are used to determine whether organic and inorganic constituents present in soil and groundwater at DP-63 present any potential risks and to support recommendations for the future status of the site Comparative values appropriate for this evaluation include the following:

- Basewide background values for metals in soil
- Literature background values for metals in soil and surface materials
- Action levels for TPH in soil
- Risk-based SSLs for organic and inorganic compounds in soil

In order to evaluate and assess detected analytes that occur naturally in soil (i.e., metals), comparisons were made against Holloman AFB Basewide background values (Radian Corporation 1993a) and literature background values available for the western U S (Shacklette and Boerngen 1984) These values are shown in Table 5-2 The Basewide background value for each metals constituent was determined at the 95 percent upper tolerance limit for data collected in areas at the Base that have not been impacted by site activities

To assess petroleum contamination, the TPH action level is used. The action level for TPH in soil is 940 milligrams per kilogram (mg/kg), and the sum of GRO, ORO, and DRO results for each sample is compared to the action level to determine the need for corrective action

Background values for organic compounds in soil are considered to be the method detection limit (MDL). Therefore, it is assumed that any detected organic compounds exceed background.

Risk-based SSLs for all analytes are further discussed in the human health and ecological risk assessments in Section 7 0 and Appendix C.

5.2.1 PA/SI Soil Sampling Results

Results from soil sampling conducted during the PA/SI in April 2002 are summarized in the PA/SI report for DP-63 and included here. The analytical results for metals samples are presented in Table 5-1. DP01 through DP03 were located in the East Area. DP04 was located in the West Area as shown in Figure 2-1

Metals were detected in all 12 samples and in the field duplicate sample collected during the PA/SI field investigation. Seventeen metals were detected in soil samples. aluminum, arsenic, barium, beryllium, calcium, chromium, cobalt, copper, iron, lead, potassium, magnesium, manganese, nickel, sodium, vanadium, and zinc Of the 17 metals detected in soil, 14 metals occurred at concentrations above the Basewide background values Based on evaluation criteria presented in EPA guidance for conducting site inspections (EPA 1992), only six metals (beryllium, cobalt, chromium, copper, manganese, and nickel) detected in soil were at concentrations greater than three times background values There was no apparent pattern of metals contamination in soil at DP-63, and it is likely that the sporadic occurrence of metals greater than three times background represents natural variability in soil geochemistry

TRPH was detected in 9 of the 12 soil samples and in the field duplicate sample collected during the PA/SI Soil concentrations of TRPH ranged from 37 7 to 263 mg/kg, and the highest concentration of TRPH was detected in a sample collected at the water table in the East Area at DP03 It is apparent that TRPH in soil is the result of past activities in the West and East Areas at DP-63

VOCs were detected in five samples collected in the East Area at DP01 and DP03. The VOCs detected in these soil samples included carbon disulfide, 2-butanone, and toluene (Table 5-1). At DP01, VOCs were only detected in the soil samples (including the field duplicate) collected at the water table, within the capillary fringe. At DP03, VOCs were detected in all samples collected at depths ranging from 12 ft to the water table. The contaminants detected at DP01 and DP03 are most likely due to releases at DP-63 during site activities. The VOCs may be remnants of fuels used during burning operations.

SVOCs were only detected in two samples collected at DP-63 during the PA/SI Diethylphthalate and bis(2-ethylhexyl)phthalate were the only SVOCs detected in soil samples, which were collected at a depth of 12 ft and at the water table within the capillary fringe (Table 5-1). SVOCs were only detected in samples collected at DP03 and are likely present due to burning activities at the site.

No pesticides or polychlorinated biphenyls were detected in any soil samples collected at DP-63 during the PA/SI field investigation.

Cyanide was only detected in one soil sample collected at DP-63, from DP03 at a depth of 21 ft bgs.

5.2.2 RI Soil Sampling Results

During the RI, soil samples were analyzed for VOCs, SVOCs, TAL metals, explosives, TPH, and cyanide. Sampling locations are shown in Figure 2-1, data presented in Appendix A, and summarized in Table 5-2. The analytical results are discussed below.

Metals

In general, metals are naturally occurring soil constituents, they were detected in all samples collected All 20 metals analyzed for were detected. Seventeen metals were detected in at least one sample above their respective Basewide background values: aluminum, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, potassium, sodium, vanadium and zinc. All of the soil samples that exceeded Basewide background concentrations were collected from either the surface (0 ft to 0.5 ft) or from two relatively deep depth horizons: 19 to 27 ft and 39 to 48 ft No exceedences were reported for the shallow 4 to 5 ft or 9 to 10 ft depth horizons.

The distinguishing feature between the shallow and deep depth horizons was lithology. As shown in Table 5-3, the shallow horizons are dominated by sand and the deep horizons by clay. Aluminum, a major clay-forming element, increases from a mean of 2,849 mg/kg and standard deviation of 1,192 mg/kg for the surface and shallow depth horizons to a mean of 11,835 mg/kg and standard deviation of 6,869 mg/kg in the deeper, clay-rich, depth horizons. One way to understand the effect of increasing clay content on concentration of other metals is to calculate correlation coefficients to indicate the degree to which the elements analyzed vary with aluminum contents A positive correlation indicates that as aluminum increases, so does the element in question, and a negative correlation indicates that as aluminum decreases, the element in question decreases Aluminum contents are positively correlated (correlation coefficient of 0 80 or greater) with barium, chromium, cobalt, iron, magnesium, manganese, potassium, thallium, and vanadium for the entire suite of samples. For only the deeper horizons, aluminum contents were positively correlated (correlation coefficient of 0.75 or greater) with barium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, potassium, sodium, vanadium, and zinc. Calcium (a major element in carbonate sediments and gypsum, but not clays) was negatively correlated (correlation coefficient of –0.24) with aluminum. These results suggest that as clay content increases, most metals concentrations will increase, either because these elements were incorporated into the clay structures or as a result of the formation of metal oxides the absorption of metallic ions onto the surface of the clay minerals and adjoining particles If samples used to calculate Basewide background concentrations of these elements were significantly lower in clay content than the DP-63 samples, exceedances in most

metals for DP-63 samples would be expected. The variation observed in samples from the deep zones could reflect natural variation as a function of the clay lithology.

Background exceedances for surface samples are grouped by area in Table 5-3. In the East Area, barium, copper, lead, sodium, and zinc exceeded background concentrations. In the West Area, calcium, copper, lead, nickel, and zinc exceeded background concentrations In the North Area, barium, calcium, copper, and zinc exceeded background concentrations. Of these exceedances, copper, nickel, lead, and zinc would most likely reflect affects from metallic ordnance disposal while sodium, calcium, and barium exceedances are most likely a result of naturally high concentrations of these elements in the arid, caliche-containing surface soils

When metals concentrations for both subsurface and surface samples are compared with the range found to occur naturally in soil in the western U.S. as shown in Table 5-3, there is only one sample with an analyte exceedance: 0 to 0.5 ft at DP13 (West Area) for copper (1,330 mg/kg). This elevated concentration likely represents particles of shrapnel in the soil sample as a result of past disposal operations, or leaching from the metal debris present on the surface within the study area

TPH

Petroleum hydrocarbons were detected in 10 of the 67 soil samples collected during the RI in all three study areas (East, West and North) representing surface soil and soil to depths of 21 ft Soil concentrations of the TPH as GRO, ORO, and DRO ranged from 0 068 to 390 mg/kg. There were no exceedances of the TPH action level (940 mg/kg) in any of the soil samples analyzed for the RI The highest concentration in the East Area was 0.16 mg/kg for GRO at 0 to 0.5 ft bgs at DP06. The highest concentration in the West Area of 530 mg/kg (140 mg/kg for ORO and 390 mg/kg DRO) was detected at a depth of 20 to 21 ft bgs. The highest concentration in the North Area at 7.6 mg/kg (7.5 B mg/kg DRO and 0 076 mg/kg GRO) was detected at the surface (0 to 0 5 ft bgs) at DP19.

VOCs

VOC detections are summarized in Table 5-2. Methylene chloride was detected in surface soil samples from three locations at the East Area: DP07 (3.8 mg/kg), DP08 (2.8 mg/kg) and DP09 (2.5 mg/kg). All detected values were reported with "B" qualifiers, indicating that the analyte was also detected in the laboratory method blank Methylene chloride is a common laboratory solvent used for sample extractions.

SVOCs

Two SVOCs were detected in the DPT soil samples.

Bis(2-ethylhexyl)phthalate and diethylphthalate were detected in eight soil samples collected from the East, West and North areas. The bis(2-ethylhexyl)phthalate detection occurred in the laboratory method blank, which suggests laboratory contamination Detections of diethylphthalate may be result of field sampling cross-contamination through the use of disposable sampling scoops and acetate sleeves. The most likely contamination source for non-surface soil samples would be the semi-transparent acetate sleeves that contained the DPT soil samples These sleeves were opened with stainless steel blades, and the soil in the sleeve was then scooped into sample jars

Cyanide

Two soil samples had detectable levels of cyanide DP08 at 24 to 25 ft bgs (0.199 B mg/kg), and DP09 at 4 to 5 ft bgs (0 266 B mg/kg)

5.3 GROUNDWATER ANALYTICAL RESULTS

Analytical data for groundwater samples collected during the RI in September 2002 were evaluated in a manner consistent with previous investigations at Holloman AFB Groundwater quality was evaluated by comparing the concentrations of detected constituents (metals, VOCs and TDS) with water quality standards from the New Mexico Water Quality Control Commission (NMWQCC) (20 6 2 NMAC) Where standards were not available, the concentrations of detected analytes compared with concentrations in the site upgradient well (DP63-MW01)

5.3.1 PA/SI Groundwater Sampling Results

Four groundwater samples and one field duplicate sample were collected during the PA/SI field program and were analyzed for explosives using EPA Method 8330. Explosives were not detected in any of the groundwater samples (Table 5-4).

Free-phase fuel product was not observed in groundwater samples collected during the PA/SI.

5.3.2 RI Groundwater Sampling Results

Five groundwater samples and one field duplicate sample were collected from newly installed groundwater monitoring wells (DP63-MW01, -MW02, -MW03, -MW04 and -MW05) during the RI field program As shown in Figure 2-1, MW01 is the upgradient well for the site, MW02 is collocated with DP15 in the North Area, MW03 is the downgradient well for the North Area, MW04 is collocated with DP07 in the East Area, and MW05 is the downgradient well for the East Area. Samples were analyzed for VOCs, SVOCs, explosives, TAL metals, and TDS. No SVOCs or explosives were detected in any of the samples. Analytical results for RI groundwater samples are shown in Table 5-5 Groundwater quality standards published by the NMWQCC are included in Table 5-5 for comparison.

Free-phase fuel product was not observed in any of the monitoring well samples collected during the RI field program.

Metals and TDS

Of the metals analyzed in groundwater samples from DP-63, only the standards only for iron and manganese were exceeded. Iron concentrations ranged from 1 to 2 5 times the standard (1 0 mg/L) The lowest iron concentration was at the East Area downgradient well (DP63-MW05) The highest iron concentration was at the East Area well, DP63-MW04 (collocated with boring DP07). Manganese concentrations ranged from 3 to 11 times the NMWQCC standard (0.2 mg/L). The lowest concentration was detected in the upgradient well DP63-MW01 and the highest concentration was detected in the North Area well DP63-MW02.

TDS ranged from 17,600 to 22,800 mg/L. The upgradient well, which represents background conditions for the site, had a value of 20,400 mg/L. All of these values exceeded the NMWQCC standard of 1,000 mg/L TDS also exceed the limit of 10,000 mg/L used to determine groundwater potability. Because TDS exceeds 10,000 mg/L, the NMWQCC standards do not apply to groundwater beneath DP-63

The elevated concentrations of metals in groundwater are most likely due to the saline conditions of the saline conditions of the upper water-bearing zone and the high turbidity associated with a saturated zone that is composed primarily of fine sand and sandy silts with some clay.

VOCs

Detections of VOCs were reported for acetone, benzene, carbon disulfide, chloroform, ethylbenzene, and xylenes Of the VOCs analyzed in groundwater samples collected from all wells, only benzene detected in well DP63-MW02 exceeded the NMWQCC standard. The VOCs detected in groundwater are likely due to past disposal activities at the Ammunition Storage Facility

5.4 SUMMARY OF THE NATURE AND EXTENT OF CONTAMINATION

Surface observations and geophysical survey data show that metallic debris occurs on the surface and subsurface of the North, East, and West areas. Based on the results from the PA/SI, the following investigations were conducted as part of the RI. soil samples were collected at the surface and at depth in the North, West, and East areas and analyzed for VOCs, SVOCs, TAL metals, TPH, explosives, and cyanide; and groundwater samples were collected from five monitoring wells and analyzed for VOCs, SVOCs, TAL metals, explosives, and TDS Major results of the investigations are as follows:

- Chemicals of potential concern (COPCs) identified during the RI include metals, VOCs, SVOCs, and TPH
- Field observations (lack of sheen or free product, low PID/FID readings, minor amounts of organic material, and oxidation patches) do not suggest high levels of subsurface contamination in any of the three areas.
- Explosives were not detected in soil or groundwater during any DP-63 investigations
- There is no obvious pattern to for correlating detected levels of organic analytes in soil Metals detected in soil show strong correlation to lithology type and do not indicate contamination TPH contamination in soil does not appear to be concentrated at the capillary fringe in RI samples.
- There is a lateral pattern of VOC and metal detections in groundwater in the North Area that is suggestive of contaminant migration downgradient of the disposal site

5.4.1 Soil

Metals in soil samples were elevated in comparison to Basewide background values, and appear to vary as a function of lithology as well as depth. Copper, lead, nickel and zinc detected in surface soil samples are most likely a function of surface contamination from munitions disposal Casing debris is visible at all 3 sites, yet only 1 detection of copper (1,330 mg/kg) from a surface soil sample at DP13 (West Area) exceeded the upper range of regional background from published literature for surface materials in the western U S. (by a factor of 4.4) Metals concentrations exceeding background values in clay-rich layers and elevated concentrations of sodium, barium, and calcium at the surface in caliche-containing soils are more likely a function of lithology than of contamination

The only VOC detected in soils during the RI was methylene chloride Three detections of methylene chloride were reported in surface soil in the East Area. Methylene chloride was also detected in the laboratory blank, suggesting laboratory contamination. During the PA/SI, soil samples from the East Area contained detectable concentrations of carbon disulfide, 2-butanone and toluene.

Only two SVOCs, bis(2-ethylhexyl)phthalate and diethylphthalate, were detected in soil These compounds were also the only SVOCs detected in PA/SI soil samples. The presence of these compounds in soil samples collected during the PA/SI and RI is probably attributable to laboratory and/or field sampling cross-contamination, respectively.

Petroleum hydrocarbons were detected in soil samples as ORO, GRO, and DRO from 0 ft to 27 ft bgs. Detections ranged from 0.068 mg/kg GRO at 4 to 5 ft bgs in DP05 (East Area) to 390 mg/kg DRO at 20 ft to 21 bgs in DP12 (West Area). GRO and DRO were also detected in the corresponding laboratory blanks. Unlike the PA/SI results, during the RI there were no detections of petroleum hydrocarbons in RI samples collected at the capillary fringe in any of the three areas.

Cyanide was detected in two subsurface soil samples in the East Area, and this is consistent with the results from the PA/SI during which cyanide was detected in one soil sample from the East Area at a depth of 21 ft bgs

5.4.2 Groundwater

Iron and manganese detected during the RI in groundwater exceeded their respective NMWQCC standards. Concentrations of TDS exceeded the NMWQCC of 1,000 mg/L in all five groundwater monitoring wells This is consistent with Basewide background concentrations, and PA/SI analyses. Elevated TDS is a function of the natural concentration of gypsum and other highly soluble minerals present in the natural sediments of the Tularosa Basin The groundwater beneath the Base is Class IIIB, and can be considered a potential source of drinking water, but is precluded from the NMWQCC regulations because TDS exceeds 10,000 mg/L.

VOCs detected in groundwater included acetone, benzene, carbon disulfide, chloroform, ethylbenzene and xylenes Groundwater from well DP63-MW02 contained the highest concentrations of all detected VOCs in samples, up to 4 times the concentration in the site upgradient well.

Table 5-1. Results for Analytes Detected in Soil Samples Collected During the PA/SI

Location	Depth Interval (ft)	TAL Metals (mg/kg)										
		Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron
DP63-DP01	7 - 8	2,070	NA	ND	ND	ND	NA	213,000	2 3	ND	ND	1,940
DP63-DP01	21 - 22	4,240	NA	ND	65 8	ND	NA	88,300	6 4	ND	ND	6,140
DP63-DP01	44 - 45 *	5,650	NA	ND	**94 4**	ND	NA	170,000	**7.4**	ND	ND	5,510
DP63-DP02	7 - 8	1,360	NA	ND	ND	ND	NA	196,000	ND	ND	ND	1,280
DP63-DP02	17 - 18	4,960	NA	ND	ND	ND	NA	190,000	7 3	ND	ND	4,920
DP63-DP02	46 - 47 *	6,930	NA	5 2	334	ND	NA	108,000	**8.3**	**75.7**	**21.2**	**8,890**
DP63-DP03	12 -13	4,560	NA	ND	53 5	ND	NA	142,000	6 2	ND	ND	5,130
DP63-DP03	21 - 22	5,970	NA	ND	50 4	ND	NA	190,000	6 3	ND	**6.2**	5,890
DP63-DP03	45 - 46 *	1,940	NA	ND	ND	ND	NA	76,700	3 9	ND	ND	2,690
DP63-DP04	5 - 6	4,090	NA	ND	ND	ND	NA	177,000	4 4	ND	ND	3,640
DP63-DP04	20 - 21	**19,600**	NA	**7.3**	**227**	**1.3**	NA	135,000	**22.4**	ND	**13.6**	**17,800**
DP63-DP04	44 - 45 *	7,970	NA	2 6	**120**	ND	NA	98,800	ND	ND	**4.9**	**8,050**
Base Background Values [1]		8,760	NA	6 88	84 4	0 400	NA	250,000	6 60	2 49	4 84	6,360
Literature Range for for Background Values [2]		5000 - 100000	< 1 - 2 6	< 0 1 - 97	70 - 5000	< 1 - 15	N/A N/A	600 - 320000	3 - 2000	< 3 - 50	2 - 300	1000 - 100000

Table 5-1. Results for Analytes Detected in Soil Samples Collected During the PA/SI

Location	Depth Interval (ft)	TAL Metals (mg/kg)								
		Lead	Magnesium	Manganese	Nickel	Potassium	Sodium	Thallium	Vanadium	Zinc
DP63-DP01	7 - 8	0 69	1,260	25 7	ND	ND	ND	NA	ND	5 1
DP63-DP01	21 - 22	3 6	4,410	91 7	ND	ND	1,500	NA	14	14 7
DP63-DP01	44 - 45 *	3	3,270	77 8	ND	ND	2,600	NA	ND	18 8
DP63-DP02	7 - 8	2 8	1,270	21	ND	ND	ND	NA	ND	ND
DP63-DP02	17 - 18	3 5	2,970	74 5	ND	1,260	1,540	NA	ND	15 1
DP63-DP02	46 - 47 *	**10.5**	4,340	**4,930**	**33.2**	1,270	2,480	NA	**45.9**	**22 1**
DP63-DP03	12 -13	3 5	3,950	102	ND	ND	1,390	NA	11 4	15 1
DP63-DP03	21 - 22	3 5	3,770	67 1	ND	1,520	2,290	NA	ND	**29**
DP63-DP03	45 - 46 *	2 8	1,610	59 6	ND	ND	1,560	NA	ND	9 5
DP63-DP04	5 - 6	1 8	2,300	62	ND	1,180	ND	NA	ND	10.7
DP63-DP04	20 - 21	**12.3**	9,370	**308**	**19.5**	**3,700**	3,900	NA	**37.3**	**58.4**
DP63-DP04	44 - 45 *	5 7	4,570	122	7 3	1,510	2,190	NA	**38.4**	**22.8**
Base Background Values [1]		8	14,700	165	5 61	2,500	5,000	NA	15 5	20 2
Literature Range for for Background Values [2]		< 10 - 700	300 - 100000	30 - 5000	< 5 - 700	1900 - 63000	500 - 100000	N/A N/A	7 - 500	10 - 2100

Table 5-1. Results for Analytes Detected in Soil Samples Collected During the PA/SI

Location	Depth Interval (ft)	Explosives (ug/kg)	VOCs (ug/kg)			SVOCs (ug/kg)		TRPH (mg/kg)	Cyanide (mg/kg)
			Carbon disulfide	2-Butanone	Toluene	Diethyl-phthalate	bis(2-Ethylhexyl) phthalate		
DP63-DP01	7 - 8	NA	ND	ND	ND	ND	ND	ND	ND
DP63-DP01	21 - 22	NA	ND	ND	ND	ND	ND	62 5	ND
DP63-DP01	44 - 45 *	NA	4497	1526	ND	ND	ND	41 4	ND
DP63-DP02	7 - 8	NA	ND	ND	ND	ND	ND	ND	ND
DP63-DP02	17 - 18	NA	ND	ND	ND	ND	ND	37 7	ND
DP63-DP02	46 - 47 *	NA	ND	ND	ND	ND	ND	71 4	ND
DP63-DP03	12 -13	NA	7904	2705	308	750	1500	38 5	ND
DP63-DP03	21 - 22	NA	7406	2752	328	ND	ND	79	0 26
DP63-DP03	45 - 46 *	NA	7242	2946	ND	100	ND	263	ND
DP63-DP04	5 - 6	NA	ND	ND	ND	ND	ND	ND	ND
DP63-DP04	20 - 21	NA	ND	ND	ND	ND	ND	39 7	ND
DP63-DP04	44 - 45 *	NA	ND	ND	ND	ND	ND	70 7	ND
Base Background Values [1]		NB	NB	NB	NB	NB	NB	NB	NB
Literature Range for		NB	NB	NB	NB	NB	NB	NB	NB
for Background Values [2]		NB	NB	NB	NB	NB	NB	NB	NB

Note Pesticides and PCBs were analyzed for but not detected

[1] Background values represent the 95 percent upper tolerance limit for data collected as part of the Basewide background study (Radian 1993)

Concentrations denoted in bold-face type exceed analyte-specific background values

[2] Literature values represent the concentration ranges for metals in soil within the Western conterminous United States (Shacklette and Boerngen, 1984)

* Sample collected below the water table

mg/kg - Milligrams per kilogram

N/A - Background value(s) not available

NA - Not analyzed

NB - No background values available

ND - Analyte not detected above the method reporting limit

SVOCs - Semivolatile organic compounds

ug/kg - Micrograms per kilogram

VOCs - Volatile organic compounds

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Table 5-2. Results for Analytes Detected in Soil Samples Collected During the RI

Sample Location	Depth Interval	Metals (mg/kg)													
		Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese
DP63-DP05	0-0 5 ft	2810	ND	ND	40 1	ND	ND	178,000	3 04	ND	6 08	2240	8 43	3780	55 8
DP63-DP05	9-10 ft	2130	ND	ND	16 7	ND	ND	188,000	ND	ND	ND	1740	1 18	1040	23 4
DP63-DP05	4-5 ft	2440	ND	ND	19 1	ND	ND	204,000	ND	ND	ND	1970	1 37	1290	29
DP63-DP05	20-21 ft	6880	ND	ND	48 6	ND	ND	151,000	6 42	ND	4 46	5060	3 41	3050	52 9
DP63-DP06	0-0 5 ft	1320	ND	ND	24 7	ND	ND	213,000	ND	ND	3 54	1010	1 75	1190	25
DP63-DP06	4-5 ft	2730	ND	1 03	22 3	ND	ND	199,000	2 46	0 886 B	1 42 B	2300	1 02 B	1640	33 7
DP63-DP06	9-10 ft	1980	ND	0 916 B	17 6	ND	ND	202,000	1 69 B	ND	0 882 B	1680	0 688 B	1070	24 3
DP63-DP06	24-25 ft	28,200	ND	3 25	104	ND	ND	175,000	28 3	6.86	15.4	19,300	10 5	23,400	201
DP63-DP06	46 5-47 5 ft	12,700	ND	ND	53 1	ND	ND	94,500	12	3.82	6.05	10,200	4 61	4930	150
DP63-DP07	0-0 5 ft	2890	ND	ND	103	ND	ND	116,000	3 68	ND	57.2	2610	759	2180	75 2
DP63-DP07	4-5 ft	2740	ND	0 669 B	23 2	ND	ND	189,000	2 19 B	ND	1 2 B	2330	1 14 B	1830	32 3
DP63-DP07	9-10 ft	1,770	ND	1 74	15 2	ND	ND	193,000	1 79 B	ND	0 964 B	1560	0 637 B	1090	38 9
DP63-DP07	24-27 ft	10,200	ND	1 63	73 5	ND	ND	174,000	9 87	3.45	6 42	8450	4 58	5070	223
DP63-DP07	43-46 5 ft	7060	ND	ND	83 6	ND	ND	118,000	6 88	ND	4 31	6660	2 95	3320	85 7
DP63-DP08	0-0 5 ft	2890	ND	ND	35 8	ND	ND	157,000	2 61	ND	4 02	2200	5 52	3820	51 3
DP63-DP08	4-5 ft	2160	ND	1 42	17 7	ND	ND	192,000	2 2 B	ND	0 923 B	1990	0 679 B	1380	26
DP63-DP08	9-10 ft	2250	ND	0 527 B	16 4	ND	ND	207,000	2 00 B	ND	1 01 B	1860	0 579 B	1180	57 1
DP63-DP08	24-25 ft	15,200	ND	2 51	120	ND	ND	143,000	14 1	7.08	11	12,900	7 77	8290	331
DP63-DP08	44-45 ft	1800	ND	ND	24 3	ND	ND	250,000	ND	ND	ND	1780	ND	1140	57 8
DP63-DP09	0-0 5 ft	3370	ND	1 62	47 9	ND	ND	190,000	2 87	ND	4 89	2640	2 21	3990	59 1
DP63-DP09	4-5 ft	2170	ND	1 43	17 2	ND	ND	202,000	2 00 B	ND	0 766 B	1930	0 633 B	1180	25 7
DP63-DP09	9-10 ft	2000	ND	ND	16 3	ND	ND	190,000	1 83 B	ND	1 02 B	1820	0 625 B	1100	22
DP63-DP09	19-20 ft	23,400	ND	3 30	115	1.09 B	ND	119,000	24.8	7.1	11.7	18,300	9 23	18,900	203
DP63-DP10	0-0 5 ft	3680	ND	ND	36 7	ND	ND	100,000	3 09	ND	13 6	2900	7 71	2870	72
DP63-DP10	4-5 ft	2080	ND	1 06 B	19 1	ND	ND	206,000	2 01 B	ND	0 751 B	1870	0 455 B	1250	49 8
DP63-DP10	9-10 ft	3880	ND	0 916 B	30 7	ND	ND	184,000	3 57	1 27 B	2 4 B	3380	1 36	1800	42 2
DP63-DP10	19-20 ft	7740	ND	1 81	52 4	0 23 B	ND	173,000	7.45	2 42	4 3	6710	3 35	3410	119
DP63-DP11	0-0 5 ft	5100	ND	1 57	65 4	ND	ND	110,000	4 07	ND	9 02	3710	3 75	12700	65 6
DP63-DP11	4-5 ft	3490	ND	1 08 B	28 5	ND	ND	165,000	3 14	1 09 B	1 88 B	3160	1 41	2470	53 4
DP63-DP11	9-10 ft	4380	ND	1 31	32	ND	ND	170,000	3 61	1 36 B	2 24 B	3550	1 83	2190	76
DP63-DP11	20-21 ft	14,000	ND	1 92	75 5	ND	ND	155,000	13 1	3 58	8 17	10,300	7 16	5680	158
DP63-DP12	0-0 5 ft	650	ND	ND	24 2	ND	ND	311000	ND	ND	4 13	443	ND	2320	12 8
DP63-DP12	4-5 ft	4210	ND	ND	31 8	ND	ND	162,000	3 51	ND	2 36	3220	2 16	1850	53 1
DP63-DP12	9-10 ft	4330	ND	ND	36 8	ND	ND	148,000	3 74	ND	2 75	3390	2 28	1900	95 2
DP63-DP12	20-21 ft	11,400	ND	1 61	76 8	ND	ND	154,000	10 1	2.82	6.67	8380	5 39	4620	138
DP63-DP13	0-0 5 ft	3910	ND	ND	46 5	ND	4 83	77,200	3 94	ND	1330	5400	132	2790	88 8
DP63-DP13	4-5 ft	2590	ND	ND	20 8	ND	ND	91,500	ND	ND	ND	2050	ND	1190	32 3
DP63-DP13	9-10 ft	2620	ND	ND	21 1	ND	ND	81,200	ND	ND	ND	2040	ND	1100	47
DP63-DP13	24-27 ft	15,000	ND	1 73	129	ND	ND	205,000	13 9	3 95	8 61	11600	6 82	6570	313
DP63-DP13	39-40 ft	18,900	ND	ND	127	ND	ND	107,000	22 3	6 76	8 88	13100	7 82	6560	249
DP63-DP14	0-0 5 ft	541	ND	ND	23 2	ND	ND	290000	ND	ND	3 2	385	ND	1190	8 65
DP63-DP14	4-5 ft	1750	ND	ND	17 9	ND	ND	94,700	ND	ND	ND	1340	ND	1220	18 5
DP63-DP14	9-10 ft	3190	ND	ND	21 9	ND	ND	85,900	3 16	ND	ND	2530	1 4	1590	41 8
DP63-DP14	24-25 ft	9270	ND	0 899 B	65 4	0 204 B	ND	190,000	8 41	2 94	5 41	7410	3 73	5630	106
DP63-DP14	47-48 ft	6390	ND	ND	31 5	0 244 B	ND	233,000	6	1 78 B	2 55 B	5120	2 46	2940	70 5

Table 5-2. Results for Analytes Detected in Soil Samples Collected During the RI (Continued)

Sample Location	Depth Interval	Metals (mg/kg)						VOCs (ug/kg)	SVOCs (ug/kg)		Total Petroleum Hydrocarbons (mg/kg)			Cyanide (mg/kg)
		Nickel	Potassium	Sodium	Thallium	Vanadium	Zinc	Methylene chloride	Bis(2-ethylhexyl) phthalate	Diethyl-phthalate	Oil Range	Diesel Range	Gasoline Range	
DP63-DP05	0-0 5 ft	3 12	1220	6460	ND	5 16	12 7	ND	ND	ND	ND	ND	ND	ND
DP63-DP05	9-10 ft	ND	662	658	ND	3 84	4 9	ND	ND	ND	ND	ND	ND	ND
DP63-DP05	4-5 ft	ND	793	759	ND	4 4	6 68	ND	ND	ND	ND	ND	0 068 B	ND
DP63-DP05	20-21 ft	4 9	1870	2030	ND	15 3	18 4	ND	ND	ND	ND	ND	ND	ND
DP63-DP06	0-0 5 ft	ND	ND	1630	ND	ND	6 16	ND	ND	ND	ND	ND	0 16	ND
DP63-DP06	4-5 ft	1 9 B	898	471	ND	7 28	8 13	ND	ND	ND	ND	ND	ND	ND
DP63-DP06	9-10 ft	1 1 B	571 B	373	ND	3 41	5 6	ND	ND	ND	ND	ND	ND	ND
DP63-DP06	24-25 ft	21 7	5300	4440	ND	43 9	69.1	ND	ND	ND	ND	ND	ND	ND
DP63-DP06	46 5-47 5 ft	9.66	2390	1670	ND	19.5	26	ND	ND	ND	ND	ND	ND	ND
DP63-DP07	0-0 5 ft	ND	744	364	ND	4 98	112	3 8 J	ND	ND	ND	ND	ND	ND
DP63-DP07	4-5 ft	1 9 B	825	559	ND	6 75	8 17	ND	ND	ND	ND	ND	0 13	ND
DP63-DP07	9-10 ft	1 38 B	204 B	315	0 708 B	3 29	5 55	ND	ND	ND	ND	ND	ND	ND
DP63-DP07	24-27 ft	7 42	1880	596	ND	18 6	26 1	ND	ND	630	ND	ND	ND	ND
DP63-DP07	43-46 5 ft	4 89	1250	1290	ND	14 2	16	ND	ND	390	ND	ND	ND	ND
DP63-DP08	0-0 5 ft	ND	929	2470	ND	6 31	9 72	2 8 B	ND	ND	ND	ND	ND	ND
DP63-DP08	4-5 ft	1 14 B	550 B	364	ND	5 66	6 38	ND	ND	ND	ND	ND	ND	ND
DP63-DP08	9-10 ft	1 32 B	720	459	ND	3 68	7 91	ND	ND	ND	ND	ND	ND	ND
DP63-DP08	24-25 ft	14.1	3340	2280	ND	24.6	48.7	ND	ND	ND	ND	ND	ND	0 199 B
DP63-DP08	44-45 ft	ND	316 B	995	ND	4 33	5 23	ND	ND	ND	ND	ND	ND	ND
DP63-DP09	0-0 5 ft	2 56	1140	2470	ND	5 94	9 22	2 5 B	ND	ND	ND	ND	ND	ND
DP63-DP09	4-5 ft	1 47 B	522 B	145	ND	4 7	6 52	ND	ND	1200	ND	ND	ND	0 266 B
DP63-DP09	9-10 ft	1 28 B	575 B	354	ND	3 72	5 81	ND	ND	ND	ND	ND	ND	ND
DP63-DP09	19-20 ft	20 1	4850	3800	2 01	35.5	59.8	ND	ND	ND	ND	ND	ND	ND
DP63-DP10	0-0 5 ft	2 48	1010	260	ND	6 47	19 4	ND	ND	ND	ND	ND	ND	ND
DP63-DP10	4-5 ft	1 74 B	664	675	ND	3 7	7 12	ND	ND	ND	ND	ND	ND	ND
DP63-DP10	9-10 ft	2 97	1030	160	ND	6 03	12 3	ND	ND	560	ND	ND	ND	ND
DP63-DP10	19-20 ft	6.03	1790	1280	ND	13	21.2	ND	ND	ND	ND	ND	ND	ND
DP63-DP11	0-0 5 ft	3 45	1590	2370	ND	10 3	35 3	ND	ND	850	ND	ND	ND	ND
DP63-DP11	4-5 ft	2 91	1070	625	ND	7 04	11 5	ND	ND	ND	ND	ND	ND	ND
DP63-DP11	9-10 ft	3 07	1250	652	ND	7 85	12 1	ND	ND	ND	ND	ND	ND	ND
DP63-DP11	20-21 ft	10.1	3130	2870	ND	24 9	33.7	ND	ND	ND	ND	ND	ND	ND
DP63-DP12	0-0 5 ft	ND	ND	1880	ND	ND	24 8	ND	ND	ND	ND	ND	ND	ND
DP63-DP12	4-5 ft	3 24	1310	1360	ND	8 34	8 56	ND	ND	ND	ND	ND	ND	ND
DP63-DP12	9-10 ft	3 02	1260	1470	ND	8 05	9 38	ND	ND	ND	ND	ND	ND	ND
DP63-DP12	20-21 ft	7 8	2720	2960	ND	18.8	25 8	ND	ND	ND	140	390 B	ND	ND
DP63-DP13	0-0 5 ft	59.6	849	84 7 B	ND	7 38	1420	ND	400 B	1600	ND	3 2 B	ND	ND
DP63-DP13	4-5 ft	ND	673	747	ND	4 86	6 98	ND	ND	ND	ND	ND	ND	ND
DP63-DP13	9-10 ft	ND	781	184	ND	4 82	6	ND	ND	ND	ND	ND	ND	ND
DP63-DP13	24-27 ft	11 3	2800	2240	ND	28.6	32.7	ND	ND	ND	ND	ND	ND	ND
DP63-DP13	39-40 ft	14 1	3410	2190	ND	28	43 2	ND	ND	ND	ND	ND	ND	ND
DP63-DP14	0-0 5 ft	ND	ND	548	ND	ND	14 4	ND	ND	ND	ND	ND	ND	ND
DP63-DP14	4-5 ft	ND	478 B	903	ND	4 31	8 8	ND	ND	ND	ND	ND	ND	ND
DP63-DP14	9-10 ft	ND	888	730	ND	6 49	8 23	ND	ND	ND	ND	ND	ND	ND
DP63-DP14	24-25 ft	6 58	2070	1890	ND	15 3	23	ND	ND	ND	ND	ND	ND	ND
DP63-DP14	47-48 ft	5 08	1550	1010	ND	9 21	14 9	ND	ND	ND	ND	ND	ND	ND

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Table 5-2. Results for Analytes Detected in Soil Samples Collected During the RI (Continued)

Sample Location	Depth Interval	Metals (mg/kg)													
		Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese
DP63-DP15	0-0 5 ft	882	ND	1 35	20 2	ND	ND	254000	ND	ND	2 82	518	ND	2290	9 97
DP63-DP15	4-5 ft	2490	ND	ND	20	ND	ND	97,200	2 57	ND	ND	2130	1 38	1390	26 9
DP63-DP15	9-10 ft	3480	ND	ND	22 9	ND	ND	95,900	3 66	ND	ND	2950	1 46	1650	45 5
DP63-DP15	24-25 ft	16,000	6 73 B	3 2	109	0 73 B	ND	148,000	16.3	6 73	12 3	16,100	8 99	14100	237
DP63-DP15	47-48 ft	5980	ND	ND	66	ND	ND	215,000	5 82	1 89 B	2 61	5280	2 37	3010	87 9
DP63-DP16	0-0 5 ft	3220	ND	ND	66 8	ND	ND	225,000	2 96	ND	47 8	2370	9 1	3490	51
DP63-DP16	4-5 ft	2780	ND	ND	20 7	ND	ND	80,100	3 16	ND	ND	2570	1 43	1280	33 8
DP63-DP16	9-10 ft	2600	ND	ND	23 4	ND	ND	85,400	3 07	ND	ND	2450	ND	1280	39 4
DP63-DP16	18-21 ft	3790	ND	ND	27 2	ND	ND	104,000	4 58	ND	ND	3560	1 66	2080	48
DP63-DP17	0-0 5 ft	2070	ND	1 56	90.7	ND	ND	219,000	2 81	ND	28.3	4730	6 15	1590	46 2
DP63-DP17	4-5 ft	4460	ND	2 62	35 3	ND	ND	150,000	5 64	ND	2 41	4590	2 19	2420	75 5
DP63-DP17	9-10 ft	4790	ND	2 49	30 6	ND	ND	154,000	5 81	ND	ND	4720	1 97	2370	74 7
DP63-DP17	24-25 ft	23,300	ND	3 63	127	0 763 B	ND	172,000	22.6	7.03	13.4	20,000	9 94	13300	303
DP63-DP17	47-48 ft	10,300	3 68 B	3 94	80 3	ND	ND	70,600	10.9	3.45	5.36	9870	4 15	4290	112
DP63-DP18	0-0 5 ft	1230	ND	ND	29 8	ND	ND	247,000	ND	ND	5.36	1000	3 05	1040	20 2
DP63-DP18	4-5 ft	2690	ND	1 47	26 3	ND	ND	216,000	3 43	ND	ND	2810	2 19	2130	40 1
DP63-DP18	9-10 ft	5460	ND	2	43 2	ND	ND	103,000	5 42	ND	3 17	4290	2 36	2770	62 6
DP63-DP18	18-21 ft	6070	ND	2	43 8	ND	ND	166,000	5 84	ND	4 33	4950	2 54	3060	75
DP63-DP19	0-0 5 ft	1890	ND	ND	64 6	ND	ND	219,000	ND	ND	10 9	1710	7 37	1820	34 1
DP63-DP19	4-5 ft	2730	ND	ND	26 8	ND	ND	200,000	ND	ND	ND	1670	ND	1820	22 5
DP63-DP19	9-10 ft	5370	ND	1 15	36 1	ND	ND	110,000	4 71	ND	2 33	3550	1 78	2340	57 4
DP63-DP19	18-21 ft	6800	ND	ND	44 3	ND	ND	173,000	6 22	ND	2 72	4940	2 38	3280	67 8
Holloman AFB Background Values		8760	7 28	6 88	84 4	0 400	1 04	250,000	6 60	2 49	4 84	6360	8 00	14700	165
Literature Range for for Background Values [c]		5000 - 100,000	< 1 - 2 6	< 0 1 - 97	70 - 5000	< 1 - 15	N/A	600 - 320,000	3 - 2000	< 3 - 50	2 - 300	1000 - 100,000	< 10 - 700	300 - 100,000	30 - 5,000

Table 5-2. Results for Analytes Detected in Soil Samples Collected During the RI (Concluded)

Sample Location	Depth Interval	Metals (mg/kg)						VOCs (ug/kg)	SVOCs (ug/kg)		Total Petroleum Hydrocarbons (mg/kg)			Cyanide (mg/kg)
		Nickel	Potassium	Sodium	Thallium	Vanadium	Zinc	Methylene chloride	Bis(2-ethylhexyl) phthalate	Diethyl-phthalate	Oil Range	Diesel Range	Gasoline Range	
DP63-DP15	0-0 5 ft	ND	168 B	898	ND	2 97	4 33	ND	ND	ND	ND	5 B	ND	ND
DP63-DP15	4-5 ft	ND	647	211	ND	5 28	7 4	ND	ND	ND	ND	ND	ND	ND
DP63-DP15	9-10 ft	2 54	890	890	ND	7 09	8 55	ND	ND	ND	ND	ND	ND	ND
DP63-DP15	24-25 ft	14 7	3600	3350	ND	30.3	56 2	ND	ND	ND	ND	ND	ND	ND
DP63-DP15	47-48 ft	4 82	1420	1960	ND	12 2	15	ND	ND	ND	ND	ND	ND	ND
DP63-DP16	0-0 5 ft	2 45	839	1130	ND	6 28	87 4	ND	ND	ND	ND	ND	ND	ND
DP63-DP16	4-5 ft	ND	765	160	ND	5 98	8 19	ND	ND	1100	ND	ND	ND	ND
DP63-DP16	9-10 ft	ND	588 B	228	ND	5 79	8 06	ND	ND	ND	ND	ND	ND	ND
DP63-DP16	18-21 ft	2.96	825	921	ND	8 81	11 7	ND	ND	ND	ND	ND	0 43	ND
DP63-DP17	0-0 5 ft	3 66	492 B	417	ND	4 44	75 4	ND	ND	ND	ND	ND	ND	ND
DP63-DP17	4-5 ft	4 65	1410	1350	1.27	10 9	19 1	ND	ND	ND	ND	ND	ND	ND
DP63-DP17	9-10 ft	3 92	1250	1040	ND	10 4	13 3	ND	ND	ND	ND	ND	ND	ND
DP63-DP17	24-25 ft	17 9	5030	2760	ND	40.2	60.4	ND	ND	2600	ND	ND	ND	ND
DP63-DP17	47-48 ft	7.36	1970	2350	ND	20.9	22.9	ND	ND	ND	ND	ND	ND	ND
DP63-DP18	0-0 5 ft	ND	ND	1070	ND	2 65	24	ND	ND	ND	ND	ND	0 27	ND
DP63-DP18	4-5 ft	2 81	1000	1610	ND	8 92	10 1	ND	ND	ND	ND	ND	ND	ND
DP63-DP18	9-10 ft	3 8	1610	1310	1 75	11 9	14	ND	ND	ND	ND	ND	ND	ND
DP63-DP18	18-21 ft	3 8	1320	1280	ND	11 7	15 3	ND	ND	ND	ND	ND	ND	ND
DP63-DP19	0-0 5 ft	ND	664	557	ND	4 29	30.8	ND	ND	ND	ND	7 5 B	0 076 B	ND
DP63-DP19	4-5 ft	ND	961	1350	ND	6 36	6 66	ND	ND	ND	ND	ND	ND	ND
DP63-DP19	9-10 ft	2 79	1350	972	ND	9 33	10 9	ND	ND	ND	ND	ND	0 16	ND
DP63-DP19	18-21 ft	3 29	1540	1340	ND	11 5	14 6	ND	ND	ND	ND	ND	ND	ND
Holloman AFB Background Values		5 61	2500	5000	11 3	15 5	20 2	NB	NB	NB	NB	NB	NB	NB
Literature Range for for Background Values [2]		< 5 - 700	1900 - 63,000	500 - 100,000	N/A	7 - 500	10 - 2100	NB	NB	NB	NB	NB	NB	NB

[1] Background values represent the 95 percent upper tolerance limit for data collected as part of the Basewide background study (Radian 1993a)
Concentrations denoted in bold-face type exceed analyte-specific background values

[2] Literature values represent the concentration ranges for metals in soil within the western conterminous United States (Shacklette and Boerngen, 1984)

B - Inorganic analyte result reported at a level below the method reporting limit and above the instrument detection limit
For organic compounds, B indicates that the analyte was detected in the corresponding method blank

J - Organic analyte result reported at a level below the method reporting limit and above the instrument detection limit

mg/kg - Milligrams per kilogram

NB - No background value exists for this analyte Organic compounds are assumed to not occur naturally

ND - Analyte not detected

ug/kg - Micrograms per kilogram

Table 5-3. Summary by Area of Lithology and Metals Results for RI Soil Samples Exceeding Basewide Background

East Area

Location	Depth (ft bgs)	Lithology	Metals Greater than Background	Depth (ft bgs)	Lithology	Metals Greater than Background	Depth (ft bgs)	Lithology	Metals Greater than Background
DP05	0-0 5	caliche sandy silt	Cu, Pb, Na	20-21	silty sand/sandy silt	Al, Ni, V, Zn	--	--	--
DP06	0-0 5	caliche sandy silt	None	24-25	silty sandy clay	Al, Ba, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, K, V, Zn	46 5-47 5	sand with silty clay	Al, Ba, Cr, Co, Cu, Fe, Mn, Ni, K, V, Zn
DP07	0-0 5	caliche sandy silt	Ba, Cu, Pb, Zn	24-27	silt, sand and clay	Al, Cr, Co, Cu, Fe, Mg, Mn, Ni, V, Zn	43-46 5	sand and clay	Cr, Fe
DP08	0-0 5	caliche sandy silt	None	24-25	sandy, silty clay	Al, Ba, Cr, Co, Cu, Fe, Mn, Ni, K, V, Zn	44-45	sand (SM)	Al, Ni, V, Zn
DP09	0-0 5	caliche sandy silt	Cu, Pb, Na	19 5-21	silty, sandy clay	Al, Ba, Be, Cr, Co, Cu, Fe, Mg, Mn, Ni, K, V, Zn	--	--	--
DP10	0-0 5	caliche sandy silt	Cu, Pb, Na	20-21	sand with clay clasts	Cr, Ni, Zn	--	--	--

West Area

Location	Depth (ft bgs)	Lithology	Metals Greater than Background	Depth (ft bgs)	Lithology	Metals Greater than Background	Depth (ft bgs)	Lithology	Metals Greater than Background
DP11	0-0 5	caliche sandy silt	Cu, Zn	20-21	sandy clay	Al, Cr, Co, Cu, Fe, Ni, K, V, Zn	--	--	--
DP12	0-0 5	caliche sandy silt	Ca, Zn	20-21	low plast clay	Al, Cr, Co, Cu, Fe, Ni, V, Zn	--	--	--
DP13	0-0 5	caliche sandy silt	Ca, Cu, Pb, Ni, Zn	24-27	clay, silt and sand	Al, Ba, Mn, Ni, V, Zn	39-40	clay	Al, Be, Mn, Ni, K, V, Zn

North Area

Location	Depth (ft bgs)	Lithology	Metals Greater than Background	Depth (ft bgs)	Lithology	Metals Greater than Background	Depth (ft bgs)	Lithology	Metals Greater than Background
DP14	0-0 5	caliche sandy silt	Ca	24-25	sand with clay at 25 ft	Al, Cr, Co, Cu, Fe, Ni, Zn	47-48	silty clay with silt lenses	Al, Ni, V, Zn
DP15	0-0 5	caliche sandy silt	Ca	24-25	sand and clay	Al, Ba, Be, Cr, Co, Cu, Fe, Pb, Mn, Ni, K, V, Zn	47-48	clay and clayey silt	Al, Ni, V, Zn
DP16	0-0 5	caliche sandy silt	Cu, Zn	18-21	sand with clayey silt	Al, Ni, V, Zn	--	--	--
DP17	0-0 5	caliche sandy silt	Ba, Cu, Zn	18-21	sand with clay, silt	Al, Ba, Be, Cr, Co, Cu, Fe, Pb, Mn, Ni, K, V, Zn	47-48	mod plast clay	Al, Cr, Co, Cu, Fe, Ni, V, Zn
DP18	0-0 5	caliche sandy silt	Cu, Zn	18-21	sand, silty sand	Al, Ni, V, Zn	--	--	--
DP19	0-0 5	caliche sandy silt	Cu, Zn	18-21	silty clay with sand	Al, Ni, V, Zn	--	--	--

Table 5-4. Results for Groundwater Samples Collected During the PA/SI

DPT Location	Groundwater Depth (feet bgs)	TRPH (mg/L)	VOCs (ug/L)	SVOCs (ug/L)	Explosives (ug/L)	Pesticides/ PCBs (ug/L)	TAL Metals (mg/L)
DP63-DP01	45	NA	NA	NA	ND	NA	NA
DP63-DP02	46	NA	NA	NA	ND	NA	NA
DP63-DP03	46	NA	NA	NA	ND	NA	NA
DP63-DP04	41	NA	NA	NA	ND	NA	NA

bgs - Below ground surface
mg/L - Milligrams per liter
NA - Not analyzed
ND - Analyte not detected above method reporting limit
PCB - Polychlorinated biphenyl
SVOC - Semivolatile organic compound
TAL - Target analyte list
TRPH - Total recoverable petroleum hydrocarbons
ug/L - Micrograms per liter
VOC - Volatile organic compound

Table 5-5. Results for Analytes Detected in Groundwater Samples Collected During the RI

Sample Location	DP63-MW01	DP63-MW02	DP63-MW03	DP63-MW04	DP63-MW05	NMWQCC Standard [1]
Metals (mg/L)						
Aluminum	1 67	1 4	ND	1 51	0 837	5 0
Arsenic	0 0042 B	0 0045 B	ND	ND	ND	0 1
Barium	0 0342	0 062	0 0402	0 0495	0 0414	1 0
Calcium	737	1030	750	731	782	NS
Cobalt	ND	0 0222	0 0119 B	ND	ND	0 05
Copper	0 0109	0 0121	0 0053 B	0 0145	0 0081 B	NS
Iron	**1 63**	**1.48**	0 081 B	**2.53**	**1.02**	1 0
Lead	ND	ND	ND	0 0028 B	ND	0 05
Magnesium	1170	756	1150	1410	1220	NS
Manganese	**0.604**	**2.2**	**0.733**	**1.18**	**1.1**	0.2
Nickel	0 0153 B	0 0169 B	0 0208	0 0184 B	0 0173 B	0.2
Potassium	11 8	13 7	19 1	13 7	13 4	NS
Selenium	ND	ND	ND	ND	0 0052 B	0 05
Sodium	3570	3230	3820	3890	3860	NS
Thallium	ND	ND	0 0069 B	ND	ND	NS
Vanadium	0 0136	0 0114	0 0064 B	0 0142	0 0114	NS
Zinc	0 0315	0.0371	0 0169 B	0 0579	0 0234	10
VOCs (ug/L)						
Acetone	23	92	24	17	52	NS
Benzene	ND	**15**	8 1	1 4	2 8	10
Carbon disulfide	0 26	0 32 J	ND	ND	0 23 B	NS
Chloroform	1 4	3 3	1 1	0 5 B	2 4	100
Ethylbenzene	ND	0 47 J	ND	ND	0 34 B	750
m-, p-Xylenes	0 49 B	1 9 J	0 41 B	ND	1 2 B	NS
o-Xylene	0 2 B	0 57 B	ND	ND	0.33 B	NS
TDS (mg/L)	**20400**	**17600**	**22200**	**19300**	**22800**	1000

[1] Groundwater quality standard from the NMWQCC (20 6 2 NMAC)

Concentrations denoted in bold-face type exceed analyte-specific groundwater standards

B - Inorganic analyte result reported at a level below the method reporting limit and above the instrument detection limit

J - Organic analyte result reported at a level below the method reporting limit and above the instrument detection limit

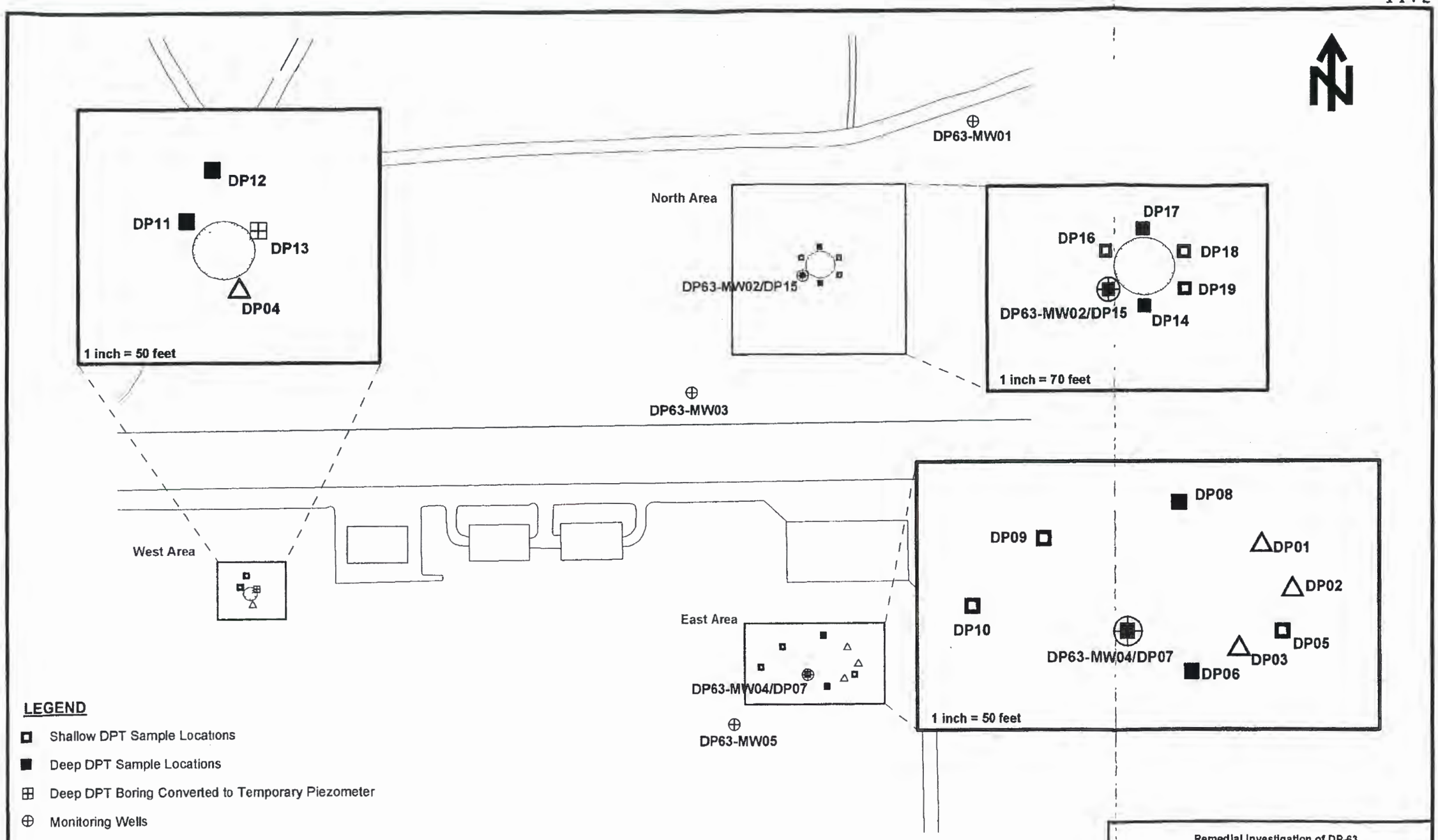
mg/L - milligrams per liter

ND - analyte not detected

NMWQCC - New Mexico Water Quality Control Commission

NS - no standard exists for this analyte

ug/L - micrograms per liter



LEGEND

- Shallow DPT Sample Locations
- Deep DPT Sample Locations
- Deep DPT Boring Converted to Temporary Piezometer
- Monitoring Wells
- PA/SI DPT Sample Location
- Geophysical Anomaly Identifed During the PA/SI

Note Monitoring wells were completed in deep DPT borings in the East and North Areas at DP07 and DP15, respectively.

Surface soil samples were collected at all DPT locations (15 total)

Site Map: 1 inch = 150 ft

Remedial Investigation of DP-63
Holloman Air Force Base, New Mexico

Figure 2-1

DP-63 Site Investigation Map

FOSTER WHEELER ENVIRONMENTAL CORPORATION

HTRW DRILLING LOG

DISTRICT: OMAHA		HOLE NUMBER: DP05
1.COMPANY NAME: Foster Wheeler Environmental Corp.	2.DRILL SUBCONTRACTOR: R & R Environmental, Inc.	SHEET 1 OF 3 SHEETS
3 SITE: Holloman AFB, NM	4 LOCATION: Holloman AFB, NM	
5.NAME OF DRILLER: Rafe Jones	6.MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe	
7.SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: Geoprobe 66DT Track Rig	8.HOLE LOCATION: DP-63, East Area	
	9.SURFACE ELEVATION: N/A	
	10.DATE STARTED: 7-08-2002	11.DATE COMPLETED: 7-08-2002
12.OVERBURDEN THICKNESS: N/A	15.DEPTH GROUNDWATER ENCOUNTERED: N/A	
13.DEPTH DRILLED INTO ROCK: N/A	16.DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: N/A	
14.TOTAL DEPTH OF HOLE: 21'	17.OTHER WATER LEVEL MEASUREMENTS (SPECIFY): 46.43' bgs @ temp well, 45.90' bgs @ DP08, 47.90' @ DP06 7/16/02	

18.GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19.TOTAL NUMBER OF CORE BOXES
None	N/A	N/A	N/A

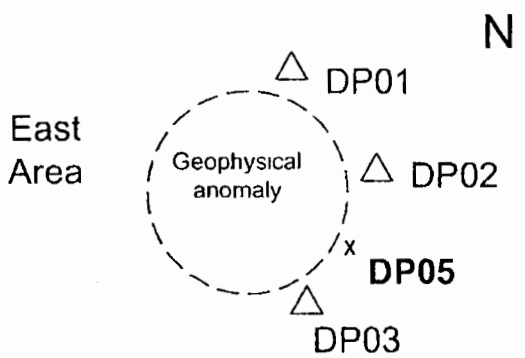
20.SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	SVOC	Pest/PCB	Cyanide/TRPH	21.TOTAL CORE RECOVERY %
DP63DP05S0401	X	X	X	X	X	
DP63DP05S0901	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23.SIGNATURE OF INSPECTOR: Patty Weston		
DP63DP05S2001	X					

22.DISPOSITION OF HOLE: hole plugged with hydrated bentonite

SCALE 1 in. = 250 ft.

LOCATION SKETCH/COMMENTS

Same location as surface soil sample DP63550150001



△ PA/SI sample location

QC: CL Brewer 8/25/02

PROJECT Holloman AFB DP-63 RI

HOLE NO. DP63-DP05

ENG FORM 5056A-R, AUG 94

(Proponent: CECW-EG)

1172114

HTRW DRILLING LOG

SITE	LOCATION	HOLE NUMBER
DP63	Holloman AFB, NM	DP05

PROJECT #	DISTRICT	INSPECTOR	SHEET	SHEETS
5155.0037.0009.H2000	OMAHA	PATRICIA WESTON	2 OF	3

ELEV. (a)	DEPTH (ft.) (b)	DESCRIPTION OF MATERIALS (c)	USCS CLASS. (d)	FIELD SCREEN RESULTS (e)	REMARKS (f)
	1	White - lt. tan fine sandy silts, clasts to 2", dry, caliche, 10% coarse sand. No cementation	ML	Bkgd = 0.7 0.5' = 2.7ppm FID	2' of core
	2	2-3' Orange tan sandy silty clay, stiff, dry, low plasticity	CL		
	3	3-4' Lt. reddish tan silt/mud fine sand, dry	ML		2' of core
	4	4-4.5' Same as above clasts to 2"		Bkgd = 1.3	Sample from 4-5' for lab analysis
	5	4.5-5' Tan clayey silt, moist	ML-CL	4-5' = 1.3ppm FID	
	6	5-6' Reddish tan fine sandy silt, moist, occasional clay lenses			2' of core
	7	Lt. reddish tan, same as above. Well graded.	ML-CL		2' of core
	8	Lt. reddish tan, same as above. No clay lenses	ML	Bkgd = 1.3 9-10' = 1.3ppm FID	Sample from 9-10' for lab analysis 2' of core
	10				
	11	Same as above.	ML		2' of core
	12	Same as above.	ML		
	13				
	14				
	15				
	16	White-tan silty fine sand, mod. cementation.	SM		12-16' - 3'10" of core
	17	White-lt. red w/ orange oxidation lenses fine sandy.	SM		Orange oxidation
	18	Tan fine sandy silt.	ML		
	19	Fine silty sand moist.	SM		16-19' - 3'10" of core
		Lt. brown fine sandy silt, silty sand, moist, no cementation.	ML-SM		Sample from 20-21' for lab analysis.

PROJECT Holloman AFB DP-63 PA/SI

HOLE NO. DP63-DP05

ENG FORM 5056A-R, AUG 94

(Proponent: CECW-EG)

HTRW DRILLING LOG

SITE	LOCATION	HOLE NUMBER
Holloman AFB, NM	DP-63	DP05

PROJECT #	DISTRICT	INSPECTOR	SHEET / SHEETS
5155.0037.0009.H2000	OMAHA	PATRICIA WESTON	3 OF 3

ELEV. (a)	DEPTH (ft) (b)	DESCRIPTION OF MATERIALS (c)	USCS CLASS. (d)	FIELD SCREEN RESULTS (e)	REMARKS (f)
		Silty sand, dark brown, dry, loose fine sand, trace coarse sand	SM		2' of core
	21				TD = 21 ft
	22				
	23				
	24				
	25				
	26				
	27				
	28				
	29				
	30				
	31				
	32				
	33				
	34				
	35				
	36				
	37				
	38				
	39				

PROJECT Holloman AFB DP-63 RI

HOLE NO. DP63-DP05

ENG FORM 5056A-R, AUG 94

(Proponent: CECW-EG)

1172116

HTRW DRILLING LOG

DISTRICT: OMAHA		HOLE NUMBER: DP06
1.COMPANY NAME: Foster Wheeler Environmental Corp.	2.DRILL SUBCONTRACTOR: R & R Environmental, Inc.	SHEET 1 OF SHEETS 4
3 SITE: DP-63	4.LOCATION: Holloman AFB, NM	
5 NAME OF DRILLER: Rafe Jones	6.MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe	
7.SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: Geoprobe 66DT Track Rig	8.HOLE LOCATION: DP-63, East Area	
	9.SURFACE ELEVATION: N/A	
	10 DATE STARTED: 7-09-2002	11.DATE COMPLETED: 7-15-2002
12.OVERBURDEN THICKNESS: N/A	15.DEPTH GROUNDWATER ENCOUNTERED: N/A	
13.DEPTH DRILLED INTO ROCK: N/A	16.DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: 47.90' 7/16/02	
14.TOTAL DEPTH OF HOLE: 52.5'	17.OTHER WATER LEVEL MEASUREMENTS (SPECIFY): 46.43' bgs @ temp well loc 7/16/02	

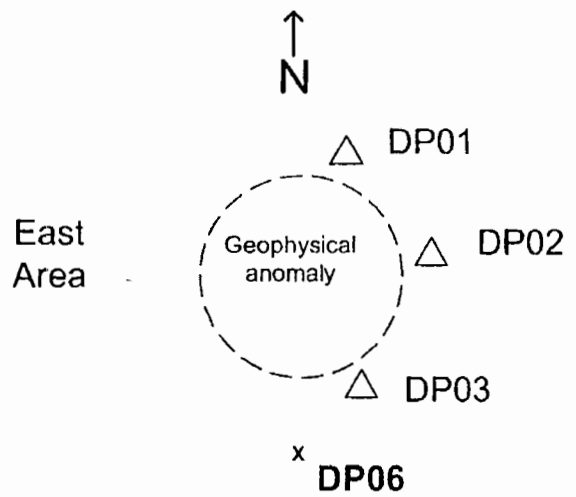
18.GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19.TOTAL NUMBER OF CORE BOXES
None	N/A	N/A	N/A

20.SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	SVOC	Pest/PCB	Cyanide/TRPH	21.TOTAL CORE RECOVERY %
DP63DP06S0401	X	X	X	X	X	
DP63DP06S0901	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23.SIGNATURE OF INSPECTOR: Patty Weston		
DP63DP06S2401 DP63DP06S4601	X					

22.DISPOSITION OF HOLE: hole plugged with hydrated bentonite	SCALE 1 in. = 250 ft.

LOCATION SKETCH/COMMENTS

Same location as surface soil sample DP63550250001



△ PA/SI sample location

QC: C L Bianchis 8/25/02

Note: screened for UXO to 12' also 14-16' overlap from 7/9/02 to 7/15/02 sampling.

PROJECT Holloman AFB DP-63 RI	HOLE NO. DP63-DP06

ENG FORM 5056A-R, AUG 94 (Proponent: CECW-EG)

1172117

HTRW DRILLING LOG

SITE	LOCATION	HOLE NUMBER
DP63	Holloman AFB, NM	DP06

PROJECT #	DISTRICT	INSPECTOR	SHEET / SHEETS
5155.0037.0009.H2000	OMAHA	PATRICIA WESTON	2 OF 4

ELEV (a)	DEPTH (ft.) (b)	DESCRIPTION OF MATERIALS (c)	USCS CLASS. (d)	FIELD SCREEN RESULTS (e)	REMARKS (f)
	1	White - lt. tan fine sandy silt, dry, moderate - poor cementation	ML		1'10" of core
	2	same as above.	ML		1'10" of core
	3 4	Tan-orange silty sand, moist, well sorted, weak, no plast.	ML	Bkgd = 0.15 4-5' = 4.09ppm FID	Sample from 4-5' for lab analysis 2' of core
	5 6	Same as above w/ tan clays to 0.5 cm (clay)	SM		2' of core
	7 8	Same as above.	SM		2' of core
	9 10	Same as above.	SM	Bkgd = 0.87 9-10' = 4.64ppm FID	Sample from 9-10' for lab analysis 2' of core
	11 12 13	Same as above.	SM	Bkgd = 0.64 14.5' = 0.94ppm FID	3' of core
	14	Same as above, black spot at 14-14.5'.	SM/ML		Rxn to HCl 2' of core
	15 16 17	White-lt. orange fine silty sand.	SM		weak Rxn to HCL
		Lt. tan-white silty sand.	SM		3' of core
	18 19	Lt. yellow-orange slity sand w/occ clay; gray clay laminations orange oxidation, no cementation.	SM-CL		No Rxn to HCl 18-20' 20-21' weak Rxn orange oxidation 3' of core particles

PROJECT Holloman AFB DP-63 PA/RI | HOLE NO. DP63-DP06

ENG FORM 5056A-R, AUG 94 (Proponent: CECW-EG)

HTRW DRILLING LOG

SITE	LOCATION	HOLE NUMBER
DP-63	Holloman AFB, NM	DP06

PROJECT #	DISTRICT	INSPECTOR	SHEET	SHEETS
5155.0037.0009.H2000	OMAHA	Patricia Weston	3 OF	4

ELEV. (a)	DEPTH (ft.) (b)	DESCRIPTION OF MATERIALS (c)	USCS CLASS. (d)	FIELD SCREEN RESULTS (e)	REMARKS (f)
		Same as above; Mod. Cementation.	SM		
	21	Same as above to 22.5'	SM		Rxn to HCl
	22				Orange oxidation staining
		Brown silty clay, stiff w/ oxidation.	CL		
	23	Red silty stiff clay w/ 20% gypsum/calcite xtls.	SM		21'-24' - 3'6" of core
	24				
	25	brown silty sandy clay, dry, sand lenses, weak 20% gypsum/ calcite xtls in clay.	CL-SM	Bkgd = 0.66 25' = 1.81ppm FID	Rxn to HCl sample at 24-25' for lab analysis
	26				3'10" of core
	27	Red sandy silty clay, dry, weak, 20% xtls.	CL		Rxn to HCl
	28	Red silty sand w/ clay lenses.	SM		26.5'-29' - 3'6" of core
	29	reddish/brown silt to 30.5'	ML		Rxn to HCl
	30	red clay lens at 29.5'		Bkgd = 0.56	
		Brown/tan clayey sandy silt w/ orange ox. stains.	CL	30' = 1.12ppm FID	Orange oxidation staining
	31	Same red/brown silt.	ML		3'10" of core
	32	Laminated red clay and clayey silty sand w/ oxidation blebs at 33.5'	CL-SM		Rxn to HCl
	33				
	34	Orange fine silty sand, dry	SM		3'6" of core
		Sandy orange clayey silt.	ML		
	35	Red silty clay w/ white xtls, stiff.	CL		No Rxn to HCl in sand; Rxn in clay
	36	Orange silty sand moist	SM		
	37	Laminated red clay/red silt, red sand, well graded.	ML (CL/SM)		3'10" of core
	38	Red-orange fine-med silty sand. Poorly sorted.	SM		No Rxn to HCl in sand; Rxn in clay
	39	Laminated silty red clay lenses in silty sand.	SM/ML		expansion cracks in core
		Red silty stiff clay.	CL		3'10" of core

PROJECT	HOLE NO.
Holloman AFB DP-63 PA/RI	DP63-DP06

ENG FORM 5056A-R, AUG 94 (Proponent. CECW-EG)

1172119

HTRW DRILLING LOG

SITE	LOCATION	HOLE NUMBER
dp-63	Holloman AFB, NM	DP06

PROJECT #	DISTRICT	INSPECTOR	SHEET	OF	SHEETS
5155.0037.0009.H2000	OMAHA	Patricia Weston	4	OF	4

ELEV (a)	DEPTH (ft.) (b)	DESCRIPTION OF MATERIALS (c)	USCS CLASS. (d)	FIELD SCREEN RESULTS (e)	REMARKS (f)
	41	Alternating red well-graded med-fine sand and red silty sandy clay.	SM CL SM CL	Bkgd = 0.3 42.5' = 2.03ppm FID	Rxn to HCl
	42	White, as above.	SM		3'10" of core
	43	Red silt w/ gypsum xlts.	ML		Rxn to HCl to 44.5'
	44	Lt. tan gypsum-rich sand.	SM		No rxn with white sand.
	45	White very fine sand, mod. cementation	SM		3'10" of core
	46	Red dry silty clay stiff. xtls to .25 cm	CL	Bkgd = 0.5 45' = 2.77ppm FID	Rxn to HCl (moderate to violent) (cement) sample at 46.5'-47.5' for lab analysis
	47	Tan fine sand. Poorly sorted. cementation last to 1".	SM		3'10" of core
	48	Wet sand, gray, fine-med	SM		wet at 47.5'
		Moist white silt.	ML		
	49	Lt. tan very fine silty sand.	SM		
		Lt. tan clayey silt. weak non-plastic core cemented to sampler.	ML		3'10" of core
	50 51 52	Wet gray med fine sand alt. w/ orange sandy silty clay and fine orange sand. well graded	SM-CL		3'10" of core
	53 54 55				TD = 52.5

PROJECT Holloman AFB DP-63 PA/RI

HOLE NO. DP63-DP06

ENG FORM 5056A-R, AUG 94

(Proponent: CECW-EG)

172-0211

HTRW DRILLING LOG

DISTRICT: OMAHA		HOLE NUMBER: DP07
1. COMPANY NAME: Foster Wheeler Environmental Corp.	2. DRILL SUBCONTRACTOR: R & R Environmental, Inc.	SHEET 1 OF SHEETS 4
3. SITE: DP-63	4. LOCATION: Holloman AFB, NM	
5. NAME OF DRILLER: Rafe Jones	6. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe	
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: Geoprobe 66DT Track Rig	8. HOLE LOCATION: DP-63, East Area	
	9. SURFACE ELEVATION: N/A	
	10. DATE STARTED: 7-09-2002	11. DATE COMPLETED: 7-16-2002
12. OVERBURDEN THICKNESS: N/A	15. DEPTH GROUNDWATER ENCOUNTERED: 46'	
13. DEPTH DRILLED INTO ROCK: N/A	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: 50.20' bgs 7/24/02	
14. TOTAL DEPTH OF HOLE: 54.5'	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): 45.9' bgs DP08 47.90' DP06 7/16/02	

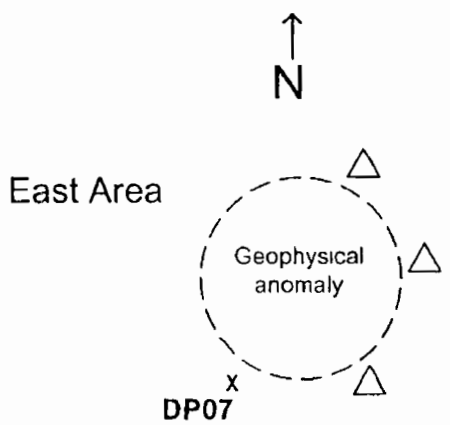
18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
None	N/A	N/A	N/A

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	SVOC	Pest/PCB	Cyanide/TRPH	21. TOTAL CORE RECOVERY %
DP63DP07S0401	X	X	X	X	X	
DP63DP07S0901	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR		
DP63DP07S2401,2,3	X			Patty Weston		
DP63DP07S4301,2,3						

22. DISPOSITION OF HOLE: temporary piezometer

SCALE: 1 in. = 100 ft.

LOCATION SKETCH/COMMENTS



(temporary piezometer location / sampling location)

△ PA/SI sample location

Note: UXO clearance to 12'

QC: CL Bierwiles 8/25/02

PROJECT: Holloman AFB DP-63 RI

HOLE NO. DP63-DP07

ENG FORM 5056A-R, AUG 94

(Proponent CECW-EG)

1172121

HTRW DRILLING LOG

SITE	LOCATION	HOLE NUMBER
DP63	Holloman AFB, NM	DP07

PROJECT #	DISTRICT	INSPECTOR	SHEET	OF	SHEETS
5155.0037.0009.H2000	OMAHA	PATRICIA WESTON	2	OF	4

ELEV. (a)	DEPTH (ft.) (b)	DESCRIPTION OF MATERIALS (c)	USCS CLASS. (d)	FIELD SCREEN RESULTS (e)	REMARKS (f)
	1	White - lt. tan sandy silt w/ clay clasts. "caliche" dry, weak. Poorly sorted.	ML		2' of core
	2	Clay-rich pink sandy silt. moderate sorting. weak. moist.	ML		
	3	Tan sandy silt lt mod. sorting, laminated, weak. clay lenses/ partings cl cm	ML/CL		
		Orange sands silt as below.	SM		2' of core
	4	Clay-rich tan low-plast med blne silty sand <5%	SC	Bkgd = 0.74	Sample from 4-5' for lab analysis.
	5	Fine sandy silt/ silty sand. orange small roots. Clasts of brown clay grades to fine sand.	SM	5' = 4.0ppm FID	2' of core
	6	Brown silty sand clasts of clay to 0.5"	SM		
	7	Orange silty fine sand. well sorted. moist.	SM		2' of core
	8	Orange silty fine sand. well sorted. clay clasts to 2".	SM	Bkgd = 1.33	Sample from 9-10' for lab analysis
	9			9' = 8.46ppm FID	2' of recovery
	10	Fine silty sand well sorted. grades from lt. orange to pale tan. weak. dry. changes to clayey silt in last 6"	ML		
	11				2' of recovery
	12	Pale tan fine silty sand, orange oxidation streaks. Well Sorted.	SM	Bkgd = 0.9	oxidation (orange staining) ivo Rxn to HCl
	13			13' = 1.0ppm FID	
	14				3' of core
	15	Lt. yellow brown sandy clayey fine silt.	ML	Bkgd = 0.3	Rxn to HCL 15-17' not 17-18'
	16			17' = 5.2ppm FID	
	17	Lt. orange/yellow silty fine sand.	SM		3'4" of core
	18	Same as above w/ orange patches of oxidation.	SM	Bkgd = 1.6	no Rxn to HCl 19-20'
	19			20' = 5.0ppm FID	Rxn 20-21' 3'6" of core

PROJECT Holloman AFB DP-63 PA/RI

HOLE NO. DP63-DP07

ENG FORM 5056A-R, AUG 94

(Proponent: CECW-EG)

HTRW DRILLING LOG

SITE	LOCATION	HOLE NUMBER
DP-63	Holloman AFB, NM	DP07

PROJECT #	DISTRICT	INSPECTOR	SHEET	SHEETS
5155.0037.0009.H2000	OMAHA	Patricia Weston	3 OF	4

ELEV (a)	DEPTH (ft) (b)	DESCRIPTION OF MATERIALS (c)	USCS CLASS. (d)	FIELD SCREEN RESULTS (e)	REMARKS (f)
		red clay, stiff, strong, low plasticity = 20% xtls (gypsum)	CL		expansion cracks in core
	21				
	22	red brown sandy silty clay w/ fine sand lenses. Laminated dry 20% coarse sand-sized xtls (gypsum?)	CL	Bkgd = 0.3 22.5' = 8.2ppm FID	rxn in expansion cracks in core 3'10" of core
	23				
	24				
	25	alternating layers - dark red brown sandy silt, silty sand and clay. dry. stratifed.	ML-SM-CL	Bkgd = 0.3 24-27' = 8.2ppm FID	sample at 24-27' for lab analysis Rxn to HCl 3'10" of core
	26				
	27	Sandy, clayey orange silt. well sorted	ML		Rxn to HCl
	28	Red and green commingled clay. tough no plasticity, 30% silty sand. dry.	CL		3'6" of core
	29				
		Red silty clay (50% silt) mod stiff. no plasticity.	CL	Bkgd = 0.1	Rxn to HCl
	30	Lt. gray green fine sandy silt, dry.	CL		
	31	Red and gray clay commingled. dry.	CL	31' = 3.4ppm FID	Xtls in clay. 3'10" of core
	32	Grayish green clay, dry, stiff; no plasticity.	CL		Rxn as above to 34'
	33	Lt. gray green fine sandy silt, dry.	ML		No rxn 34-34.5'
	34	Red clay, stiff, tough no plasticity.	CL		Expansion cracks in core 3'10" of core
	35	red clay as above 20% silty-sand size xtls.	CL		Rxn to HCl
	36	tan fine sand lenses 36-38'			Expansion cracks in core 3'10" of core
	37	See above.	CL-SM		Rxn in clays, no rxn in sands.
	38	Red-orange fine silty sand. white weak clay layers. Clay is plastic.	CL		3' of core
	39	Lt. orange sandy clayey silt. weak. 5% coarse sand.	ML		

PROJECT	HOLE NO.
Holloman AFB DP-63 PA/RI	DP63-DP07

ENG FORM 5056A-R, AUG 94 (Proponent: CECW-EG)

1172123

HTRW DRILLING LOG

SITE	LOCATION	HOLE NUMBER
dp-63	Holloman AFB, NM	DP07

PROJECT #	DISTRICT	INSPECTOR	SHEET	SHEETS
5155.0037.0009.H2000	OMAHA	Patricia Weston	4 OF	4

ELEV. (a)	DEPTH (ft.) (b)	DESCRIPTION OF MATERIALS (c)	USCS CLASS. (d)	FIELD SCREEN RESULTS (e)	REMARKS (f)
	41	Alternating red well-graded med-fine sand and red silty sandy clay.	CL		Rxn to HCl 3'10" of core
	42 43	White and red commingled clay. red: strong stiff, white: weak sandy silty clay w/ black clasts to 1". with yellow sand lens	CL SM CL		Rxn to HCl sample taken at 43-46.5' for lab analysis 3'10" of core
	44 45 46	Red and tan stiff sandy silty clay w/ sand lenses. Wet at ~ 46.5'	CL SM CL	Bkgd = 1.0 45.5' = 6.4ppm FID	Rxn to HCl 3'10" of core
	47 48 49	Wet red clay, gypsum xtls to 1 cm.	CL		no rxn to HCl 3'10" of core
	50	See above.	CL		rxn to HCl @ 51'
	51	Lt. tan silty moist tough clay.	CL		3'10" of core
	52 53 54 55				TD - 51.5'

PROJECT Holloman AFB DP-63 PA/RI

HOLE NO. DP63-DP07

ENG FORM 5056A-R, AUG 94

(Proponent: CECW-EG)

HTRW DRILLING LOG

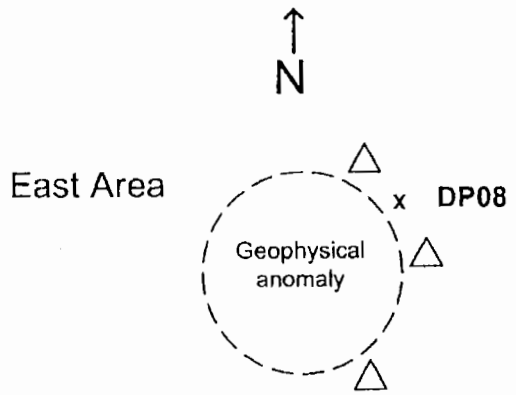
DISTRICT: OMAHA		HOLE NUMBER: DP08
1. COMPANY NAME: Foster Wheeler Environmental Corp.	2. DRILL SUBCONTRACTOR: R & R Environmental, Inc.	SHEET 1 OF SHEETS 4
3. SITE: DP-63	4. LOCATION: Holloman AFB, NM	
5. NAME OF DRILLER: Rafe Jones	6. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe	
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: Geoprobe 66DT Track Rig	8. HOLE LOCATION: DP-63, East Area	
	9. SURFACE ELEVATION: N/A	
	10. DATE STARTED: 7-09-2002	11. DATE COMPLETED: 7-15-2002
12. OVERBURDEN THICKNESS: N/A	15. DEPTH GROUNDWATER ENCOUNTERED: 48'	
13. DEPTH DRILLED INTO ROCK: N/A	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: 45.90' bgs 7/16/02	
14. TOTAL DEPTH OF HOLE: 52.5'	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): 47.9' bgs DP08 47.90' DP06 7/16/02	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
None	N/A	N/A	N/A

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	SVOC	Pest/PCB	Cyanide/TRPH	21. TOTAL CORE RECOVERY %
DP63DP08S0401	X	X	X	X	X	
DP63DP08S0901	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR		
DP63DP08S2401	X			Patty Weston		
DP63DP08S4401						

22. DISPOSITION OF HOLE: hydrated bentonite	SCALE: 1 in. = 100 ft.

LOCATION SKETCH/COMMENTS



△ PA/SI sample location

Note: UXO clearance to 12'

QC: C L Brannelis 8/25/02

PROJECT: Holloman AFB DP-63 RI	HOLE NO. DP63-DP08

ENG FORM 5056A-R, AUG 94 (Proponent: CECW-EG)

1172125

HTRW DRILLING LOG

SITE	LOCATION	HOLE NUMBER
DP63	Holloman AFB, NM	DP08

PROJECT #	DISTRICT	INSPECTOR	SHEET	SHEETS
5155.0037.0009.H2000	OMAHA	PATRICIA WESTON	2 OF	4

ELEV. (a)	DEPTH (ft.) (b)	DESCRIPTION OF MATERIALS (c)	USCS CLASS. (d)	FIELD SCREEN RESULTS (e)	REMARKS (f)
	1	Top 2" brown soil. Rest: lt pink-orange fine sandy silt. Clast of clay to 0.25" "caliche" Dry. no plast. no strength.	MH/OH ML		2' of core
	2 3	Lt. orange mosit silty sand alt. clast (clay) to 0.25"	SM		1'9" of core
	4 5	See above. No clasts.	SM	Bkgd = 2.0 5' = 9.2ppm FID	Sample from 4-5' for lab analysis 2' of core
	6 7	See above.	SM		2' of core
	8 9 10 11	Orange. clay, friable sandy silt to fine silty sand dry.	ML/SM	Bkgd = 2.0 9' = 6.1ppm FID	Sample from 9-10' for lab analysis 3'10" of core
	12	Lt. orange silty fine sand dry.	SM	Bkgd = 0.0	
	13	White silty fine sand, dry	SM	14' = 5.4ppm FID	Rxn to HCl 12-13' and 14-15' No Rxn in white sand
	14	Lt orange silty fine sand, no clasts, no cementation, dry.	SM		3'10" of core
	15 16 17	Same as above, weak cementation.	SM	Bkgd = 0.2 17' = 3.8ppm FID	Rxn to HCL 3' of core
	18 19	Same as above, no cementation.	SM	Bkgd = 0.2 20' = 6.6ppm FID	Rxn to HCl

PROJECT Holloman AFB DP-63 PA/RI

HOLE NO. DP63-DP08

ENG FORM 5056A-R, AUG 94

(Proponent: CECW-EG)

HTRW DRILLING LOG

SITE	LOCATION	HOLE NUMBER
DP-63	Holloman AFB, NM	DP08

PROJECT #	DISTRICT	INSPECTOR	SHEET	SHEETS
5155.0037.0009.H2000	OMAHA	Patricia Weston	3 OF	4

ELEV (a)	DEPTH (ft.) (b)	DESCRIPTION OF MATERIALS (c)	USCS CLASS. (d)	FIELD SCREEN RESULTS (e)	REMARKS (f)
			SM		3' of core
	21	Same as above to 22'.	SM	Bkgd = 0.22	
	22	Fine, lt. orange sandy silt w/ clay laminations, brown dry noplasticity, stiff.	ML-CL	22' = 6.4ppm FID	rxn to HCl 3'10" of core
	23				
	24	Brown sandy silty clay, dry, stiff, mod toughness	CL	Bkgd = 0.42 25' = 5.7ppm FID	sample at 24-25' for lab analysis Rxn to HCl 3' of core
	25				
	26	Same as above, red.	CL		Rxn to HCl
	27	Brown silty sandy clay.	ML		
	28	Brownish-orange fine silty sand, dry.	CL		3'6" of core
	29	Red sandy silty clay dry. no plasticity, stiff.	CL	Bkgd = 0.41 31' = 5.44ppm FID	Rxn to HCl
	30	Red fine sand, dry.	SM		
	31	Red sandy clay, dry. No plasticity.	CL		3'10" of core
	32	Red and greenish-gray silty sandy clay 20-50% silty sand moderate plasticity weak, no strength.	CL	Bkgd = 0.24 34' = 0.45ppm FID	Rxn to HCl Expansion cracks in core. 3'10" of core
	33				
	34				
	35	Red and greenish gray silty sandy clay w/ lenses of sandy silt, whitish pale gray, low plasticity, weak well graded.	CL-ML	35' = 0.0ppm FID	Rxn to HCl 3'10" of core
	36				
	37				
	38	Red silty sandy clay w/ lens of lt gray silty plastic, soft clay at 37.8-37.9'	CL		Rxn to HCl 3'10" of core
	39				

PROJECT	HOLE NO.
Holloman AFB DP-63 PA/RI	DP63-DP08

ENG FORM 5056A-R, AUG 94 (Proponent: CECW-EG)

1172127

HTRW DRILLING LOG

SITE	LOCATION	HOLE NUMBER
DP-63	Holloman AFB, NM	DP08

PROJECT #	DISTRICT	INSPECTOR	SHEET	SHEETS
5155.0037.0009.H2000	OMAHA	Patricia Weston	4 OF	4

ELEV. (a)	DEPTH (ft.) (b)	DESCRIPTION OF MATERIALS (c)	USCS CLASS. (d)	FIELD SCREEN RESULTS (e)	REMARKS (f)
	41	Alternating red well-graded med-fine sand and red silty sandy clay.	CL-SM	Bkgd = 0 2 40' = 0 6ppm FID	3'10" of core
	42 43	same as above. lenses of white moist sand.	CL-SM	Bkgd = 0.12 43' = 1.2ppm FID	Rxn to HCl (white xtls) not in clay. 3' of core
	44	White silty fine sand, moist.	SM	Bkgd = 0.25	Sample from 44-45' for lab analysis
	45	Lt. tan silty clayey fine sand.	SM	45' = 0.90ppm FID	Rxn to HCl 3'10" of core
	46	Grayish-orange silty sandy clay, moist, mod toughness, low plasticity.	CL	Bkgd = 0.28	Rxn to HCl
	47	Tan-white sandy silt, moist.	ML	47.5' = 0.88ppm FID	3' of core
	48	Wet red low plasticity clay.	CL		Rxn to HCl @ 51'
	49	Sandy silty gray clay. stiff. low plasticity.	CL		
		White silty sand w/ black lenses < 5 mm thick.	SM		3'10" of core
	50 51 52	Lt. yellow brown wet sandy clay/silt.	CL-ML	Bkgd = 0.39 50' = 1.42ppm FID	No rxn 50-51' Rxn 51-52.5' 3'10" of core
	53 54 55				TD = 52.5'

PROJECT Holloman AFB DP-63 PA/RI

HOLE NO. DP63-DP08

ENG FORM 5056A--R, AUG 94

(Proponent: CECW--EG)

HTRW DRILLING LOG

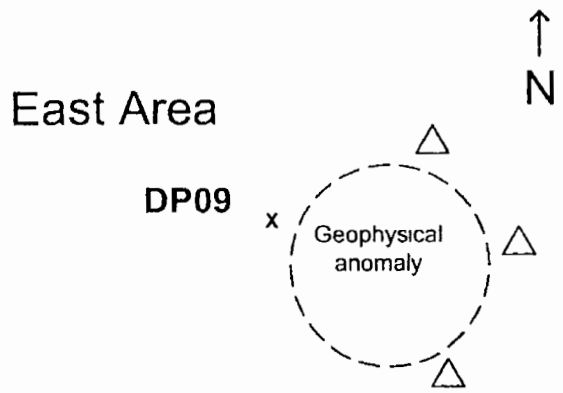
DISTRICT: OMAHA		HOLE NUMBER: DP09
1. COMPANY NAME: Foster Wheeler Environmental Corp.	2. DRILL SUBCONTRACTOR: R & R Environmental, Inc.	SHEET 1 OF SHEETS 3
3. SITE: DP-63	4. LOCATION: Holloman AFB, NM	
5. NAME OF DRILLER: Rafe Jones	6. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe	
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: Geoprobe 66DT Track Rig	8. HOLE LOCATION: DP-63, East Area	
	9. SURFACE ELEVATION: N/A	
	10. DATE STARTED: 7-09-2002	11. DATE COMPLETED: 7-09-2002
12. OVERBURDEN THICKNESS: N/A	15. DEPTH GROUNDWATER ENCOUNTERED: N/A	
13. DEPTH DRILLED INTO ROCK: N/A	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: N/A	
14. TOTAL DEPTH OF HOLE: 21'	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): 45.9' bgs DP08, 47.90' DP06 7/16/02	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
None	N/A	N/A	N/A

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	SVOC	Pest/PCB	Cyanide/TRPH	21. TOTAL CORE RECOVERY
DP63DP09S0401	X	X	X	X	X	x
DP63DP09S0901	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR		
DP63DP09S2001	X			Patty Weston		

22. DISPOSITION OF HOLE: hydrated bentonite	SCALE 1 in. = 100ft.

LOCATION SKETCH/COMMENTS



△ PA/SI sample location

Note: UXO clearance to 12'

QC: C.L. Bierwirtz 8/25/02

PROJECT Holloman AFB DP-63 RI	HOLE NO. DP63-DP09

ENG FORM 5056A-R, AUG 94 (Proponent: CECW-EG)

1172129

HTRW DRILLING LOG

SITE	LOCATION	HOLE NUMBER
DP63	Holloman AFB, NM	DP09

PROJECT #	DISTRICT	INSPECTOR	SHEET	SHEETS
5155.0037.0009.H2000	OMAHA	PATRICIA WESTON	2 OF	3

ELEV. (a)	DEPTH (ft.) (b)	DESCRIPTION OF MATERIALS (c)	USCS CLASS. (d)	FIELD SCREEN RESULTS (e)	REMARKS (f)
	1	Lt. pink-orange sandy silt w/ clay. Laminated with clasts to 1". Dry, no strength. 1.5' - lt. orange lam. clay-rich stiff	ML		1'7" of core
	2 3	Grades from lt. orange laminated dry clay rich silt to fine orange sandy silt at 3'. No clasts, well sorted. Dry.	ML		2' of core
	4 5	Orange moist fine, well-graded sandy silts, no clasts. Silty sand.	ML/SM	Bkgd = 1.64 5' = 10.12ppm FID	Sample from 4-5' for lab analysis 2' of core
	6 7	Same as above.	ML/SM		2' of core
	8 9	Same as above.	ML/SM	Bkgd = 2.64 9' = 9.02ppm FID	Sample from 9-10' for lab analysis 2' of core
	10 11	Same as above.	ML/SM		2' of core
	12 13 14	Same as above to 12.5' 12.5' color orange to greenish-yellowish/lt.brown fine silty sand/sandy silt with darker modules of sand. Orange oxidation patch at 13', 2mm wide by 2" long	ML/SM		3' of core
	15 16 17	Lt. tan silty clay-rich sandy silt. No strength oxidation nodales. Grades to laminated silty clay, dark tan w/ oxidation (?) Moderate strength, no plasticity.	ML/CL		3' of core
	18 19	10" (to 18'10") dk. tan silty clay. Grades to dk brown, mod strong clay. w/ silty lens at 19.5' sandy.	CL/SM	Bkgd = 1.0 20' = 13.04ppm FID	Sample taken at 19.5-21' sample had clay/sand lens

PROJECT Holloman AFB DP-63 PA/RI

HOLE NO. DP63-DP09

ENG FORM 5056A-R, AUG 94

(Proponent: CECW-EG)

HTRW DRILLING LOG

SITE	LOCATION	HOLE NUMBER
DP-63	Holloman AFB, NM	DP09

PROJECT #	DISTRICT	INSPECTOR	SHEET / SHEETS
5155.0037.0009.H2000	OMAHA	Patricia Weston	3 OF 3

ELEV. (a)	DEPTH (ft.) (b)	DESCRIPTION OF MATERIALS (c)	USCS CLASS. (d)	FIELD SCREEN RESULTS (e)	REMARKS (f)
		See previous page.			3'10" of core
	21				TD = 21'
	22				
	23				
	24				
	25				
	26				
	27				
	28				
	29				
	30				
	31				
	32				
	33				
	34				
	35				
	36				
	37				
	38				
	39				

PROJECT Holloman AFB DP-63 PA/RI

HOLE NO. DP63-DP09

ENG FORM 5056A-R, AUG 94

(Proponent: CECW-EG)

1172131

HTRW DRILLING LOG

DISTRICT: OMAHA		HOLE NUMBER: DP10
1. COMPANY NAME: Foster Wheeler Environmental Corp.	2. DRILL SUBCONTRACTOR: R & R Environmental, Inc.	SHEET 1 OF SHEETS 3
3. SITE: DP-63	4. LOCATION: Holloman AFB, NM	
5. NAME OF DRILLER: Rafe Jones	6. MANUFACTURER'S DESIGNATION OF DRILL: Geoprobe	
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: Geoprobe 66DT Track Rig	8. HOLE LOCATION: DP-63, East Area	
	9. SURFACE ELEVATION: N/A	
	10. DATE STARTED: 7-09-2002	11. DATE COMPLETED: 7-09-2002
12. OVERBURDEN THICKNESS: N/A	15. DEPTH GROUNDWATER ENCOUNTERED: N/A	
13. DEPTH DRILLED INTO ROCK: N/A	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: N/A	
14. TOTAL DEPTH OF HOLE: 21'	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): 47.9' bgs DP06, 7/16/02	

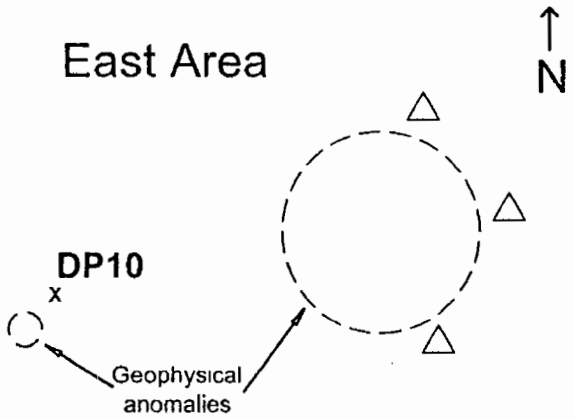
18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
None	N/A	N/A	N/A

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	SVOC	Pest/PCB	Cyanide/TRPH	21. TOTAL CORE RECOVERY
DP63DP10S0401	X	X	X	X	X	x
DP63DP10S0901	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR		
DP63DP10S2001	X			Patty Weston		

22. DISPOSITION OF HOLE: hydrated bentonite

SCALE 1 in. = 100 ft.

LOCATION SKETCH/COMMENTS



△ PA/SI sample location

Note: UXO clearance to 12'

QC: C.L. Brennan 8/25/02

PROJECT Holloman AFB DP-63 RI

HOLE NO. DP63-DP10

ENG FORM 5056A-R, AUG 94

(Proponent: CECW-EG)

1172132

HTRW DRILLING LOG

SITE	LOCATION	HOLE NUMBER
DP63	Holloman AFB, NM	DP10

PROJECT #	DISTRICT	INSPECTOR	SHEET	SHEETS
5155.0037.0009.H2000	OMAHA	PATRICIA WESTON	2 OF	3

ELEV. (a)	DEPTH (ft.) (b)	DESCRIPTION OF MATERIALS (c)	USCS CLASS. (d)	FIELD SCREEN RESULTS (e)	REMARKS (f)
	1	Soil and sandy silt. Dry, pink-white w/ tan clasts of silty clay. No strength.	ML		1'6" of core
	2–3	Lt. tan laminated sandy silt, silt to 3.5. Dry. 3.5' - tan silty fine sand. Moist.	ML		2' of core
	4–5	Lt. orange moist fine silty sand. Well sorted.	SM	Bkgd = 1.82 4' = 12ppm FID	Sample taken at 4-5' for lab analysis 2' of core
	6–7	Lt. orange to lt. yellow-brown silty fine sand/sandy silt.	SM/ML		2' of core
	8–9	Lt. orange to white fine silty sand/ sandy silt to 9'. 9' fine orange silty sand moist.	ML/SM	Bkgd = 0.24 9' = 9.4ppm FID	Sample taken at 9-10' for lab analysis 2' of core
	10–11	Same as above.	SM		2' of core
	12–14	Same as above.	SM		3' of core
	15–18	Orange silty fine sand with a few coarse sand-sized clasts of clay.	SM	Bkgd = 1.43	3'10" of core
	19	Same as above.	SM	20' = 13.5ppm FID	Sample taken at 20-21'

PROJECT Holloman AFB DP-63 PA/RI

HOLE NO. DP63-DP10

ENG FORM 5056A-R, AUG 94

(Proponent: CECW-EG)

1172176

HTRW DRILLING LOG	SITE DP-63	LOCATION Holloman AFB, NM	HOLE NUMBER DP63-MW05
PROJECT # 5155.0037.0009.H0000	DISTRICT OMAHA	INSPECTOR PATRICIA WESTON	SHEET OF SHEETS

ELEV. (a)	DEPTH (ft.) (b)	DESCRIPTION OF MATERIALS (c)	USCS CLASS (d)	FIELD SCREEN RESULTS (e)	REMARKS (f)
	21	fewer cuttings of same moist reddish brown sand. 21-25'	SM		
	22				
	23			1.13 ppm @23'	
	24			1.38 ppm @24'	
	25	as above <2% white silt balls. 25-26'	SM	1.08 ppm @25'	
	26	as above w/ balls of brown silty clay 26-27'	SM/CL		
	27	1% dry stiff clasts to 2" of red/brown clay 27-28'	CL		
	28	brownish red sandy silty clay 2.5YR 4/4 28-31'	CL	1.10 ppm @28'	
	29				
	30				
	31	brownish red silty sandy clay 2.5YR 4/4 in 2" or smaller angular clasts, non-plastic. 31-33'	CL	1.16 ppm	
	32				
	33	same as above but in <1cm balls. slightly moist. slightly plastic. tough. 33-35'	CL	0.98 ppm	
	34				
	35	angular clasts as above. 35-41'		1.09 ppm	
	36		CL		
	37				
	38				
	39				
	40	see 31' above	CL		

1172177

HTRW DRILLING LOG	SITE DP-63	LOCATION Holloman AFB, NM	HOLE NUMBER DP63-MW05
PROJECT # 5155.0037.0009.H0000	DISTRICT OMAHA	INSPECTOR PATRICIA WESTON	SHEET OF SHEETS

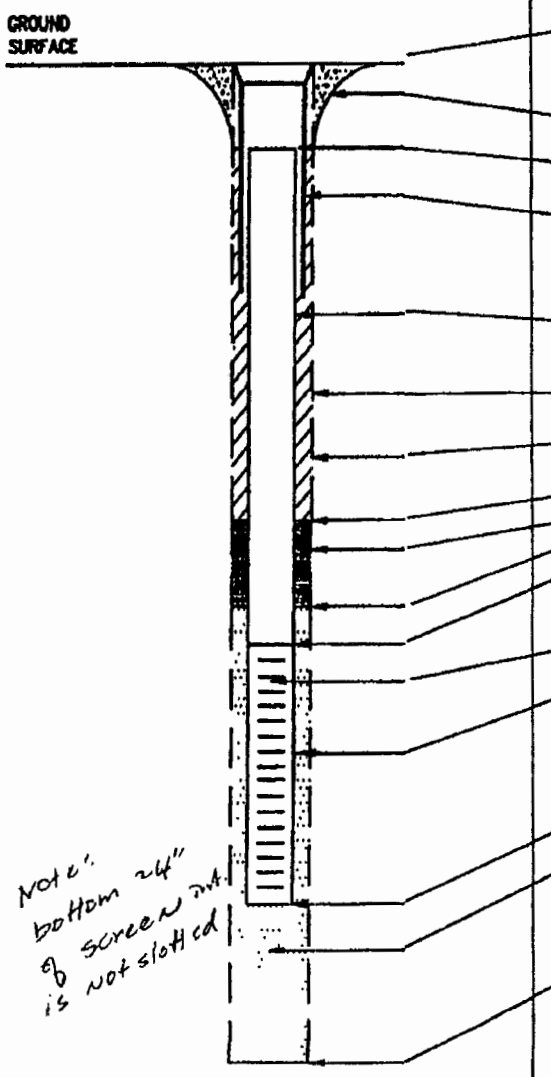
ELEV (a)	DEPTH (ft.) (b)	DESCRIPTION OF MATERIALS (c)	USCS CLASS. (d)	FIELD SCREEN RESULTS (e)	REMARKS (f)
	41		CL		
	42	lg angular clasts of slightly moist reddish brown sandy silty clay.	CL	0.88 ppm @42'	
	43	same as above. angular clasts to 1.5"	CL	1.05 ppm @43'	
	44	4" angular clasts of moist dk reddish brown non to slightly plastic brown silty sandy clay. Gypsum xtls to 0.5" Tough! 5YR 4/4.	CL	1.16 ppm @44'	
	45				
	46		CL		
	47	balls & small (1") angular clasts of reddish brown silty sandy clay 5YR 4/4.	CL		
	48	moist fine ~~silty~~ sandy silty clay. non to slightly plastic 2.5 YR 4/3 Reddish brown			
	49				
	50	Reddish brown moist slightly plastic silty sandy clay. 1cm angs. dra balls ~~&~~ cuttings	CL	Cuttings 50-54' 0.25 ppm FID 0.15 ppm FID in drum & cuttings PID FID	
	51				
	52				
	53				
	54	same as above to 58 ft	CL	0.08/0.01 ppm in auger @55' PID FID 1.60/0.50 ppm	
	55				
	56				
	57				
	58				
		TD = 58 ft CLB			

1172178

WELL ID DP63-MW 01

MONITORING WELL CONSTRUCTION DIAGRAM

PROJECT: DP-63 RI, Holloman AFB, New Mexico	DRILLING COMPANY: THF Drilling, Inc.
PROJECT NO.: 5155.0037.0009.H2000	DRILLER: George Guzman/Paul Schuman
INSTALLATION DATE(S): 8/21/02-8/22/02	DRILLING METHOD/ EQUIPMENT: Hollow-stem auger
FIELD GEOLOGIST: Patricia Weston	DEVELOPMENT METHOD: Bailing



GROUND SURFACE ELEVATION: N/A

ELEVATION OF TOP OF SURFACE CASING: ~~4~~ 3' above g.s.

TYPE OF SURFACE SEAL: Concrete

ELEVATION OF TOP OF RISER: 2.5' above g.s.

I.D. OF SURFACE CASING (IN.): 10"

TYPE OF SURFACE CASING: ☐ Flush-mount steel box ☒ Steel riser

I.D. OF RISER PIPE (IN.): 2"

TYPE OF RISER PIPE: Schedule-40 PVC

BOREHOLE DIAMETER (IN.): 8"

TYPE OF BACKFILL: Bentonite-cement grout

DEPTH TOP OF SEAL (FT.): 39.5'

TYPE OF SEAL: Bentonite pellets

DEPTH TOP OF SAND PACK (FT.): 44'

DEPTH TOP OF SCREEN (FT.): 47.1' ~~47.1~~ PW CLB

TYPE OF SCREEN: Schedule-40 PVC

SLOT SIZE X LENGTH (FT.): 0.01 inch, 10.0 ft

TYPE OF SAND PACK: 10-20 silica sand

DEPTH BOTTOM OF SCREEN (FT.): 57.1 ~~57.1~~ ~~57.1~~ PW

DEPTH BOTTOM OF SAND PACK (FT.): 57.1

TYPE OF BACKFILL BELOW OBSERVATION WELL: None

DEPTH OF BOREHOLE (FT.): 57.6 measured

QC: Carol Bierman 9/16/02

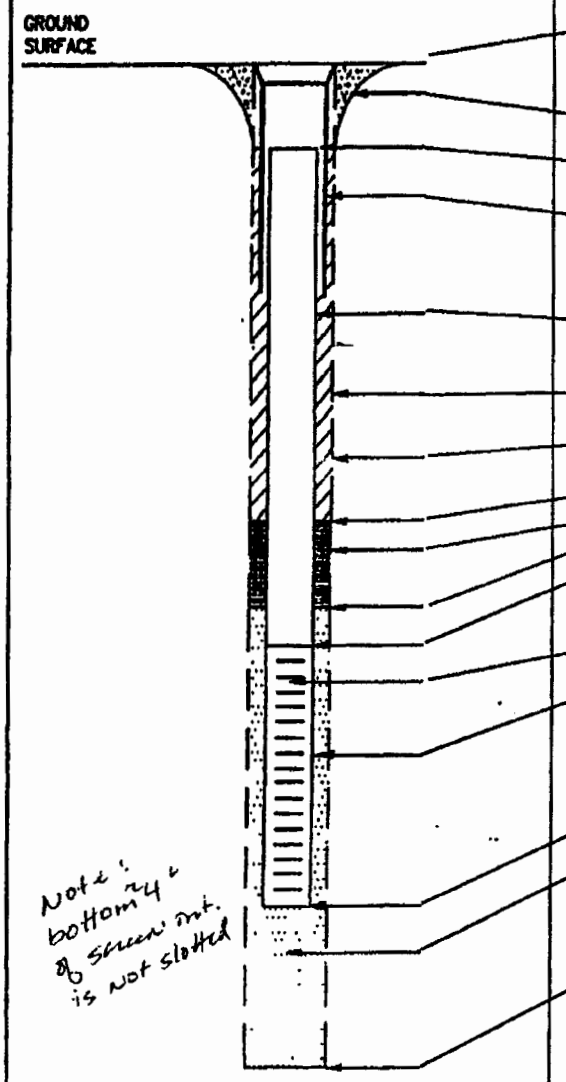
1172179

WELL ID DP63-MW 02

MONITORING WELL CONSTRUCTION DIAGRAM

(co-located w/DP15)

PROJECT: DP-63 RI, Holloman AFB, New Mexico	DRILLING COMPANY: THF Drilling, Inc.
PROJECT NO.: 5155.0037.0009.H2000	DRILLER: George Guitman/Paul Schumer
INSTALLATION DATE(S): 8/20/02 - 8/21/02	DRILLING METHOD/ EQUIPMENT: Hollow-stem auger
FIELD GEOLOGIST: Patricia Weston	DEVELOPMENT METHOD: Bailing



Note: bottom 4' of screen mt. is not slotted

GROUND SURFACE ELEVATION: N/A

ELEVATION OF TOP OF SURFACE CASING: 3' above g.s.

TYPE OF SURFACE SEAL: Concrete

ELEVATION OF TOP OF RISER: 2.5' above g.s.

I.D. OF SURFACE CASING (IN.): ~~9~~ 10"

TYPE OF SURFACE CASING: ☐ Flush-mount steel box ☒ Steel riser

I.D. OF RISER PIPE (IN.): 2"

TYPE OF RISER PIPE: Schedule-40 PVC

BOREHOLE DIAMETER (IN.): 8"

TYPE OF BACKFILL: Bentonite-cement grout

DEPTH TOP OF SEAL (FT.): 40'

TYPE OF SEAL: Bentonite pellets

DEPTH TOP OF SAND PACK (FT.): 44'

DEPTH TOP OF SCREEN (FT.): 48.18'

TYPE OF SCREEN: Schedule-40 PVC

SLOT SIZE X LENGTH (FT.): 0.01 inch, ft

TYPE OF SAND PACK: 10-20 silica sand

DEPTH BOTTOM OF SCREEN (FT.): ~~58.5~~ 58.18'

DEPTH BOTTOM OF SAND PACK (FT.): 58.5'

TYPE OF BACKFILL BELOW OBSERVATION WELL: Stock 10/20 silica

DEPTH OF BOREHOLE (FT.): 58.5'

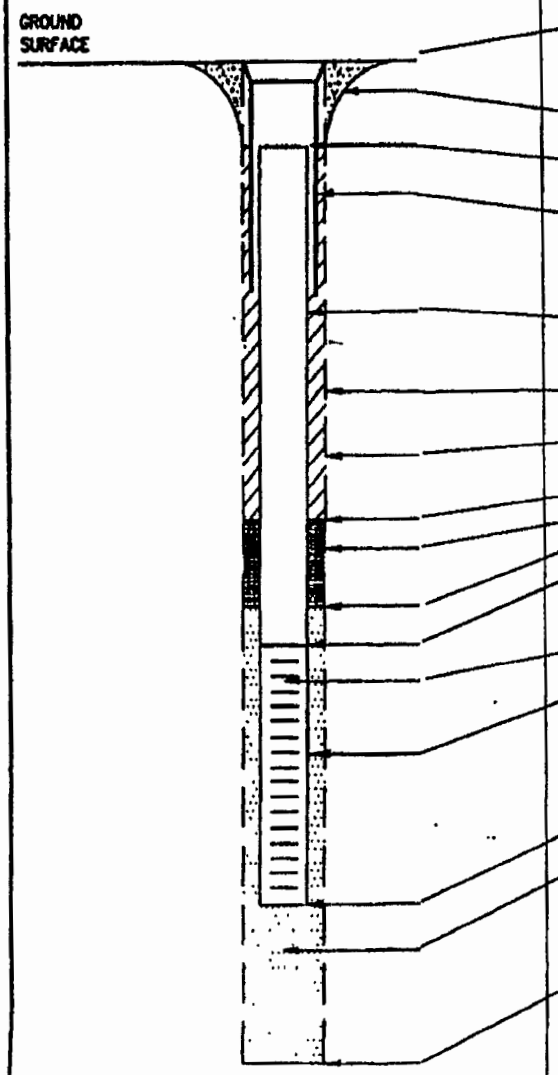
QC: Carol Bienvenu 9/16/02

1172180

WELL ID DP63-MW 03

MONITORING WELL CONSTRUCTION DIAGRAM

PROJECT: DP-63 RI, Holloman AFB, New Mexico	DRILLING COMPANY: THF Drilling, Inc.
PROJECT NO.: 5155.0037.0009.H2000	DRILLER: George Guzman / Paul Schuman
INSTALLATION DATE(S): 8/20/02 - 8/22/02	DRILLING METHOD/ EQUIPMENT: Hollow-stem auger
FIELD GEOLOGIST: Patricia Weston	DEVELOPMENT METHOD: Bailing



GROUND SURFACE ELEVATION: N/A

ELEVATION OF TOP OF SURFACE CASING: 3' above g.s.

TYPE OF SURFACE SEAL: Concrete

ELEVATION OF TOP OF RISER: 2.5' above ground

I.D. OF SURFACE CASING (IN.): 10"

TYPE OF SURFACE CASING: ☐ Flush-mount steel box ☒ Steel riser

I.D. OF RISER PIPE (IN.): 2"

TYPE OF RISER PIPE: Schedule-40 PVC

BOREHOLE DIAMETER (IN.): 8"

TYPE OF BACKFILL: Bentonite-cement grout

DEPTH TOP OF SEAL (FT.): 41'

TYPE OF SEAL: Bentonite pellets

DEPTH TOP OF SAND PACK (FT.): 44'

DEPTH TOP OF SCREEN (FT.): 47.4'

TYPE OF SCREEN: Schedule-40 PVC

SLOT SIZE X LENGTH (FT.): 0.01 inch, 10.0 ft

TYPE OF SAND PACK: 10-20 silica sand

DEPTH BOTTOM OF SCREEN (FT.): 57.4

DEPTH BOTTOM OF SAND PACK (FT.): 57.7

TYPE OF BACKFILL BELOW OBSERVATION WELL: ~~N/A~~ None CLB

DEPTH OF BOREHOLE (FT.): 57.7

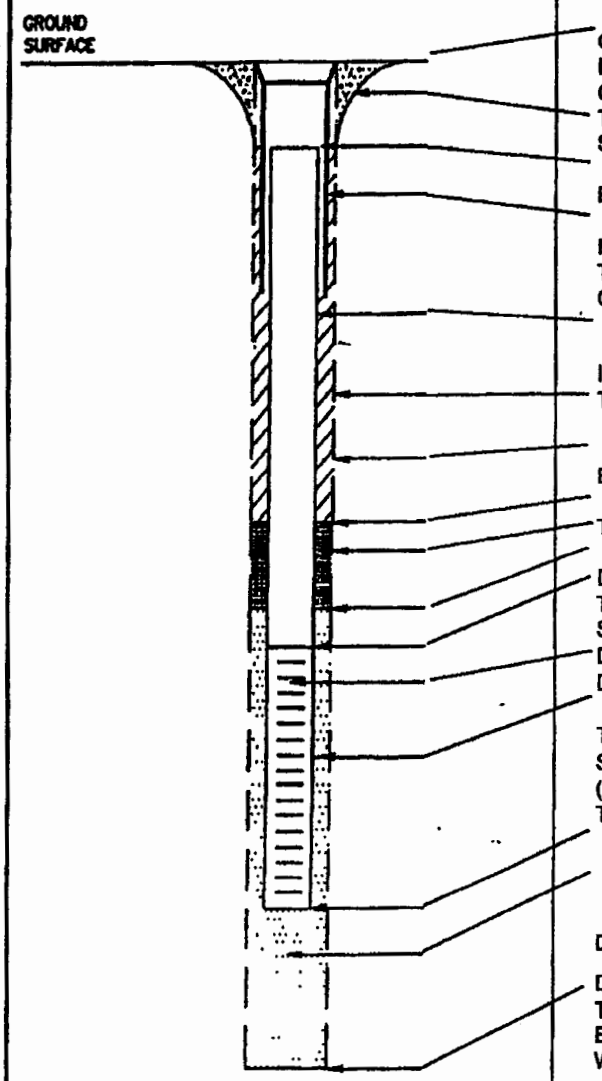
QC: Carol Brewer 9/16/02

1172181

WELL ID DP63-MW04

MONITORING WELL CONSTRUCTION DIAGRAM

PROJECT: DP-63 RI, Holloman AFB, New Mexico	DRILLING COMPANY: THF Drilling, Inc.
PROJECT NO.: 5155.0037.0009.H2000	DRILLER: George Guzman/Paul Schwab
INSTALLATION DATE(S): 8/19/02-8/21/02	DRILLING METHOD/ EQUIPMENT: Hollow-stem auger
FIELD GEOLOGIST: Patricia Weston	DEVELOPMENT METHOD: Bailing



GROUND SURFACE ELEVATION: N/A

ELEVATION OF TOP OF SURFACE CASING: g.s.

TYPE OF SURFACE SEAL: Concrete

ELEVATION OF TOP OF RISER: 3" bgs

I.D. OF SURFACE CASING (IN.): 12"

TYPE OF SURFACE CASING: ☒ Flush-mount steel box ☐ Steel riser

I.D. OF RISER PIPE (IN.): 2"

TYPE OF RISER PIPE: Schedule-40 PVC

BOREHOLE DIAMETER (IN.): 8"

TYPE OF BACKFILL: Bentonite-cement grout

DEPTH TOP OF SEAL (FT.): 38.5'

TYPE OF SEAL: Bentonite pellets

DEPTH TOP OF SAND PACK (FT.): 42' ~~44.5'~~ pw

DEPTH TOP OF SCREEN (FT.): 44.90'

TYPE OF SCREEN: Schedule-40 PVC

SLOT SIZE X LENGTH (FT.): 0.01 inch, 10.0 ft

TYPE OF SAND PACK: 10-20 silica sand

DEPTH BOTTOM OF SCREEN (FT.): 54.90'

DEPTH BOTTOM OF SAND PACK (FT.): 55'

TYPE OF BACKFILL BELOW OBSERVATION WELL: N/A

DEPTH OF BOREHOLE (FT.): 55'

QC: Carol Bienvilis 9/16/02

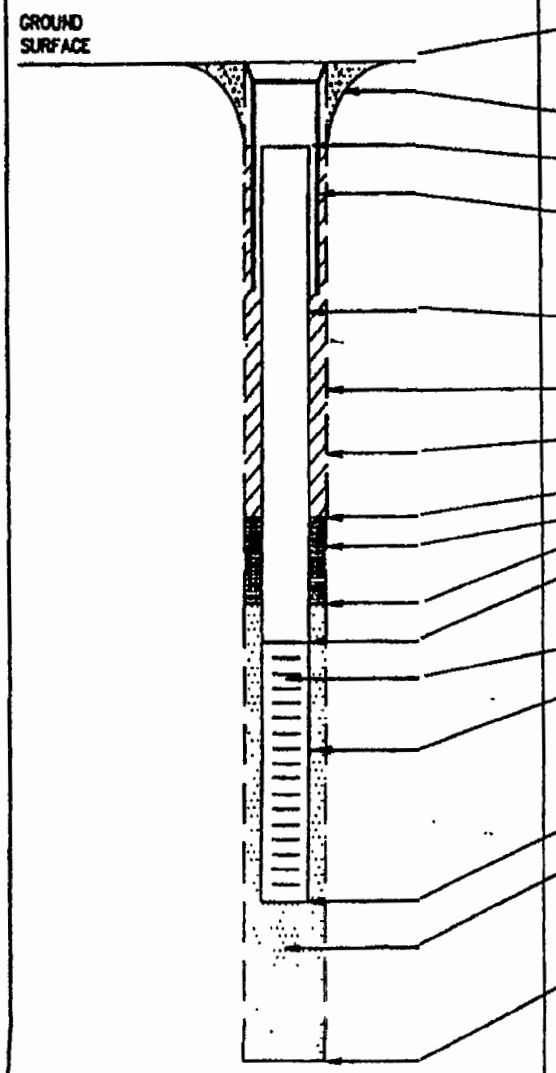
1172182

WELL ID DP63-MW05

MONITORING WELL CONSTRUCTION DIAGRAM

(E. area downgradient)

PROJECT: DP-63 RI, Holloman AFB, New Mexico	DRILLING COMPANY: THF Drilling, Inc.
PROJECT NO.: 5155.0037.0009.H2000	DRILLER: George Gutman/Paul Schulman
INSTALLATION DATE(S): 8/19/02 - 8/21/02	DRILLING METHOD/ EQUIPMENT: Hollow-stem auger
FIELD GEOLOGIST: Patricia Weston	DEVELOPMENT METHOD: Bailing



GROUND SURFACE ELEVATION: N/A

ELEVATION OF TOP OF SURFACE CASING: g.s.

TYPE OF SURFACE SEAL: Concrete

ELEVATION OF TOP OF RISER: 3" bgs

I.D. OF SURFACE CASING (IN.): 12"

TYPE OF SURFACE CASING: ☒ Flush-mount steel box ☐ Steel riser

I.D. OF RISER PIPE (IN.) 2"

TYPE OF RISER PIPE: Schedule-40 PVC

BOREHOLE DIAMETER (IN.): 8"

TYPE OF BACKFILL: Bentonite-cement grout

DEPTH TOP OF SEAL (FT.): 36.5'

TYPE OF SEAL: Bentonite pellets

DEPTH TOP OF SAND PACK (FT.): 40.9'

DEPTH TOP OF SCREEN (FT.): 45.05'

TYPE OF SCREEN: Schedule-40 PVC

SLOT SIZE X LENGTH (FT.): 0.01 inch, 10.0 ft

TYPE OF SAND PACK: 10-20 silica sand

DEPTH BOTTOM OF SCREEN (FT.): 55.05'

DEPTH BOTTOM OF SAND PACK (FT.): 55'

TYPE OF BACKFILL BELOW OBSERVATION WELL: N/A

DEPTH OF BOREHOLE (FT.): 55.2

QC: Carol Bramlett 9/16/02

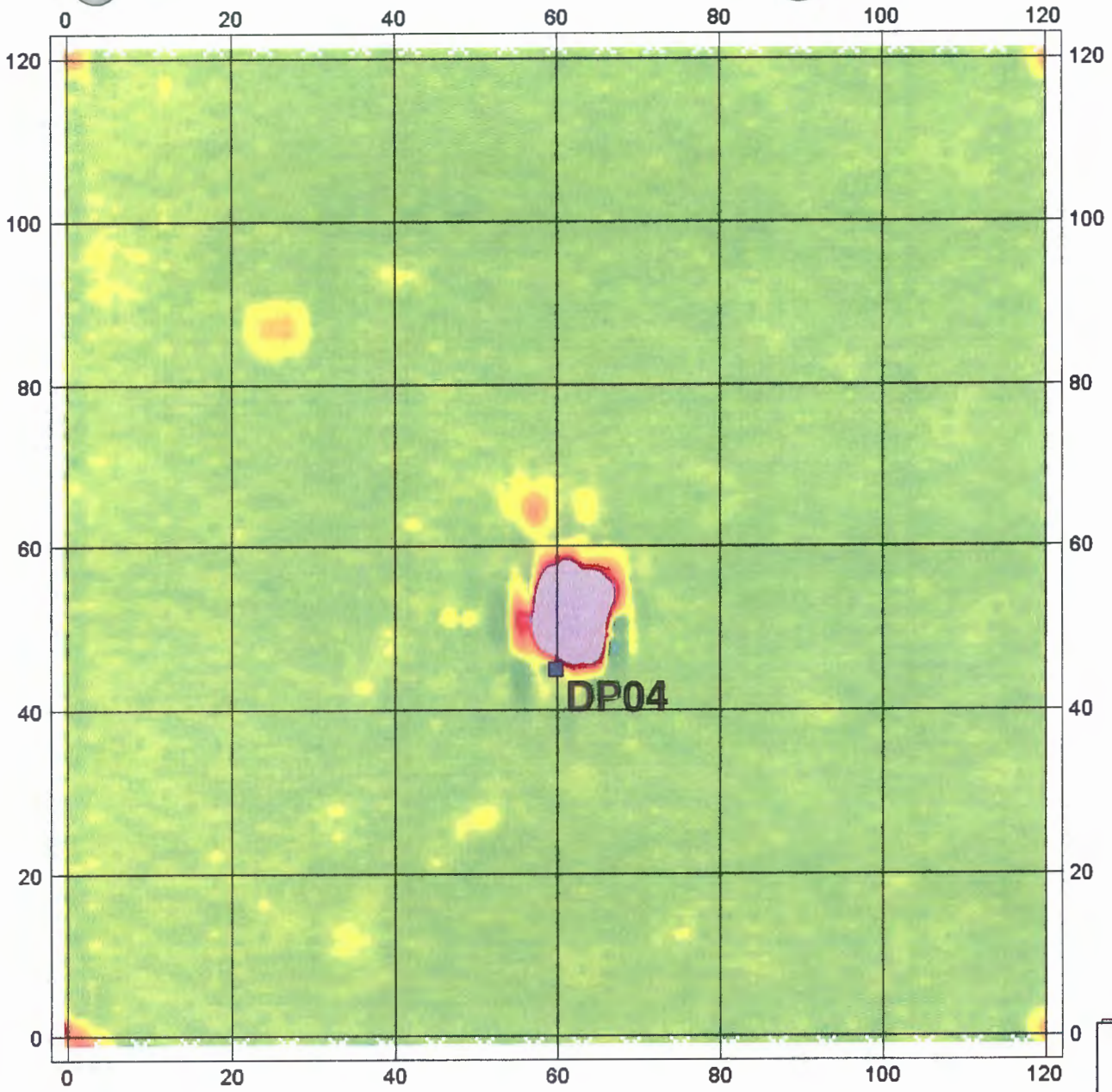
APPENDIX D

GEOPHYSICAL RESULTS

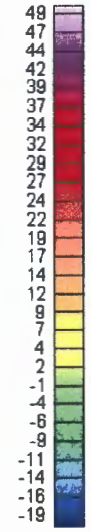
FINAL REPORT FOR PRELIMINARY ASSESSMENT/SITE INSPECTION OF DP-63 DISPOSAL PIT 63

FOSTER WHEELER ENVIRONMENTAL CORPORATION

JANUARY 2001



Site 2--West Area



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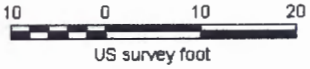


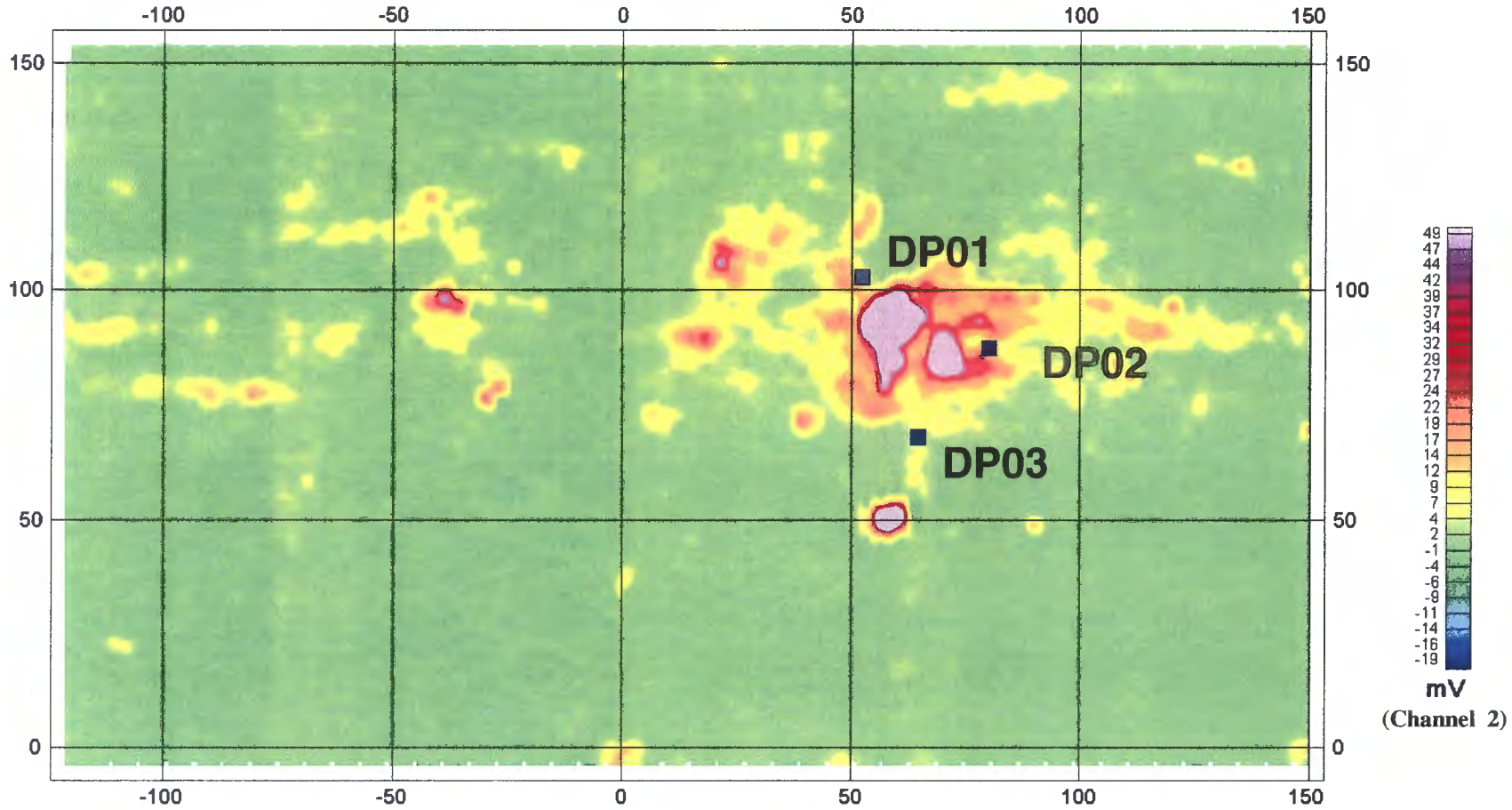
Note: Survey completed in March 2000.

FOSTER WHEELER ENVIRONMENTAL CORPORATION

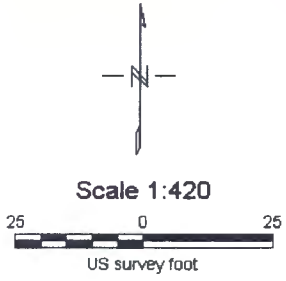
Figure 2-2

DP-63 West Area Geophysical Map

Site 1--East Area



Note: Survey completed in March 2000.

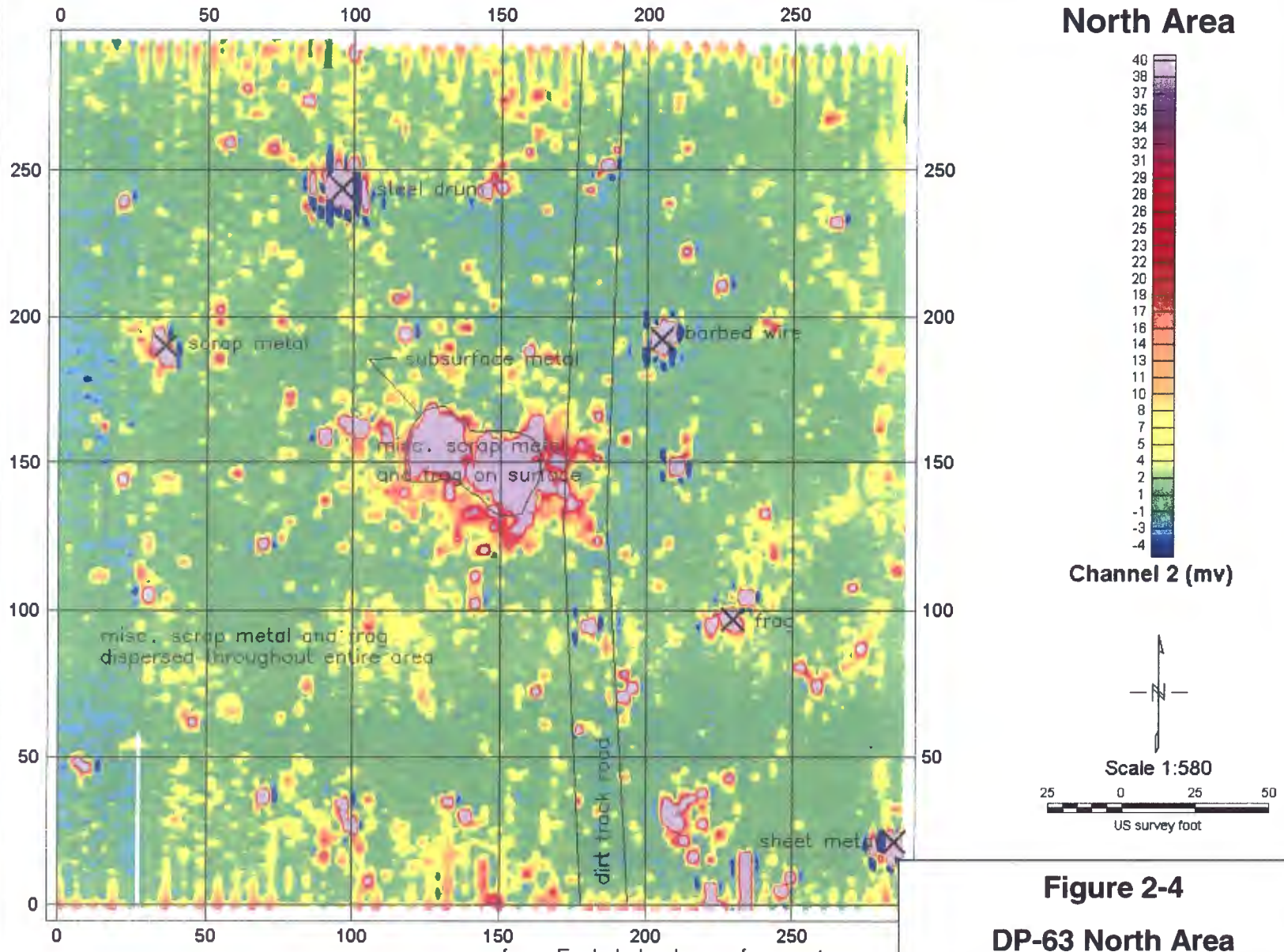


FOSTER WHEELER ENVIRONMENTAL CORPORATION

Figure 2-3

DP-63 East Area Geophysical Map

Note: Survey completed in September 2000.



FOSTER WHEELER ENVIRONMENTAL CORPORATION

Figure 2-4

DP-63 North Area Geophysical Map

APPENDIX E

BASE CIVIL ENGINEER WORK REQUEST AIR FORCE FORM 332

BASE CIVIL ENGINEER WORK REQUEST

(See Back of This Form Set for Instructions)

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average .3 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to the Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project 0704-0188, Washington DC 20503. Please DO NOT RETURN your form to either of these addresses. Send your completed form to HQ AFESC/DEMG.

SECTION 1 - TO BE COMPLETED BY REQUESTER

1. FROM *(Organization)*	2. OFFICE SYMBOL	3. DATE OF REQUEST	4. WORK REQUEST NO. *(For BCE Use)*
5. NAME AND PHONE NO. OF REQUESTER		6. REQUIRED COMPLETION DATE	7. BUILDING, FACILITY OR STREET ADDRESS WHERE WORK IS TO BE ACCOMPLISHED

8. DESCRIPTION OF WORK TO BE ACCOMPLISHED *(Include Sketch or Plan, when appropriate)*

9. BRIEF JUSTIFICATION FOR WORK TO BE ACCOMPLISHED *(Not required for maintenance and repair)*

10. DONATED RESOURCES

☐ FUNDS	☐ LABOR	☐ MATERIAL	☐ CONTRACT BY REQUESTER	☐ NONE

11. NAME OF REQUESTER	12. GRADE OF REQUESTER	13. SIGNATURE OF REQUESTER *(See Instructions on back)*

14. COORDINATION

SECTION II - FOR BASE CIVIL ENGINEER USE

15. WORK ORDER *(Place an "X" in the appropriate box.)*

☐ IN- SERVICE	☐ SELF-HELP	☐ CONTRACT	☐ SABER

16. DIRECT SCHEDULED WORK *(Place an "X" in the appropriate box.)*

☐ EMERGENCY	☐ URGENT	☐ ROUTINE	☐ SELF-HELP	☐ M/C

17. SELF-HELP *(Place an "X" in the appropriate box.)*

☐ BRIEFING REQUIRED	☐ ADEQUATE COORDINATION	☐ INSPECTION REQUIRED

SECTION III - COMPLETE ONLY IF WORK IS TO BE ACCOMPLISHED BY WORK ORDER

18. WORK CLASS	19. PRIORITY	20. ESTIMATED HOURS	21. ESTIMATED FUNDED COST	22. ESTIMATED TOTAL COST

☐ 23 THERE IS NO NEED FOR AN ENVIRONMENTAL ASSESSMENT (AFR 19-2)	☐ 24. A WRITTEN ASSESSMENT IS BEING/HAS BEEN PROCESSED	☐ 25. APPROVED	☐ 26. DISAPPROVED

27. REMARKS

SECTION IV - APPROVING AUTHORITY

28. NAME AND GRADE *(Please Type or Print)*	29. SIGNATURE	30. DATE

CONTINUATION SHEET FOR AF FORM 332

(COMPUTER GENERATED)

1. **FROM** *(Organization)*	2. **OFFICE SYMBOL**	3. **DATE OF REQUEST**	4. **WORK REQUEST NO.** *(For BCE Use)*
5. **NAME AND PHONE NO. OF REQUESTER**		6. **REQUIRED COMPLETION DATE**	7. **BUILDING, FACILITY OR STREET ADDRESS WHERE WORK IS TO BE ACCOMPLISHED**

8. **DESCRIPTION OF WORK TO BE ACCOMPLISHED** *(Include Sketch or Plan, when appropriate)*

APPENDIX F

PORTIONS OF BHATE STANDARD OPERATING PROCEDURE NO. 10

1 MONITORING WELL INVESTIGATION

1.1 Objective

It is the policy of Bhate to design, install, and construct monitoring wells in a manner that ensures that all wells installed meet the criteria of being 1) adequately sealed to prevent surface contamination or cross contamination between aquifers; 2) capable of yielding high quality groundwater samples representative of true water quality within the target unit; 3) adequately protected; and 4) in compliance with all applicable State and federal regulations. The procedures set forth in the section apply to all Bhate and contract personnel who are responsible, both directly and indirectly, for the design of monitoring well systems, for oversight of drilling and construction operations, and for evaluation of the suitability and reliability of monitoring wells and data and measurements obtained from monitoring wells.

1.2 Procedure

Monitoring wells are installed primarily to provide information on the hydrogeology of a site and to determine the extent of migration of contaminants, if any. Well permits will be obtained prior to initiating construction, repair, or abandonment of any monitoring well. The drilling subcontractor, who must be certified in the appropriate state, will obtain the permits. The certified well driller or his representative must be present at the site during all drilling operations. All drilling personnel must meet all applicable OSHA requirements. The supervising hydrogeologist must be fully knowledgeable and experienced with federal and state requirements/regulations for groundwater monitoring programs.

Site-specific work plans will specify drilling methods to be used, and will present proposed well design and construction details. The drilling methods, well design, and well construction will adhere to the criteria and methodologies presented in this document. The proposed well design will be based on existing subsurface and groundwater fluctuation data. The design will present these data with the grain size of the filter pack and a discussion of the procedure to be used in the field for determining screen placement. All equipment, well materials and tools that will enter the borehole must be steam cleaned with a high temperature pressure washer (water at 200°F and 1,500 psi) prior to installation. The cleaned materials will be wrapped in clean Visqueen plastic and protected from possible contaminants. If needed, they will be steam cleaned again immediately before installation. The specifications presented herein are to be adhered to unless a site-specific variance has been granted by the appropriate authorities.

1.2.1 Well Design Specifications

Well Screen

In general, the standard monitoring well screen installed at a site will consist of a 2-inch inside diameter Schedule 40 PVC screen with 0.010 inch slots. If site specific conditions warrant, well

screen materials will be designed based on site specific data or selected depending upon the known or suspected chemical contaminants at the site, and so that the completed monitoring well provides data, which meet the project data quality objectives. Monitoring well screens will be sized to retain over 90% of the filter pack. Well screen materials will be of the same size and strength material as the well riser, and will be a non-contaminating, continuous wrap design. Factory-slotted screens will be acceptable for USACE projects as long as the suspected contaminants do not include those that have an affinity for sorbing onto soil particles (e.g., PCBs and PAHs) or metals. In such cases, continuous-wrapped screen will be required. No glues, adhesives, lead shot, or lead wool will be used to connect the riser sections or screen. No field-slotted screen will be permitted.

Filter Pack

The filter pack material will be clean, washed, well-rounded silica sand sized to perform as a filter between the formation material and the well screen. Proper documentation will be furnished concerning the composition, grain-size distribution, cleaning procedure, and chemical analysis. The filter pack gradation shall have a uniformity coefficient (C_u) of not more than 2.5, and shall be sized so that the slotted screen will retain 90 percent of the material.

The standard filter pack material used for monitoring wells will typically conform to the size appropriate for slot screen. The following table provides the appropriate sized filter pack material in accordance with ASTM D 5092-90 (ASTM, 1990).

Table 1-1. Grain Size Distribution Chart

Size of Screen Opening, mm (in.)	Slot No.	Sand Pack Mesh Size Names(s)	1% Passing Size (D-1), mm	Effective Size (D-10), mm	30% Passing Size (D-30), mm
0.125 (0.005)	5	100	0.09 to 0.12	0.14 to 0.17	0.17 to 0.21
0.25 (0.010)	10	20 to 40	0.25 to 0.35	0.4 to 0.5	0.5 to 0.6
0.50 (0.020)	20	10 to 20	0.7 to 0.9	1.0 to 1.2	1.2 to 1.5
0.75 (0.030)	30	10 to 20	0.7 to 0.9	1.0 to 1.2	1.2 to 1.5
1.0 (0.040)	40	8 to 12	1.2 to 1.4	1.6 to 1.8	1.7 to 2.0
1.5 (0.060)	60	6 to 9	1.5 to 1.8	2.3 to 2.8	2.5 to 3.0
2.0 (0.080)	80	4 to 8	2.0 to 2.4	2.4 to 3.0	2.6 to 3.1

In addition to the primary filter pack installed along the screened interval of the monitoring well, a secondary filter pack consisting of finer material will be installed to prevent bentonite pellets from commingling with the primary filter pack.

Well Riser

Well riser (casing) will consist of polyvinyl chloride (PVC) or stainless steel. PVC pipe will be new, threaded, flush-jointed, and as a minimum, conform to the requirements of ASTM F480-81/SDR 13.5 (Schedule 40). PVC pipe will bear markings identifying the material as that specified, and will carry the seal of the National Sanitation Foundation. Stainless steel pipe will consist of new, flush-jointed, and threaded, Type 304, corrosion-resistant steel. Unless noted in the site-specific work plans, monitoring wells will be 2-inch inside diameter (ID).

Bentonite Seal

The bentonite seal will be composed of commercially manufactured sodium bentonite pellets, which do not exceed 0.25-inch diameter. Clean, potable water will be used to hydrate the bentonite.

Annular Seal

The cement grout will consist of a mixture of Portland Cement (ASTM C 150-00) and water in the proportion of approximately 6 to 7 gallons of approved water per bag of cement (94 pounds). In addition, 3 to 5 percent by weight of sodium bentonite powder will be added. The minimum acceptable grout weight will be 14 pounds per gallon (lbs/gal). The cement grout weight will be determined using a mud balance. Water may be added to the mix in small amounts, at the discretion of the field geologist, to achieve pumpability.

1.2.2 Borehole Completion

Procedures for the drilling and advancement of soil borings are presented in BSOP No. 1, Section 4. Drilling techniques employed must minimize disturbance of subsurface samples and must not introduce contamination to the subsurface or allow contaminants, if any, in shallow hydrogeologic units to migrate to deeper units. A Monitoring Well Installation Detail Form (Attachment 1-1) will be completed for each monitoring well. This form includes a comprehensive list of pertinent drilling hydrogeologic and monitoring well construction information.

1.2.3 Well Construction

At all times during the progress of the work, precautions will be taken to prevent tampering with the well or the entrance of foreign material into it. Run-off will be prevented from entering the well during construction.

Depending on site conditions, consideration should be given to overdrill the borehole so that soils that have not been removed or that have fallen into the borehole during auguring or drill stem retrieval will fall to the bottom of the borehole below the depth of the filter pack and the screen. Normally 3 to 5 feet are sufficient for overdrilling. Once the desired depth of the borehole has been attained, the borehole will be prepared for installation of the well casing and

screen. If drilling fluid was used, it must be flushed from the borehole with clean potable water to the extent possible without causing borehole collapse. The well casing/screen assembly will then be inserted into the borehole. For wells that are being installed beneath a confining or semi-confining unit, or are intended to monitor deep members or portions of an aquifer, the well casing/screen assembly will be installed within pre-set surface casing, to prevent cross-connections between different aquifer zones. If a well cannot be properly completed to prevent such an interchange of water between water-bearing zones or to prevent a loss of artesian pressure, the well will be abandoned and plugged.

The casing/screen assembly will be installed as follows:

1. Prior to installation of the casing and screen, the lengths and diameters of all components (including the bottom plug or cap) will be measured and recorded on the Casing/Well Screen Tally Form (Attachment 1-2). The casing riser and screen assembly will be installed round, plumb, and true to line.

2. A bottom plug will be attached to the bottom of the screened section.

3. The well screen will be connected to the riser sections of the casing assembly. For wells intended to monitor the upper surficial aquifer near the water table, the well screen will be installed so as to straddle the free water surface, extending both above and below the water table to accommodate seasonal or other variations in its elevation. In all cases, the top of the screen will be located at least 2 feet below the base of the down-hole seal. Screen slot size will be 0.10 inches, or the appropriate size based on grain-size distribution analyses and filter back design, as discussed above.

4. For wells installed to depths exceeding 50 feet, centralizers will be placed at locations just below the screen, just above the location of the bentonite seal, and at 50-foot intervals along the riser casing. Stabilizers will not be used if their installation prevents the placement of the annular materials.

5. Well risers will extend at least 2.5 feet above the ground surface, unless well casings must be completed at ground surface level as specified by the client or mandated by site conditions and planned use of the well. If a flush finish completion is conducted, the placement of annular materials will be done in such a way that the inside of the well casing is protected, i.e., the protective vault will be waterproof and strong enough to support anticipated loads.

6. The primary filter pack will be placed in the annulus between the well material and borehole using a tremie pipe, starting with the tremie at the bottom of the borehole and working the tremie upward as the filter pack is placed. When using hollow stem augers (HSAs), the augers will be raised incrementally during the installation of the filter pack. Attempts will be made to keep the bottom of the augers below the top of the filter pack during installation. The level of the top of the filter pack in the annulus will be continually verified by tag-line measurement during placement. The filter pack will extend at least 2 feet above the top of the screen. The volume of the installed filter pack will be compared with the annular volume

to verify proper placement of the filter pack. This material accounting will be recorded in the field book.

7. A secondary filter pack, at least 2 feet thick and consisting of material finer than the primary filter pack, but of similar composition, will be placed in the annulus between the primary filter pack and the overlaying bentonite seal. This secondary filter is intended to prevent movement of the seal or grout (or both) into the underlying primary filter pack.

8. A bentonite seal at least 2 feet thick will be placed in increments of four 6-inch lifts immediately above the filter pack. Pouring of the pellets is acceptable for boreholes less than 50 feet where the annular space is large enough to limit the potential for bridging and to allow measurements to ensure that the pellets have been placed at proper intervals. For depths greater than 50 feet, the bentonite pellets will be installed through a tremie pipe. The bentonite pellet seal will be hydrated either by pouring water or utilizing the tremie pipe with an approximately equal volume of clean, potable water, and allowed to hydrate a minimum of 30 minutes between lifts before proceeding. If water is used, its source and the volume used should be documented in the field book. After the placement of the final lift, the bentonite seal will be allowed to hydrate another 2 hours before grouting the remaining annulus. The level of the top of the bentonite seal will be verified by tag-line measurement prior to grouting. When using HSAs, the bottom of the augers will be left in the borehole as close as possible above the bentonite seal.

9. To grout the remaining annular space, a side-discharging tremie pipe will then be maintained 3 feet above the bentonite seal and will be used to slowly place the cement/bentonite grout mixture. When using HSAs, the augers will be pulled incrementally during the grouting procedures to limit borehole collapse. Grout will be pumped into the annulus through the tremie pipe until undiluted grout flows from the borehole at the ground surface. The grout will be allowed to cure for at least 24 hours prior to development.

1.2.4 Double Cased Wells

Surface casing will be installed in the borehole when drilling a monitoring well that will be installed at depths below relatively impermeable (confining) layers or below depths of known contamination. The purpose of the surface casing is to prevent cross-contamination between two aquifer zones and to prevent dragging contamination down to a greater depth during the drilling procedure.

A pilot borehole should be drilled and the surface casing installed to slightly below the known depth of contamination or a minimum of 2 feet into the confining layer. The diameter of the surface casing will be sufficient to contain the inner casing and a 2-inch annular space. The size of the borehole should be sufficient to maintain a 2-inch annular space between the borehole walls and the surface casing. The material of the surface casing may vary, but it will be chemically inert and able to withstand potential chemical degradation and any forces exerted on the casing during its installation and monitoring well construction.

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The outer casing should be grouted by the tremie method from the bottom to within 2 feet of the ground surface. The grout should be pumped into the annular space between the outer casing and the borehole wall. This will be accomplished by either placing the tremie tube in the annular space and pumping the grout from the bottom of the borehole to the surface, or placing a grout shoe or plug inside the casing at the bottom of the borehole and pumping the grout through the bottom grout plug and up the annular space on the outside of the casing. If the casing is set into very tight clay, both of the above methods may have to be used, because the clay usually forms a tight seal in the bottom and around the outside of the casing preventing grout from flowing freely during grout injection. A minimum of 24 hours will be allowed for the grout seal to cure before attempting to drill through it. The grout mixture used to seal the outer annular space will be a neat cement mixture of one 94-lb bag of Type I Portland Cement per approximately 7 gallons of water and 3 to 5 percent bentonite powder by weight.

When drilling through the seal, care will be taken to avoid cracking, shattering, and/or washing out the seal. If caving conditions exist such that the outer casing cannot be sufficiently sealed by grouting, the out casing should be driven into place and a grout seal placed in the bottom of the casing. Removal of outer casings, which are sometimes called temporary surface casings, after the well screens and casings have been installed and grouted, is not acceptable. Trying to remove outer surface casings after the inner casings have been grouted could jeopardize the structural integrity of the well. The boring will be advanced through the surface casing to the target depth for monitoring well installation. The borehole beneath the surface casing will be of sufficient diameter to maintain a 2-inch annular space between the monitoring well and the borehole well.

1.2.5 Well Head Completion

Upon completion of the well, a suitable vented cap will be installed on the top of the well riser. The well riser will be surrounded by a larger diameter protective steel or PVC casing rising approximately 3 feet above ground level and set a minimum of 2 feet below the ground surface into the cement grout backfill. A drain hole at least 0.25 inches in diameter will be drilled at the base of the protective casing. The protective casing will be provided with a locking cap and a brass padlock or the well casing will be secured with a plastic expansion cap locked with a hexagonal key. All locks used at a particular site will be keyed alike. If wells are required to be finished flush with the grout or pavement, these will be fitted with a watertight, flush-mounted, traffic-rated steel cover at least 6 inches larger in diameter than the well riser. The well casing will be secured with a plastic expansion cap locked with a hexagonal key.

A minimum 3-foot by 3-foot by 4-inch thick concrete pad, sloped away from the well, will be constructed around the monitoring well with the top outer edge at the final ground elevation. At locations where vehicular traffic is likely, the concrete pad will be reinforced with reinforcement wire or rebar. Three or four 3-inch diameter or larger concrete-filled steel or PVC posts will be equally spaced around the well and cemented in place around the concrete pad. The base of these posts shall extend 2 feet bls and be appropriately 3 feet tall. Metal rebar may be installed inside the posts for additional stabilization. The concrete pad surface immediately surrounding

the top of the well will be sloped away from the well. After the well is installed, the area will be cleaned and all discarded material will be properly disposed.

1.2.6 Documentation and Recording

In addition to providing standard field documentation procedures, a Monitoring Well Construction Form (Attachment 1-1) will be prepared to provide an accurate "as-built" diagram of each well and will include the following information:

- Project and site names, well number and the total depth of the completed well
- Depth of any grouting or sealing, and the amount of cement and/or bentonite used, and to the total borehole depth and elevation
- Depth, elevation, and type of well casing
- Installation date or dates, and name of the driller and the geologist installing the well
- All pertinent construction details of monitoring wells, such as depth to and description of all annular fill materials; gradation of filter packs; length, location (depth and elevation), diameter, slot size, material, and manufacturer of well casing and screen; position of centralizers; and location of any blank pipe or intermediate casing installed in the well
- Description of surface completion, including protective steel casing, protective pipes, and concrete surface seal
- Surveyed coordinates and elevation of top of ground and top of well riser. The accuracy of the survey points will be in accordance with BSOP No. 11.
- A brief stratigraphic log, showing depths to and descriptions of major lithologic changes encountered in the well borehole

A discussion of information to include in the boring logs is presented in BSOP No. 1. All original well record form, field report forms and geologist logs will be maintained in the project file.

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ATTACHMENT 1-1

MONITORING WELL INSTALLATION DETAIL FORM

Bhate Environmental Associates — **WELL CONSTRUCTION DIAGRAM (Flush Mount)**

Project/Phase:		Well/Boring No.:	
Location:		Drilling Method:	
Client:		Date(s):	
Drilling Contractor:		Northing (NAD 83):	
Driller:		Easting (NAD 83):	
Geologist:		Bhate Project #:	

NOT TO SCALE

Surface Elevation: _____

Top of Casing Elevation: _____

Borehole Diameter (in): _____

Well Casing Diameter (in): _____

Depth to Water (ft) _____

During Drilling: _____

Date _____

Pre Development: _____

Date _____

Post Development: _____

Date _____

Top of Bentonite Seal: _____

Top of Filter Pack: _____

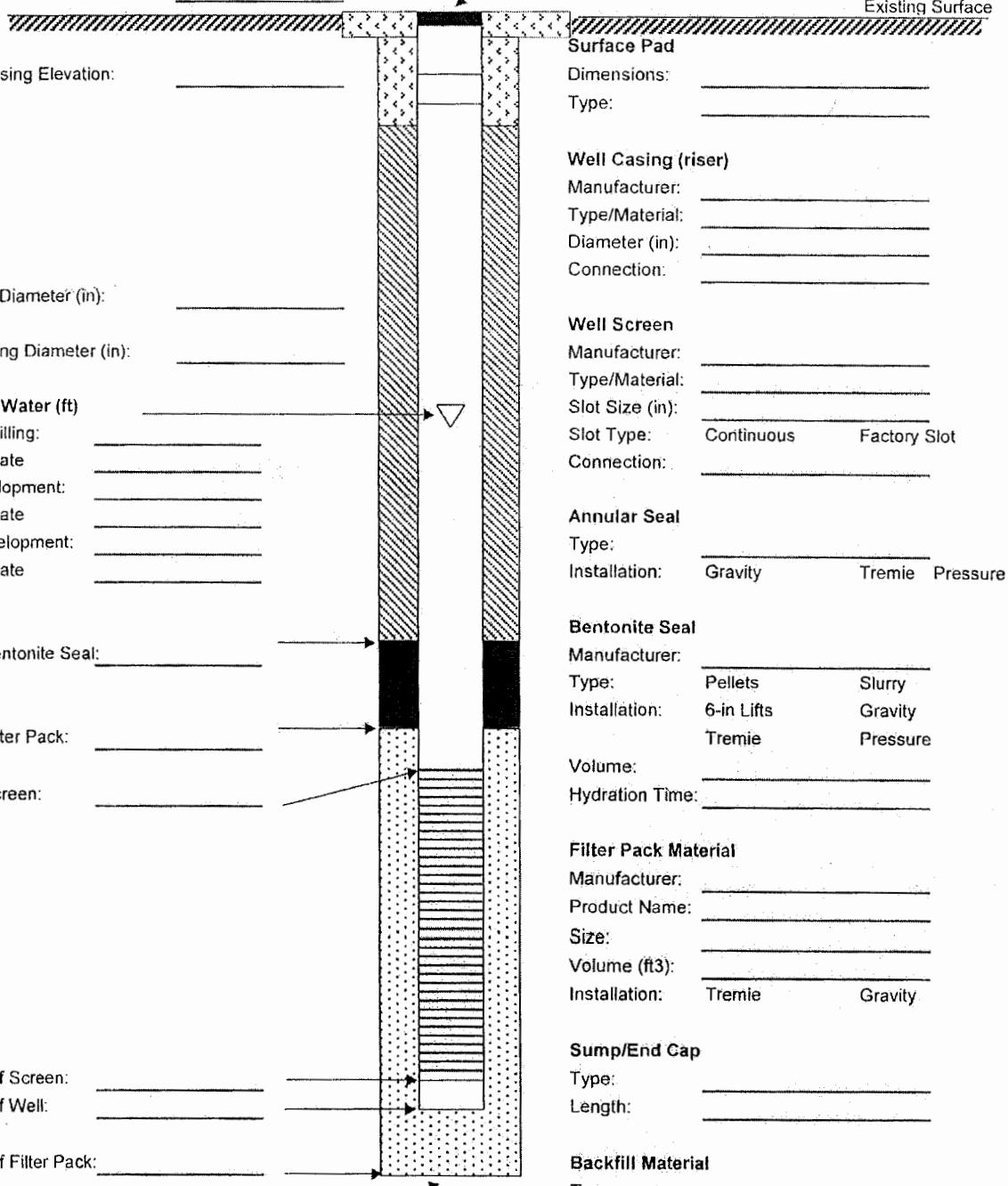
Top of Screen: _____

Bottom of Screen: _____

Bottom of Well: _____

Bottom of Filter Pack: _____

Borehole Depth: _____



Protective Casing

Type: _____

Dimensions: _____

Length: _____

Surface Pad

Dimensions: _____

Type: _____

Well Casing (riser)

Manufacturer: _____

Type/Material: _____

Diameter (in): _____

Connection: _____

Well Screen

Manufacturer: _____

Type/Material: _____

Slot Size (in): _____

Slot Type: Continuous Factory Slot

Connection: _____

Annular Seal

Type: _____

Installation: Gravity Tremie Pressure

Bentonite Seal

Manufacturer: _____

Type: Pellets Slurry

Installation: 6-in Lifts Gravity

Tremie Pressure

Volume: _____

Hydration Time: _____

Filter Pack Material

Manufacturer: _____

Product Name: _____

Size: _____

Volume (ft3): _____

Installation: Tremie Gravity

Sump/End Cap

Type: _____

Length: _____

Backfill Material

Type: _____

Volume: _____

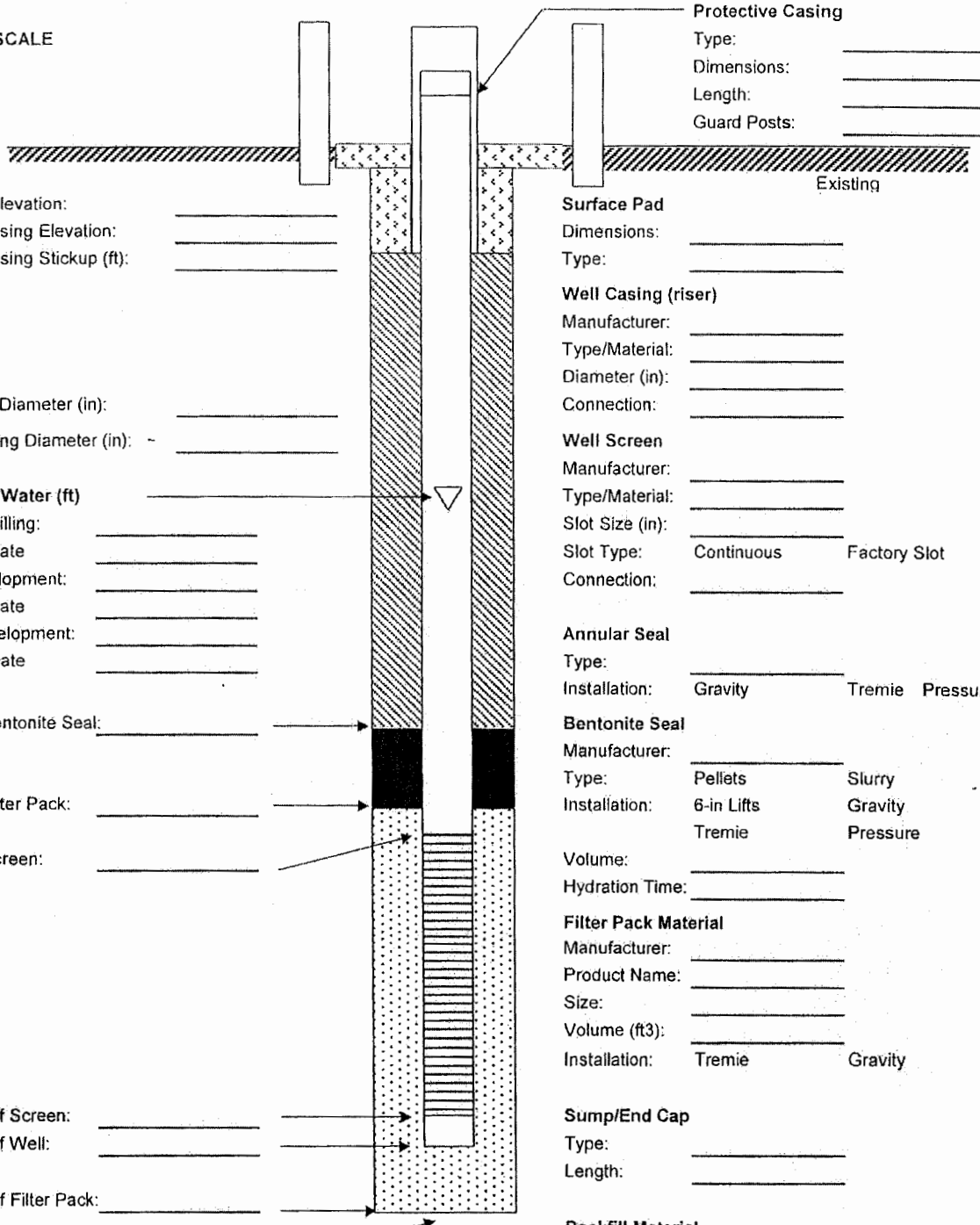
Comments:

Bhate Environmental Associates — **WELL CONSTRUCTION DIAGRAM (Above Grade)**

Project/Phase: _____
Location: _____
Client: _____
Drilling Contractor: _____
Driller: _____
Geologist: _____

Well/Boring No.: _____
Drilling Method: _____
Date(s): _____
Northing (NAD 83): _____
Easting (NAD 83): _____
Bhate Project #: _____

NOT TO SCALE



Protective Casing
Type: _____
Dimensions: _____
Length: _____
Guard Posts: _____

Surface Elevation: _____
Top of Casing Elevation: _____
Top of Casing Stickup (ft): _____

Borehole Diameter (in): _____
Well Casing Diameter (in): _____

Depth to Water (ft)
During Drilling: _____
Date _____
Pre Development: _____
Date _____
Post Development: _____
Date _____

Top of Bentonite Seal: _____
Top of Filter Pack: _____
Top of Screen: _____
Bottom of Screen: _____
Bottom of Well: _____
Bottom of Filter Pack: _____
Borehole Depth: _____

Surface Pad
Dimensions: _____
Type: _____

Well Casing (riser)
Manufacturer: _____
Type/Material: _____
Diameter (in): _____
Connection: _____

Well Screen
Manufacturer: _____
Type/Material: _____
Slot Size (in): _____
Slot Type: Continuous Factory Slot
Connection: _____

Annular Seal
Type: _____
Installation: Gravity Tremie Pressure

Bentonite Seal
Manufacturer: _____
Type: Pellets Slurry
Installation: 6-in Lifts Gravity
Tremie Pressure
Volume: _____
Hydration Time: _____

Filter Pack Material
Manufacturer: _____
Product Name: _____
Size: _____
Volume (ft3): _____
Installation: Tremie Gravity

Sump/End Cap
Type: _____
Length: _____

Backfill Material
Type: _____
Volume: _____

Comments:

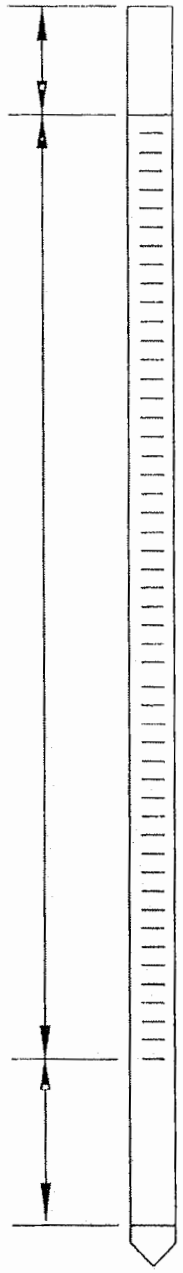
ATTACHMENT 1-2

CASING/WELL SCREEN TALLY FORM

BHATE
Environmental Engineers and Scientists

CASING TALLY

WELL NUMBER _____

ITEM NO.	DESCRIPTION	LENGTH (FEET)	SCREEN DIAGRAM
			

PROJECT NAME: _____ CLIENT: _____

PROJECT NUMBER/PHASE: _____ PROJECT LOCATION: _____

DRILLING MTHD: _____

DATE STARTED: _____ DATE FINISHED: _____ ENGINEER/GEOLOGIST: _____

ATTACHMENT 2-1

WATER LEVEL DATA SUMMARY FORM

WATER-LEVEL DATA SUMMARY

Project Name/Number	Date
	Field Personnel #1
Site Name	Field Personnel #2
Client	Field Personnel #3
Survey Datum (NGVD)	Weather (previous 24 hours)
Measuring Device	

Well Number	Time (hhmm)	Measuring Point		Depth to Water (ft, TOC)	Elevation of Water (ft, NGVD)
		Description	Elevation (ft, NGVD)		

Notes: NGVD = National Geodetic Vertical Datum
TOC = Top of Well Casing

Comments/Observations

ATTACHMENT 3-1

MONITORING WELL DEVELOPMENT LOG

Monitoring Well Development Log

Page ____ of ____

Date Started (yr/mo/day) _____ Data Completed (yr/mo/day) _____

Field Personnel _____

Project _____

Site Name _____

Job No. _____ Well ID _#_____

____Upgradient ____Downgradient ____Sidegradient

Weather Conditions _____

Air Temperature _____ °F

Total WellDepth (TWD)
From Top of Casing (TOC)= _____ 1/100 ft

Depth to Ground Water (DGW)
From Top of Casing (TOC)= _____ 1/100 ft

Length of Water Column (LWC) = TWD – DGW = _____ 1/100 ft

1 Casing Volume (OCV) – LWC x ____ = _____ gallons

5 Casing Volumes = _____ gallons

Method of Well Development _____

_____

Total Volume of Water Removed _____ gallons

Date/Time	Discharge Rate (gpm)	Cumulative Volume Purged (gallons)	Water Temperature (°C)	pH	Eh	Specific Conductivity (umhos/cm)	Turbidity/Color (NTUs)	Dissolved Oxygen (mg/L)	Sand Content (%)	Remarks

COMMENTS/OBSERVATIONS: _____

Monitoring Well Development Log (Continued)

Page ____ of ____

Project _____

Job No. _____ Well ID No. _____

Date/Time	Discharge Rate (gpm)	Cumulative Volume Purged (gallons)	Water Temperature (°C)	pH	Eh	Specific Conductivity (umhos/cm)	Turbidity/Color (NTUs)	Dissolved Oxygen (mg/L)	Sand Content (%)	Remarks

COMMENTS/OBSERVATIONS: _____

ATTACHMENT 4-1

FIELD DATA INFORMATION LOG FOR GROUNDWATER SAMPLING

Field Data Information Log for Groundwater Sampling

Page ____ of ____

Date Started (yr/mo/day) _____
Field Personnel _____
Site Name _____
Job No. _____
Well ID _#_____
____Upgradient _____Downgradient _____Sidegradient
Weather Conditions _____
Air Temperature _____ °F
Total WellDepth (TWD) = _____ 1/100 ft
Depth to Ground Water (DGW) = _____ 1/100 ft
Length of Water Column (LWC) = TWD – DGW = _____ 1/100 ft
1 Casing Volume (OCV) – LWC x _____ = _____ gallons
_____ gal = Standard Evacuation Volume
Method of Well Evacuation _____
Method of Sample Collection _____
Total Volume of Water Removed _____ gallons

Casing Diameter _____ inches
Casing Material _____
Measuring Point Elevation _____ 1/100 ft
Height of Riser (above land surface) _____ 1/100 ft
Land Surface Elevation _____ 1/100 ft
Screened Interval _____ 1/100 ft
Dedictated Pump or Bailer YES___ NO____ Type _____
Steel Guard Pipe Around Casing YES___ NO____
Locking Cap YES___ NO____
Protective Post/Abutment YES___ NO____
Well Integrity Satisfactory YES___ NO____
Well Yield LOW_____ MODERATE_____ HIGH_____
Comments/Observations _____

FIELD ANALYSES

VOLUME PURGED (gallons)							
Pumping Rate (gpm)							
TIME (military)							
pH (S.U.)							
Specific Conductivity							
Water Temp (°C)							
Dissolved Oxygen (mg/L)							
Oxidation Reduction Potentail (ORP) (mV)							
Water Level (ft/TOC)							

COMMENTS/OBSERVATIONS: _____

Field Data Information Log for Groundwater Sampling (Continued)

Site Name_____

Job No._____ Well ID No._____

FIELD ANALYSES							
VOLUME PURGED (gallons)							
Pumping Rate (gpm)							
TIME (military)							
pH (S.U.)							
Specific Conductivity							
Water Temp (°C)							
Dissolved Oxygen (mg/L)							
Oxidation Reduction Potentail (ORP) (mV)							
Water Level (ft/TOC)							

COMMENTS/OBSERVATIONS:_____

FIELD ANALYSES							
VOLUME PURGED (gallons)							
Pumping Rate (gpm)							
TIME (military)							
pH (S.U.)							
Specific Conductivity							
Water Temp (°C)							
Dissolved Oxygen (mg/L)							
Oxidation Reduction Potentail (ORP) (mV)							
Water Level (ft/TOC)							

COMMENTS/OBSERVATIONS:_____

APPENDIX G

SITE-SPECIFIC ADDENDUM TO THE BASEWIDE QUALITY ASSURANCE PROJECT PLAN

QUALITY ASSURANCE PROJECT PLAN ADDENDUM

VOLUNTARY CORRECTIVE MEASURES

DISPOSAL PIT 63 (DP-63)

HOLLOMAN AIR FORCE BASE, NEW MEXICO

Prepared for:

49 CES/CEV
Holloman Air Force Base
New Mexico

Under Contract To:

U.S. Army Corps of Engineers
Omaha District
Omaha, Nebraska

Contract No.
DACA45-03-D0023
Delivery/Task Order No. 008

February 2006

Prepared by:

Bhate Environmental Associates, Inc.
1608 13th Avenue South, Suite 300
Birmingham, Alabama 35205

Bhate Project No. 9050044

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QUALITY ASSURANCE PROJECT PLAN ADDENDUM

DISPOSAL PIT 63 (DP-63)

VOLUNTARY CORRECTIVE MEASURES
HOLLOMAN AIR FORCE BASE
NEW MEXICO

REVIEW SHEET

COMMITMENT TO IMPLEMENT THIS QUALITY ASSURANCE PROJECT PLAN ADDENDUM

Judy Solomon		September 30, 2005
Senior Chemist	Signature	Date
Frank Gardner, P.G.		September 30, 2005
Project Manager	Signature	Date
John Hymer		September 30, 2005
Site Manager	Signature	Date

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QUALITY ASSURANCE PROJECT PLAN ADDENDUM

DISPOSAL PIT 63 (DP-63)
VOLUNTARY CORRECTIVE MEASURES
HOLLOMAN AIR FORCE BASE
NEW MEXICO

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3 Data Categories 3-1

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Tables

2-1 Summary of Screening Data

2-2 Summary of Definitive Data

3-1 Summary of Field QC Samples

3-2 Summary of Laboratory QC Limits

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LIST OF ACRONYMS

Bhate	Bhate Environmental Associates, Inc.
DP	Disposal Pit
DQOs	Data Quality Objectives
DRO	Diesel Range Organics
ERPIMS	Environmental Resources Program Information Management System
GRO	Gasoline Range Organics
HAFB	Holloman Air Force Base
LCL	Lower Control Limit
LCS	Laboratory Control Sample
MDL	Method Detection Limit
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NELAC	National Environmental Laboratory Accreditation Conference
NFA	No Further Action
ORO	Oil Range Organics
OVA	Organic vapor analyzer
ORP	Oxidation Reduction Potential
QA	Quality Assurance
QAM	Quality Assurance Manual
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RPD	Relative Percent Difference
SOPs	Standard Operating Procedures
SVOC	Semivolatile Organic Compounds
TAL	Total Analyte List

LIST OF ACRONYMS (CONTINUED)

TDS	Total dissolved solids
TPH	Total Petroleum Hydrocarbon
UCL	Upper Control Limit
µg/kg	Micrograms per kilogram
µg/L	Micrograms per liter
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
UVF	Ultra Violet Florescent
VCM	Voluntary Corrective Measures
VOC	Volatile Organic Compound

QUALITY ASSURANCE PROJECT PLAN ADDENDUM

This Quality Assurance Project Plan Addendum (QAPP Addendum) has been developed to assure that sample collection, analyses, and evaluations are legally and scientifically defensible for the Voluntary Corrective Measures, Disposal Pit (DP-63) at Holloman Air Force Base (HAFB). This document is an addendum to the *Basewide Quality Assurance Project Plan, Holloman Air Force Base, New Mexico* (Bhate, November 2003) (Basewide QAPP) and must be used in conjunction with that document. This document contains the site specific information for the work at DP-63 outlined in the *Voluntary Corrective Measures Work Plan, ERP Site No. DP-63, Holloman Air Force Base, New Mexico* (Bhate, February 2006) (DP-63 Work Plan).

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1 INTRODUCTION

The U.S. Army Corps of Engineers, Omaha District (USACE) has retained Bhate Environmental Associates, Inc., (Bhate) to perform Voluntary Corrective Measures (VCMs) at Disposal Pit 63 (DP-63) at Holloman Air Force Base (HAFB), New Mexico. Bhate is performing this work on behalf of HAFB under the Service Contract with the USACE (Contract No. DACA-45-03-D-0023, Delivery Order No. 8).

See the Basewide QAPP and DP-63 Work Plan for additional information on HAFB and DP-63.

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2 PROJECT LABORATORY

The analytical work for this project will be preformed by Accutest Laboratories in Orlando, Fl 32811. The laboratory personnel who will be involved with this project include:

- Harry Behzadi, Accutest Laboratory Director
- Sue Bell, Accutest Project Manager
- Svetlana Izosimova, Accutest Quality Assurance Officer

Accutest Laboratories is certified by both the National Environmental Laboratory Accreditation Conference (NELAC) and the USACE, and has extensive previous experience in working on USACE projects. The Accutest Laboratories Quality Assurance Manual (QAM) and Standard Operating Procedures (SOPs) have been reviewed by Bhate and found to meet all the requirements for this project. The QAM and SOPs are available for further review if required.

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3 DATA CATEGORIES

The data use determines the required levels of data quality. The two levels of data quality established by the USACE are screening and definitive. Under this QAPP Addendum, the data to be generated under each level in this investigation are presented in Table 2-1 (Screening) and Table 2-2 (Definitive). The screening data generated as part of this project will be conducted and reported by field personnel. Confirmation of the field samples will be conducted by Accutest Laboratories. The Definitive data generated by the laboratory will be presented with limited data deliverables (i.e. Level II data packages), using a 14 day turn-around-time.

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4 DATA QUALITY ASSURANCE AND QUALITY CONTROL

The general data Quality Assurance (QA) and Quality Control (QC) requirements for HAFB are presented in the Basewide QAPP. The field QC requirements for this project are presented in Table 3-1. The project specific laboratory QC limits are listed in Table 3-2.

All final definitive data will be reviewed and validated by the Bhate Senior Chemist, Ms. Judy Solomon, based on the guidelines of the United States Environmental Protection Agency (USEPA) *National Functional Guidelines for Data Validation* and the site specific laboratory QC limits.

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5 REFERENCES

Bhate, November 2003. *Final Basewide Quality Assurance Project Plan*, Holloman Air Force Base, New Mexico.

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TABLES

Table 2-1
Summary of Screening Data

Parameter	Matrix	Testing Method
TPH	Soil	Organic Vapor Analyzer (OVA)
TPH	Soil	SiteLAB® Analytical Test Kit Ultra Violet Florescent (UVF)-3100A

Table 2-2
Summary of Definitive Data

Parameter	Matrix	Testing Method
Volatile Organic Compounds (VOCs)	Soil, Water	USEPA SW-846 Method 8260B
Semivolatile Organic Compounds (SVOCs)	Soil, Water	USEPA SW-846 Method 8270C
Total Analyte List (TAL) Metals	Soil, Water	USEPA SW-846 Methods 6010B and 7471A
Total Petroleum Hydrocarbons (TPH)	Soil, Water	USEPA SW-846 Method 8015
Total Dissolved Solids (TDS)	Water	USEPA 160.1

Table 3-1
Summary of Field QC Samples

Matrix	Analysis	Number of Field Samples	Equipment Blanks	Trip Blanks*	Field Duplicates	Field Splits	MS/MSD	Total
Water	Volatile Organic Compounds (VOCs) per EPA Method 8260B	8	0	1	1	0	1	11
	Semivolatile Organic Compounds (SVOCs) per EPA Method 8270C	8	0	0	1	0	1	10
	TAL Metals by Environmetnal Protection Agency (EPA) 6010B/7470A	8	0	0	1	0	1	10
	Total Petroleum Hydrocarbon (TPH) by EPA Method 8015	8	0	0	1	0	1	10
	Total Dissolved Solids EPA 160.1	8	0	0	1	0	0	9
Soil	VOCs per EPA Method 8260B	29	0	3	3	0	1	36
	SVOCs per EPA Method 8270C	29	0	0	3	0	1	33
	Target Analyte List (TAL) Metals by EPA 6010B/7471A	29	0	0	3	0	1	33
	TPH by EPA Method 8015	29	0	0	3	0	1	33

*Estimated, one trip blank will accompany every shipment of volatile samples

Table 3-2
Summary of Accutest Laboratory QC Limits

Parameter	MDL		LCS				Matrix Spike Water			Matrix Spike Soil		
			Water		Soil		Recovery		MS	Recovery		MSD
	Water	Soil	LCL	UCL	LCL	UCL	LCL	UCL	RPD	LCL	UCL	RPD
VOCs per EPA Method 8260B	µg/L	µg/kg	%	%	%	%	%	%	%	%	%	%
Acetone	5	25	44	142	51	136	45	127	15	14	140	33
Acetonitrile	10	20	--	--	--	--	--	--	--	--	--	--
Acrolein	5	13	32	168	28	180	26	185	18	20	144	42
Acrylonitrile	5	13	35	130	43	151	39	140	12	22	116	31
Allyl Chloride	5	5	--	--	--	--	--	--	--	--	--	--
Benzene	0.5	2	80	120	74	124	72	125	7	63	135	23
Benzyl chloride	0.6	2.5	--	--	--	--	--	--	--	--	--	--
Bromodichloromethane	0.5	2	75	120	74	124	72	120	8	63	126	23
Bromoform	0.5	1	60	129	62	141	55	127	11	62	141	20
Bromobenzene	0.5	2	76	114	78	117	72	113	10	56	145	30
Bromochloromethane	0.5	2	75	121	77	126	73	121	9	64	120	23
Bromodichloromethane	0.5	2	75	120	74	124	72	120	8	63	126	23
n-Butylbenzene	0.5	2	76	122	75	131	69	122	10	45	159	32
sec-Butylbenzene	0.5	2	84	122	78	128	75	125	9	54	164	31
tert-Butylbenzene	0.5	2	77	124	76	126	70	125	12	60	161	30
Bromomethane	1	2	60	165	52	156	52	172	16	38	188	27
2-Butanone (MEK)	2.5	10	58	127	63	138	51	128	10	27	112	32
Carbon disulfide	1	2	65	147	59	148	60	147	12	47	165	29
Carbon tetrachloride	0.5	2	69	137	67	131	56	145	12	64	148	24
Chlorobenzene	0.5	2	82	112	78	117	79	113	7	64	130	24
Chloroethane	1	2	67	148	63	142	56	164	14	57	160	29
Chloroform	0.5	2	78	118	75	121	75	120	8	68	131	24
1-Chlorohexane	1	2	82	130	76	137	77	127	9	52	162	26
o-Chlorotoluene	0.5	2	80	121	79	124	76	122	9	59	162	32
p-Chlorotoluene	0.5	2	78	120	79	124	73	120	9	59	155	29
2-Chloroethyl vinyl ether	2.5	10	23	132	31	165	8	137	18	16	159	31
Chloromethane	1	2	58	152	50	150	53	155	19	50	150	20
Dibromochloromethane	0.4	2	68	118	78	120	63	119	9	60	119	23
Dichlorodifluoromethane	0.5	3	43	173	33	172	35	184	21	41	185	30
1,2-Dichlorobenzene	0.5	2	77	115	79	119	73	114	8	59	138	28
1,3-Dichlorobenzene	0.5	2	78	116	78	119	74	114	7	56	128	27
1,4-Dichlorobenzene	0.5	2	77	113	78	117	74	112	7	57	134	26
cis-1,4-Dichloro-2-butene	--	--	--	--	--	--	--	--	--	--	--	--
1,1-Dichloroethane	0.5	2	75	117	72	120	70	122	10	60	114	22
1,2-Dichloroethane	0.5	1	68	121	75	121	64	124	7	75	121	20
1,1-Dichloroethene	0.5	3	67	134	64	126	61	137	15	55	149	28
cis-1,2-Dichloroethene	0.5	2	81	120	75	124	74	125	9	66	132	24
trans-1,2-Dichloroethene	0.5	2	74	125	70	122	70	127	11	63	137	27
1,2-Dichloropropane	0.5	2	78	122	74	126	74	123	8	65	128	23

Table 3-2
Summary of Accutest Laboratory QC Limits

Parameter	MDL		LCS				Matrix Spike Water			Matrix Spike Soil		
			Water		Soil		Recovery		MS	Recovery		MSD
	Water	Soil	LCL	UCL	LCL	UCL	LCL	UCL	RPD	LCL	UCL	RPD
1,3-Dichloropropane	0.5	2	72	116	77	177	70	116	8	58	114	25
2,2-Dichloropropane	0.5	2	68	134	66	126	64	133	13	60	144	27
1,1-Dichloropropene	0.5	2	84	127	73	132	80	126	9	67	148	25
cis-1,3-Dichloropropene	0.3	2	73	115	72	120	65	112	10	57	118	25
trans-1,3-Dichloropropene	0.3	2	69	115	75	118	59	116	11	58	115	25
1,2-Dibromo-3-chloropropane	1	2	54	125	71	128	49	127	18	39	105	33
1,2-Dibromomethane	0.5	2	68	116	78	117	67	113	10	55	107	24
Ethylbenzene	0.5	2	82	115	77	120	73	119	8	63	142	25
Ethyl methacrylate	2	5	--	--	--	--	--	--	--	--	--	--
Freon 113	0.6	2	72	148	66	147	67	151	14	61	169	28
2-Hexanone	2.5	10	60	125	68	136	54	131	11	35	109	34
Hexachlorobutadiene	0.5	2	62	138	69	139	52	133	13	17	160	37
Hexane	1	2	70	148	55	166	62	153	12	28	170	32
Isopropylbenzene	0.5	2	83	129	79	134	79	127	8	59	177	29
p-Isopropyltoluene	0.5	2	85	125	80	134	77	126	8	53	168	31
Methylene bromide	0.5	2	75	114	74	121	73	115	9	56	109	24
Methylene chloride	1	5	66	125	51	142	61	129	11	40	183	34
4-Methyl-2-pentanone	2.5	10	61	128	69	136	57	136	11	44	99	32
Methacrylonitrile	10	10	--	--	--	--	--	--	--	--	--	--
Methyl iodide	2.5	2	61	140	65	133	52	141	12	52	150	30
Methyl methacrylate	2.5	5	71	128	63	143	76	115	11	56	106	27
Methyl tert butyl ether	0.5	2	67	127	77	131	61	129	9	53	122	28
Napthalene	1	2	62	129	75	134	52	127	13	20	116	35
Pentachloroethane	5	5	--	--	--	--	--	--	--	--	--	--
Propionitrile	10	10	--	--	--	--	--	--	--	--	--	--
n-Propylbenzene	0.5	2	80	122	77	125	73	123	10	59	163	31
Styrene	0.5	2	58	125	74	120	64	124	11	54	130	26
1,1,2,2-Tetrachloroethane	0.3	2	67	119	76	121	64	120	10	45	121	33
Tetrachloroethene	0.5	2	75	126	68	127	70	126	9	54	154	27
Toluene	0.5	2	81	114	74	118	67	123	8	62	142	29
1,2,3-Trichlorobenzene	0.5	2	65	125	76	129	58	121	12	24	135	31
1,2,4-Trichlorobenzene	0.5	2	66	122	75	121	58	120	11	39	125	32
1,1,1-Trichloroethane	0.5	2	78	132	70	130	72	133	8	70	149	25
1,1,2-Trichloroethane	0.5	2	74	115	77	118	72	116	9	60	114	25
1,2,3-Trichloropropane	1	2	68	114	75	121	63	116	13	39	125	32
Trichloroethene	0.5	2	80	115	72	122	73	117	10	59	143	25
Trichlorfluoromethane	0.5	2	65	163	60	147	52	164	16	59	171	28
trans-1,4-dichloro-2-butene	5	10	38	130	68	131	27	131	22	41	114	31
Vinyl chloride	0.5	2.5	70	151	64	144	63	161	18	64	165	27
Vinyl acetate	5	10	42	146	47	132	37	154	10	13	113	42

Table 3-2
Summary of Accutest Laboratory QC Limits

Parameter	MDL		LCS				Matrix Spike Water			Matrix Spike Soil		
			Water		Soil		Recovery		MS	Recovery		MSD
	Water	Soil	LCL	UCL	LCL	UCL	LCL	UCL	RPD	LCL	UCL	RPD
m,p-xylene	0.5	2.5	83	118	79	122	74	123	7	61	146	25
o-xylene	0.5	2	77	119	75	123	68	123	7	60	141	25
1,2,4-Trimethylbenzene	1	2	77	119	79	121	68	122	10	50	161	32
1,3,5-Trimethylbenzene	1	2	81	120	78	126	70	125	9	57	164	31
1,2-Dichloroethane-d4 (surr)	--	--	73	126	74	125	--	--	--	--	--	--
4-Bromofluorobenzene (surr)	--	--	83	119	61	157	--	--	--	--	--	--
Dibromofluoromethane (surr)	--	--	86	115	78	123	--	--	--	--	--	--
Toluene-d8 (surr)	--	--	86	112	71	137	--	--	--	--	--	--
SVOCs by EPA Method 8270C	µg/L	µg/kg	%	%	%	%	%	%	%	%	%	%
Acenaphthene	1	33	62	101	66	104	55	103	20	57	106	19
Acenaphthylene	1	33	65	113	66	106	55	113	20	55	110	18
Anthracene	1	33	69	107	66	109	66	105	14	59	109	21
Benzoic acid	2	330	8	45	55	110	16	73	41	13	117	32
Benzyl alcohol	1	33	34	104	58	103	48	106	24	46	106	23
Benzo(a)anthracene	1	33	68	106	66	111	65	103	16	52	120	20
Benzo(b)fluoranthene	1	33	68	110	64	115	62	110	17	50	122	21
Benzo(k)fluoranthene	1	33	68	112	67	116	63	110	17	54	117	21
Benzo(g,h,i)perylene	2	67	63	115	62	113	58	111	17	50	118	23
Benzo(a)pyrene	1	33	70	114	65	115	65	113	16	48	124	21
bis(2-Chloroethoxy)methane	1	170	57	103	57	89	49	100	24	45	94	19
bis(2-Chloroethyl)ether	2	67	64	106	61	95	54	103	24	47	99	24
bis(2-Chloroisopropyl)ether	1	33	52	120	56	100	49	109	22	44	100	23
bis(2-ethylhexyl)phthalate	2.5	170	64	115	60	118	55	120	22	55	125	21
4-Bromophenyl-phenylether	1	33	73	103	68	106	68	102	16	59	107	20
Butylbenzylphthalate	2	83	69	108	62	114	65	109	17	57	118	20
4-Chloroaniline	4	130	57	104	29	80	39	101	21	25	78	30
4-Chloro-3-methylphenol	2	33	64	103	60	105	60	101	18	33	123	38
2-Chloronaphthalene	1	33	64	102	66	97	58	101	22	53	102	19
2-Chlorophenol	2	33	62	103	61	97	53	102	24	31	113	23
4-Chlorophenyl-phenylether	1	33	71	104	68	103	65	103	18	59	105	18
Chrysene	1	33	68	103	67	112	65	100	18	48	124	20
Dibenz(a,h)anthracene	2	67	62	115	63	110	57	111	20	45	121	23
Dibenzofuran	1	33	69	104	65	99	64	102	17	57	101	19
3,3'-Dichlorobenzidine	5	170	42	110	30	90	18	112	22	15	90	31
2,4-Dichlorophenol	2	33	59	103	64	102	55	100	24	54	105	20
Diethylphthalate	2	83	64	110	64	109	59	110	18	59	107	19
2,4-Dimethylphenol	2	33	43	94	50	102	36	98	26	46	104	22
Dimethylphthalate	2	83	44	120	66	105	40	116	25	56	108	20
Di-n-butylphthalate	2	83	68	109	62	110	63	107	17	55	112	20
4,6-Dinitro-o-cresol	5	67	47	119	59	123	40	127	24	27	119	35

Table 3-2
Summary of Accutest Laboratory QC Limits

Parameter	MDL		LCS				Matrix Spike Water			Matrix Spike Soil		
			Water		Soil		Recovery		MS	Recovery		MSD
	Water	Soil	LCL	UCL	LCL	UCL	LCL	UCL	RPD	LCL	UCL	RPD
2,4-Dinitrophenol	10	330	12	125	41	120	14	135	39	5	110	46
2,4-Dinitrotoluene	2	67	65	111	60	108	60	110	16	44	118	26
2,6-Dinitrotoluene	2	67	77	111	63	106	60	111	19	48	115	20
Di-n-octylphthalate	2.5	170	63	120	59	132	58	126	23	58	134	23
Fluoranthene	1	33	68	111	63	108	62	108	17	47	119	25
Fluorene	1	33	66	105	65	109	60	105	17	59	108	18
Hexachlorobenzene	1	33	69	103	65	106	64	102	16	56	107	21
Hexachlorobutadiene	2	67	55	90	55	93	45	93	26	42	94	25
Hexachlorocyclopentadiene	2	67	26	95	30	123	20	92	34	30	123	20
Hexachloroethane	2	67	59	104	58	91	51	105	26	40	93	32
Indeno(1,2,3-cd)pyrene	2	67	63	118	59	115	61	111	19	50	118	26
Isophorone	1	33	64	107	60	102	59	103	23	52	101	19
2-Methylnaphthalene	1	33	66	100	63	93	56	100	23	42	103	22
2-Methylphenol	2	33	54	91	57	97	46	100	23	44	101	28
3&4-Methylphenol	2	33	48	86	56	98	43	100	23	38	107	31
Naphthalene	1	33	62	101	64	94	52	102	23	42	105	24
2-Nitroaniline	4	83	65	111	60	110	61	107	18	55	108	20
3-Nitroaniline	4	83	61	106	41	90	47	107	26	38	92	20
4-Nitroaniline	4	120	60	113	53	103	48	119	21	42	101	23
Nitrobenzene	1	33	61	106	60	96	51	103	25	42	105	21
2-Nitrophenol	2	33	64	104	62	100	53	104	25	38	111	21
4-Nitrophenol	10	330	22	50	52	116	32	81	28	44	111	22
N-Nitrosodiphenylamine	2	33	69	114	68	108	62	112	16	59	111	21
N-Nitroso-di-n-propylamine	2	67	64	109	54	99	57	103	24	41	107	23
Pentachlorophenol	10	330	50	111	54	111	44	118	16	42	110	25
Phenanthrene	1	33	68	104	67	110	64	103	15	60	110	21
Phenol	2	33	25	33	59	96	31	77	26	32	111	29
Pyrene	1	67	64	105	65	115	59	107	21	50	126	25
2,4,5-Trichlorophenol	2	33	66	104	65	104	61	102	18	53	108	19
2,4,6-Trichlorophenol	2	33	60	103	64	102	55	103	21	53	107	20
2,4,6-Tribromophenol (surr)	--	--	36	137	50	128	--	--	--	--	--	--
2-Fluorobiphenyl (surr)	--	--	45	118	46	122	--	--	--	--	--	--
2-Fluorophenol (surr)	--	--	19	90	45	114	--	--	--	--	--	--
Nitrobenzene-d5 (surr)	--	--	49	119	41	123	--	--	--	--	--	--
Phenol-d5 (surr)	--	--	10	68	44	124	--	--	--	--	--	--
Terphenyl-d14 (surr)	--	--	46	135	45	135	--	--	--	--	--	--

Table 3-2
Summary of Accutest Laboratory QC Limits

Parameter	MDL		LCS				Matrix Spike Water			Matrix Spike Soil		
			Water		Soil		Recovery		MS	Recovery		MSD
	Water	Soil	LCL	UCL	LCL	UCL	LCL	UCL	RPD	LCL	UCL	RPD
***TAL Metals by EPA Method 6010B/7470A/7471A**	µg/L	mg/kg										
Aluminum	16	3.2	80	120	80	120	75	125	16	75	125	20
Antimony	2.2	0.27	80	120	80	120	75	125	13	75	125	20
Arsenic	2.9	0.3	80	120	80	120	83	116	12	75	113	20
Barium	0.5	0.05	80	120	80	120	82	116	13	75	122	20
Beryllium	0.7	0.06	80	120	80	120	86	119	12	75	120	20
Cadmium	0.6	0.03	80	120	80	120	80	115	13	75	116	20
Calcium	26	2.4	80	120	80	120	75	125	14	75	125	20
Chromium	0.5	0.08	80	120	80	120	82	120	12	75	125	20
Cobalt	0.4	0.07	80	120	80	120	83	117	14	80	112	20
Copper	0.8	0.06	80	120	80	120	87	120	13	75	125	20
Iron	7.5	0.71	80	120	80	120	76	125	14	75	125	20
Lead	1.2	0.14	80	120	80	120	84	118	10	75	121	20
Magnesium	5.8	0.41	80	120	80	120	75	125	15	75	125	20
Manganese	0.2	0.02	80	120	80	120	75	125	13	75	125	20
Nickel	1.1	0.11	80	120	80	120	81	121	10	75	122	20
Potassium	36	0.71	80	120	80	120	76	125	18	75	125	20
Selenium	2.4	0.35	80	120	80	120	84	121	13	75	110	20
Silver	0.9	0.07	80	120	80	120	77	125	14	75	120	20
Sodium	77	7.2	80	120	80	120	75	125	10	75	125	20
Thallium	3.8	0.39	80	120	80	120	86	121	14	75	118	20
Vanadium	0.6	0.03	80	120	80	120	87	118	14	80	118	20
Zinc	0.8	0.11	80	120	80	120	82	123	13	75	125	20
Mercury	0.08	0.0054	80	120	80	120	62	131	20	47	157	20
Total Petroleum Hydrocarbons by EPA Method 8015	µg/L	µg/kg	%	%	%	%	%	%	%	%	%	%
C6-C10 (GRO)	50	2500	50	150	66	122	50	150	20	37	142	17
Bromofluorobenzene (surr)	--	--	50	150	62	135	--	--	--	--	--	--
C10-C22 (DRO)	100	5000	--	--	50	150	--	--	--	--	--	--
C22-C36 (ORO)	100	5000	50	150	50	150	50	150	25	50	150	25
Ortho-terphenyl (surr)	--	--	50	150	50	150	--	--	--	--	--	--

*TAL - Matrix Spike limits are actually the Duplicate Spike limits.

DRO - Diesel range organics
EPA - Environmental Protection Agency
GRO - Gasoline range organics
LCL - Lower control limit
LCS - Laboratory Control Sample
MDL - Method Detection Limit
MS - Matrix spike
MSD - Matrix spike duplicate
ORO - Oil Range Organics
RPD - Relative percent difference
SVOCs - Semivolatile organic compounds
TAL - Target Aanlyte List
UCL - Upper control limit
µg/kg - Milligrams per kilogram
µg/L - Micrograms per kilogram
VOCs - Volatile organic compounds

APPENDIX H

UFGS SECTION 02111 *EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL* SEPTEMBER 2003

GUIDE SPECIFICATION FOR CONSTRUCTION

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DIVISION 02 - SITE CONSTRUCTION

SECTION 02111

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09/03

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USACE / NAVFAC / AFCESA | UFGS-02111 (September 2003)

Preparing Activity: USACE | Superseding UFGS-02111 (September 2001)

GUIDE SPECIFICATION FOR CONSTRUCTION

****

SECTION 02111

EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL
09/03

****

NOTE: This guide specification covers the requirements for excavation, handling, and temporary storage of contaminated material.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

****

PART 1 GENERAL

****

NOTE: The following information should be shown on the project drawings:

a. Overall site plan, borrow areas, stockpile areas, storage areas, security requirements, special shoring requirements, boring logs, and access routes.

b. Individual site plans of each area of contamination with site features such as buildings, roads, utilities, topography, trees, shrubs, surface conditions, etc.

c. Limits of pavement removal, fence removal, and the location of ancillary equipment to be removed.

All specific chemical testing procedures (including air emissions analysis) should be addressed in the Sampling and Analysis Plan required by Section 01450 CHEMICAL DATA QUALITY CONTROL.

When applicable, the use of onsite field screening or field analysis (supported at a prescribed frequency by fixed laboratory analysis) should be encouraged to avoid prolonged delays or equipment downtime. Details on the appropriate application and use of field analyses can be found in Appendix H of EM 200-1-3.

****

1.1 REFERENCES

****

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest guide specification. Use of SpecsIntact automated reference checking is recommended for projects based on older guide specifications.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D 1556	(2000) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(2002) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))
ASTM D 2167	(1994; R 2001) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2487	(2000) Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(2001) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 422	(1963; R 2002) Particle-Size Analysis of Soils
ASTM D 5434	(1997; R 2003) Field Logging of Subsurface Explorations of Soil and Rock
ASTM D 698	(2000a) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2003) Safety and Health Requirements Manual

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1926	Safety and Health Regulations for Construction
40 CFR 302	Designation, Reportable Quantities, and Notification

1.2 MEASUREMENT AND PAYMENT

****

NOTE: These paragraphs should be deleted if the work is in one lump-sum contract price. Coordinate requirements of these paragraphs with the bidding schedule.

****

1.2.1 Measurement

****

NOTE: Modify this paragraph if the method of payment will be on a weight basis.

****

Measurement for excavation and on-site transportation shall be based on the actual number of cubic meters yards of contaminated material in-place prior to excavation. Determination of the volume of contaminated material excavated shall be based on cross-sectional volume determination reflecting the differential between the original elevations of the top of the contaminated material and the final elevations after removal of the contaminated material. Measurement for backfilling of excavated areas shall be based on in-place cubic meters yards of compacted fill. Measurement for construction of stockpile areas shall be based on the number of square meters yards of stockpile liner constructed.

1.2.2 Payment

1.2.2.1 Excavation and Transportation

Compensation for excavation and onsite transportation of contaminated material will be paid as a unit cost. This unit cost shall include any other items incidental to excavation and handling not defined as having a specific unit cost.

1.2.2.2 Backfilling

Compensation for backfill soil, transportation of backfill, backfill soil conditioning, backfilling, compaction, and geotechnical testing will be paid as a single unit cost.

1.2.2.3 Stockpiling

Compensation for construction of stockpile areas will be paid for as a unit cost. This unit cost shall include all aspects of grading, preparation, handling, placement, maintenance, removal, treatment, and disposal of stockpile cover materials and liner materials and all other items incidental to construction of stockpiles.

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy projects.

Submittal items not designated with a "G" are considered as being for information only for Army projects and for Contractor Quality Control approval for Navy projects.

****

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Surveys; G, [_____]

Separate cross-sections of each area before and after excavation and after backfilling.

SD-03 Product Data

Work Plan; G, [_____]

Work Plan within [30] [_____] calender days after notice to proceed. No work at the site, with the exception of site inspections and surveys, shall be performed until the Work Plan is approved. The Contractor shall allow [30] [_____] calender days

in the schedule for the Government's review. No adjustment for time or money will be made if resubmittals of the Work Plan are required due to deficiencies in the plan. At a minimum, the Work Plan shall include:

a. Schedule of activities.

b. Method of excavation and equipment to be used.

c. Shoring or side-wall slopes proposed.

d. Dewatering plan.

e. Storage methods and locations for liquid and solid contaminated material.

f. Borrow sources and haul routes.

g. Decontamination procedures.

h. Spill contingency plan.

Closure Report; G, [_____]

[_____] copies of the Closure Report within [14] [_____] calender days of work completion at the site.

SD-06 Test Reports

Backfill; G, [_____]
Surveys; G, [_____]
Confirmation Sampling and Analysis; G, [_____]
Sampling of Stored Material; G, [_____]
Sampling Liquid; G, [_____]
Compaction; G, [_____]

Test results.

1.4 SURVEYS

Surveys shall be performed immediately prior to and after excavation of contaminated material to determine the volume of contaminated material removed. Surveys shall also be performed immediately after backfill of each excavation. The Contractor shall provide cross-sections on [7.6] [_____] meter [25] [_____] foot intervals and at break points for all excavated areas. Locations of confirmation samples shall also be surveyed and shown on the drawings. Surveys shall be performed in accordance with Section: [_____].

1.5 REGULATORY REQUIREMENTS

1.5.1 Permits and Licenses

****
NOTE: Include additional site specific requirements in this paragraph.
****

The Contractor shall obtain required federal, state, and local permits for

excavation and storage of contaminated material. Permits shall be obtained at no additional cost to the Government.

1.5.2 Air Emissions

****
NOTE: An air pathway analysis should be performed during design to determine what air monitoring and controls are required. Guidance on air pathway analyses is provided in EP 1110-1-21 Air Pathway Analysis for the Design of Hazardous, Toxic, and Radioactive Waste (HTRW) Remedial Action Projects. Specify perimeter air monitoring requirements in Section 01355 ENVIRONMENTAL PROTECTION.
****

Air emissions shall be monitored and controlled in accordance with Section 01355.

1.6 DESCRIPTION OF WORK

****
NOTE: Include any pertinent information regarding project/site conditions in this paragraph, the appendices to the specifications, or on the drawings.

If oversize material such as debris and foundations are present, the specification should describe treatment, handling, and disposal requirements for this material. Measurement and payment procedures should also be described for this material.

If clean soil overlies the contaminated material, the specification should describe how this material will be measured, removed, stored, and tested to verify they are clean.
****

The work shall consist of excavation and temporary storage of approximately [_____] cubic meters yards of contaminated material. Approximate locations of contaminated material are shown on the drawings. Characterization data on the nature and extent of the contaminated material is shown in Appendix [_____]. Subsurface conditions are shown [on the drawings] [in Appendix [_____]]. The Contractor shall submit a Work Plan as specified in the Submittals paragraph. The Contracting Officer shall be notified within [24] [_____] hours, and before excavation, if contaminated material is discovered that has not been previously identified or if other discrepancies between data provided and actual field conditions are discovered. Backfill material is [not available onsite] [available onsite and typically consists of [_____]]. Ground water is approximately [_____] meters feet below pre-excavation ground surface.

1.7 CHEMICAL TESTING

Required sampling and chemical analysis shall be conducted in accordance with Section 01450A CHEMICAL DATA QUALITY CONTROL.

1.8 SCHEDULING

The Contractor shall notify the Contracting Officer [_____] calender days prior to the start of excavation of contaminated material. The [Contracting Officer will] [Contractor shall] be responsible for contacting regulatory agencies in accordance with the applicable reporting requirements.

PART 2 PRODUCTS

2.1 BACKFILL

****

NOTE: If contaminated material removal is part of a larger project and a backfilling specification is needed for the project as a whole, refer to another specification such as Section 02315 EXCAVATION, FILLING AND BACKFILLING FOR BUILDINGS for Buildings, for backfill requirements and delete the following paragraphs.

In many cases, the degree of engineering control of the materials used as backfill may not need to be as stringent as described in this paragraph. In other cases, such as under pavements, special compaction and material requirements may apply and the specification will need to be revised to address these special requirements or another specification section should be referenced.

Backfill and topsoil brought in from offsite is usually tested to verify the material is clean. Quality assurance samples taken by the Government may also be prudent to verify the seller's claims by analyzing for target analytes. Backfill is commonly tested for the site specific contaminants being cleaned up and/or is based on suspicion of contamination at the site from which the backfill is originating.

At some sites, previously contaminated material which has been removed from the excavation is reused as backfill following treatment to remove the contaminant of concern.

****

Backfill material shall be obtained from [the location indicated on the drawings] [offsite sources approved by the Contracting Officer]. Backfill shall be classified in accordance with ASTM D 2487 as GW, GP, GM, GC, SW, SP, SM, SC, ML, MH, CL, or CH and shall be free from roots and other organic matter, trash, debris, snow, ice or frozen materials. Backfill material shall be tested for the parameters listed below at a frequency of once per [3000] [_____] cubic meters yards. A minimum of one set of classification tests shall be performed per borrow source. [One] [_____] backfill sample per borrow source shall also be collected and tested for the chemical parameters listed below.

Physical Parameter	Criteria	Test Method
Grain Size	[_____]	ASTM D 422
Compaction	[_____]	ASTM D 698
[_____]	[_____]	[_____]

Chemical Parameter	Test Frequency	Criteria
[_____]	[_____]	[_____]

Backfill shall not be used until borrow source chemical and physical test results have been submitted and approved.

2.2 SPILL RESPONSE MATERIALS

The Contractor shall provide appropriate spill response materials including, but not limited to the following: containers, adsorbents, shovels, and personal protective equipment. Spill response materials shall be available at all times when contaminated materials/wastes are being handled or transported. Spill response materials shall be compatible with the type of materials and contaminants being handled.

PART 3 EXECUTION

3.1 EXISTING STRUCTURES AND UTILITIES

No excavation shall be performed until site utilities have been field located. The Contractor shall take the necessary precautions to ensure no damage occurs to existing structures and utilities. Damage to existing structures and utilities resulting from the Contractor's operations shall be repaired at no additional cost to the Government. Utilities encountered that were not previously shown or otherwise located shall not be disturbed without approval from the Contracting Officer.

3.2 CLEARING

****

NOTE: Grubbing is typically not required at sites where contaminated soil is being excavated for treatment and/or disposal. Typically, vegetation that is cut off above a certain height is defined as clean and any stumps and brush below this height are defined as contaminated.

****

Clearing shall be performed to the limits shown on the drawings in accordance with Section 02231 CLEARING AND GRUBBING.

3.3 CONTAMINATED MATERIAL REMOVAL

****

NOTE: Excavations should be marked and secured in accordance with the requirements specified in Section 01351 SAFETY, HEALTH, AND EMERGENCY RESPONSE (HTRW/UST).

****

3.3.2 Excavation

****
NOTE: For large excavations, more than one excavation log may be required.
****

Areas of contamination shall be excavated to the depth and extent shown on the drawings and not more than [60] [_____] mm [0.2] [_____] feet beyond the depth and extent shown on the drawings unless directed by the Contracting Officer. Excavation shall be performed in a manner that will limit spills and the potential for contaminated material to be mixed with uncontaminated material. An excavation log describing visible signs of contamination encountered shall be maintained for each area of excavation. Excavation logs shall be prepared in accordance with ASTM D 5434.

3.3.3 Shoring

If workers must enter the excavation, it shall be evaluated, shored, sloped or braced as required by EM 385-1-1 and 29 CFR 1926 section 650.

3.3.4 Dewatering

****
NOTE: Dewatering can significantly increase the cost of a project involving the excavation of contaminated material and should be carefully considered during design. TM 5-818-5 Dewatering and Groundwater Control provides guidance on the design of dewatering systems.

If water from dewatering operations will be allowed to discharge on or into the ground, an NPDES permit for dewatering is required. Reference the permits paragraph of Section 01355 ENVIRONMENTAL PROTECTION for permit requirements.
****

Surface water shall be diverted to prevent entry into the excavation. [Dewatering shall be limited to that necessary to assure adequate access, a safe excavation, prevent the spread of contamination, and to ensure that compaction requirements can be met.] [No dewatering shall be performed without prior approval of the Contracting Officer.]

3.4 CONFIRMATION SAMPLING AND ANALYSIS

****
NOTE: Confirmation samples and analyses are used to verify cleanup criteria have been met. These test results should be of relatively high quality. For this reason, the designer should consider the regulatory requirements, the complexity of the monitoring needed, and quantitative Data Quality Objectives in determining the analytical methods specified.

The number of confirmation samples must be based on the size of the excavation and regulatory requirements. For small excavations, a minimum of

one sample should be taken from near the center of the excavation (or where there is the highest potential for contamination). Additional samples may be oriented symmetrically relative to the center sample and the limits of the excavation.

Many military facilities have base-wide sampling and analysis plans which have been approved by the applicable regulatory agencies. These plans may specify the number of confirmation samples which must be taken.

For larger excavations, EPA 230/02-89-042 Methods of Evaluation and Attainment of Cleanup Standards provides guidance on the design of statistically based sampling intervals.

With regulator approval, confirmation sampling and analysis may be accomplished using an averaging technique for comparison to cleanup criteria. This is based on the fact that most soil risk exposure scenarios do not model contamination as existing in discrete hot spots but as a more disperse phenomenon. Two ways to accomplish this averaging technique are to take discrete samples and average the data or by compositing sample material before analysis. A composite sample typically consists of 4 to 6 samples which are mixed together. One sample is then obtained from the composite sample for analysis. EM 200-1-3 provides guidance on compositing samples. Composite samples are not applicable to volatile organic contaminants because the compositing process will result in volatilization of contaminants. If composite samples are required, Section 01450 CHEMICAL DATA QUALITY CONTROL should be edited by a qualified chemist to describe procedures for compositing samples.

Confirmation sampling at a site with radioactive contamination in surface soils or on building surfaces will be performed in accordance with the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG-1575, EPA 402-R-97-016. This manual is a guide for confirmation survey design (planning) and for data evaluation. Its primary purpose is to acquire legally defensible data concerning the post excavation residual radioactivity at the site to demonstrate that the site meets release criteria.

****

The Contracting Officer shall be present to inspect the removal of contaminated material from each site. After all material suspected of being contaminated has been removed, the excavation shall be examined for evidence of contamination. If the excavation appears to be free of contamination, field analysis shall be used to determine the presence of [_____] contamination using [a real time vapor monitoring instrument] [immunoassay field kits] [_____]. Excavation of additional material shall

be as directed by the Contracting Officer. After all suspected contaminated material is removed, confirmation samples shall be collected and analyzed for the following contaminants:

Chemical Parameter	Action Level
[_____]	[_____]

Samples shall be collected at a frequency of one per [_____] square meters yards from the bottom [and each of the side walls] or as directed by the Contracting Officer. A minimum of one sample shall be collected from the bottom [and each side wall] of the excavation. Based on test results, the Contractor shall propose any additional excavation which may be required to remove material which is contaminated above action levels. Additional excavation shall be subject to approval by the Contracting Officer. Locations of samples shall be marked in the field and documented on the as-built drawings.

3.5 CONTAMINATED MATERIAL STORAGE

****

NOTE: For CERCLA sites, permits are not required to store hazardous waste in a stockpile. However, storage structures and conditions must be in compliance the Applicable, Relevant, and Appropriate Regulations (ARARs). For RCRA sites, permits are required to store hazardous waste in a stockpile. However, for RCRA sites, hazardous waste can be stored in a drum or roll-off unit for up to 90 days without a permit.

For temporary storage of more than 90 days, dual containment of hazardous liquid and some hazardous solids may be required. Containment system requirements are described in 40 CFR 264.175. For stock piles that meet the definition of a waste pile, see 40 CFR 264.250.

To provide secondary containment, tanks and roll-off units are sometimes stored on lined areas similar in design to what is described in paragraph Stockpiles.

****

Material shall be placed in temporary storage [immediately after excavation] [after treatment while awaiting test results]. The following paragraphs describe acceptable methods of material storage. Storage units shall be in good condition and constructed of materials that are compatible with the material or liquid to be stored. If multiple storage units are required, each unit shall be clearly labeled with an identification number and a written log shall be kept to track the source of contaminated material in each temporary storage unit.

3.5.1 Stockpiles

****

NOTE: Check state regulations to determine the minimum requirements for stockpiles and modify this paragraph accordingly. For contaminated material with high moisture content, the subgrade for the

stockpile must be sloped and a sump should be provided.

Scrim reinforced geomembranes are commonly specified for stockpile covers and liners. Due to their higher strength properties, scrim reinforced geomembranes can generally be thinner than non-reinforced geomembranes.

For post treatment stockpiles, chemical testing is usually required to determine if material is contaminated or clean. Maximum stockpile size should be based on the required frequency of chemical testing. For example, if chemical tests are required at a frequency of one per 1,000 cubic meters (cubic yards), then stockpiles should be no greater than 1,000 cubic meters (cubic yards) in size.

****

Stockpiles shall be constructed to isolate stored contaminated material from the environment. The maximum stockpile size shall be [_____] cubic meters. yards. Stockpiles shall be constructed to include:

a. [A chemically resistant geomembrane liner free of holes and other damage. Non-reinforced geomembrane liners shall have a minimum thickness of [0.5] [_____] mm. [20] [_____] mils. Scrim reinforced geomembrane liners shall have a minimum weight of 20 kg/100 square meters. 40 lbs. per 1000 square feet. The ground surface on which the geomembrane is to be placed shall be free of rocks greater than 12 mm 0.5 inches in diameter and any other object which could damage the membrane.] [Pavement shall be used as the liner system. Pavement shall be constructed in accordance with Section [_____]].

b. Geomembrane cover free of holes or other damage to prevent precipitation from entering the stockpile. Non-reinforced geomembrane covers shall have a minimum thickness of 0.25 mm. 10 mils. Scrim reinforced geomembrane covers shall have a minimum weight of 13 kg/100 square meters 26 lbs. per 1000 square feet. The cover material shall be extended over the berms and anchored or ballasted to prevent it from being removed or damaged by wind.

c. Berms surrounding the stockpile, a minimum of 300 mm 12 inches in height. Vehicle access points shall also be bermed.

d. The liner system shall be sloped to allow collection of leachate. Storage and removal of liquid which collects in the stockpile, in accordance with paragraph Liquid Storage.

3.5.2 Roll-Off Units

Roll-off units used to temporarily store contaminated material shall be water tight. A cover shall be placed over the units to prevent precipitation from contacting the stored material. The units shall be located [as shown on the drawings] [_____]. Liquid which collects inside the units shall be removed and stored in accordance with paragraph Liquid Storage.

3.5.3 Liquid Storage

Liquid collected from excavations and stockpiles shall be temporarily stored in [220 L barrels] [[2000] [_____] L tanks]. [55 gallon barrels] [[500] [_____] gallon tanks]. Liquid storage containers shall be water-tight and shall be located [as shown on the drawings] [_____].

3.6 SAMPLING

3.6.1 Sampling of Stored Material

****

NOTE: Additional samples are sometimes collected from excavated material to determine the contaminants present prior to treatment or disposal.

Composite samples are often collected from stockpiled material. However, composite samples cannot be taken if the samples are being analyzed for volatile organic contaminants.

At sites with radioactive contamination, ex-situ sampling of excavated material is typically performed to ensure that the material meets disposal facility acceptance criteria and, in some cases, to assist with the preparation of shipping papers. The ex-situ sampling regime is site-specific. It is usually determined in consultation with the disposal facility and its regulatory agency.

****

Samples of stored material shall be collected at a frequency of once per [_____] cubic meters. yards. Samples shall be tested for the following:

Chemical Parameter	Action Level
[_____]	[_____]

Stored material with contaminant levels that exceed the action levels shall be treated [offsite. Analyses for contaminated material to be taken to an offsite treatment facility shall conform to local, state, and federal criteria as well as to the requirements of the treatment facility. Documentation of all analyses performed shall be furnished to the Contracting Officer. Additional sampling and analyses to the extent required by the approved offsite treatment, storage or disposal (TSD) facility shall be the responsibility of the Contractor and shall be [performed at no additional cost to the Government] [subject to approval by the Contracting Officer].] [onsite. Treatment shall be in accordance with Section [_____].]

3.6.2 Sampling Liquid

****

NOTE: Liquid should generally be tested for the same contaminants as are found in the contaminated solid material being removed. The frequency of testing should be determined on a site specific basis. Offsite disposal will generally require additional testing and analysis prior to disposal.

NPDES requirements must be considered for onsite disposal of liquids.

****

Liquid collected from [excavations] [storage areas] [decontamination facilities] shall be sampled at a frequency of once for every [2,000] [_____] L [500] [_____] gallons of liquid collected. Samples shall be tested for the following:

Chemical Parameter	Action Level
[_____]	[_____]

Liquid with contaminant levels that exceed action levels shall be treated [offsite. Analyses for contaminated liquid to be taken to an offsite treatment facility shall conform to local, state, and federal criteria as well as to the requirements of the treatment facility. Documentation of all analyses performed shall be furnished to the Contracting Officer. Additional sampling and analysis to the extent required by the approved offsite treatment, storage or disposal (TSD) facility receiving the material shall be the responsibility of the Contractor and shall be [performed at no additional cost to the Government] [subject to approval by the Contracting Officer].] [onsite. Treatment shall be in accordance with Section [_____].]

3.6.3 Sampling Beneath Storage Units

****

NOTE: At some sites, samples are collected to verify the soil on which a storage unit is placed has not become contaminated.

Sampling along any connecting pipelines that transport contaminated liquid may also be appropriate. A standard practice is to sample at 6 m (20 foot) intervals under piping and at connections such as bends, elbows, or tees.

****

Samples from beneath each storage unit shall be collected prior to construction of and after removal of the storage unit. Samples shall be collected at a frequency of one per each [_____] square meters yards from a depth interval of [0 to 0.15] [_____] m [0 to 0.5] [_____] feet and shall be tested for the following:

Chemical Parameter	Action Level
[_____]	[_____]

Based on test results, soil which has become contaminated above action levels shall be removed at no additional cost to the Government. Contaminated material which is removed from beneath the storage unit shall be handled in accordance with paragraph Sampling of Stored Material. As directed by the Contracting Officer and at no additional cost to the Government, additional sampling and testing shall be performed to verify areas of contamination found beneath stockpiles have been cleaned up to below action levels.

3.7 SPILLS

****

NOTE: Regarding preestablished spill reporting procedures, the designer should consult CEMP-RT memorandum of 20 July 1995, Subject: Spill Reporting Procedures for USACE Personnel Involved in HTRW Projects.

Evaluate whether a contingency plan is needed per 40 CFR 262.34. This regulation is a potential requirement for large quantity generators of hazardous waste. At military installations, a plan is typically already in place.

****

In the event of a spill or release of a hazardous substance (as designated in 40 CFR 302), pollutant, contaminant, or oil (as governed by the Oil Pollution Act (OPA), 33 U.S.C. 2701 et seq.), the Contractor shall notify the Contracting Officer immediately. If the spill exceeds the reporting threshold, the Contractor shall follow the pre-established procedures as described in the [RCRA Contingency Plan] [Base Wide Contingency Plan] [_____] for immediate reporting and containment. Immediate containment actions shall be taken to minimize the effect of any spill or leak. Cleanup shall be in accordance with applicable federal, state, and local regulations. As directed by the Contracting Officer, additional sampling and testing shall be performed to verify spills have been cleaned up. Spill cleanup and testing shall be done at no additional cost to the Government.

3.8 BACKFILLING

****

NOTE: If allowed by the regulatory authority, field analyses should be used to reduce laboratory turn-around time and minimize the duration an excavation must be left open.

After completion of backfilling, a 0.15 meter (6 inch) layer of top soil is typically placed in areas that are not paved. The topsoil is placed in a single lift to the lines and grades shown on the drawings. Top soil and seeding requirements should be described in a different section of the specification package.

****

3.8.1 Confirmation Test Results

Excavations shall be backfilled immediately after all contaminated materials have been removed and confirmation test results have been approved. Backfill shall be placed and compacted to the lines and grades shown on the drawings.

3.8.2 Compaction

****

NOTE: The following paragraph outlines density requirements for in-place backfill. If the density

of the backfill is not critical, modify this paragraph by replacing the density testing requirements with procedural requirements for compaction.

****

Approved backfill shall be placed in lifts with a maximum loose thickness of [200] [_____] mm. [8] [_____] inches. Soil shall be compacted to [90] [_____] percent of [ASTM D 698] [ASTM D 1557] maximum dry density. Density tests shall be performed at a frequency of once per [930] [_____] square meters [10,000] [_____] square feet per lift. A minimum of [one density test] [[_____] density tests] shall be performed on each lift of backfill placed. Field in-place dry density shall be determined in accordance with ASTM D 1556, ASTM D 2167, or ASTM D 2922. If ASTM D 2922 is used, a minimum of one in ten tests shall be checked using ASTM D 1556 or ASTM D 2167. Test results from ASTM D 1556 or ASTM D 2167 shall govern if there is a discrepancy with the ASTM D 2922 test results.

3.9 DISPOSAL REQUIREMENTS

Offsite disposal of contaminated material shall be in accordance with Section 02120A TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS.

3.10 CLOSURE REPORT

****

NOTE: In addition to progress photos, video tapes have been used at some sites to record site activities.

****

[_____] copies of a Closure Report shall be prepared and submitted within [14] [_____] calender days of completing work at the site. The report shall be labeled with the contract number, project name, location, date, name of general contractor, and the Corps of Engineers District contracting for the work. The Closure Report shall include the following information as a minimum:

a. A cover letter signed by a [responsible company official] [Professional Engineer registered in the State of [_____] who is a responsible company official] certifying that all services involved have been performed in accordance with the terms and conditions of the contract documents and regulatory requirements.

b. A narrative report including, but not limited to, the following:

(1) site conditions, ground water elevation, and cleanup criteria;

(2) excavation logs;

(3) field screening readings;

(4) quantity of materials removed from each area of contamination;

(5) quantity of water/product removed during dewatering;

(6) sampling locations and sampling methods;

(7) sample collection data such as time of collection and method of preservation;

(8) sample chain-of-custody forms; and

(9) source of backfill.

c. Copies of all chemical and physical test results.

d. Copies of all manifests and land disposal restriction notifications.

e. Copies of all certifications of final disposal signed by the responsible disposal facility official.

f. Waste profile sheets.

g. Scale drawings showing limits of each excavation, limits of contamination, known underground utilities within 15 m 50 feet of excavation, sample locations, and sample identification numbers. On-site stockpile, storage, treatment, loading, and disposal areas shall also be shown on the drawings.

h. Progress Photographs. Color photographs shall be used to document progress of the work. A minimum of four views of the site showing the location of the area of contamination, entrance/exit road, and any other notable site conditions shall be taken before work begins. After work has been started, activities at each work location shall be photographically recorded [daily] [weekly]. Photographs shall be a minimum of 76.2 x 127.0 mm 3 x 5 inches and shall include:

(1) Soil removal and sampling.

(2) Dewatering operations.

(3) Unanticipated events such as spills and the discovery of additional contaminated material.

(4) Contaminated material/water storage, handling, treatment, and transport.

(5) Site or task-specific employee respiratory and personal protection.

(6) Fill placement and grading.

(7) Post-construction photographs. After completion of work at each site, the Contractor shall take a minimum of four views of each excavation site.

A digital version of all photos shown in the report shall be included with the Closure Report. Photographs shall be a minimum of 76mm by 127 mm 3 inches by 5 inches and shall be mounted back-to-back in double face plastic sleeves punched to fit standard three ring binders. Each print shall have an information box attached. The box shall be typewritten and arranged as follows:

Project Name:
Location:
Photograph No.:

Direction of View:
Date/Time:
Description of View:

-- End of Section --

APPENDIX I

PORTIONS OF USEPA INNOVATIVE TECHNOLOGY VERIFICATION REPORT: *FIELD MEASUREMENT TECHNOLOGIES FOR TOTAL PETROLEUM HYDROCARBONS IN SOIL*

United States
Environmental Protection
Agency

Office of Research and
Development
Washington, DC 20460

EPA/600/R-01/080
September 2001

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Innovative Technology Verification Report

Field Measurement Technologies for Total Petroleum Hydrocarbons in Soil

siteLAB® Corporation
siteLAB® Analytical Test Kit UVF-3100A

SITE

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16. Abstract

siteLA.B(& Analytical Test Kit UVF-3 I OOA (UVF-3 I OOA) developed by siteLABqD Corporation (siteLABa)) was demonstrated under the U.S. Environmental Protection Agency Superfund Innovative Technology Evaluation Program in June 2000 at the Navy Base Ventura County site in Port Hueneme, California. The purpose of the demonstration was to collect reliable performance and cost data for the UVF-3 I OOA and six other field measurement devices for total petroleum hydrocarbons (TPH) in soil. In addition to assessing ease of device operation, the key objectives of the demonstration included determining the (1) method detection limit, (2) accuracy and precision, (3) effects of interferents and soil moisture content on TPH measurement, (4) sample throughput, and (5) TPH measurement costs for each device. The demonstration involved analysis of both performance evaluation samples and environmental samples collected in five areas contaminated with gasoline, diesel, lubricating oil, or other petroleum products. The performance and cost results for a given field measurement device were compared to those for an off-site laboratory reference method, "Test Methods for Evaluating Solid Waste" (SW-846) Method 8015B (modified). During the demonstration, siteLAB& required 37 hours, 20 minutes, for TPH measurement of 199 samples and 13 extract duplicates. The TPH measurement costs were estimated to be $7,090 for siteLA.Be's UVF-3 I OOA rental option; $7,720 for the UVF-3 I OOA on-site testing support service option; and $17,670 for the UVF-310OA purchase option compared to $42,500 for the reference method. The method detection limits were determined to be 3.4 and 6.32 milligrams per kilogram for the UVF-3100A and reference method, respectively. During the demonstration, the UVF-3100A exhibited good accuracy and precision, ease of use, and lack of sensitivity to interferents that are not petroleum hydrocarbons (neat materials, including tetrachloroethene; turpentine; and 1,2,4-trichlorobenzene and soil spiked with humic acid). However, the device showed less than 5 percent response to neat materials (methyl-tert-butyl ether and Stoddard solvent) that are petroleum hydrocarbons. In addition, it exhibited minor sensitivity to soil moisture content during TPH measurement of weathered gasoline soil samples. Despite some of the limitations observed during the demonstration, the demonstration findings collectively indicated that the UVF-3100A is a reliable field measurement device for TPH in soil.

Mention of trade names, corporate names or commercial products does not constitute endorsement or recommendation by EPA for use.

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Innovative Technology Verification Report

siteLAB® Corporation
siteLAB® Analytical Test Kit UVF-3100A

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ETV

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Abbreviations, Acronyms, and Symbols

>	Greater than
≤	Less than or equal to
±	Plus or minus
µg	Microgram
µm	Micrometer
AC	Alternating current
AEHS	Association for Environmental Health and Sciences
AFB	Air Force Base
API	American Petroleum Institute
ASTM	American Society for Testing and Materials
bgs	Below ground surface
BTEX	Benzene, toluene, ethylbenzene, and xylene
BVC	Base Ventura County
Calibration Kit	UVF Calibration Kit
CCV	Continuing calibration verification
CFC	Chlorofluorocarbon
CFR	*Code of Federal Regulations*
DC	Direct current
DER	Data evaluation report
DRO	Diesel range organics
EDRO	Extended diesel range organics
EDRO standard	EDRO C_{10}-C_{40} Aromatics (Weathered Diesel) standard
EPA	U.S. Environmental Protection Agency
EPH	Extractable petroleum hydrocarbon
EPH standard	EPH C_{11}-C_{22} Aromatic Hydrocarbons standard
ERA	Environmental Resource Associates
Extraction Kit	20-Sample Extraction Kit
Extraction System	UVF-3100A Extraction System
FFA	Fuel Farm Area
FID	Flame ionization detector
GC	Gas chromatograph
GRO	Gasoline range organics
HPLC	High-performance liquid chromatography
ICV	Initial calibration verification
IDW	Investigation-derived waste
ITVR	Innovative technology verification report
kg	Kilogram
L	Liter
LCS	Laboratory control sample
LCSD	Laboratory control sample duplicate

Abbreviations, Acronyms, and Symbols (Continued)

MCAWW	"Methods for Chemical Analysis of Water and Wastes"
MDL	Method detection limit
Means	R.S. Means Company
mg	Milligram
min	Minute
mL	Milliliter
mm	Millimeter
MMT	Monitoring and Measurement Technology
MS	Matrix spike
MSD	Matrix spike duplicate
MTBE	Methyl-tert-butyl ether
n-C_x	Alkane with "x" carbon atoms
NERL	National Exposure Research Laboratory
NEX	Naval Exchange
ng	Nanogram
nm	Nanometer
ORD	Office of Research and Development
ORO	Oil range organics
OSWER	Office of Solid Waste and Emergency Response
PAH	Polynuclear aromatic hydrocarbon
PC	Petroleum company
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethene
PE	Performance evaluation
PHC	Petroleum hydrocarbon
PPE	Personal protective equipment
PRA	Phytoremediation Area
PRO	Petroleum range organics
QA	Quality assurance
QC	Quality control
R^2	Square of the correlation coefficient
RPD	Relative percent difference
RSD	Relative standard deviation
SFT	Slop Fill Tank
SITE	Superfund Innovative Technology Evaluation
siteLAB®	siteLAB® Corporation
STL Tampa East	Severn Trent Laboratories in Tampa, Florida
SW-846	"Test Methods for Evaluating Solid Waste"
TPH	Total petroleum hydrocarbons
UST	Underground storage tank
UVF-3100A	siteLAB® Analytical Test Kit UVF-3100A
VPH	Volatile petroleum hydrocarbon
VPH standard	VPH C_9-C_{10} + BTEX Aromatic Hydrocarbons standard

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Chapter 1
Introduction

The U.S. Environmental Protection Agency (EPA) Office of Research and Development (ORD) National Exposure Research Laboratory (NERL) conducted a demonstration of seven innovative field measurement devices for total petroleum hydrocarbons (TPH) in soil. The demonstration was conducted as part of the EPA Superfund Innovative Technology Evaluation (SITE) Monitoring and Measurement Technology (MMT) Program using TPH-contaminated soil from five areas located in three regions of the United States. The demonstration was conducted at Port Hueneme, California, during the week of June 12, 2000. The purpose of the demonstration was to obtain reliable performance and cost data on field measurement devices in order to provide (1) potential users with a better understanding of the devices' performance and operating costs under well-defined field conditions and (2) the developers with documented results that will assist them in promoting acceptance and use of their devices. The TPH results obtained using the seven field measurement devices were compared to the TPH results obtained from a reference laboratory chosen for the demonstration, which used a reference method modified for the demonstration.

This innovative technology verification report (ITVR) presents demonstration performance results and associated costs for the siteLAB® Analytical Test Kit UVF-3100A (UVF-3100A). The UVF-3100A was developed by the Oak Ridge National Laboratory in collaboration with siteLAB® Corporation (siteLAB®) under the sponsorship of the U.S. Department of Energy and the EPA. Specifically, this report describes the SITE Program, the scope of the demonstration, and the components and definition of TPH (Chapter 1); the innovative field measurement device and the technology upon which it is based (Chapter 2); the three demonstration sites (Chapter 3); the demonstration approach (Chapter 4); the selection of the reference method and laboratory (Chapter 5); the assessment of reference method data quality (Chapter 6); the performance of the field measurement device (Chapter 7); the economic analysis for the field measurement device and reference method (Chapter 8); the demonstration results in summary form (Chapter 9); and the references used to prepare the ITVR (Chapter 10). Supplemental information provided by siteLAB® is presented in the appendix.

1.1 Description of SITE Program

Performance verification of innovative environmental technologies is an integral part of the regulatory and research mission of the EPA. The SITE Program was established by the EPA Office of Solid Waste and Emergency Response (OSWER) and ORD under the Superfund Amendments and Reauthorization Act of 1986. The overall goal of the SITE Program is to conduct performance verification studies and to promote the acceptance of innovative technologies that may be used to achieve long-term protection of human health and the environment. The program is designed to meet three primary objectives: (1) identify and remove obstacles to the development and commercial use of innovative technologies, (2) demonstrate promising innovative technologies and gather reliable performance and cost information to support site characterization and cleanup activities, and (3) develop procedures and policies that encourage the use of innovative technologies at Superfund sites as well as at other waste sites or commercial facilities.

The intent of a SITE demonstration is to obtain representative, high-quality performance and cost data on one or more innovative technologies so that potential users can assess the suitability of a given technology for a specific application. The SITE Program includes the following elements:

- **MMT Program**—Evaluates innovative technologies that sample, detect, monitor, or measure hazardous and toxic substances. These technologies are expected to provide better, faster, or more cost-effective methods for producing real-time data during site characterization and remediation studies than do conventional technologies.

- **Remediation Technology Program**—Conducts demonstrations of innovative treatment technologies to provide reliable performance, cost, and applicability data for site cleanups.

- **Technology Transfer Program**—Provides and disseminates technical information in the form of updates, brochures, and other publications that promote the SITE Program and participating technologies. The Technology Transfer Program also offers technical assistance, training, and workshops to support the technologies. A significant number of these activities are performed by EPA's Technology Innovation Office.

The TPH field measurement device demonstration was conducted as part of the MMT Program, which provides developers of innovative hazardous waste sampling, detection, monitoring, and measurement devices with an opportunity to demonstrate the performance of their devices under actual field conditions. These devices may be used to sample, detect, monitor, or measure hazardous and toxic substances in water, soil gas, soil, and sediment. The technologies include chemical sensors for in situ (in place) measurements, soil and sediment samplers, soil gas samplers, groundwater samplers, field-portable analytical equipment, and other systems that support field sampling or data acquisition and analysis.

The MMT Program promotes acceptance of technologies that can be used to (1) accurately assess the degree of contamination at a site, (2) provide data to evaluate potential effects on human health and the environment, (3) apply data to assist in selecting the most appropriate cleanup action, and (4) monitor the effectiveness of a remediation process. The program places a high priority on innovative technologies that provide more cost-effective, faster, and safer methods for producing real-time or near-real-time data than do conventional, laboratory-based technologies. These innovative technologies are demonstrated under field conditions, and the results are compiled, evaluated, published, and disseminated by the ORD. The primary objectives of the MMT Program are as follows:

- Test and verify the performance of innovative field sampling and analytical technologies that enhance sampling, monitoring, and site characterization capabilities

- Identify performance attributes of innovative technologies to address field sampling, monitoring, and characterization problems in a more cost-effective and efficient manner

- Prepare protocols, guidelines, methods, and other technical publications that enhance acceptance of these technologies for routine use

The MMT Program is administered by the Environmental Sciences Division of the NERL in Las Vegas, Nevada. The NERL is the EPA center for investigation of technical and management approaches for identifying and quantifying risks to human health and the environment. The NERL mission components include (1) developing and evaluating methods and technologies for sampling, monitoring, and characterizing water, air, soil, and sediment; (2) supporting regulatory and policy decisions; and (3) providing the technical support needed to ensure effective implementation of environmental regulations and strategies. By demonstrating innovative field measurement devices for TPH in soil, the MMT Program is supporting the development and evaluation of methods and technologies for field measurement of TPH concentrations in a variety of soil types. Information regarding the selection of field measurement devices for TPH is available in American Petroleum Institute (API) publications (API 1996, 1998).

The MMT Program's technology verification process is designed to conduct demonstrations that will generate high-quality data so that potential users have reliable information regarding device performance and cost. Four steps are inherent in the process: (1) needs identification and technology selection, (2) demonstration planning and implementation, (3) report preparation, and (4) information distribution.

The first step of the verification process begins with identifying technology needs of the EPA and the regulated community. The EPA regional offices, the U.S. Department of Energy, the U.S. Department of Defense, industry, and state environmental regulatory agencies are

asked to identify technology needs for sampling, monitoring, and measurement of environmental media. Once a need is identified, a search is conducted to identify suitable technologies that will address the need. The technology search and identification process consists of examining industry and trade publications, attending related conferences, exploring leads from technology developers and industry experts, and reviewing responses to *Commerce Business Daily* announcements. Selection of technologies for field testing includes evaluation of the candidate technologies based on several criteria. A suitable technology for field testing

- Is designed for use in the field
- Is applicable to a variety of environmentally contaminated sites
- Has potential for solving problems that current methods cannot satisfactorily address
- Has estimated costs that are lower than those of conventional methods
- Is likely to achieve better results than current methods in areas such as data quality and turnaround time
- Uses techniques that are easier or safer than current methods
- Is commercially available

Once candidate technologies are identified, their developers are asked to participate in a developer conference. This conference gives the developers an opportunity to describe their technologies' performance and to learn about the MMT Program.

The second step of the verification process is to plan and implement a demonstration that will generate high-quality data to assist potential users in selecting a technology. Demonstration planning activities include a predemonstration sampling and analysis investigation that assesses existing conditions at the proposed demonstration site or sites. The objectives of the predemonstration investigation are to (1) confirm available information on applicable physical, chemical, and biological characteristics of contaminated media at the sites to justify selection of site areas for the demonstration; (2) provide the technology developers with an opportunity to evaluate the areas, analyze representative samples, and identify logistical requirements; (3) assess the overall logistical requirements for conducting the demonstration; and (4) provide the reference laboratory with an opportunity to identify any matrix-specific analytical problems associated with the contaminated media and to propose appropriate solutions. Information generated through the predemonstration investigation is used to develop the final demonstration design and sampling and analysis procedures.

Demonstration planning activities also include preparing a detailed demonstration plan that describes the procedures to be used to verify the performance and cost of each innovative technology. The demonstration plan incorporates information generated during the predemonstration investigation as well as input from technology developers, demonstration site representatives, and technical peer reviewers. The demonstration plan also incorporates the quality assurance (QA) and quality control (QC) elements needed to produce data of sufficient quality to document the performance and cost of each technology.

During the demonstration, each innovative technology is evaluated independently and, when possible and appropriate, is compared to a reference technology. The performance and cost of one innovative technology are not compared to those of another technology evaluated in the demonstration. Rather, demonstration data are used to evaluate the individual performance, cost, advantages, limitations, and field applicability of each technology.

As part of the third step of the verification process, the EPA publishes a verification statement and a detailed evaluation of each technology in an ITVR. To ensure its quality, the ITVR is published only after comments from the technology developer and external peer reviewers are satisfactorily addressed. In addition, all demonstration data used to evaluate each innovative technology are summarized in a data evaluation report (DER) that constitutes a complete record of the demonstration. The DER is not published as an EPA document, but an unpublished copy may be obtained from the EPA project manager.

The fourth step of the verification process is to distribute information regarding demonstration results. To benefit technology developers and potential technology users, the EPA distributes demonstration bulletins and ITVRs through direct mailings, at conferences, and on the Internet. The ITVRs and additional information on the

SITE Program are available on the EPA ORD web site (http://www.epa.gov/ORD/SITE).

1.2 Scope of Demonstration

The purpose of the demonstration was to evaluate field measurement devices for TPH in soil in order to provide (1) potential users with a better understanding of the devices' performance and costs under well-defined field conditions and (2) the developers with documented results that will assist them in promoting acceptance and use of their devices.

Chapter 2 of this ITVR describes both the technology upon which the UVF-3100A is based and the field measurement device itself. Because TPH is a "method-defined parameter," the performance results for the device are compared to the results obtained using an off-site laboratory measurement method—that is, a reference method. Details on the selection of the reference method and laboratory are provided in Chapter 5.

The demonstration had both primary and secondary objectives. Primary objectives were critical to the technology verification and required the use of quantitative results to draw conclusions regarding each field measurement device's performance as well as to estimate the cost of operating the device. Secondary objectives pertained to information that was useful but did not necessarily require the use of quantitative results to draw conclusions regarding the performance of each device. Both the primary and secondary objectives are discussed in Chapter 4.

To meet the demonstration objectives, samples were collected from five individual areas at three sites. The first site is referred to as the Navy Base Ventura County (BVC) site; is located in Port Hueneme, California; and contained three sampling areas. The Navy BVC site lies in EPA Region 9. The second site is referred to as the Kelly Air Force Base (AFB) site; is located in San Antonio, Texas; and contained one sampling area. The Kelly AFB site lies in EPA Region 6. The third site is referred to as the petroleum company (PC) site, is located in north-central Indiana, and contained one sampling area. The PC site lies in EPA Region 5.

In preparation for the demonstration, a predemonstration sampling and analysis investigation was completed at the three sites in January 2000. The purpose of this investigation was to assess whether the sites and sampling areas were appropriate for evaluating the seven field measurement devices based on the demonstration objectives. Demonstration field activities were conducted between June 5 and 18, 2000. The procedures used to verify the performance and costs of the field measurement devices are documented in a demonstration plan completed in June 2000 (EPA 2000). The plan also incorporates the QA/QC elements that were needed to generate data of sufficient quality to document field measurement device and reference laboratory performance and costs. The plan is available through the EPA ORD web site (http://www.epa.gov/ORD/SITE) or from the EPA project manager.

1.3 Components and Definition of TPH

To understand the term "TPH," it is necessary to understand the composition of petroleum and its products. This section briefly describes the composition of petroleum and its products and defines TPH from a measurement standpoint. The organic compounds containing only hydrogen and carbon that are present in petroleum and its derivatives are collectively referred to as petroleum hydrocarbons (PHC). Therefore, in this ITVR, the term "PHC" is used to identify sample constituents, and the term "TPH" is used to identify analyses performed and the associated results (for example, TPH concentrations).

1.3.1 Composition of Petroleum and Its Products

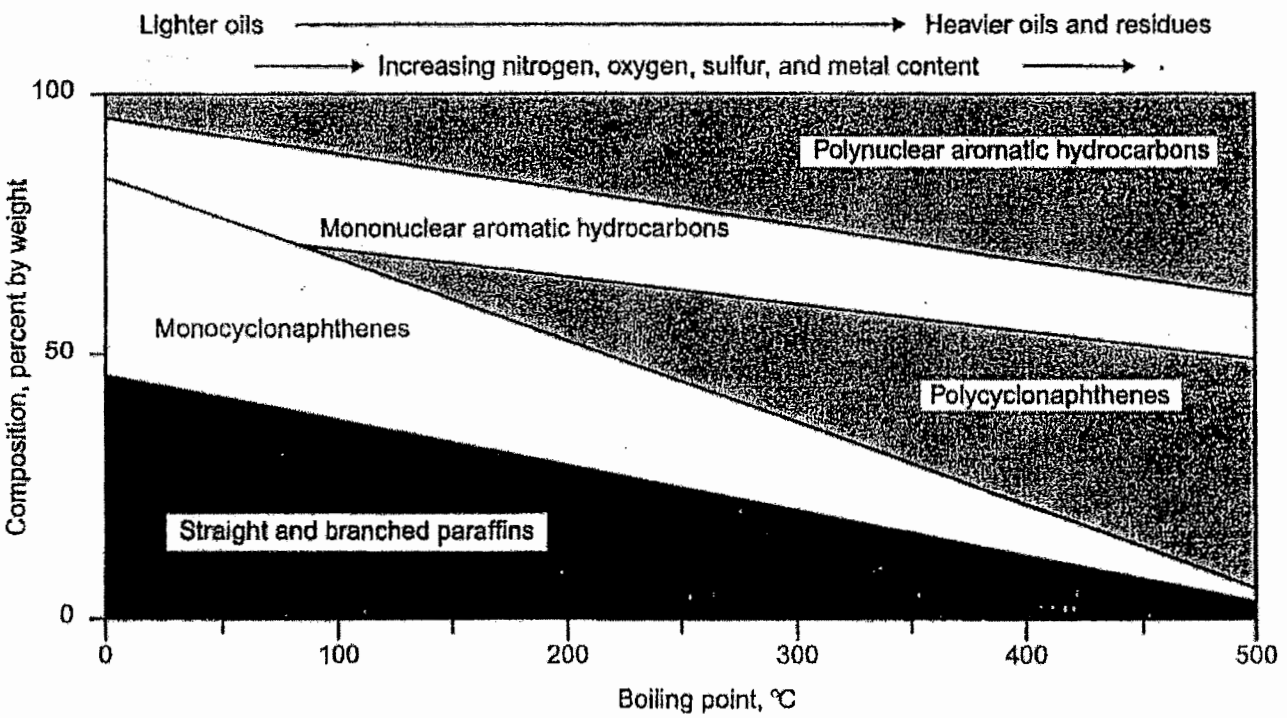
Petroleum is essentially a mixture of gaseous, liquid, and solid hydrocarbons that occur in sedimentary rock deposits. On the molecular level, petroleum is a complex mixture of hydrocarbons; organic compounds of sulfur, nitrogen, and oxygen; and compounds containing metallic constituents, particularly vanadium, nickel, iron, and copper. Based on the limited data available, the elemental composition of petroleum appears to vary over a relatively narrow range: 83 to 87 percent carbon, 10 to 14 percent hydrogen, 0.05 to 6 percent sulfur, 0.1 to 2 percent nitrogen, and 0.05 to 1.5 percent oxygen. Metals are present in petroleum at concentrations of up to 0.1 percent (Speight 1991).

Petroleum in the crude state (crude oil) is a mineral resource, but when refined it provides liquid fuels, solvents, lubricants, and many other marketable products. The hydrocarbon components of crude oil include

paraffinic, naphthenic, and aromatic groups. Paraffins (alkanes) are saturated, aliphatic hydrocarbons with straight or branched chains but without any ring structure. Naphthenes are saturated, aliphatic hydrocarbons containing one or more rings, each of which may have one or more paraffinic side chains (alicyclic hydrocarbons). Aromatic hydrocarbons contain one or more aromatic nuclei, such as benzene, naphthalene, and phenanthrene ring systems, that may be linked with (substituted) naphthenic rings or paraffinic side chains. In crude oil, the relationship among the three primary groups of hydrocarbon components is a result of hydrogen gain or loss between any two groups. Another class of compounds that is present in petroleum products such as automobile gasoline but rarely in crude oil is known as olefins. Olefins (alkenes) are unsaturated, aliphatic hydrocarbons.

The distribution of paraffins, naphthenes, and aromatic hydrocarbons depends on the source of crude oil. For example, Pennsylvania crude oil contains high levels of paraffins (about 50 percent), whereas Borneo crude oil contains less than 1 percent paraffins. As shown in Figure 1-1, the proportion of straight or branched paraffins decreases with increasing molecular weight or boiling point fraction for a given crude oil; however, this is not true for naphthenes or aromatic hydrocarbons. The proportion of monocyclonaphthenes decreases with increasing molecular weight or boiling point fraction, whereas the opposite is true for polycyclonaphthenes (for example, tetralin and decalin) and polynuclear aromatic hydrocarbons (PAH); the proportion of mononuclear aromatic hydrocarbons appears to be independent of molecular weight or boiling point fraction.

Various petroleum products consisting of carbon and hydrogen are formed when crude oil is subjected to distillation and other processes in a refinery. Processing of crude oil results in petroleum products with trace quantities of metals and organic compounds that contain nitrogen, sulfur, and oxygen. These products include liquefied petroleum gas, gasoline, naphthas, kerosene, fuel oils, lubricating oils, coke, waxes, and asphalt. Of these products, gasoline, naphthas, kerosene, fuel oils, and lubricating oils are liquids and may be present at petroleum-contaminated sites. Except for gasoline and



Source: Speight 1991

Figure 1-1. Distribution of various petroleum hydrocarbon types throughout boiling point range of crude oil.

some naphthas, these products are made primarily by collecting particular boiling point fractions of crude oil from a distillation column. Because this classification of petroleum products is based on boiling point and not on chemical composition, the composition of these products, including the ratio of aliphatic to aromatic hydrocarbons, varies depending on the source of crude oil. In addition, specific information (such as boiling points and carbon ranges) for different petroleum products, varies slightly depending on the source of the information. Commonly encountered forms and blends of petroleum products are briefly described below. The descriptions are primarily based on information in books written by Speight (1991) and Gary and Handwerk (1993). Additional information is provided by Dryoff (1993).

1.3.1.1 Gasoline

Gasoline is a major exception to the boiling point classification described above because "straight-run gasoline" (gasoline directly recovered from a distillation column) is only a small fraction of the blended gasoline that is commercially available as fuel. Commercially available gasolines are complex mixtures of hydrocarbons that boil below 180 °C or at most 225 °C and that contain hydrocarbons with 4 to 12 carbon atoms per molecule. Of the commercially available gasolines, aviation gasoline has a narrower boiling range (38 to 170 °C) than automobile gasoline (-1 to 200 °C). In addition, aviation gasoline may contain high levels of paraffins (50 to 60 percent), moderate levels of naphthenes (20 to 30 percent), a low level of aromatic hydrocarbons (10 percent), and no olefins, whereas automobile gasoline may contain up to 30 percent olefins and up to 40 percent aromatic hydrocarbons.

Gasoline composition can vary widely depending on the source of crude oil. In addition, gasoline composition varies from region to region because of consumer needs for gasoline with a high octane rating to prevent engine "knocking." Moreover, EPA regulations regarding the vapor pressure of gasoline, the chemicals used to produce a high octane rating, and cleaner-burning fuels have affected gasoline composition. For example, when use of tetraethyl lead to produce gasoline with a high octane rating was banned by the EPA, oxygenated fuels came into existence. Production of these fuels included addition of methyl-tert-butyl ether (MTBE), ethanol, and other oxygenates. Use of oxygenated fuels also results in reduction of air pollutant emissions (for example, carbon monoxide and nitrogen oxides).

1.3.1.2 Naphthas

"Naphtha" is a generic term applied to petroleum solvents. Under standardized distillation conditions, at least 10 percent of naphthas should distill below 175 °C, and at least 95 percent of naphthas should distill below 240 °C. Naphthas can be both aliphatic and aromatic and contain hydrocarbons with 6 to 14 carbon atoms per molecule. Depending on the intended use of a naphtha, it may be free of aromatic hydrocarbons (to make it odor-free) and sulfur (to make it less toxic and less corrosive). Many forms of naphthas are commercially available, including Varnish Makers' and Painters' naphthas (Types I and II), mineral spirits (Types I through IV), and aromatic naphthas (Types I and II). Stoddard solvent is an example of an aliphatic naphtha.

1.3.1.3 Kerosene

Kerosene is a straight-run petroleum fraction that has a boiling point range of 205 to 260 °C. Kerosene typically contains hydrocarbons with 12 or more carbon atoms per molecule. Because of its use as an indoor fuel, kerosene must be free of aromatic and unsaturated hydrocarbons as well as sulfur compounds.

1.3.1.4 Jet Fuels

Jet fuels, which are also known as aircraft turbine fuels, are manufactured by blending gasoline, naphtha, and kerosene in varying proportions. Therefore, jet fuels may contain a carbon range that covers gasoline through kerosene. Jet fuels are used in both military and commercial aircraft. Some examples of jet fuels include Type A, Type A-1, Type B, JP-4, JP-5, and JP-8. The aromatic hydrocarbon content of these fuels ranges from 20 to 25 percent. The military jet fuel JP-4 has a wide boiling point range (65 to 290 °C), whereas commercial jet fuels, including JP-5 and Types A and A-1, have a narrower boiling point range (175 to 290 °C) because of safety considerations. Increasing concerns over combat hazards associated with JP-4 jet fuel led to development of JP-8 jet fuel, which has a flash point of 38 °C and a boiling point range of 165 to 275 °C. JP-8 jet fuel contains hydrocarbons with 9 to 15 carbon atoms per molecule. Type B jet fuel has a boiling point range of 55 to 230 °C and a carbon range of 5 to 13 atoms per molecule. A new specification is currently being developed by the American Society for Testing and Materials (ASTM) for Type B jet fuel.

1.3.1.5 Fuel Oils

Fuel oils are divided into two classes: distillates and residuals. No. 1 and 2 fuel oils are distillates and include kerosene, diesel, and home heating oil. No. 4, 5, and 6 fuel oils are residuals or black oils, and they all contain crude distillation tower bottoms (tar) to which cutter stocks (semirefined or refined distillates) have been added. No. 4 fuel oil contains the most cutter stock, and No. 6 fuel oil contains the least.

Commonly available fuel oils include No. 1, 2, 4, 5, and 6. The boiling points, viscosities, and densities of these fuel oils increase with increasing number designation. The boiling point ranges for No. 1, 2, and 4 fuel oils are about 180 to 320, 175 to 340, and 150 to 480 °C, respectively. No. 1 and 2 fuel oils contain hydrocarbons with 10 to 22 carbon atoms per molecule; the carbon range for No. 4 fuel oil is 22 to 40 atoms per molecule. No. 5 and 6 fuel oils have a boiling point range of 150 to 540 °C but differ in the amounts of residue they contain: No. 5 fuel oil contains a small amount of residue, whereas No. 6 fuel oil contains a large amount. No. 5 and 6 fuel oils contain hydrocarbons with 28 to 90 carbon atoms per molecule. Fuel oils typically contain about 60 percent aliphatic hydrocarbons and 40 percent aromatic hydrocarbons.

1.3.1.6 Diesel

Diesel is primarily used to operate motor vehicle and railroad diesel engines. Automobile diesel is available in two grades: No. 1 and 2. No. 1 diesel, which is sold in regions with cold climates, has a boiling point range of 180 to 320 °C and a cetane number above 50. The cetane number is similar to the octane number of gasoline; a higher number corresponds to less knocking. No. 2 diesel is very similar to No. 2 fuel oil. No. 2 diesel has a boiling point range of 175 to 340 °C and a minimum cetane number of 52. No. 1 diesel is used in high-speed engines such as truck and bus engines, whereas No. 2 diesel is used in other diesel engines. Railroad diesel is similar to No. 2 diesel but has a higher boiling point (up to 370 °C) and lower cetane number (40 to 45). The ratio of aliphatic to aromatic hydrocarbons in diesel is about 5. The carbon range for hydrocarbons present in diesel is 10 to 28 atoms per molecule.

1.3.1.7 Lubricating Oils

Lubricating oils can be distinguished from other crude oil fractions by their high boiling points (greater than 400 °C) and viscosities. Materials suitable for production of lubricating oils are composed principally of hydrocarbons containing 25 to 35 or even 40 carbon atoms per molecule, whereas residual stocks may contain hydrocarbons with 50 to 60 or more (up to 80 or so) carbon atoms per molecule. Because it is difficult to isolate hydrocarbons from the lubricant fraction of petroleum, aliphatic to aromatic hydrocarbon ratios are not well documented for lubricating oils. However, these ratios are expected to be comparable to those of the source crude oil.

1.3.2 Measurement of TPH

As described in Section 1.3.1, the composition of petroleum and its products is complex and variable, which complicates TPH measurement. The measurement of TPH in soil is further complicated by weathering effects. When a petroleum product is released to soil, the product's composition immediately begins to change. The components with lower boiling points are volatilized, the more water-soluble components migrate to groundwater, and biodegradation can affect many other components. Within a short period, the contamination remaining in soil may have only some characteristics in common with the parent product.

This section provides a historical perspective on TPH measurement, reviews current options for TPH measurement in soil, and discusses the definition of TPH that was used for the demonstration.

1.3.2.1 Historical Perspective

Most environmental measurements are focused on identifying and quantifying a particular trace element (such as lead) or organic compound (such as benzene). However, for some "method-defined" parameters, the particular substance being measured may yield different results depending on the measurement method used. Examples of such parameters include oil and grease and surfactants. Perhaps the most problematic of the method-defined parameters is TPH. TPH arose as a parameter for wastewater analyses in the 1960s because of petroleum industry concerns that the original "oil and grease" analytical method, which is gravimetric in nature, might inaccurately characterize petroleum industry wastewaters that contained naturally occurring vegetable oils and greases along with PHCs. These naturally occurring materials are typically long-chain fatty acids (for example, oleic acid, the major component of olive oil).

Originally, TPH was defined as any material extracted with a particular solvent that is not adsorbed by the silica gel used to remove fatty acids and that is not lost when the solvent is evaporated. Although this definition covers most of the components of petroleum products, it includes many other organic compounds as well, including chlorinated solvents, pesticides, and other synthetic organic chemicals. Furthermore, because of the evaporation step in the gravimetric analytical method, the definition excludes most of the petroleum-derived compounds in gasoline that are volatile in nature. For these reasons, an infrared analytical method was developed to measure TPH. In this method, a calibration standard consisting of three components is analyzed at a wavelength of 3.41 micrometers (μm), which corresponds to an aliphatic CH_2 hydrocarbon stretch. As shown in Table 1-1, the calibration standard is designed to mimic a petroleum product having a relative distribution of aliphatic and aromatic compounds as well as a certain percentage of aliphatic CH_2 hydrocarbons. The infrared analytical method indicates that any compound that is extracted by the solvent, is not adsorbed by silica gel, and contains a CH_2 bond is a PHC. Both the gravimetric and infrared analytical methods include an optional, silica gel fractionation step to remove polar, biogenic compounds such as fatty acids, but this cleanup step can also remove some petroleum degradation products that are polar in nature.

In the 1980s, because of the change in focus from wastewater analyses to characterization of hazardous waste sites that contained contaminated soil, many parties began to adapt the existing wastewater analytical methods for application to soil. Unfortunately, the term "TPH" was in common use, as many states had adopted this term (and the wastewater analytical methods) for cleanup activities at underground storage tank (UST) sites. Despite efforts by the API and others to establish new analyte names (for example, gasoline range organics [GRO] and diesel range organics [DRO]), "TPH" is still present in many state regulations as a somewhat ill-defined term, and most state programs still have cleanup criteria for TPH.

1.3.2.2 Current Options for TPH Measurement in Soil

Three widely used technologies measure some form of TPH in soil to some degree. These technologies were used as starting points in deciding how to define TPH for the demonstration. The three technologies and the analytes measured are summarized in Table 1-2.

Of the three technologies, gravimetry and infrared are discussed in Section 1.3.2.1. The third technology, the gas chromatograph/flame ionization detector (GC/FID), came into use because of the documented shortcomings of the other two technologies. The GC/FID had long been used in the petroleum refining industry as a product QC tool to determine the boiling point distribution of pure petroleum products. In the 1980s, environmental laboratories began to apply this technology along with sample preparation methods developed for soil samples to measure PHCs at environmental levels (Zilis, McDevitt, and Parr 1988). GC/FID methods measure all organic compounds that are extracted by the solvent and that can be chromatographed. However, because of method limitations, the very volatile portion of gasoline compounds containing four or five carbon atoms per molecule is not addressed by GC/FID methods; therefore, 100 percent recovery cannot be achieved for pure gasoline. This omission is not considered significant because these low-boiling-point aliphatic compounds (1) are not expected to be present in environmental samples (because of volatilization) and (2) pose less environmental risk than the aromatic hydrocarbons in gasoline.

The primary limitation of GC/FID methods relates to the extraction solvent used. The solvent should not interfere with the analysis, but to achieve environmental levels of

Table 1-1. Summary of Calibration Information for Infrared Analytical Method

Standard Constituent	Constituent Type	Portion of Constituent in Standard (percent by volume)	Number of Carbon Atoms				Portion of Aliphatic CH_2 in Standard Constituent (percent by weight)
			Aliphatic			Aromatic	
			CH_3	CH_2	CH	CH	
Hexadecane	Straight-chain aliphatic	37.5	2	14	0	0	91
Isooctane	Branched-chain aliphatic	37.5	5	1	1	0	14
Chlorobenzene	Aromatic	25	0	0	0	5	0
Average							35

Table 1-2. Current Technologies for TPH Measurement

Technology	What Is Measured	What Is Not Measured
Gravimetry	All analytes removed from the sample by the extraction solvent that are not volatilized	Volatiles; very polar organics
Infrared	All analytes removed from the sample by the extraction solvent that contain an aliphatic CH_2 stretch	Benzene, naphthalene, and other aromatic hydrocarbons with no aliphatic group attached; very polar organics
Gas chromatograph/flame ionization detector	All analytes removed from the sample by the extraction solvent that can be chromatographed and that respond to the detector	Very polar organics; compounds with high molecular weights or high boiling points

detection (in the low milligram per kilogram [mg/kg] range) for soil, some concentration of the extract is needed because the sensitivity of the FID is in the nanogram (ng) range. This limitation has resulted in three basic approaches for GC/FID analyses for GRO, DRO, and PHCs.

For GRO analysis, a GC/FID method was developed as part of research sponsored by API and was the subject of an interlaboratory validation study (API 1994); the method was first published in 1990. In this method, GRO is defined as the sum of the organic compounds in the boiling point range of 60 to 170 °C, and the method uses a synthetic calibration standard as both a window-defining mix and a quantitation standard. The GRO method was specifically incorporated into EPA "Test Methods for Evaluating Solid Waste" (SW-846) Method 8015B in 1996 (EPA 1996). The GRO method uses the purge-and-trap technique for sample preparation, effectively limiting the TPH components to the volatile compounds only.

For DRO analysis, a GC/FID method was developed under the sponsorship of API as a companion to the GRO method and was interlaboratory-validated in 1994. In the DRO method, DRO is defined as the sum of the organic compounds in the boiling point range of 170 to 430 °C. As in the GRO method, a synthetic calibration standard is used for quantitation. The DRO method was also incorporated into SW-846 Method 8015B in 1996. The technology used in the DRO method can measure hydrocarbons with boiling points up to 540 °C. However, the hydrocarbons with boiling points in the range of 430 to 540 °C are specifically excluded from SW-846 Method 8015B so as not to include the higher-boiling-point petroleum products. The DRO method uses a solvent extraction and concentration step, effectively limiting the method to nonvolatile hydrocarbons.

For PHC analysis, a GC/FID method was developed by Shell Oil Company (now Equilon Enterprises). This method was interlaboratory-validated along with the GRO and DRO methods in an API study in 1994. The PHC method originally defined PHC as the sum of the compounds in the boiling point range of about 70 to 400 °C, but it now defines PHC as the sum of the compounds in the boiling point range of 70 to 490 °C. The method provides options for instrument calibration, including use of synthetic standards, but it recommends use of products similar to the contaminants present at the site of concern. The PHC method has not been specifically incorporated into SW-846; however, the method has been used as the basis for the TPH methods in several states, including Massachusetts, Washington, and Texas. The PHC method uses solvent microextraction and thus has a higher detection limit than the GRO and DRO methods. The PHC method also begins peak integration after elution of the solvent peak for n-pentane. Thus, this method probably cannot measure some volatile compounds (for example, 2-methyl pentane and MTBE) that are measured using the GRO method.

1.3.2.3 Definition of TPH

It is not possible to establish a definition of TPH that would include crude oil and its refined products and exclude other organic compounds. Ideally, the TPH definition selected for the demonstration would have

- Included compounds that are PHCs, such as paraffins, naphthenes, and aromatic hydrocarbons
- Included, to the extent possible, the major liquid petroleum products (gasoline, naphthas, kerosene, jet fuels, fuel oils, diesel, and lubricating oils)
- Had little inherent bias based on the composition of an individual manufacturer's product

- Had little inherent bias based on the relative concentrations of aliphatic and aromatic hydrocarbons present
- Included much of the volatile portion of gasoline, including all weathered gasoline
- Included MTBE
- Excluded crude oil residuals beyond the extended diesel range organic (EDRO) range
- Excluded nonpetroleum organic compounds (for example, chlorinated solvents, pesticides, polychlorinated biphenyls [PCB], and naturally occurring oils and greases)
- Allowed TPH measurement using a widely accepted method
- Reflected accepted TPH measurement practice in many states

Several states, including Massachusetts, Alaska, Louisiana, and North Carolina, have implemented or are planning to implement a TPH contamination cleanup approach based on the aliphatic and aromatic hydrocarbon fractions of TPH. The action levels for the aromatic hydrocarbon fraction are more stringent than those for the aliphatic hydrocarbon fraction. The approach used in the above-mentioned states involves performing a sample fractionation procedure and two analyses to determine the aliphatic and aromatic hydrocarbon concentrations in a sample. However, in most applications of this approach, only a few samples are subjected to the dual aliphatic and aromatic hydrocarbon analyses because of the costs associated with performing sample fractionation and two analyses.

For the demonstration, TPH was not defined based on the aliphatic and aromatic hydrocarbon fractions because

- Such a definition is used in only a few states.
- Variations exist among the sample fractionation and analysis procedures used in different states.
- The repeatability and versatility of sample fractionation and analysis procedures are not well documented.
- In some states, TPH-based action levels are still used.
- The associated analytical costs are high.

As stated in Section 1.3.2.2, analytical methods currently available for measurement of TPH each exclude some portion of TPH and are unable to measure TPH alone while excluding all other organic compounds, thus making TPH a method-defined parameter. After consideration of all the information presented above, the GRO and DRO analytical methods were selected for TPH measurement for the demonstration. However, because of the general interest in higher-boiling-point petroleum products, the integration range of the DRO method was extended to include compounds with boiling points up to 540 °C. Thus, for the demonstration, the TPH concentration was the sum of all organic compounds that have boiling points between 60 and 540 °C and that can be chromatographed, or the sum of the results obtained using the GRO and DRO methods. This approach accounts for most gasoline, including MTBE, and virtually all other petroleum products and excludes a portion (25 to 50 percent) of the heavy lubricating oils. Thus, TPH measurement for the demonstration included PHCs as well as some organic compounds that are not PHCs. More specifically, TPH measurement did not exclude nonpetroleum organic compounds such as chlorinated solvents, other synthetic organic chemicals such as pesticides and PCBs, and naturally occurring oils and greases. A silica gel fractionation step used to remove polar, biogenic compounds such as fatty acids in some GC/FID methods was not included in the sample preparation step because, according to the State of California, this step can also remove some petroleum degradation products that are also polar in nature (California Environmental Protection Agency 1999). The step-by-step approach used to select the reference method for the demonstration and the project-specific procedures implemented for soil sample preparation and analysis using the reference method are detailed in Chapter 5.

Chapter 2
Description of Ultraviolet Fluorescence Spectroscopy and the UVF-3100A

Measurement of TPH in soil by field measurement devices generally involves extraction of PHCs from soil using an appropriate solvent followed by measurement of the TPH concentration in the extract using an optical method. An extraction solvent is selected that will not interfere with the optical measurement of TPH in the extract. Some field measurement devices use light in the visible wavelength range, and others use light outside the visible wavelength range (for example, ultraviolet light).

The optical measurements made by field measurement devices may involve absorbance, reflectance, or fluorescence. In general, the optical measurement for a soil extract is compared to a calibration curve in order to determine the TPH concentration. Calibration curves may be developed by (1) using a series of calibration standards selected based on the type of PHCs being measured at a site or (2) establishing a correlation between off-site laboratory measurements and field measurements for selected, site-specific soil samples.

Field measurement devices may be categorized as quantitative, semiquantitative, and qualitative. These categories are explained below.

- A **quantitative measurement device** measures TPH concentrations ranging from its reporting limit through its linear range. The measurement result is reported as a single, numerical value that has an established precision and accuracy.

- A **semiquantitative measurement device** measures TPH concentrations above its reporting limit. The measurement result may be reported as a concentration range with lower and upper limits.

- A **qualitative measurement device** indicates the presence or absence of PHCs above or below a specified value (for example, the reporting limit or an action level).

The UVF-3100A is a field measurement device capable of providing quantitative TPH measurement results. Optical measurements made using the UVF-3100A are based on ultraviolet fluorescence spectroscopy, which is described in Section 2.1. Calibration curves for the UVF-3100A are developed using calibration standards.

Section 2.1 describes the technology upon which the UVF-3100A is based, Section 2.2 describes the UVF-3100A itself, and Section 2.3 provides siteLAB® contact information. The technology and device descriptions presented below are not intended to provide complete operating procedures for measuring TPH concentrations in soil using the UVF-3100A. Detailed operating procedures for the device, including soil extraction, TPH measurement, and TPH concentration calculation procedures, are available from siteLAB®. Supplemental information provided by siteLAB® is presented in the appendix.

2.1 Description of Ultraviolet Fluorescence Spectroscopy

This section describes the technology, ultraviolet fluorescence spectroscopy, upon which the UVF-3100A is based. This technology is suitable for measuring aromatic hydrocarbons independent of their carbon range. TPH measurement using ultraviolet fluorescence spectroscopy involves extraction of PHCs from soil using an organic solvent. Light in the ultraviolet range is used to irradiate the extract and measure its TPH concentration.

Figure 2-1 shows a general schematic of ultraviolet fluorescence spectroscopy. The excitation and emission optics shown in the figure consist of optical lenses that are

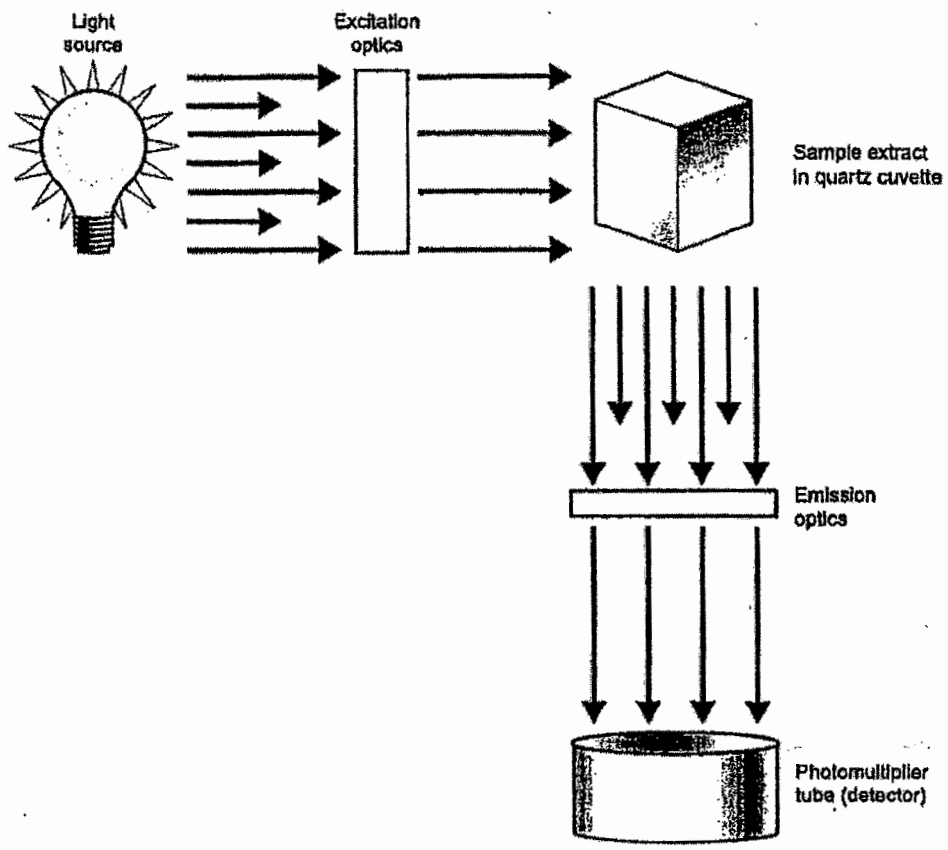


Figure 2-1. Schematic of ultraviolet fluorescence spectroscopy.

used to focus light on a monochromator. A monochromator is a series of optical filters that reduce a broad-wavelength light beam to a single-wavelength beam.

In ultraviolet fluorescence spectroscopy, a multiple-wavelength lamp that emits light in the ultraviolet range is used as a light source. The ultraviolet light is directed through the excitation optics. When the resulting, focused ultraviolet light is used to irradiate the sample extract under analysis, some of the ultraviolet light is absorbed by the molecules in the extract, resulting in excitation of those molecules. The excited state of the molecules is transient, and in many cases, the excess energy is lost as heat when the molecules return to a stable state. However, some molecules return to a stable state by emitting the excess energy as light in the ultraviolet range. The light emitted has longer wavelengths than those of the ultraviolet light absorbed by the molecules and can be detected and measured. The phenomenon of releasing excess energy as light is described as fluorescence.

A large number of organic molecules and a small number of inorganic ions can fluoresce. In general, organic molecules with aromatic rings are the most likely to fluoresce. Some common classes of fluorescent organic molecules include aromatic hydrocarbons, alkyl-substituted aromatic hydrocarbons, aromatic amines, aromatic amino acids, some halo-substituted aromatic hydrocarbons, phenols, heterocyclic molecules, and a few aromatic acids (Fritz and Schenk 1987). Therefore, ultraviolet fluorescence spectroscopy may be used to identify the concentration of fluorescing PHCs—specifically, the aromatic hydrocarbon portion of TPH—in a sample extract.

In ultraviolet fluorescence spectroscopy, the emission optics are placed at a 90-degree angle to the excitation optics. The longer-wavelength light emitted by the excited molecules passes through the emission optics and is detected by a photomultiplier tube. The photomultiplier tube detects and amplifies the emitted light and converts

it into an electrical signal that is used to determine the intensity of the light emitted (fluorescence intensity). The emission optics and photomultiplier tube are placed at a 90-degree angle to the light source in order to minimize the light source interference detected by the photomultiplier tube.

A spectrum of fluorescence intensity versus emission wavelength is generated and evaluated to determine whether any of the peaks correspond to known groups of hydrocarbons. The fluorescence intensity of a sample extract depends on the amount of ultraviolet light absorbed by the extract at a specified wavelength. The amount of light absorbed can be calculated using Beer-Lambert's law, which may be expressed as shown in Equation 2-1.

$$A = \epsilon bc \qquad (2\text{-}1)$$

where

- A = Absorbance
- ϵ = Molar absorptivity (centimeter per mole per liter [L])
- b = Light path length (centimeter)
- c = Concentration of absorbing species (mole per L)

Thus, according to Beer-Lambert's law, the absorbance of aromatic hydrocarbons is directly proportional to the total concentration of the absorbing aromatic hydrocarbons and the path length of the ultraviolet light that is not absorbed by the sample extract and passes through the extract. In Equation 2-1, the molar absorptivity is a proportionality constant, which is a characteristic of the absorbing aromatic hydrocarbon and changes as the wavelength or the light irradiating the sample extract changes. Therefore, Beer-Lambert's law applies only to monochromatic light (light energy of one wavelength).

Because the fluorescence intensity of a sample extract depends on the amount of light energy absorbed by the extract, the fluorescence intensity of an extract is directly proportional to the concentrations of aromatic hydrocarbons in the extract. To determine the aromatic hydrocarbon concentration of a sample extract, a calibration curve can be generated based on the fluorescence intensity and the corresponding aromatic hydrocarbon concentrations using known standards that are selected based on the type of PHCs being measured at a site. Alternatively, a calibration curve can be generated based on the fluorescence intensity and the corresponding site-specific TPH, GRO, or EDRO results.

2.2 Description of UVF-3100A

The UVF-3100A was developed by siteLAB®. The device is manufactured for siteLAB® by Turner Designs and has been modified and distributed for environmental use by siteLAB®. The UVF-3100A has been commercially available since October 1998. This section describes the device and summarizes its operating procedure.

2.2.1 Device Description

The siteLAB® portable fluorometer included in the UVF-3100A is fitted with excitation and emission filters that are appropriate for TPH analysis of soil samples. In addition, siteLAB® has developed and provides software that can be used to manage and present data generated by the UVF-3100A.

The fluorometer uses a mercury vapor lamp with a predominant emission of 254-nanometer (nm) wavelength as its light source. Light from the lamp is directed through an excitation filter with a bandwidth of 254 nm before it irradiates a sample extract held in a quartz cuvette. Depending on the analysis being conducted, the fluorometer is fitted with an appropriate emission filter that corresponds to the wavelength at which the sample extract is expected to fluoresce. For GRO, an emission filter with a bandwidth between 275 and 285 nm is used, and for EDRO, an emission filter with a bandwidth between 300 and 400 nm is used. These filters are used because GRO and EDRO aromatic hydrocarbons fluoresce within these wavelength ranges. Both the excitation and emission filters are fitted into sleeves that fit into ports in the fluorometer. Methanol is used as the extraction solvent to analyze soil samples using the UVF-3100A.

The UVF-3100A can be used to measure petroleum products. Because aromatic hydrocarbons fluoresce when they are excited by ultraviolet light, the fluorometer can measure their concentrations in sample extracts. Aliphatic hydrocarbons do not fluoresce; therefore, the fluorometer cannot quantify aliphatic hydrocarbon concentrations. However, according to siteLAB®, its software can estimate aliphatic hydrocarbon fractions and individual PAH or benzene, toluene, ethylbenzene, and xylene (BTEX) concentrations. The software produces such estimates by generating response factors based on aromatic and

aliphatic hydrocarbon ratios for two to five site-specific samples analyzed by an off-site laboratory using a GC method. In addition, if results are generated using a particular calibration curve (for example, a curve prepared using synthetic standards), the siteLAB® software may be used to generate results based on an alternate calibration curve (for example, a curve prepared using petroleum products).

siteLAB® has determined method detection limits (MDL) for the UVF-3100A by analyzing sand blanks; the MDLs claimed by siteLAB® for petroleum products in soil range from 0.08 to 6.9 mg/kg and are listed in Table 2-1. An evaluation of the MDL, accuracy, and precision achieved by the UVF-3100A during the demonstration is presented in Chapter 7.

Table 2-1. UVF-3100A Method Detection Limits

Petroleum Product or Hydrocarbons	Method Detection Limit for Soil (milligram per kilogram)
No. 2 fuel oil	0.50
No. 4 fuel oil	0.20
No. 6 fuel oil	0.08
Diesel	0.60
50 percent weathered diesel	0.34
Gasoline	6.9
50 percent weathered gasoline	3.9
Motor oil	1.0
Polynuclear aromatic hydrocarbons (EDRO)	0.04
Benzene, toluene, ethylbenzene, and xylene (GRO)	0.10

The operating temperature range for the UVF-3100A is 0 to 38 °C. The lowest operating temperature is based on the possibility of the fluorometer's quartz crystal display freezing. According to siteLAB®, the UVF-3100A does not have a storage temperature or operating humidity restriction.

The UVF-3100A contains three primary components: the (1) UVF-3100A Extraction System (Extraction System), (2) 20-Sample Extraction Kit (Extraction Kit), and (3) UVF Calibration Kit (Calibration Kit). Table 2-2 lists the items included in each of these components. The Extraction System, Extraction Kit, and Calibration Kit fit in a portable field case that is 36 inches long, 24 inches wide, and 12 inches high and weighs 55 pounds. The UVF-3100A may be operated using a direct current (DC) power source such as a 12-volt power outlet in an automobile; therefore, an alternating current (AC) power source is not required in the field. During the demonstration, siteLAB® operated the UVF-3100A using AC power from the demonstration field trailer.

Table 2-2. UVF-3100A Components

UVF-3100A Extraction System
- Fluorometer
- Alternating current power adapter
- Direct current power converter
- RS-232 cable
- Quartz cuvettes (2)
- Timer (batteries included)
- Certified clean sand (500 grams)
- High-performance liquid chromatography-grade methanol (1 liter)
- Solvent dispenser bottle
- 5-milliliter volumetric flask
- 10-milliliter volumetric flask
- Tissue wipes
- 2 stainless-steel spatulas
- Adjustable pipette
- Test tube rack
- Battery-powered balance (9-volt battery included)
- Markers
- Shaker/mixer can
- siteLAB® software
- Portable field case
- Instruction manual and quick reference guide

20-Sample Extraction Kit
- 20 extraction jars
- 20 weighing boats
- 20 pipette tips
- 20 syringes with detachable filters
- 40 10-milliliter test tubes
- 40 stainless-steel mixing balls

UVF Calibration Kit
- 5 calibration standards
- Reference method standard

Connecting the fluorometer to a computer allows downloading and manipulation of calibration and sample data using the siteLAB® software, although a computer connection is not needed to collect or read data. An RS-232 cable is provided to connect the fluorometer to a computer. At a minimum, the computer used should support the Microsoft Windows 95 operating system and have Microsoft Excel software installed. If a computer that does not meet these requirements is used, a special computer program and technical support can be provided by siteLAB® to assist the user in manipulating data.

According to siteLAB®, 40 to 50 samples can be analyzed in an 8-hour period by one field technician using the UVF-3100A. Each sample takes 5 to 10 minutes to process and 5 to 10 seconds to analyze. siteLAB® does not

provide the user with a training video. However, the sample analysis procedures for the UVF-3100A can be learned with a few practice attempts using the instruction manual provided with the Extraction System. siteLAB® provides technical support over the telephone during regular business hours at no additional cost. Although it is not required for operation of the UVF-3100A, siteLAB® also offers 0.5 to 1 day of training in device operation and data management. The cost of this training, excluding travel and per diem costs for a siteLAB® instructor, is included in the purchase cost of the UVF-3100A.

siteLAB® considers the UVF-3100A to be innovative because the device adapts a laboratory technology for field use. The device is able to separately report aromatic hydrocarbon concentrations for GRO and EDRO analyses.

2.2.2 Operating Procedure

Measuring TPH in soil using the UVF-3100A involves extraction and concentration measurement. The UVF-3100A can measure both GRO and EDRO components of sample extracts. Both analyses may be performed on one sample extract; however, the emission filter must be replaced and the device must be recalibrated between the GRO and EDRO analyses. During the demonstration, siteLAB® calibrated the UVF-3100A using an Extractable Petroleum Hydrocarbons (EPH) C_{11}-C_{22} Aromatic Hydrocarbons standard (EPH standard) and an EDRO C_{10}-C_{40} Aromatics (Weathered Diesel) standard (EDRO standard) for EDRO analyses and a Volatile Petroleum Hydrocarbons (VPH) C_9-C_{10} + BTEX Aromatic Hydrocarbons standard (VPH standard) for GRO analyses. During the demonstration, extraction of a given soil sample was completed by adding 10 milliliters (mL) of methanol to 10 grams of the sample. The mixture was agitated manually using the shaker/mixer can. A syringe with a detachable filter was used to transfer the extract to a test tube. The extract was then decanted into a quartz cuvette that was placed in the chamber of the fluorometer. The extract was analyzed, and the device displayed the TPH concentration in parts per million, which is equivalent to a soil concentration in mg/kg. If the extract was diluted, or if a soil sample was extracted using a soil to solvent ratio other than 1:1, the dilution was entered in the siteLAB® software analysis report, and the software calculated the soil concentration. Calibration checks of the fluorometer were performed by analyzing a methanol blank after analysis of every 20 samples. In addition, QC checks of the fluorometer were also performed by analyzing a sand blank six times during the demonstration.

2.3 Developer Contact Information

Additional information about the UVF-3100A can be obtained from the following source:

siteLAB® Corporation
Mr. Steve Greason
27 Greensboro Road
Hanover, NH 03755
Telephone: (603) 643-7800
Fax: (603) 643-7900
E-mail: sgreason@site-lab.com
Internet: www.site-lab.com

APPENDIX J

NMED TPH SCREENING GUIDELINES NOVEMBER 2005

NEW MEXICO ENVIRONMENT DEPARTMENT TPH SCREENING GUIDELINES
November 2005

In some instances, it may be practical to assess areas of soil contamination that are the result of releases of petroleum products such as jet fuel and diesel, using total petroleum hydrocarbon (TPH) analyses. TPH results may be used to delineate the extent of petroleum-related contamination at these sites and ascertain if the residual level of petroleum products in soil represents an unacceptable risk to future users of the site. Petroleum hydrocarbons represent complex mixtures of compounds, some of which are regulated constituents and some compounds that are not regulated. In addition, the amount and types of the constituent compounds in a petroleum hydrocarbon release differ widely depending on what type of product was spilled and how the spill has weathered. This variability makes it difficult to determine the toxicity of weathered petroleum products in soil solely from TPH results; however, these results can be used to approximate risk in some cases, depending upon the nature of the petroleum product, the release scenario, how well the site has been characterized, and anticipated potential future land uses. In some cases, site clean up cannot be based solely on results of TPH sampling. The New Mexico Environment Department (NMED) will make these determinations on a case by case basis. If NMED determines that additional data are necessary, these TPH guidelines must be used in conjunction with the screening guidelines for individual petroleum-related contaminants in Table 3 and other contaminants, as applicable.

The screening levels for each petroleum carbon range from the Massachusetts Department of Environmental Protection (MADEP) Volatile Petroleum Hydrocarbons/Extractable Petroleum Hydrocarbons (VPH/EPH) approach and the percent composition table below were used to generate screening levels corresponding to total TPH. Except for waste oil, the information in the compositional assumptions table was obtained from the Massachusetts Department of Environmental Protection guidance document *Implementation of the MADEP VPH/EPH Approach* (October 31, 2002). TPH toxicity was based only on the weighted sum of the toxicity of the hydrocarbon fractions listed in Table 1.

Table 1. TPH Compositional Assumptions in Soil

Petroleum Product	C11-C22 Aromatics	C9-C18 Aliphatics	C19-C36 Aliphatics
Diesel #2/ new crankcase oil	60%	40%	0%
#3 and #6 Fuel Oil	70%	30%	0%
Kerosene and jet fuel	30%	70%	0%
Mineral oil dielectric fluid	20%	40%	40%
Unknown oil[a]	100%	0%	0%
Waste Oil[b]	0%	0%	100%

[a] Sites with oil from unknown sources must be tested for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), metals, and polychlorinated biphenyls (PCBs) to determine if other potentially toxic constituents are present. The TPH guidelines in Table 2 are not designed to be protective of exposure to these constituents therefore they must be tested for, and compared to, their individual NMED soil screening guidelines.

[b] Compositional assumption for waste oil developed by NMED is based on review of chromatographs of several types of waste oil. Sites with waste oil must be tested for VOCs, SVOCs, metals, and PCBs to determine if other potentially toxic constituents are present. The TPH guidelines in Table 2 are not designed to be protective of exposure to these constituents therefore they must be tested for, and compared to, their individual NMED soil screening guidelines.

A TPH screening guideline was calculated for each of the types of petroleum product based on the assumed composition from Table 1 for petroleum products and the direct soil standards incorporating ceiling concentrations given in the MADEP VPH/EPH Excel spreadsheet for each of the carbon fractions. Groundwater concentrations are based on the weighted sum of the noncarcinogenic toxicity of the petroleum fractions.

Method 1 from the MADEP VPH/EPH document was applied, which represents generic cleanup standards for soil and groundwater. Method 1 applies if contamination exists in only soil and groundwater. The MADEP VPH/EPH further divides groundwater into standards. Standard GW-1 applies when groundwater may be used for drinking water purposes. GW-1 standards are based upon ingestion and use of groundwater as a potable water supply. The TPH screening guidelines for sites with potable groundwater are presented in Table 2a.

Table 2a. TPH Screening Guidelines for Potable Groundwater (GW-1)

TPH			Concentration in Groundwater (mg/L)
Petroleum Product	**Residential Direct Exposure (mg/kg)**	**Industrial Direct Exposure (mg/kg)**	
Diesel #2/crankcase oil	520	1120	1.72
#3 and #6 Fuel Oil	440	890	1.34
Kerosene and jet fuel	760	1810	2.86
Mineral oil dielectric fluid	1440	3040	3.64
Unknown oil [a]	200	200	0.2
Waste Oil [b]	2500	5000	Petroleum-Related Contaminants
Gasoline	Not applicable	Not applicable	Petroleum-Related Contaminants

[a] Sites with oil from unknown sources must be tested for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), metals, and polychlorinated biphenyls (PCBs) to determine if other potentially toxic constituents are present. The TPH guidelines in Table 2 are not designed to be protective of exposure to these constituents therefore they must be tested for, and compared to, their individual NMED soil screening guidelines.

[b] Compositional assumption for waste oil developed by NMED is based on review of chromatographs of several types of waste oil. Sites with waste oil must be tested for VOCs, SVOCs, metals, and PCBs to determine if other potentially toxic constituents are present. The TPH guidelines in Table 2 are not designed to be protective of exposure to these constituents therefore they must be tested for, and compared to, their individual NMED soil screening guidelines.

The second standard is GW-2, which is applicable for sites where the depth to groundwater is less than 15 feet from the ground surface <u>and</u> within 30 feet of an occupied structure. The structure may be either residential or industrial. GW-2 standards are based upon "inhalation exposures that could occur to occupants of the building impacted by volatile compounds, which partition from the groundwater" (MADEP 2001). The GW-2 screening guidelines ONLY apply for the evaluation of inhalation exposures. If potential ingestion or contact with contaminated soil and/or

groundwater could occur, then the screening guidelines provided in Table 2.a should be applied. Table 2.b lists the TPH screening guidelines for the inhalation scenario.

Table 2b. TPH Screening Guidelines – Vapor Migration and Inhalation of Groundwater (GW-2)

TPH			Concentration in Groundwater (mg/L)
Petroleum Product	**Residential Direct Exposure (mg/kg)**	**Industrial Direct Exposure (mg/kg)**	
Diesel #2/crankcase oil	880	2200	30.4
#3 and #6 Fuel Oil	860	2150	35.3
Kerosene and jet fuel	940	2350	15.7
Mineral oil dielectric fluid	1560	3400	10.4
Unknown oil [a]	800	2000	50.0
Waste Oil [b]	2500	5000	Petroleum-Related Contaminants
Gasoline	Not applicable	Not applicable	Petroleum-Related Contaminants

[a] Sites with oil from unknown sources must be tested for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), metals, and polychlorinated biphenyls (PCBs) to determine if other potentially toxic constituents are present. The TPH guidelines in Table 2 are not designed to be protective of exposure to these constituents therefore they must be tested for, and compared to, their individual NMED soil screening guidelines.

[b] Compositional assumption for waste oil developed by NMED is based on review of chromatographs of several types of waste oil. Sites with waste oil must be tested for VOCs, SVOCs, metals, and PCBs to determine if other potentially toxic constituents are present. The TPH guidelines in Table 2 are not designed to be protective of exposure to these constituents therefore they must be tested for, and compared to, their individual NMED soil screening guidelines.

Mineral oil based hydraulic fluids can be evaluated for petroleum fraction toxicity using the screening guidelines from Tables 2a and 2b specified for waste oil, because this type of hydraulic fluid is composed of approximately the same range of carbon fractions as waste oil. However, these hydraulic fluids often contain proprietary additives that may be significantly more toxic than the oil itself; these additives must be considered on a site- and product-specific basis (see ATSDR hydraulic fluids profile reference). **Use of alternate screening guideline values requires prior written approval from the New Mexico Environment Department.** TPH screening guidelines in Tables 2a and 2b must be used in conjunction with the screening levels for petroleum-related contaminants given in Table 3 because the TPH screening levels are NOT designed to be protective of exposure to these individual petroleum-related contaminants. Table 3 petroleum-related contaminants screening levels are based on the New Mexico Environment Department soil screening levels (SSLs) released in February 2004.

The list of petroleum-related contaminants does not include polyaromatic hydrocarbons (PAHs) with individual screening levels that would exceed the total TPH screening levels (acenaphthene, anthracene, flouranthene, flourene, and pyrene). In addition, these TPH screening guidelines are based solely on human health, not ecological risk considerations, protection of surface water, or

potential indoor air impacts from soil vapors. Potential soil vapor impacts to structures or utilities are not addressed by these guidelines. Site-specific investigations for potential soil vapor impacts to structures or utilities must be done to assure that screenings are consistently protective of human health, welfare or use of the property. NMED believes that use of these screening guidelines will allow more efficient screenings of petroleum release sites at sites while protecting human health and the environment. Copies of the references cited below are available on the MADEP website at http://www.state.ma.us/dep/bwsc/vph_eph.htm and the NMED website at http://www.nmenv.state.nm.us/HWB/guidance.html.

Table 3. Petroleum-Related Contaminants Screening Guidelines

Petroleum-Related Contaminants	Values for Direct Exposure to Soil		NMED DAF[a] 20 GW protection (mg/kg in soil)	NMED DAF[b] 1 GW protection (mg/kg in soil)
	NMED residential SSL (mg/kg)	NMED Industrial SSL (mg/kg)		
Benzene	2.70E+01	7.36E+01	2.83E-02	1.41E-03
Toluene	2.48E+02	2.48E+02	6.80E+00	3.40E-01
Ethyl benzene	1.06E+04	2.54E+04	1.05E+01	5.25E-01
Xylene[c]	1.32E+02	1.32E+02	1.01E+01	5.07E-01
Naphthalene	7.19E+01	9.83E+01	3.93E-01	1.97E-02
2-methyl naphthalene	1.00E+03[d]	2.50E+03[d]	---[d]	---[d]
Benzo(a)anthracene	6.21E+00	2.34E+01	1.10E+00	5.49E-02
Benzo(b)fluoranthene	6.21E+00	2.34E+01	3.40E+00	1.7E-01
Benzo(k)fluoranthene	6.21E+01	2.34E+02	3.40E+01	1.70E+00
Benzo(a)pyrene	6.21E-01	2.34E+00	6.12E+00	3.06E-01
Chrysene	6.21E+02	2.34E+03	1.10E+02	5.49E+00
Dibenz(a,h) anthracene	6.21E-01	2.34E+00	1.05E+00	5.24E-02
Indeno(1,2,3-c,d) pyrene	6.21E+00	2.34E+01	9.58E+00	4.79E-01

[a] DAF – Dilution Attenuation Factor
[b] For contaminated soil in contact with groundwater
[c] Based upon total xylenes
[d] No NMED value available, value taken from MADEP 2002

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New Mexico Environment Department, Hazardous Waste Bureau and Groundwater Quality Bureau Voluntary Remediation Program. 2004. "Technical Background Document for Development of Soil Screening Levels." February 2004. Revision 2.0.

APPENDIX K

ACCUTEST LABORATORIES
USACE LABORATORY VALIDATION APPROVAL
US DEPARTMENT OF ARMY
JULY 9, 2004

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
12565 WEST CENTER ROAD
OMAHA NE 68144-3869

REPLY TO ATTENTION OF

July 9, 2004

Hazardous, Toxic and Radioactive Waste
Center of Expertise

Svetlana Izosimova
Accutest Laboratories Southeast, Inc.
4405 Vineland Road, Suite C-15
Orlando, FL 32811

Dear Ms Izosimova:

This correspondence addresses the recent evaluation of Accutest Laboratories Southeast, Inc. of Orlando, FL by the U.S. Army Corps of Engineers (USACE) for chemical analysis in support of the USACE Hazardous, Toxic and Radioactive Waste Program.

Your laboratory is now validated for the parameters listed below:

METHOD(1)	PARAMETERS	MATRIX(2)
300.0/9056	Anions(5)	Water(3)
5030B/8021B	Aromatic Volatile Organics	Water(3)
5030B/8021b	Aromatic Volatile Organics	Solids(3)
9010B/9014	Cyanide	Water(3)
9010B/9014	Cyanide	Solids(3)
8330A	Explosives6	Water
8330A	Explosives6	Solids
7196A	Hexavalent Chromium	Water(3)
1664	Oil and Grease	Water(3)
1664	Oil and Grease	Solids(3)
3510C/8081A	Organochlorine Pesticides	Water(3)
3550B/8081A	Organochlorine Pesticides	Solids(3)
3510C/8082	Polychlorinated Biphenyls	Water(3)
3550B/8082	Polychlorinated Biphenyls	Solids(3)
3510C/8270C	Semivolatile Organics	Water(3)
3550B/8270C	Semivolatile Organics	Solids(3)
3010A/6010B/7470A	TAL Metals(4)	Water(3)
3050B/6010B/7471A	TAL Metals(4)	Solids(3)

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3510C/5030/Mod 8015	TPH - DRO/GRO	Water[3]
3550B/5030/Mod 8015	TPH - DRO/GRO	Solids[3]
5030B/5035/8260B	Volatile Organics	Water[3]
5030B/5035/8260B	Volatile Organics	Solids[3]

Remarks:

1) Sample preparation methods have been added to reflect program policy change.

2) 'Solids' includes soils, sediments, and solid waste.

3) The laboratory has successfully analyzed a Proficiency Testing (PT) sample for this method/matrix.

4) TAL Metals: Aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc.

5) Anions: Chloride, fluoride, sulfate, nitrate, nitrite, and ortho-phosphate.

6) Approval for this parameter is based on review of SOPs only.

Enclosed for your information is a copy of the Laboratory Inspection and Evaluation Report. Your laboratory has responded to the deficiencies as noted in the report. No further responses are necessary.

Based on the successful analysis of the National Environmental Laboratory Accreditation Conference Proficiency Testing samples for the appropriate fields of testing, the results of the laboratory inspection, and your Corrective Action Report, your laboratory will be validated for sample analysis by the methods listed above. The evaluation, which was conducted for your facility, is based substantially on ISO Guide 25 (General Requirements for the Competence of Testing Laboratories) and USACE Engineering Manual (EM) 200-1-3, Appendix I (Shell for Analytical Chemistry Requirements). The period of validation is 24 months and expires on July 9, 2006.

The USACE reserves the right to conduct additional laboratory inspections or to suspend validation status for any or all of the listed parameters if deemed necessary. It should be noted that your laboratory may not subcontract USACE analytical work to any other laboratory location without the approval of this office. This laboratory validation does not guarantee the delivery of any analytical samples from a USACE Contracting Officer Representative.

Any questions or comments can be directed to Richard Kissinger at (402) 697-2569. General questions regarding laboratory validation may be directed to the Laboratory Validation Coordinator at (402) 697-2574.

Sincerely,

Marcia C. Davies

Enclosure

Marcia C. Davies, Ph.D.
Director, USACE Hazardous,
Toxic and Radioactive Waste
Center of Expertise

APPENDIX L

SITE-SPECIFIC ADDENDUM TO THE BASEWIDE HEALTH AND SAFETY PLAN

SITE-SPECIFIC ADDENDUM TO THE BASEWIDE HEALTH AND SAFETY PLAN

DISPOSAL PIT 63 (DP-63)

HOLLOMAN AIR FORCE BASE, NEW MEXICO

Prepared for:

49 CES/CEV
Holloman Air Force Base
New Mexico

Under Contract To:

U.S. Army Corps of Engineers
Omaha District
Omaha, Nebraska

Contract No.
DACA45-03-D0023
Delivery/Task Order No. 008

February 2006

Prepared by:

Bhate Environmental Associates, Inc.
1608 13th Avenue South, Suite 300
Birmingham, Alabama 35205

Bhate Project No. 9050044

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SITE-SPECIFIC ADDENDUM TO THE BASEWIDE HEALTH AND SAFETY PLAN

DISPOSAL PIT 63 (DP-63) HOLLOMAN AIR FORCE BASE, NEW MEXICO

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A - Activity Hazards Analyses

B – General Work and Safety Rules

ACRONYMS AND ABBREVIATIONS

ACGIH	American Conference of Governmental Industrial Hygienists
AHA	Activity Hazard Analysis
ANSI	American National Standards Institute
Bhate	Bhate Environmental Associates, Inc.
CGI	Combustible gas indicator
CIH	Certified Industrial Hygienist
CFR	Code of Federal Regulations
CPR	Cardiopulmonary Resuscitation
DP	Disposal pit
EM	Engineering manual
FID	Flame ionization detector
HASP	Health and Safety Plan
HSM	Health and Safety Manager
MEC	Munitions and Explosives of Concern
MSDS	Material Safety Data Sheet
mg/M^3	milligrams per cubic meter of air
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration
PCS	Petroleum Contaminated Soil
PEL	Permissible Exposure Limit
PID	Photoionization detector
P.G.	Professional Geologist
PPE	Personal protective equipment
ppm	Parts per million
RA	Remedial Action
SLM	Sound level meter
SPF	Sun protection factor
SSHO	Site Safety and Health Officer

ACRONYMS AND ABBREVIATIONS (CONTINUED)

TLV	Threshold Limit Value
UXO	Unexploded Ordnance
VCM	Voluntary Corrective Measures
VOCs	Volatile Organic Compounds

1 PROJECT SAFETY COORDINATION

The Bhate Environmental Associates, Inc., (Bhate) personnel who are responsible for safety and health issues at the Disposal Pit 63 (DP-63) project site are identified in Table 1-1. A signature below indicates that the respective personnel have reviewed and approved this *Site-Specific Addendum to the Basewide Health and Safety Plan* (HASP) submitted by Bhate for implementation of this Scope of Services. The requirements of this site-specific addendum are applicable to Bhate employees, their subcontractors, and site visitors.

Table 1-1. Project Personnel and Health and Safety Responsibilities

Title	Name	Office Telephone
Site Manager/SSHO	Mr. John Hymer	(505) 679-2100
Senior Project Manager	Mr. Frank Gardner, P.G.	(970) 216-7819
Health and Safety Manager	Ms. Judy McBride, CIH	(205) 918-4000

SSHO – Site Safety and Health Officer
CIH – Certified Industrial Hygienist
P.G. – Professional Geologist

COMMITMENT TO IMPLEMENT THE SITE SAFETY AND HEALTH PLAN

Frank Gardner, P.G.
Senior Project Manager

September 30, 2005
Date

Judy McBride, CIH
Health and Safety Manager/Plan Preparer

September 30, 2005
Date

John Hymer
Site Manager/Site Health and Safety Officer

September 30, 2005
Date

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2 PROJECT BACKGROUND AND SCOPE

The main objective of this Voluntary Corrective Measures (VCM) remedial excavation is to remove, through excavating, and properly remediate or dispose of petroleum contaminated soils (PCS) at the DP-63 site. Over a period of years, various fuels have been released through incineration of explosives in the disposal pits. The anticipated activities for the project include:

- Mobilization and demobilization of various equipment;
- Installation of soil borings and monitoring wells;
- Soil and groundwater sampling;
- Soil excavation and loading; and,
- Excavated soils placement and land-farm maintenance, as applicable.

A Remedial Action (RA) of Munitions and Explosives of Concern (MEC) will be conducted prior to the initiation of the VCM activities. Any unexploded ordnance (UXO) and metal fragments will be removed during the RA. Once the RA is complete, the US Army Corp of Engineers will conduct a geophysical survey of the areas. This UXO work is separate from the work under this VCM Work Plan and this site-specific addendum to the HASP; therefore, once this UXO work has been completed and an all clear is given, work under the VCM Work Plan will begin. Therefore, no additional risk from UXO should be encountered.

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3 HAZARD ASSESSMENT AND CONTROLS

3.1 Task Hazard(s) Summary

The potential health and safety hazards of this task are summarized below in Table 3-1. The potential for encountering these hazards is ranked (high, moderate, or low) based on the work to be performed and the hazard control measures to be used.

Table 3-1. Task Hazards Summary

Summary	Hazard Potential [High, Moderate, Or Low]	Description of Potential Hazards
_√_**Safety** (i.e. Walking and working surfaces, heavy equipment, traffic, falls, excavations, power and hand tools, materials handling, confined spaces, electrical safety, etc.)	• Moderate All tasks and their control measures are addressed in Task Specific Activity Hazard Analyses (AHAs)	• Walking and working surfaces • Heavy equipment and vehicular traffic • Materials handling • Slips, trips, and falls • Excavating
_√_**Utilities**	• Moderate	• Buried • Over head • Building Although these hazards should not be associated with this particular scope of work, it is necessary to verify that the hazards can be controlled.
_√_**Chemical**	• Moderate	• Potential for exposure to neat products should be limited to equipment fluids (fuel, lubricants, coolant, etc.) • Petroleum Hydrocarbons • Explosives
_√_**Physical**	• Moderate	• Thermal stressors • Equipment noise
_√_**Biological** (i.e. Plants, animals, insects, spiders, infectious waste)	• Low	Potential for contact should be minimal

3.2 Hazard Control Measures

General safe work practices and control measures are identified and summarized in the Basewide HASP. Additional task-specific hazards and control measures are identified for non-routine tasks as part of the AHA process. AHAs have been developed for each of the following activities listed in Table 3-2 and are included in Attachment A.

Table 3-2. Task-Specific Hazard Control Measures by AHA

Activities with an AHA	
General Site Activities/Mobilization and Demobilization	Soil Excavation and Loading
Soil Boring and Monitoring Well Installation	Soils Placement and Land-farm Maintenance

3.3 Written Safety Procedures and Programs

Table 3-3 provides a summary of the existing safety procedures and programs which will be used for this task or site. Copies of applicable procedures and programs are included in Basewide HASP, as indicated.

Table 3-3. Written Safety Procedures and Programs

Reference Procedure or Program	Applicable Section(s)
Bhate Hazard Communication Program	All (Refer to Basewide HASP)
Bhate Respiratory Protection Program	All (Refer to Basewide HASP)
Bhate Hearing Conservation Program	All (Refer to Basewide HASP)

3.4 Permits

Table 3-4 summarizes the required work permits that must be completed prior to the start of field work. No Bhate work permits are anticipated for this project.

Table 3-4. Required Work Permits

Permit	Notes and comments (reference activities, procedures, and coordination with appropriate organizations)
HAFB Excavation Permit	Site Manager will arrange for AF Form 332 to be completed and obtain a dig permit/utility clearance through the HAFB Infrastructure Organization

4 PERSONAL PROTECTIVE EQUIPMENT

4.1 Purpose

The purpose of this program is to ensure that personal protective equipment (PPE) is selected in accordance with 29 Code of Federal Regulations (CFR) Part 1910.132, properly used and maintained, and that Bhate personnel are properly trained in the inspection, use, and maintenance of PPE.

4.2 Scope

This program applies to all Bhate operations including the activities of contractors on Bhate-managed projects.

4.3 Definition

4.3.1 Personal Protective Equipment

Items which are worn and are designed to protect the health and safety of an employee. This includes, but it is not limited to, chemical resistant shoes, boots, gloves, chemical protective clothing, hard hats, safety glasses, hearing protection, cooling/heating vests, life-lines and harnesses, and respirators. Additional program requirements for respirators are provided in the Respiratory Protection Program in the Basewide HASP.

4.3.2 Responsibilities

4.3.2.1 All Bhate Personnel

All personnel required to use PPE are responsible for wearing the appropriate PPE when required, inspecting the PPE prior to use, properly wearing the PPE, and as necessary, properly maintaining the PPE.

4.3.2.2 Project Management Personnel

The Site Manager is responsible for understanding the specific PPE requirements for each project task and ensuring that PPE is provided and worn when required and in the intended manner.

4.3.2.3 Site Safety and Health Officer

The SSHO is responsible for:

- Monitoring PPE usage;
- Recommending modifications to PPE requirements to project management and the Health and Safety Manager (HSM), as necessary;
- Ensuring that project personnel have the proper training on the PPE which they are required to use, and performing training and retraining, as necessary.

The following PPE as presented in Table 4-1 will be used for the identified activities:

Table 4-1. Personal Protective Equipment by Activity

Activity	Head/Face	Foot	Hands	Respiratory	Clothing
Mobilization / Demobilization	Hard Hat (for overhead hazards), Safety Glasses[1] with rigid side shields.	Steel toed boots	Leather gloves as needed	None[3, 4]	Minimum of long pants and shirts with a minimum 4-inch sleeve, reflective vest
General Site Labor	Hard Hat (for overhead hazards), Safety Glasses[1] with rigid side shields.	Steel toed boots	Leather gloves as needed	None[3, 4]	Minimum of long pants and shirts with a minimum 4-inch sleeve, reflective vest
Equipment Operation and Well Installation	Hard Hat[2] (for overhead hazards), Safety Glasses[1] with rigid side shields.	Steel toed boots. Boot covers for entering and exiting equipment.	Leather gloves as needed	None [3, 4] N95 Air Purifying Respirator with Organic vapor cartridges based on monitoring	Minimum of long pants and shirts with a minimum 4-inch sleeve, reflective vest
Equipment Decontamination	Hard Hat[2] (for overhead hazards), Safety Glasses[1] with rigid side shields.	Steel toed boots. Boot covers.	Chemical resistant gloves	None[3, 4] N95 Air Purifying Respirator with Organic vapor cartridges based on monitoring	Minimum of long pants and shirts with a minimum 4-inch sleeve, reflective vest Tyvek coveralls may be worn as recommended by the SSHO

Activity	Head/Face	Foot	Hands	Respiratory	Clothing
Soil and Groundwater Sampling	Hard Hat[2] (for overhead hazards), Safety Glasses[1] with rigid side shields.	Steel toed boots	Chemical resistant gloves	As required [3, 4] N95 Air Purifying Respirator with Organic vapor cartridges based on monitoring	Minimum of long pants and shirts with a minimum 4-inch sleeve Tyvek coveralls may be worn as recommended by the SSHO
Supervision of Work	Hard Hat (for overhead hazards), Safety Glasses[1] with rigid side shields.	Steel toed boots	Leather gloves as needed	As required [3, 4]	Minimum of long pants and shirts with a minimum 4-inch sleeve, reflective vest

Note:

[1] Safety Glasses with rigid side shields approved by American National Standards Institute (ANSI) Z-87 required at all times.

[2] Hard hats are not required inside fully enclosed equipment cabs.

[3] Voluntary use of respirators is authorized for comfort from nuisance dusts and odors, provided they are issued and used in accordance with established respiratory protection program procedures.

[4] Cartridge change out will occur at the following conditions:

- Damage to cartridge
- Cartridge is wet, restriction in breathing, unusual odors
- Cartridge is visibly clogged with dust, restriction in breathing
- After 8 hours of use
- Changes that may be otherwise identified in 29 CFR Section 1910.120.

The following qualified person certifies that the selection of PPE is based on best available information about the work requirements and anticipated hazards.

Printed Name:	Signature:	Date:
Judy McBride, CIH **Bhate Health and Safety Manager**	Judy McBride	**September 30, 2005**

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5 SITE MONITORING

Site monitoring shall be performed as necessary for site remediation work. This section covers general site monitoring for employee exposure to physical and chemical hazards including air contaminants (dust, metals, volatile organic compounds (VOCs), and other specific compounds).

Minimum site monitoring requirements are determined during the project design stage, and are specified in the site-specific addendum to the HASP. Site monitoring shall be performed by, or under the direction of a SSHO.

5.1 Required Site Monitoring

Site monitoring is required under the following conditions:

- When required by the contract, or site-specific addendum to the HASP
- When required by specific Occupational Safety and Health Administration (OSHA) standards (e.g., 29 CFR Part 1910.120, hearing conservation, asbestos, benzene, cadmium, inorganic arsenic, lead, formaldehyde, vinyl chloride, etc.)
- When worker exposure is reasonably anticipated to be greater than 50% of the OSHA Permissible Exposure Limit (PEL), American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV), or other recognized occupational exposure limit
- When necessary to verify the adequacy of hazard control measures and/or PPE, including respiratory protection
- When necessary to assess and evaluate worker exposure, or to resolve worker complaints or concerns

With the concurrence of the HSM, site monitoring may be discontinued after representative initial monitoring is conducted and worker exposures are shown to be adequately controlled through the use of engineering, work practice, or PPE control measures. If work activities change so that the initial monitoring is no longer representative of worker exposure, monitoring must be reinitiated.

5.2 Monitoring Strategy

The site monitoring program considers the factors that may affect worker exposure and the following elements:

- Monitoring requirements, contaminants, and monitoring equipment limitations
- Specific work locations (DP-63), work activities, work practices, personnel, and equipment to be used onsite
- Health and safety program requirements for site monitoring

5.3 Direct Reading Exposure Monitoring

Direct reading instruments for exposure monitoring are extremely useful on construction and hazardous waste sites. The primary advantages include ease of use, ability to monitor constantly changing conditions, and the rapid detection of flammable atmospheres, oxygen deficiency, certain gases and vapors, and physical hazards including noise and radiation.

The following are some of the instruments that may be used for exposure monitoring:

- Photoionization detector (PID)
- Flame ionization detector (FID)
- Combustible gas indicator (CGI)
- Specific gas monitors (e.g., oxygen, carbon monoxide, hydrogen sulfide)
- Colorimetric indicating tubes (e.g., Draeger tubes)
- Specialized air monitors
- Noise dosimeter
- Sound level meter (SLM)

Routine direct reading monitoring results (date/time, calibration information, results, and activities monitored) shall be recorded on the Air Monitoring Data Sheet (Real-Time Air Monitoring) or an equivalent form if approved by the Health and Safety Manager. Monitoring results shall be recorded initially and periodically throughout the monitoring period (e.g., every 15 minutes, when results are above background levels, when site operations or locations change, or when unexpected site conditions arise). When direct reading air monitoring results at the work location equal or exceed the action levels specified in the site-specific addendum to the HASP, the SSHO shall conduct exclusion zone perimeter air monitoring. If the air concentrations at the perimeter of the exclusion zone equal or exceed the action level(s), the boundaries of the exclusion zone shall be expanded as necessary to maintain exclusion zone air contaminant concentrations below the action level(s).

Site monitoring will be conducted using direct-reading instruments primarily in the workers' breathing zone. To the extent feasible, site operations will be conducted and modified as needed to ensure that personnel are situated upwind of the excavation activities. Initial upwind background and work-zone readings will be obtained before the initiation of activities. Readings of breathing zones (unless location is otherwise specified) will be taken periodically during all activities. The SSHO has the authority to modify the level of protection required for work at this site as well as halt operations as deemed necessary to control personal exposures. Monitoring results will be recorded on an Atmospheric Monitoring Log Field Health and Safety form maintained by the SSHO. Monitoring, calibrating, and maintaining instruments are the responsibility of the SSHO. Table 5-1 summarizes the site monitoring parameters and action levels applicable for direct reading exposure monitoring.

Table 5-1. Direct Reading Exposure Monitoring

Activity(s)	Instrument	Action Level(s) and Frequency	Actions
Excavation Soil Placement at and Maintenance of Land-farm Soil Sampling	TVA 1000B OVA PID/FID ToxiRae Personal PID	0 - 9 ppm Every 15 minutes during intrusive activities	Continue work in required PPE and continue monitoring.
		10 - 49 ppm (Sustained for more than 5 minutes)	**Monitor for VOCs.** Ensure personnel are upwind, notify the Site Manager. SSHO may upgrade PPE to Level C respiratory protection with organic vapor cartridge, as necessary.
	Draeger Air Monitor w/ Benzene chips (By colorimetric tube or similar) Where indicted by PID readings	No detection up to 0.2 ppm	Continue work activities in required protective equipment.
		> 0.2 ppm	Cease work, exit the area to upwind location and notify the Site Manager.
	Personal DataRam or similar particulate monitor	⊴.5 mg/M^3 particulates (average) not to exceed 5.0 mg/M^3 5 minute monitoring periods every 15 minutes as necessary if visible dust is not controlled	Stop work, increase dust suppression

Notes:
ppm = parts per million
mg/M^3 – Milligrams per cubic meter

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6 SITE CONTROL

Site-specific site control measures will be used to control access to the work area. Table 6-1 and Table 6-2 summarize the site control requirements applicable for both general work areas and work areas with potentially contaminated soils, respectively.

Table 6-1. Site Control for General Work Area(s)

Location	Site Control Procedure (discuss important elements such as signs, barricades, fencing, briefings, sign-in/out logs, etc.)
General Work Area	Due to the location of the project site, access will be coordinated with the Site Manager and HAFB Operations. Access will be made via a specified route.

Table 6-2. Site Control for Potentially Contaminated Area(s)

Location	Site Control Procedure (discuss important elements such as signs, barricades, briefings, qualifications, required supplies and equipment, sign-in/out logs, etc.)
Support Zone	Located outside of contaminated areas, access will be from clean areas or from the Exclusion Zone through the Contamination Reduction Zone.
Contamination Reduction Zone	The Contamination Reduction Zone will be demarcated with caution tape or temporary construction fencing. Decontamination stations will be located here.
Exclusion Zone	Exclusion Zone work areas will be clearly demarcated with caution tape or temporary construction fencing. All access to this area will require the use of a sign-in/out log.

Required decontamination procedures are described below in Table 6-3.

Table 6-3. Decontamination Procedures by Location

Type of Decontamination	Decontamination Methods
Personnel decontamination	Personnel will be required to thoroughly wash hands and face upon leaving the Contamination Reduction Zone, and especially prior to eating, drinking or smoking. Disposable PPE (from potential sampling events) will be collected for proper disposal. Additional decontamination procedures will be developed by the SSHO as needed.
Equipment decontamination	Work efforts will be made to minimize equipment contact with contaminated materials. Prior to leaving the work area and land-farm following placement of contaminated soils, equipment (tires, excavator/loader buckets, hand tools) will be dry decontaminated. Soils from the dry decontamination process will be disposed with the excavated materials. Decontamination tools may include brooms and shovels.

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7 COMMUNICATIONS

Cellular telephones will be available to contact emergency services as required. Refer to Sections 10, 11, and 12 of this site-specific HASP addendum for emergency situations and appropriate actions. Site communication amongst employees shall be a combination of audio, equipment/air horns, and/or line of sight hand communications. **Cellular telephone use is not permitted while operating equipment.**

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8 MEDICAL SURVEILLANCE AND TRAINING

The medical surveillance and training requirements for Bhate's on-site employees working at DP-63 will follow the requirements outlined in the Basewide HASP Sections 5 and 7.4.

8.1 On-site Training Requirements

All personnel performing on-site work activities, wherein they may be exposed to hazards resulting from field activities, will have completed applicable training in compliance with 29 CFR Part 1910/29 CFR Part 1926 and Engineering Manual (EM) 385-1-1. Table 8-1 provides a summary of the minimum training requirements for site project personnel.

Table 8-1. Required Worker Training and Site-Specific Training

Required Worker Training	Site-Specific Training Requirements
√ 40-hour General Site Worker √ 8-hour Supervisor (as applicable) √ 8-hour Refresher (as applicable) No retraining requirements are anticipated during the project.	All personnel working on site shall attend site-specific orientation/training prior to starting on site project work. This training will be facilitated by the SSHO.

8.2 Additional Training Requirements

Additionally, at a minimum, two persons certified in First Aid and Cardiopulmonary Resuscitation (CPR) will be continuously present during site operations.

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9 HAZARDOUS CHEMICALS

Hazardous chemicals (as defined in 29 CFR Section 1910.1200) to be brought or used on-site are identified below. This chemical inventory and Material Safety Data Sheet (MSDSs) will be maintained by the SSHO.

Table 9-1. Sample Chemical Identification

Chemical Name	Amount	Location	Purpose
Assorted fuels, lubricants, coolants, etc. necessary for equipment operation	No storage planned. Quantities limited to immediate use requirements of on-site equipment.	No storage planned. Materials to be brought on-site by vendor's maintenance vehicle.	Equipment Servicing and Operation
Calibration gases for air monitoring equipment, if required for the particular instruments in use	One small aluminum cylinder of each required gas. (Each contains approximately 35 L of gas mixture)	Storage with monitoring equipment in trailer.	Calibration of air monitoring equipment

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10 EMERGENCY ACTION AND RESPONSE

Personnel responsible for coordinating emergency response actions during the DP-63 site remediation activities are identified below in Table 10-1. A map showing directions to the authorized medical facility is attached in Figure 12-1.

Table 10-1. Emergency Coordinator

Responsibility	Name	Phone Number(s)
Task Emergency Coordinator	Mr. John Hymer	Office (505) 679-2100 Cell (505) 491-9171

If an emergency situation develops which requires evacuation of the work area, the evacuation procedures in Table 10-2 shall be followed.

Table 10-2. Evacuation Procedures

Evacuation Step	Methods and Comments
Notify affected workers	Use of site communication methods as applicable
Evacuate to safe location	Assemble at the primary evacuation site (support area outside of the exclusion zone)
Assemble and account for workers	Emergency Coordinator shall account for personnel using site Sign in/Sign out sheet
Notify Fire and Emergency Services	Notification as needed
Complete incident report	Follow the Incident Reporting and Investigation Procedure

Table 10-3 summarizes potential emergency situations and response actions that are applicable for the DP-63 project site.

Table 10-3. Potential Emergency Situations

In Case Of	Response Actions
Injury or illness	Treat injury with applicable First Aid. All work related injuries beyond first aid will result in notification of Emergency Services and notification of the employee supervisor. Any employee requiring advanced medical treatment will be accompanied by a knowledgeable company employee that can answer potential questions on job duties and hazards. Make notifications in accordance with the Incident Reporting and Investigation Procedure.
Chemical exposure	First Aid shall be provided such as but not limited to: move victim to fresh air, remove contaminated clothing, flush affected skin with water, and seek medical attention.
Fire or explosion	Notify emergency services immediately. All personnel shall evacuate the immediate area of the fire and move to an upwind location. Personnel shall not engage in fire fighting activities use of fire extinguisher) unless trained to do so and only in the incipient stages of fire.
Adverse weather	Tornados, lightning or other threatening weather conditions will result in an immediate shut down of operations and evacuation of personnel. Lightning proximity will be determined by measuring the time interval between the visually observed lightning flash and the subsequent sound of thunder. An interval less than 30 seconds will prompt the shut down. Operations will be shut down for the period of the storm passing plus an additional 20 minutes.
Material spill or release	Vehicles and equipment will be maintained and inspected so as to prevent fluid leaks. Should any vehicle fluid leaks occur the equipment will be taken out of service to make necessary repairs and any contaminated material will be clean-up and disposed of properly. Spill kits will be available to facilitate prompt containment and clean-up of spills. Notification will be made in accordance with the Incident Reporting and Investigation Procedure. Storage areas will be designed to have secondary containment as required, work plans executed to accommodate stormwater runoff and minimize the potential for contamination spread.

11 EMERGENCY CONTACTS

In the event of an emergency, the following contacts should be made, as appropriate:

HAFB Emergency Number (using HAFB phone system).....9-911
Operators will assist with Medical, Fire, and Police emergencies

HAFB Security Force.....(505) 572-5037

HAFB Fire Protection.....(505) 572-1117

HAFB Hospital – 49th Medical Group (Main switchboard).....(505) 572-2778

Civilian Hospital (Alamogordo) Gerald Champion Regional Medical Center.....(505) 439-6100

After initial contacts have been made and the situation has stabilized, notify the Site Manager/SSHO, Senior Project Manager, and/or HSM, as appropriate.

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12 HOSPITAL DIRECTIONS

In the event of a true medical emergency ("life or limb"), HAFB Emergency Services should be used. Notification of any injury must be made to HAFB Emergency Services. Bhate personnel and subcontractors should not transport injured personnel to the HAFB Hospital without prior authorization from HAFB Emergency Services.

Other injuries should be treated as necessary at Gerald Champion Regional Medical Center at 2669 Scenic Drive, Alamogordo, NM 88330. From HAFB, exit the Main Gate and proceed east on US-70 onto US-54, continue north on US-54 to Indian Wells Road, turn right heading east to Scenic Drive, and turn left on Scenic proceed to the medical center. A map to this hospital is presented in Figure 12-1.

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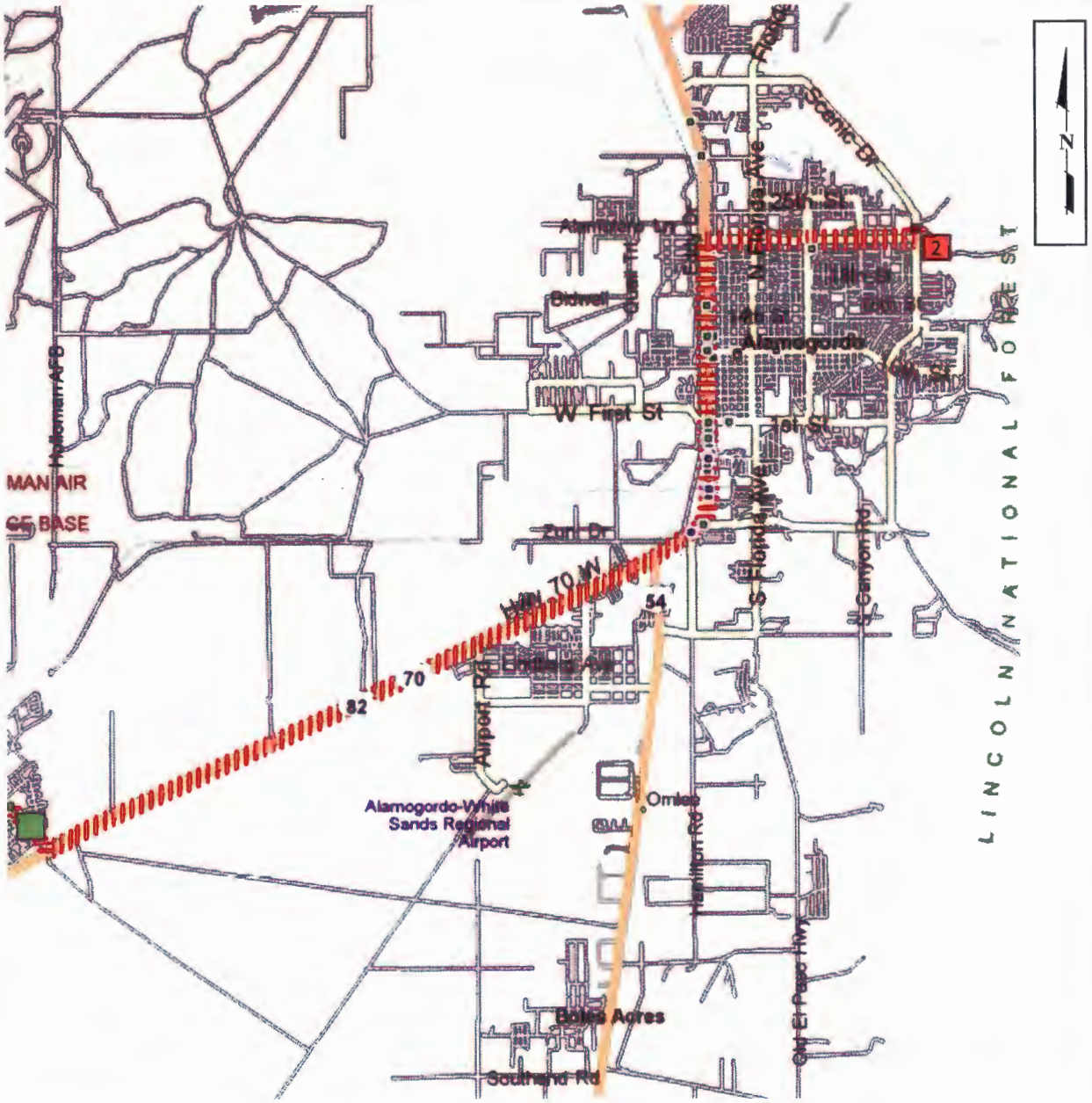
FIGURES

ATTACHMENT A

ACTIVITY HAZARD ANALYSES (AHAS)



bhate associates
ENGINEERING, SCIENCE AND CONSTRUCTION

Source: Microsoft Expedia Street Maps

HOSPITAL ROUTE MAP
Gerald Champion Regional Hospital

Not to Scale

Date
10/01/03

Holloman Air Force Base
Health and Safety Plan

Figure 12-1

ATTACHMENT A

ACTIVITY HAZARD ANALYSES (AHAS)

AHA No.	AHA Title
AHA - 1	General Site Activities/Mobilization and Demobilization
AHA - 2	Soil Boring and Monitoring Well Installation
AHA - 3	Soil Excavation and Loading
AHA - 4	Soils Placement and Land-farm Maintenance

Activity Hazard Analysis (AHA) – 1

Task: General Site Activities/Mobilization and Demobilization		**Project:** DP-63
Minimum Personal Protective Equipment (PPE): Level D PPE		**Location:** Holloman Air Force Base, New Mexico
Activity	**Potential Hazard(s)**	**Control Measures**
General site activities Mobilization and Demobilization Note: Each workday shall begin with a mandatory daily safety meeting for all on-site workers	Slips, trips, or falls on walking and working surfaces	• Maintain clean work areas by following good housekeeping procedures • Be alert for uneven terrain and steep slopes • Wear slip resistant footwear when walking/working on slippery surface • Keep work area free of dirt, grease, slippery materials, debris, and tools • Provide adequate lighting in all work areas • Flag or cover work areas to protect against falls
	Exposure to high noise from heavy equipment and power tools	• Hearing protection will be worn with a noise reduction rating capable of maintaining personal exposure below 85 dBA (ear muffs or plugs) • SSHO will determine the need for hearing protection (e.g. difficulty with voice communication at a distance of 3 feet or less) • All equipment will be equipped with manufacturer's required mufflers
	Eye injury	• Use approved safety glasses with rigid side shields.
	Overhead hazards	• Personnel will be required to wear hard hats that meet ANSI Standard Z89.1 in all construction areas, and areas with overhead hazards
	Dropped objects	• Steel toe boots meeting ANSI Standard Z41 will be worn in all construction areas
	Back injury from lifting heavy loads	• Site personnel will be instructed on proper lifting techniques • Mechanical devices should be used to reduce manual handling of materials • Team lifting should be utilized if mechanical devices are not available
	Thermal Stressors (i.e. heat stress, cold stress)	• Employees will have appropriate clothing for variable weather • Wear long sleeves and long pants, sunscreen with a high sun protection factor (SPF) on exposed skin • Employees will take breaks and drink plenty of fluids, as necessary, to prevent heat stress • Refer to the Basewide HASP for detailed information on heat and cold stress

AHA – 1 (continued)

Activity	Potential Hazard(s)	Control Measures
General site activities Mobilization and Demobilization (continued)	Spills/Fire	• Fuel cans will be National Fire Protection Association (NFPA) approved and used with pouring spout or funnel • Equipment shall be conducted in approved locations • Spill and absorbent materials will be readily available • Smoking and open flames are not permitted in fueling/greasing areas • All heavy equipment will be equipped with a ABC type fire extinguishers which will be inspected monthly and documented
	Vehicular traffic in work area and heavy equipment operation	• Maintain awareness of vehicle movement in work area • Exercise caution when approaching heavy equipment • Equipment will be equipped with functioning back-up alarms, signal lamps and alerting horns; operators are required to use seat belts
	Inclement weather (Thunderstorms and tornadoes)	• Halt activities immediately and take cover during thunderstorm or tornado warnings, shelter in a building if possible, and stay away from windows • If outdoors, crouch close to ground and limit body surface in contact with ground by staying on feet • Listen to radio or TV announcements for pending weather information • Do not try to outrun a tornado on foot or in a vehicle
	Extension cords	• Extension cords shall be inspected daily • Extension cords that have faulty plugs, damaged insulation, or are unsafe in any way shall be removed from service • Cords shall be protected from damage from sharp edges, projection, pinch points (doorways), and vehicular traffic • Cords shall be designed for heavy duty use

Equipment Used	Inspection Requirements	Training Requirements
Level D PPE First Aid Kits Portable Eyewash Fire Extinguishers Mobilization Equipment	Weekly inspections will be performed on fire extinguishers. Weekly inspections will be performed on first aid kits. Portable eye wash will be inspected weekly.	Personnel have read and understand the work plan and AHA Site specific briefing At least two individuals on-site will have current CPR and First aid training

Activity Hazard Analysis (AHA) – 2

Task: Soil boring and monitoring well installation		**Project:** DP-63
Minimum Personal Protective Equipment (PPE): Level D PPE		**Location:** Holloman Air Force Base, New Mexico
Activity	**Potential Hazard(s)**	**Control Measures**
Soil Boring and Sampling Hazards and recommended controls from AHA – 1 apply	Drill Rig Hazards Including but not limited to: Flying debris, falling objects, noise, hydraulic failures, unguarded machinery, equipment rollover, movement of large, heavy drilling tools, etc.	• Drill rig is to be operated and maintained by qualified operators • A Drill Rig Inspection Checklist should be completed daily to ensure that the rig is operating properly (the inspection will include fittings, cables, pins, connections, lubrication points, controls, emergency stops, etc.) • To the extent possible, the terrain should be level and the condition of the ground such that unexpected movement of the rig is unlikely • Stabilize the rig prior to boring • Wear required PPE (hard hat, safety glasses, work gloves, ear muffs or plugs, steel toe work boots), ensure loose clothing is secured • Maintain good housekeeping on and around drill rig
	Overhead/buried utilities	• Conduct a utility locate to identify the location of underground utilities in boring locations and complete any required dig permits • Overhead utilities should be considered live until determined otherwise • Maintain a minimum distance of 15 feet from overhead utilities • All underground utilities must be clearly marked before beginning work • No borings shall be made within a 4 foot "Buffer Zone" of any utility marking
	Exposure to soil contaminants	• To the extent feasible, limit contact with subsurface materials • Wear required PPE when conducting intrusive activities • SSHO shall conduct breathing zone monitoring for VOCs with a PID in accordance with requirements for site monitoring; SSHO may require an upgrade in PPE or modification to work based on monitoring results • Use appropriate decontamination methods

AHA – 2 (Continued)

Activity	Potential Hazards	Recommended Controls
Monitoring Well Installation	Pinch points	• Utilize appropriate PPE (leather gloves) when handling well casings and tools
	Dust	• Use care when installing well materials (sand, bentonite, Portland cement) into monitoring well to prevent dust generation; position body in an upwind location
Well Development / Groundwater depth measurement and sampling	Exposure to groundwater contaminants	• Position body upwind from monitoring well prior to opening cap • Wear appropriate PPE including chemical resistant gloves and Tyvek coveralls to minimize potential contact with groundwater, as appropriate • Conduct work activities in a manner that minimizes potential contact with groundwater • Collect all PPE and disposable sampling equipment and dispose of properly • Wash hands and face prior to eating, drinking, or smoking
Safety Equipment Used	**Inspection Requirements**	**Training Requirements**
Level D PPE First Aid Kit Fire Extinguisher	Informal daily work area inspections to be conducted by the SSHO	• Site personnel have read and understand the site-specific addendum to the HASP • Site personnel possess all of the required training as specified in the site-specific addendum to the HASP • Site personnel received site specific safety indoctrination • At least two individuals on-site will have current CPR and First aid training

Activity Hazard Analysis (AHA) – 3

Task: Soil Excavation and Loading		**Project:** DP-63
Minimum Personal Protective Equipment (PPE): Level D PPE		**Location:** Holloman Air Force Base, New Mexico
Activity	**Potential Hazard(s)**	**Control Measures**
Excavation Hazards and recommended controls from AHA – 1 apply	Overhead/buried utilities	• Completion of a HAFB Excavation Permit is required prior to the start of excavation activities • Overhead utilities should be considered live until determined otherwise • Maintain a minimum distance of 15 feet from overhead utilities • All underground utilities must be clearly marked before beginning work
	Heavy equipment operation	• Construction equipment operators shall have the experience, skills, and knowledge to safely operate the equipment to be used • Personnel in areas in which heavy equipment is being operated shall wear high visibility traffic safety vests and make eye contact with the operator before approaching • Access to the work area shall be coordinated with the Site Manager • Equipment (including trucks) shall be inspected and documented at the beginning of each shift • Maintain awareness of vehicle movement in work area • Exercise caution when approaching heavy equipment • Equipment will be equipped with functioning back-up alarms, signal lamps and alerting horns; operators are required to use seat belts • Signs, barricades, flagmen, and/or other traffic control devices will be used to control traffic in the work area • Buckets and attachments shall be placed on the ground if operator not at controls or if ground personnel approach
	Excavation Safety	• Ensure equipment is placed so as to not contribute to a cave-in situation • No personnel will be allowed to enter the excavation unless the excavation has been properly inspected, shoring and means of egress installed as necessary, all heavy equipment has been moved away from the affected edges, and any spoils have been removed from the edge • Do not place spoil piles closer than 2 feet from the edge of the excavation

AHA – 3 (continued)

Activity	Potential Hazard(s)	Control Measures
	Exposure to soil contaminants	• Utilize appropriate PPE and decontamination procedures • Conduct work activities in a manner that minimizes potential contact with excavated materials • Monitor air contaminant levels in employee breathing zone if conditions indicate possible exposure (e.g. excessive dust or odor); adjust work parameters or PPE if needed
Soils Loading Hazards and Controls associated with Excavation apply	Falling materials and flying debris striking personnel	• Loading equipment must have cab protection, functioning back-up alarms, signal lamps and alerting horns. Operators are required to use seat belts • Ground personnel are not permitted to approach equipment in motion or while materials being handled; maintain clear radius of machine • Operator must minimize the amount of materials spilled on the exterior of trucks during loading operations
	Dust	• Adequate dust suppression with water should be utilized to minimize visible dust emissions • If visible dust is prevalent, utilize personal dust monitor to evaluate
	Striking heavy equipment and operators	• Construction equipment operators shall have the experience, skills, and knowledge to safely operate the equipment to be used • Equipment will be operated with cab doors and windows closed
	Overloading capacity	• Load charts of all equipment will be reviewed and followed
Equipment Used	**Inspection Requirements**	**Training Requirements**
Level D PPE First Aid Kits Portable Eyewash Fire Extinguishers Heavy Equipment (Loader, Excavator, Haul Trucks)	Inspect PPE before and after each use First aid kits will be inspected weekly Portable eye wash will be inspected weekly Fire extinguishers will be inspected, maintained monthly and equipped with inspection tags Daily inspections will be performed Weekly inspections will be documented	• Training in PPE inspection, use, and maintenance is conducted as part of the initial hazardous waste 40-hour training. This training provides personnel with an understanding of the inspection, use (including donning, doffing, adjusting, and wearing), limitations, care, and maintenance of PPE • Personnel have read and understand the work plan and AHA • Site specific briefing • At least two individuals on-site will have current CPR and First aid training

Activity Hazard Analysis (AHA) – 4

Task: Soils Placement and Land-farm Maintenance		**Project:** DP-63
Minimum Personal Protective Equipment (PPE): Level D PPE		**Location:** Holloman Air Force Base, New Mexico
Activity	**Potential Hazard(s)**	**Control Measures**
Soil Placement and Land-farm Maintenance Hazards and recommended controls from AHA – 1 apply	Exposure to soil contaminants	• Utilize appropriate PPE and decontamination procedures • Conduct work activities in a manner that minimizes potential contact with excavated materials • Utilize placement method that minimizes haul truck traffic through contaminated material • Monitor for hazards, adjust work parameters or PPE if needed
	Heavy equipment operation	• Construction equipment operators shall have the experience, skills, and knowledge to safely operate the equipment to be used • Personnel in areas in which heavy equipment is being operated shall wear high visibility traffic safety vests and make eye contact with the operator before approaching • Access to the work area shall be coordinated with the Site Manager • Equipment (including trucks) shall be inspected and documented at the beginning of each shift • Maintain awareness of vehicle movement in work area • Exercise caution when approaching heavy equipment • Equipment will be equipped with functioning back-up alarms, signal lamps and alerting horns • Operators are required to use seat belts • Signs, barricades, flagmen, and/or other traffic control devices will be used to control traffic in the work area • Buckets and attachments shall be placed on the ground if operator not at controls or if ground personnel approach

AHA – 4 (Continued)

Equipment Used	Inspection Requirements	Training Requirements
Level D PPE First Aid Kits Portable Eyewash Fire Extinguishers Heavy Equipment (Loader, Excavator, Haul Trucks)	Inspect PPE before and after each use First aid kits will be inspected weekly Portable eye wash will be inspected weekly Fire extinguishers will be inspected, maintained monthly and equipped with inspection tags Daily inspections will be performed. Weekly inspections will be documented	Training in PPE inspection, use, and maintenance is conducted as part of the initial hazardous waste 40-hour training. This training provides personnel with an understanding of the inspection, use (including donning, doffing, adjusting, and wearing), limitations, care, and maintenance of PPE. Personnel have read and understand the work plan and AHA Site specific briefing At least two individuals on-site will have current CPR and First aid training

ATTACHMENT B

GENERAL WORK AND SAFETY RULES

ATTACHMENT B

GENERAL WORK AND SAFETY RULES

All site personnel will adhere to the following general safety rules. These precautionary measures are designed to reduce the risks of inadvertent or accidental injury or chemical exposure during onsite operations.

1. All site personnel must attend each day's Daily Safety Briefing.
2. Be familiar with standard operating procedures and adhere to all instructions and requirements in the Corporate Health and Safety Plan or site-specific addendum to the HASP.
3. Any individual taking prescribed drugs shall inform the SSHO of the type of medication. The SSHO will review the matter with the HSM, as necessary, who will decide if the employee can safely work onsite while taking the medication.
4. Medicine and alcohol can exacerbate the effects from exposure to toxic chemicals. While field operations are in effect, alcoholic beverage intake should be minimized or avoided during off-work hours. Personnel performing onsite operations should not take prescribed drugs where the potential for absorption, inhalation, or ingestion of toxic substances exists unless specifically approved by a qualified physician. Do not work when ill.
5. The personal protective equipment specified by the Corporate Health and Safety Plan or site-specific addendum to the HASP shall be worn by all site personnel. This includes hard hats and safety glasses which must be worn at all times in active work areas.
6. Facial hair (beards, long sideburns, or mustaches) which may interfere with a satisfactory fit of a respirator mask is not allowed on any person who may be required to wear a respirator.
7. Eating, drinking, chewing tobacco or gum, smoking, and any other practice that may increase the possibility of hand-to-mouth contact is prohibited in the work area. (Exceptions may be permitted by the SSHO to allow fluid intake during heat stress conditions.)
8. All lighters, matches, cigarettes, and other forms of tobacco are prohibited in the work area.
9. All signs and demarcations shall be followed. Such signs and demarcations shall not be removed except as authorized by the SSHO.
10. No one shall enter a permit-required confined space without a permit. Confined space entry permits shall be implemented as issued.
11. All personnel must follow Hot Work Permits as issued.
12. All personnel must follow the work-rest regimens and other practices required by the heat stress program.
13. Rest breaks shall be taken in approved locations.
14. All personnel must follow lockout/tagout procedures when working on equipment involving moving parts or hazardous energy sources.
15. No person shall operate equipment unless trained and authorized.

16. No one may enter an excavation greater than 4 feet deep unless authorized by the Competent Person. Excavations must be sloped or shored properly. Safe means of access and egress from excavations must be maintained.
17. Ladders and scaffolds shall be solidly constructed, in good working condition, and inspected prior to use. No one may use defective ladders or scaffolds.
18. Fall protection or fall arrest systems must be in place when working at elevations greater than 6 feet for temporary working surfaces and 4 feet for fixed platforms.
19. Safety belts, harnesses, and lanyards must be selected by the Site Manager. The user must inspect the equipment prior to use. No defective personal fall protection equipment shall be used. Personal fall protection that has been shock loaded must be discarded.
20. Hand and portable power tools must be inspected prior to use. Defective tools and equipment shall not be used.
21. Ground fault interrupters shall be used for cord and plug equipment used outdoors or in damp locations. Electrical cords shall be kept out of walkways and puddles unless protected and rated for the service.
22. Improper use, mishandling, or tampering with health and safety equipment and samples is prohibited.
23. Horseplay of any kind is prohibited.
24. Possession or use of alcoholic beverages, controlled substances or firearms on any site is forbidden.
25. All incidents, no matter how minor must be reported immediately to the Site Manager.
26. All personnel shall be familiar with the Site Emergency Response Plan.

The above health and safety rules are not all inclusive and it is your responsibility to comply with all regulations set forth by OSHA, the Bhate Corporate Health and Safety Plan, site-specific addendum to the HASP, or our Clients.