HAFB 06

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January 3, 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, SWMU 8 Soil Remediation, Holloman Air Force Base, New Mexico

Dear Mr. Kieling:

Bhate Environmental Associates, Inc. (Bhate) is pleased to submit the above referenced document for your review and comment.

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
SWMU 8 SOIL REMEDIATION
HOLLOMAN AFB, 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-D-0023
Task Order No. 017

December 2005

Prepared by:

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

Bhate Project No. 9050291.01.01

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VOLUNTARY CORRECTIVE MEASURES WORK PLAN
SWMU 8 SOIL REMEDIATION
HOLLOMAN AFB, NEW MEXICO

REVIEW SHEET

This Work Plan has been reviewed and approved by:

John Hymer Site Manager	Signature	Date
Jim Moore, P.G. Project Manager	Signature	Date
Frank Gardner, P.G. Program Manager	Signature	Date

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VOLUNTARY CORRECTIVE MEASURES WORK PLAN
SWMU 8 SOIL REMEDIATION
HOLLOMAN AFB, NEW MEXICO

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ACRONYMS AND ABBREVIATIONS

AAF	Army Air Field
AFB	Air Force Base
AFCESA	Air Force Civil Engineer Support Agency
AF Fm	Air Force Form
amsl	Above mean sea level
ANSI	American National Standards Institute
AOC	Area of Concern
ASTM	American Society for Testing and Materials
bgs	Below ground surface
Bhate	Bhate Environmental Associates, Inc.
BTEX	Benzene, toluene, ethylbenzene, and xylenes
CDW	Construction-Derived Waste
CES/CEV	Civil Engineering Squadron/Combat Engineer Vehicle
CIH	Certified Industrial Hygienist
COC	Chain-of-custody
CRZ	Contamination Reduction Zone
cu yds	Cubic yards
DRO	Diesel range organics
DQO	Data quality objective
ERPIMS	Environmental Restoration Program Information Management System
EZ	Exclusion Zone
°F	Degrees Fahrenheit
FID	Flame ionization detector
ft	Feet
GC	Gas chromatogram
GRO	Gasoline range organics
HAFB	Holloman Air Force Base
HASP	Health and Safety Plan
hrs	Hours
IRP	Installation Restoration Program
ln ft	Linear feet
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
mL	Milliliter
MS	Matrix spike
MSD	Matrix spike duplicate
NAVFAC	Naval Facilities Engineering Command
NFA	No further action
NMED	New Mexico Environment Department
NMWQCC	New Mexico Water Quality Control Commission
ORO	Oil range organics
OSHA	Occupational Safety and Health Administration
OVA	Organic vapor analyzer

OWS	Oil/Water Separator
PAH	Polynuclear aromatic hydrocarbons
PCS	Petroleum-contaminated soils
P.G.	Professional Geologist
PID	Photo ionization detector
POL	Petroleum, Oil, and Lubricants
PPE	Personal protective equipment
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
SSHO	Site Safety and Health Officer
SSL	Soil Screening Level
SOP	Standard Operating Procedure
SVOC	Semi-volatile organic compounds
SWMU	Solid Waste Management Unit
SWPPP	Storm Water Pollution Prevention Plan
SZ	Support Zone
TAL	Target Analyte List
TCLP	Toxicity Characteristic Leaching Procedure
TSD	Treatment, storage, and disposal
TDS	Total dissolved solids
TPH	Total petroleum hydrocarbons
TRPH	Total recoverable petroleum hydrocarbons
UFGS	Unified Facilities Guide Specifications
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
UVF	Ultra violet flourometer
VCMs	Voluntary Corrective Measures
VOC	Volatile organic compounds
WOT	Waste Oil Tank
WRCC	Western Regional Climate Center
WSMR	White Sands Missile Range
WWTF	Waste water treatment facility

1 INTRODUCTION

Bhate Environmental Associates, Inc., (Bhate) has been retained by the U.S. Army Corps of Engineers (USACE), under contract DACA45-03-D-0023, Task Order No. 017, to conduct Voluntary Corrective Measures (VCMs) at several of the Solid Waste Management Units (SWMUs) at Holloman Air Force Base (HAFB), New Mexico. This document is to provide a work plan that will serve as the primary working document for the excavation activities of the petroleum-contaminated soils (PCS) located at SWMU 8 (former Oil/Water Separator) on the south side of Building 231. This plan provides the relevant site specific information and requirements as outlined in the respective Scope of Work for remedial activities at SWMU 8 Soil Remediation. The primary objective of this VCM is to remove, through excavation, and properly dispose the PCS under the covered walkway located between Buildings 231 and 232. Groundwater and soil conditions under Buildings 231 and 232 will be evaluated under a separate Work Plan Addendum. 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 approval for site closure from NMED.

The document has been written to provide relevant information on the geologic, hydrologic, and other environmental conditions for HAFB and at the site and the procedures by which the VCM will be completed. Information is provided for the entire Base and its surrounding environ as well as SWMU 8, specifically. This VCM calls for the removal of all PCS at the site through excavation with verification of complete removal via confirmation sampling from the excavation.

1.1 Base and Site Description

1.1.1 HAFB

HAFB is located in southeastern New Mexico in Otero County, New Mexico, approximately 100 miles north-northeast of El Paso, Texas, and 6 miles west of Alamogordo, New Mexico (Figure 1). The following Base information has been taken from: the *Characterization Summary and No Further Action (NFA) Documentation for Installation Restoration Program (IRP) Sites SS-2/5 POL* [Petroleum, Oil, and Lubricants] *Yard (AOC* [Area of Concern] *T), SD-47 POL Washrack Area (SWMU 133), and SS-60 Building 828 (SWMU 230)* by Foster Wheeler (March, 1998) and the *2001 Long-Term Groundwater Monitoring Report, Holloman Air Force Base, New Mexico,* by Foster Wheeler (July 2002). Although neither document pertains directly to the SWMU 8 Soil Remediation site, they do contain descriptive information regarding the Base and general area.

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.

1.1.2 SWMU 8 Site

SWMU 8 is the former underground Oil/Water Separator (OWS) that was located on the south side of Building 231. Building 231 (Auto Hobby Center) is located on the main base at Holloman at 642 West Connecticut Avenue (Figure 2). The OWS was abandoned and filled with sand (Ebasco Services, Inc., 1995). The OWS was 4 feet wide, 8 feet long and 4 feet deep and was located east of the covered walkway which connects Buildings 231 and 232. Two previous remedial action soil excavations conducted by Ebasco Services (1995) and Foster Wheeler (1997) have removed 80-90 percent of the PCS and the abandoned OWS. Viewing from the southwest, photograph 1, shows the covered walkway and the approximate area where the remaining PCS is located. The locations of the two previous soil excavations are located behind the covered walkway where the shed is located.

Photograph 1. Southwest view of SWMU 8 PCS/Excavation Area

Records indicate that the OWS accepted wash water from a heavy equipment wash rack located adjacent to the unit. Over a period of years the OWS released wash water rinsate containing oils, detergents and fuels into the surrounding soil. The initial removal and investigation/characterization activities began in August 1995 when the abandoned OWS and 21 cubic yards (cu yds) (28 tons) of PCS were removed (Ebasco Services, Inc., 1995). Figure 3 shows the location of the former OWS, and the limits of this excavation.

It was then discovered that contaminated soil extended beyond what had been anticipated for the first phase of remediation. After removal, contamination was identified in the five native

subsurface soil samples collected from the excavation corners and one from the center of the excavation. These soil samples were analyzed for total recoverable petroleum hydrocarbons (TRPH), volatile organic compounds (VOC), semi-volatile organic compounds (SVOC), and Target Analyte List (TAL) metals. Field activities were postponed in order to determine the most efficient method of closure. The initial excavation was backfilled with clean soil compacted to grade. Subsequently, NMED approved leaving intact TRPH-contaminated soil that extended under in-place structures as long as it posed no risk. Due to this agreement, excavation was determined to be the best closure method (Ebasco, 1995).

Excavation activities were continued in April 1997, and the original excavation was extended eastward from the eastern edge of the original excavation (Figure 4). An additional 31.8 cu yds (43 tons) of TRPH-contaminated soil were excavated during the second phase of remediation. Four representative samples of in-place soil were taken from the walls of the new excavation and analyzed for TRPH, VOCs, SVOCs, benzene, toluene, ethylbenzene, and xylenes (BTEX), and metals. The second-phase analytical results, which represent in-place soil conditions upon completion of excavation activities, did not exceed the current NMED Total Petroleum Hydrocarbon (TPH) Screening Guidelines (NMED, November, 2005). The second excavation was backfilled with clean soil (Foster Wheeler, 1997).

1.2 Physiography

1.2.1 Tularosa Basin

HAFB is located within the Sacramento Mountains Physiographic Province on the western edge of the Sacramento Mountains. 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. HAFB is located in the Tularosa Sub-basin which is part of the Central Closed Basins. The San Andreas 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.

1.2.2 HAFB and SWMU 8 Site

HAFB is approximately 59,600 acres in area, and is located at a mean elevation of 4,093 feet above mean sea level (ft amsl). The site's ground surface is relatively flat and covered with gravel, concrete sidewalks, and asphalt parking lots (Figure 3). The covered walkway which connects Buildings 231 and 232 extends over the remaining area of PCS.

1.3 Surface Water

1.3.1 Tularosa Basin

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 as evidenced by the ancient Lake Otero which encompassed a much larger area of possibly upwards of several hundred square miles. Its remains are the Alkali Flat (the exposed lake bed of Lake Otero) and Lake Lucero. Lake Lucero is a temporary feature of merely a few inches in depth during the rainy season as the dry lake bed occasionally partially fills with water.

The 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).

1.3.2 HAFB and SWMU 8 Site

Within the boundaries of the SWMU 8 Soil Remediation site, the run-off is controlled by the minimal topographic relief as per the existing grade and landscaping with surface drainage towards the adjacent asphalt parking area. Appurtenances can be found placed along the perimeter of the parking area to the southwest for collection into the Base storm water drainage system. Within the walled area of the site, open non-concrete (gravel) areas will allow for precipitation to percolate downward and/or evaporate.

1.4 Groundwater

1.4.1 Tularosa Basin

Groundwater occurs under unconfined conditions in the unconsolidated deposits beneath Holloman AFB. The primary source of recharge for groundwater in the aquifer is percolation of rainfall and stream runoff through the coarse, unconsolidated alluvial fan deposits along the western flank of the Sacramento Mountains. Groundwater percolates downward into the alluvial sediments at the edge of the shallow aquifer and migrates down-gradient through progressively finer-grained sediments into the basin.

1.4.2 HAFB and SWMU 8 Site

Beneath HAFB, groundwater ranges from 5 to 50 ft. Groundwater flow 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. Depth to groundwater at the Building 231 former OWS location is approximately 10 feet below ground surface (ft bgs)

based on observations during the previous remedial actions and flows to the southwest.

Previous analyses indicate total dissolved solids (TDS) of greater than 10,000 milligrams per liter (mg/L) in groundwater beneath HAFB. This exceeds the New Mexico Water Quality Control Commission (NMWQCC) limit as potable water and thus, the groundwater beneath HAFB has been designated as unfit for human consumption. Likewise, United States Environmental Protection Association (USEPA) guidelines have identified the groundwater as a Class IIIB water source, characterized by TDS concentrations exceeding 10,000 mg/L.

1.5 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 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. 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.

1.6 Geology

1.6.1 Tularosa Basin

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 by 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 Andreas mountain ranges). In the millions of years following, rainfall, snowmelt, and wind eroded the mountain sediments depositing the alluvium in the basin (i.e. Tularosa Sub-basin). Water carrying eroded gypsum and alluvium continues to flow into the basin with no route of exit.

The Tularosa Sub-basin is geologically described as a bolson, which is an extensive flat alluvium-floored depression, into which drainage from the surrounding mountains flows toward a central playa. The overlying alluvium generally consists of unconsolidated gravels (limestone, dolomite, and gypsum), sands, and clays. A fining sequence from the San Andreas and Sacramento 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 silty clay containing gypsum and are contiguous with the alluvial fan and eolian deposits.

Mesozoic rocks in the northwest mark the Colorado Plateau, topped by younger Tertiary strata. Quaternary age sediments have washed off the Southern Rockies into the open basins and the Rio Grande Rift, a failed spreading center or aulacogen. This would-be ocean basin runs up the center of the state with the Rio Grande flowing down its middle, exposing the Paleozoic and Precambrian rocks on its uplifted flanks. Later Cenozoic volcanic intrusions of Quaternary and Tertiary age are also associated with the rifting.

The great Permian Basin of Texas continues into the state from the southeast with younger Quaternary-Tertiary sediments of the Great Plains cover the whole eastern edge. Basin-and-range terrain of Tertiary sediments and volcanics appear in the extreme southwest coupled with wide dry basins choked with Quaternary coarse sediments eroded from the blocks of uplifted older rocks.

1.6.2 HAFB and SWMU 8 Site

The lacustrine deposits are observed throughout HAFB. There has been the identification of stiff caliche layers, varying in thickness, as well at different areas of HAFB. At the site, soils are predominantly silty sands and interbedded clays.

In general, subsurface soils at the site consist of slightly moist clayey silts with varying amounts of medium to fine sand and caliche to depths ranging from 4 to 5 ft bgs. These soils display low to no plasticity and weak cementation of the caliche fraction. Generally, soils beneath 5 ft are characterized as silty medium to fine sands and sandy silts with occasional layers demonstrating higher percentages of clay content. Soils tend to be moist to saturated below the water table.

2 HISTORICAL DATA REVIEW

2.1 Phase I Oil Water Separator Remedial Action

In August 1995, Ebasco removed the abandoned OWS, excavated 21 cu yds of PCS and initiated characterization of the surrounding subsurface soil. As part of the first phase of the project, five native soil closure samples were collected inside the excavation and submitted to an offsite laboratory for analysis (Appendix A1). Four samples were collected from the excavation corners (SWMU-8-01-7 through SWMU-8-04-7), and one from the center of the excavation (SWMU-8-05-7) at a depth of 7 ft bgs (Ebasco, 1995). The sample locations are shown on Figure 3.

The five closure samples were analyzed for TRPH, VOCs, SVOCs, and TAL metals. TRPH concentrations of 23,000 milligrams per kilogram (mg/kg), 31,000 mg/kg, 6,500 mg/kg, 1,200 mg/kg, and 940 mg/kg were present in samples SWMU-8-01-7, SWMU-8-02-7, SWMU-8-03-7, SWMU-8-04-7, and SWMU-8-05-7, respectively. Several VOC analytes by USEPA Method 8240 were detected in samples SWMU-8-01-7 and SWMU-8-02-7. No VOC analytes were detected above the laboratory quantitation limits in samples SWMU-8-03-7 through SWMU-8-05-7. In the SVOC samples, naphthalene concentrations were present in SWMU-8-01-7 and SWMU-8-05-7. In addition, 2-methylnaphthalene concentrations were present in samples SWMU-8-01-7 through SWMU-8-03-7. None of the other SVOC analytes in USEPA Method 8270 were detected above laboratory quantitation limits in any of the samples. USEPA 6000/7000 Series TAL metals analytical results indicated various metals in all five samples (Ebasco, 1995). With the exception of TRPH, all of the detected petroleum-related compounds were below the current NMED TPH Screening Guidelines (NMED, November, 2005) and all metals were below the NMED Soil Screening Levels (NMED, August, 2004).

2.2 Phase II Petroleum Contaminated Soil Remedial Action

In April 1997, Foster Wheeler extended the original excavation eastward from the eastern edge of the previous excavation and removed an additional 31.8 cu yds of PCS. During the second phase of the project, four soil samples (SWMU08-01-06 through SWMU08-04-06) were taken from the walls of the second excavation (approximately 6 ft bgs) and submitted to an offsite laboratory for analysis (Appendix A2). These samples were analyzed for TRPH, VOCs, SVOCs, BTEX, and metals. The sample locations are illustrated on Figure 4.

TRPH concentrations of 78 mg/kg, <20 mg/kg, 58 mg/kg, and 25 mg/kg were present in samples SWMU08-01-06, SWMU08-02-06, SWMU08-03-06, and SWMU08-04-06, respectively. VOCs (by USEPA Method 8240), SVOCs (USEPA Method 8270B), and BTEX (USEPA Method 8021A) were not detected above laboratory quantitation limits in any of the samples. The analytical results, which represent in-place soil conditions upon completion of the second excavation, did not exceed the current NMED TPH Screening Guidelines (NMED, November, 2005) and all metals were below the NMED Soil Screening Levels (NMED, August, 2004).

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3 EXCAVATION PROCEDURES

The objective of the soil remediation at SWMU 8 is to excavate, transport, and dispose the remaining PCS located on the southwestern side of the initial excavation (under the covered walkway that connects Buildings 231 and 232). Subsurface soils either contaminated by TPH at levels exceeding 880 mg/kg or soils posing a risk due to exposures to volatile organic compounds (VOCs), and/or semi-volatile organic compounds (SVOCs) as established by the NMED soil screening guidance will be removed. Contaminated soils will be removed to approximately one foot below the site's encountered groundwater table. This depth will ensure complete removal of PCS and account for any potential smear zone. Horizontally, the excavation will be completed based upon TPH levels of greater than 880 mg/kg as determined by soil samples collected subsequent to the excavation and analyzed at a fixed-base laboratory.

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. For the planned activities, inclusive of the temporary clean soil stock piles, the total area of disturbance and/or excavation is less than one acre. Therefore, a project SWPPP will not be prepared and submitted.

At this time, excavation is proposed to be bordered to the northwest by Building 231 and to the southeast by Building 232 and will extend approximately 15 ft to the southwest of the covered walkway wall (Figure 5). Soil and groundwater conditions under Buildings 231 and 232 will be evaluated under a separate Work Plan Addendum. Except where noted below, the excavation activities will be conducted in accordance with the procedures outlined in Unified Facilities Guide Specifications (UFGS) Section 02111 *Excavation and Handling of Contaminated Material* (Appendix B). 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.

3.1 Pre-Excavation Activities

Before excavation and other site activities can begin, there are several pre-construction documents and approval requirements to be met, including: Form 332 approval, dig permit with utility clearances, 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.

Prior to initiating excavation activities, a subsurface soil sample will be collected (3 -7 ft bgs) immediately southwest of the former OWS. The soil sample will be analyzed by the toxicity characteristic leaching procedure (TCLP) for VOCs, SVOCs, and metals to characterize the contaminated soil prior to treatment at the FT-31 landfarm.

3.1.1 AF Form 332

Prior to initiating excavation activities a completed and approved Air Force Form (AF Fm) 332, will be obtained (a blank AF Fm 232 is included as Appendix C), authorizes construction work at HAFB and is required for the initiation of any construction work. This work order describes what activities will 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 Base utility group for approval to begin work at the excavation site. Prior to the submittal of AF Fm 332, the area of excavation was clearly delineated 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 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.

3.1.3 Excavation Area Site Safety

As an Occupational Safety and Health Administration (OSHA) Class II excavation, site safety is concerned with the excavation and the areas around the excavation. Concerns include: the proper designation and demarcation of excavation boundaries (i.e. exclusion zone [EZ], contamination reduction zone [CRZ], and support zone [SZ]), compliance with excavation requirements, posting of potential hazards, and control of un-authorized site personnel. This is discussed in the 2003 *Basewide Health and Safety Plan* (HASP) (Bhate, December 2003). Because the excavation occurs in a high pedestrian traffic area, site control will be paramount to the safety at the site. Notification of the excavation activities, duration, and alternate routes for pedestrian traffic will have been provided to the appropriate personnel in Buildings 231 and 232 prior to the initiation of any field activities.

At a minimum, the site will be secured with caution tape surrounding the perimeter of the site 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 persons. A CRZ and/or EZ will be established as guided by the HASP and prevailing site conditions. The depth to the bottom of the excavation is expected to reach 10 to 12 ft below grade. At the immediate edge of the excavation, a temporary construction fence will be erected completely around the excavation site. Postings will indicate the excavation hazard as well.

3.2 Decontamination Procedures

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

3.3 Excavation Activities

3.3.1 Excavation Boundary

The approximate limit of the area to be excavated during activities outlined under this VCM Work Plan is shown on Figure 5 as the dashed line. Based upon the estimated horizontal extent of contamination, an estimated 25 cu yds of overburden will be required to be removed. This material will be temporarily stockpiled on site in an area to be determined.

Prior to the excavation of overburden, the covered walkway and sidewalk will be removed. All construction debris will be disposed of at the Base re-use area for processing.

3.3.2 Excavation Shoring

During the excavation activities, personnel will not enter the excavation at any time. Shoring may need to be erected ensuring that the excavation sidewalls do not collapse. The determination will be made as the excavation progresses. If any slumping or sidewall failure is evident, then shoring will be implemented.

Excavation activities associated with previous investigations indicates native soils to demonstrate significant stability achieving near vertical walls during excavations. The soils, except for the backfill from the two previous excavations, are native as determined from the previous remedial actions. The soils associated with the former OWS have not been characterized; their geotechnical properties for stability are unknown. At this time, shoring of the excavation is not intended.

3.3.3 Soil Excavation

Excavation activities will utilize the appropriate excavation equipment and a wheel loader to assist with soil management. All overburden soils determined to be clean will be removed prior to the removal of the contaminated soils. The clean overburden soils will be temporarily stockpiled for subsequent backfilling. Soil stockpiles will be managed as to not allow for any material to be removed or transported off-site via wind or precipitation (Section 6, *Waste Management*).

The contaminated subsurface smear zone is estimated to begin at five to seven feet above the groundwater table. Applicable HAFB Standard Operating Procedures (SOPs) for completing this excavation are located in Appendix A of the *Basewide Quality Assurance Project Plan*,

(Bhate, November 2003). All contaminated soils will be live loaded and directly transported to the FT-31 Base landfarm or previously approved offsite disposal facility.

3.3.3.1 Soil Screening

Throughout the excavation, observation of discoloration and unusual odors will be documented. Potential PCSs will be field screened for petroleum hydrocarbon contamination using the UVF-3100A flourometer in accordance with the *EPA Field Measurement Technologies for Total Petroleum Hydrocarbons in Soil* guideline (Appendix D). 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 regulatory limit for PCS and will be managed in accordance with Section 6, *Waste Management,* of this work plan. Soils demonstrating a concentration below 880 mg/kg will be stockpiled for backfill once the excavation is complete. The excavation sampling quantities and analysis is summarized in Table 3-1.

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 4, *Soil Sampling and Analysis,* of this work plan.

3.3.3.2 Soil Segregation

The 880 mg/kg action level for PCS is found listed in Table 2b of the NMED Residential Direct Exposure Limit for diesel #2/crankcase oil in the TPH Screening Guidelines, November, 2005 (Appendix E). 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 #2/crankcase oil 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 a surface release. These soils are from the surface to an approximate depth of 4 ft bgs, totaling approximately 25 cu yds. **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. They will be found in the depth range from 3 to 5 ft bgs with an approximate volume of 50 cu yds. The **contaminated soils** are those that are definitively contaminated as validated by laboratory analytical data. These soils are typically the lower 3 ft just above the water table, in a depth range from 5 to 8 ft bgs, totaling approximately 75 cu yds. Due to the small size of this site, suspected contaminated soils will be handled as though they are contaminated and live loaded and directly transported to the FT-31 Landfarm for treatment or to a previously approved offsite treatment facility.

3.3.3.3 Confirmation Soil Sampling

After the excavation is complete, and all 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.

3.3.4 Excavation Backfilling and Compaction

Clean soils will be obtained for backfill as needed from a local sand/gravel provider. Below 4-ft bgs, the backfill will be placed in 24-inch lifts and compacted using a hydraulic plate compactor (Appendix F) to at least 18 inches. For depths from 4-ft bgs to 1-ft bgs, the excavation will be backfilled in 9-inch lifts with compaction to at least 6 inches. The compaction of the final two base lifts will be confirmed by determination of the soil density via an in-place nuclear densiometer, or similar per American Society for Testing and Materials (ASTM) Method D 2922 (Appendix G). The final 12-inches of backfill will adhere to the specifications of Subgrade Preparation found in UFGS Section 02770A *Concrete Sidewalks and Curbs and Gutters* (Appendix H) and discussed in Section 3.3.6.1, *Sidewalk Reconstruction* of this work plan.

3.3.5 Soil Disposal

Contaminated soils exceeding 880 mg/kg of TPH will be either transported to the permitted FT-31 Landfarm for treatment/processing, or transported to an off-site treatment, storage, and disposal (TSD) facility. Prior to the mobilization of the excavation effort, if the permitted base landfarm is at operational capacity, disposal of the soils will be to a previously approved off-site facility. Soils will be handled, transported, and managed in accordance with the NMED guidelines and respective facility's requirements.

3.3.6 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.

3.3.6.1 Sidewalk Reconstruction

The section(s) of walk way which have been removed or damaged during the excavation will be replaced in similar construction and match in appearance to that which was removed. The design and construction, inclusive of materials, will be completed in accordance with the UFGS specifications for concrete sidewalks and gutters, Section 02770A *Concrete Sidewalks and Curbs and Gutters*, March 2004 (Appendix H). Matching of the new sidewalk to the existing sidewalk has primacy over the UFGS guideline. The guideline should be adhered to utilizing best management practices and holding to the intent of the guideline. The guideline shall be implemented in its entirety except for the following Parts and/or subparts:

Sections 1.1 through 1.3
Section 1.6.2
Sections 2.2.2 and 2.2.3
Sections 3.7.1.1 and 3.7.1.3

Sections 2.1.3-Reinforcement Steel; 3.5.3-Reinforcement Steel Placement; and 3.7.4-Protective Coating are only applicable if the existing sidewalk is constructed in a similar manner.

4 SOIL SAMPLING AND ANALYSIS

The project soil sampling requirements, detailed in Table 3-1, include field screening samples, stock pile samples, and confirmation samples. Table 4-1 provides the sample collection information inclusive of the container type, quantity, and holding times.

4.1 Field Screening Sampling

Soils will be periodically field screened utilizing soil-headspace screening techniques via the field organic vapor analyzer (OVA). Confirmatory field TPH analysis of the OVA headspace samples will be performed with the field fluorometer in accordance with the USEPA *Innovative Technology Report: Field Measurement Technologies for Total Petroleum Hydrocarbons in Soil – siteLAB® Analytical Test Kit UVF-3100A*, September 2001 guideline (Appendix D). From these samples, final QA confirmation analysis in accordance with the NMED specified gas chromatogram (GC) Methods will be accomplished via a fixed-base laboratory.

4.1.1 Initial Field Screening

The HAFB Base excavation guideline for PCS requires initial field screening via headspace analysis every 100 cu yds. Due to the relatively small area being excavated, this sampling scheme would allow for only 2 field screening samples and a single field confirmatory sample. To improve the accuracy of the screening of the excavated soils, the field screening frequency will increase to one sample per 25 cu yds removed for a total of 6 samples to be screened via the OVA.

4.1.2 Field Confirmatory Screening

A field confirmatory frequency of 50% with the ultra-violet fluorometer (UVF) will be implemented instead of the normal 10% per the USACE and USEPA (SW846) guidelines for QA/QC requirements of site investigations for contamination. The adjusted resulting quantity is a total of 3 of the 6 samples to be field checked with the UVF. Confirmatory TPH analysis is by the SiteLAB® Analytical Test Kit UVF-3100A. This test uses a 10 gram sample of soil, where the petroleum compounds are extracted with methanol. The extract is decanted into a quartz cuvette and placed in the chamber of the fluorometer. The TPH concentration is displayed as parts per million, which is equivalent to mg/kg. 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 EPA Method analyses.

4.1.3 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-gasoline range organics (TPH-GRO) [C_6-C_{10}], TPH-DRO [C_{10}-C_{22}], and TPH-oil-range organics (TPH-ORO) [C_{22}-C_{36}]. Laboratory validation will also be performed for VOCs (USEPA Method

8260B) and SVOCs (USEPA Method 8270C). Laboratory analyses will be completed at an expedited turn-around-time of 24 hours.

4.2 Excavation Confirmation Sampling

Excavation confirmation samples will be collected at the frequency of one per 20 linear ft 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, -DRO and –GRO, using USEPA Method 8015B, VOCs (USEPA Method 8260B), SVOCs (USEPA Method 8270C). 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. Data will adhere to project data quality objectives (DQO) requirements, method reporting limits, duplicate field samples, and QC samples as established within the *Basewide Quality Assurance Project Plan* (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.

4.2.1 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 8015B, VOCs (USEPA Method 8260B), and SVOCs (USEPA Method 8270C).

4.2.2 Analytical Methods

Each laboratory soil sample (including the field duplicates) will be analyzed for their respective analytes in accordance with Table 4-2. Samples will be analyzed for BTEX, as VOCs, by Method 8260B, polynuclear aromatic hydrocarbons (PAHs), as SVOCs, by Method 8270C, and TPHs by Method 8015B.

Laboratory analyzed samples will be completed by Accutest Laboratories in Orlando, Florida. A copy of their USACE validation is included in Appendix I.

5 RISK BASED CLEAN-UP APPROACH

The objective of the excavation activities presented is to remove the remaining PCS from the SWMU 8 site to support closure of the site. Data collected as a result of field screening will be evaluated based upon the DQO's for the project. The results from the offsite 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 due to exposure at the site. Soil and groundwater conditions under Buildings 231 and 232 will be evaluated under a separate Work Plan Addendum. 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.

5.1 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 offsite analytical laboratory. As discussed in Section 4 of this report, *Soil Sampling and Analysis*, the 880 mg/kg action level for PCS is found as the Residential Direct Exposure Limit for diesel #2/crankcase oil, listed in Table 2b, of the NMED TPH Screening Guidelines, November, 2005 (Appendix E).

5.2 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 the revised NMED guidance document *Technical Background Document for Development of Soil Screening Levels, Revision 2.0*, August 2004 (NMED, 2004). Tables containing the soil screening levels (SSLs) from this guidance document are provided in Appendix J. Laboratory data for each collected soil sample will be compared to these SSLs.

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6 WASTE MANAGEMENT

Construction-Derived Waste (CDW) generated by the activities of this excavation include excavated soil, decontamination residuals, and personal protective equipment (PPE) (Table 6-1). Each waste stream will be managed and characterized according to the following guidelines. Waste containers and the decontamination pad will be managed in a secure area.

6.1 Excavated Soil

6.1.1 Clean Soils – Stockpiles

The clean soil stockpiles will be constructed in accordance with best management practices to mitigate soil loss due to erosion, wind, and run-off. They will employ the use of a plastic liner, straw bales for berming 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.

6.1.2 Contaminated Soils – Base Landfarm

Excavated contaminated soils will be handled in accordance with Sections 3 and 4 of this work plan. Contaminated soils will be live loaded and transported to the selected location for treatment/disposal; either the FT-31 Landfarm or an offsite subcontractor location.

6.2 Decontamination Water

Decontamination water is anticipated to be non-hazardous and as such, can be disposed of through the HAFB waste water treatment facility (WWTF). 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 WWTF will be combined with the excavated contaminated soil for disposal.

6.3 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.

6.4 Construction Ruble

Unless visibly stained, all construction debris is assumed to be non-hazardous, non-contaminated, and will be disposed of accordingly at the Base re-use facility.

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7 PROJECT QUALITY ASSURANCE

The laboratory performing the chemical sample analysis will follow the *Basewide Quality Assurance Project Plan* (Bhate, November 2003).

7.1 Standard Operating Procedures

Applicable SOPs for completing this excavation are located in Appendix A of the *Basewide QAPP* (Bhate, November 2003).

7.2 Sample Identification

Each environmental 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 field sample and will be classified as blind samples. The duplicate samples will appear in sequence with the regular samples. The identifier nomenclature will adhere to the procedures and guidelines established in the *Basewide QAPP*. Sample labeling will adhere to the format provided in the *Basewide QAPP*.

7.3 Project Documentation

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

7.3.1 Sample Documentation

Sample documentation, identification, and tracking will adhere to the prescribed methods found in the *Basewide QAPP*. 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 number. Chain-of-custody 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.

7.3.2 Field Logbook

Personnel will use only bound field logbooks for the maintenance of 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 in the following format:

Documentation and reporting of events and activities will be made in chronological order on the right page of an open 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 accountable documents 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 at the top of every page in the left-hand corner of the right page.
- The time of entry recordings will be in columnar form down the left-hand side of the right page.

7.3.3 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.

7.3.4 Data Reporting

Data obtained during the excavation, 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 matrix spike/matrix spike duplicate (MS/MSD) samples are to be collected concurrently. The data will 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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8 HEALTH AND SAFETY REQUIREMENTS

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

Site security is part of safety at the site for the excavation. Items of concern include the proper designation and demarcation of the investigation boundaries (i.e., SZ, CRZ, and EZ), as appropriate. Likewise, compliance with any intrusive work requirements, posting of potential hazards, and control of un-authorized site personnel will be completed. This is discussed in the *Basewide HASP*.

At a minimum, the site will be secured with caution tape surrounding the perimeter of the site 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 persons. A CRZ and/or EZ will be established as guided by the HASP and site prevailing conditions.

Excavation depths are expected to exceed 4 ft, and be less than 12 ft. Sidewall benching will not be completed.

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9 ORGANIZATION AND SCHEDULE

During the corrective measures activities at the SWMU 8 site, Mr. John Hymer will serve as the Bhate Site Manager overseeing and directing all excavation sampling activities. Mr. Hymer will also provide on-site management of any sub-contractors for the project. Mr. Jim Moore is the Bhate Project Manager and will ensure required project documents, permits, contractual agreements, and other program tasks are completed. Key project personnel are listed in Table 8-1. The excavation activities are anticipated to begin in mid 2006 and will last approximately 2 weeks.

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10 REFERENCES

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TABLES

Table 3-1. Sampling Plan

SWMU 8 Soil Remediation
Voluntary Corrective Measures Work Plan
Holloman AFB, New Mexico
Bhate Project No. 9050291.01.01

Sample Type	Contamination Profile	Purpose	Frequency	Estimated Quantity	Method/ Analyses	Requested Analyses Time
Field Screening	Un-impacted Soils	Initial Field Screening	Every 25 cu yds	6	OVA: VOCs	24 hrs
		Field Confirmatory	Every 50 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 25 cu yds	6	OVA: VOCs	
		Field Confirmatory	Every 100 cu yds	3	UVF: TPH	
		Laboratory Validation	Every 300 cu yds	1	Laboratory: TPH, TCLP VOCs, TCLP SVOCs, and TCLP metals	
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 = Ultra-violet flourometer; OVA = Organic vapor analyzer; TCLP = Toxicity Characteristic Leaching Procedure

Table 4-1. Sample Collection Information

SWMU 8 Soil Remediation Voluntary Corrective Measures Work Plan Holloman AFB, New Mexico Bhate Project No. 9050291.01.01							
Soil Collection Information	**ANALYTE METHOD**						
	VOC (8260B)	**SVOC (8270C)**	**TPH (8015B)**	**Soil Moisture**	**TCLP VOC (1311/8260B)**	**TCLP SVOC (1311/8270C)**	**TCLP Metals (1311/6010/7000)**
Container	Encore	4 oz glass jar	Non-preserved 40-mL vial (Terra-core)	8 oz glass jar	8 oz glass jar	8 oz glass jar	8 oz glass jar
Container Quantity	3	1	1	1	1	1	1
Holding Time	48 hours	7 days	7 days	14 days	14 days	14 days	180 days

NOTES: oz = Ounce; mL = Milliliter; TPH = Total Petroleum Hydrocarbons; VOCs = Volatile Organic Compounds; SVOCs = Semi-Volatile Organic Compounds; TCLP = Toxicity Characteristic Leaching Procedure

Table 4-2. Sample Analytes and Methodologies

SWMU 8 Soil Remediation Voluntary Corrective Measures Work Plan Holloman AFB, New Mexico Bhate Project No. 9050291.01.01	
Analysis	**Soil and Groundwater**
BTEX (VOCs)	EPA Method 8260B
PAH (SVOCs)	EPA Method 8270C
TPH (GRO/DRO/ORO)	EPA Method 8015B
Carbon Fractions	TM 1006
TCLP VOCs	EPA Method 1311/8260B
TCLP SVOCs	EPA Method 1311/8270C
TCLP Metals	EPA Method 1311/6010/7000
NOTES: BTEX = Benzene, toluene, ethylbenzene, and xylenes; 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; TCLP = Toxicity Characteristic Leaching Procedure; PAH = Polynuclear Aromatic Hydrocarbons; EPA = Environmental Protection Agency	

Table 4-3. Carbon Fractions for Petroleum Hydrocarbons

SWMU 8 Soil Remediation Voluntary Corrective Measures Work Plan Holloman AFB, New Mexico Bhate Project No. 9050291.01.01	
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 = 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 = 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).	

*Analysis may be truncated at C28 if there does not appear to be significant amounts of higher carbons.

Table 6-1. Proposed Waste Streams

SWMU 8 Soil Remediation Voluntary Corrective Measures Work Plan Holloman AFB, New Mexico Bhate Project No. 90502.01.01				
Activity	**Waste Stream**			
	PPE	**Soil**	**Water**	**Debris**
Equipment Decontamination				
Excavation				

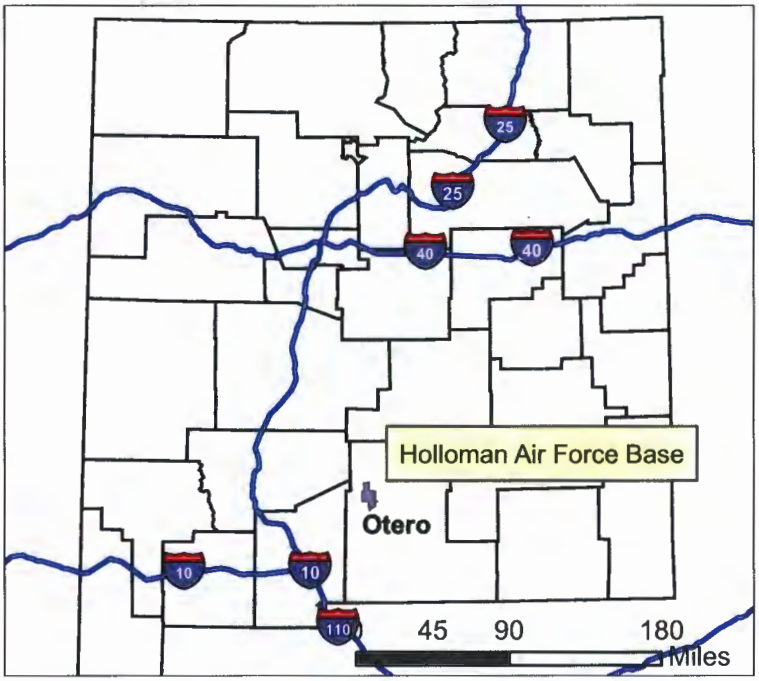
NOTE: PPE = Personal protective equipment

Table 8-1. Key Personnel and Responsibilities

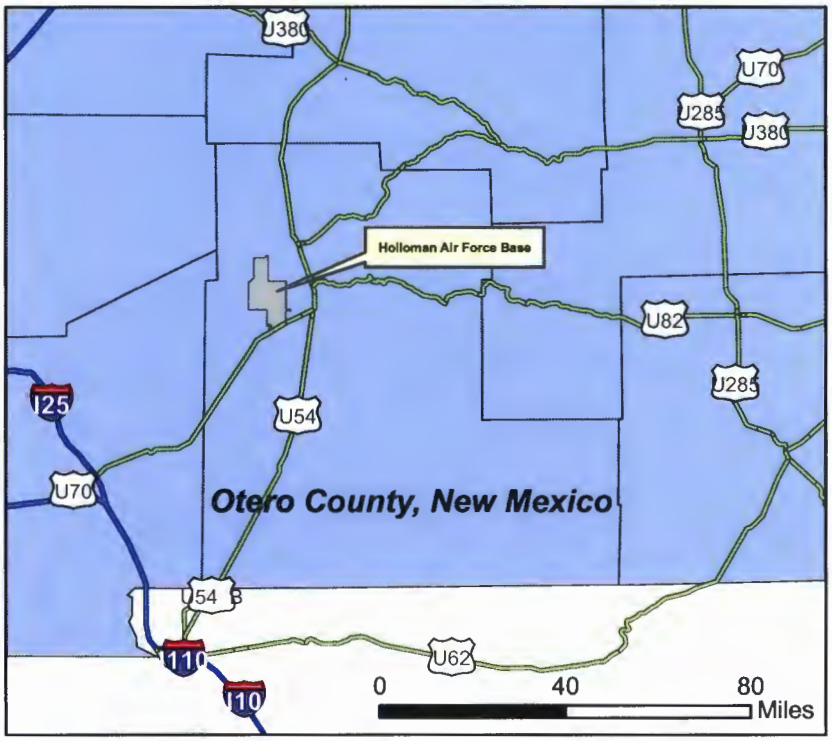
SWMU 8 Soil Remediation Voluntary Corrective Measures Work Plan Holloman AFB, New Mexico Bhate Project No. 9050291.01.01		
Name	**Project Title/Assigned Role**	**Phone Numbers**
Mr. John Hymer	Site Manager/SSHO	Work: (505) 491-9171
To be determined	Field Team Leader	To be determined
Mr. Frank Gardner, P.G.	Bhate Program Manager	Work: (303) 386-6454
Mr. Jim Moore, P.G.	Senior Geologist/Project Manager	Work: (303) 929-4840
Ms. Judith McBride, CIH	Health and Safety Specialist	Work: (205) 918-4000
NOTES: P.G. = Professional Geologist; SSHO = Site Safety and Health Officer; CIH = Certified Industrial Hygienist		

FIGURES

Site Vicinity



Site Location



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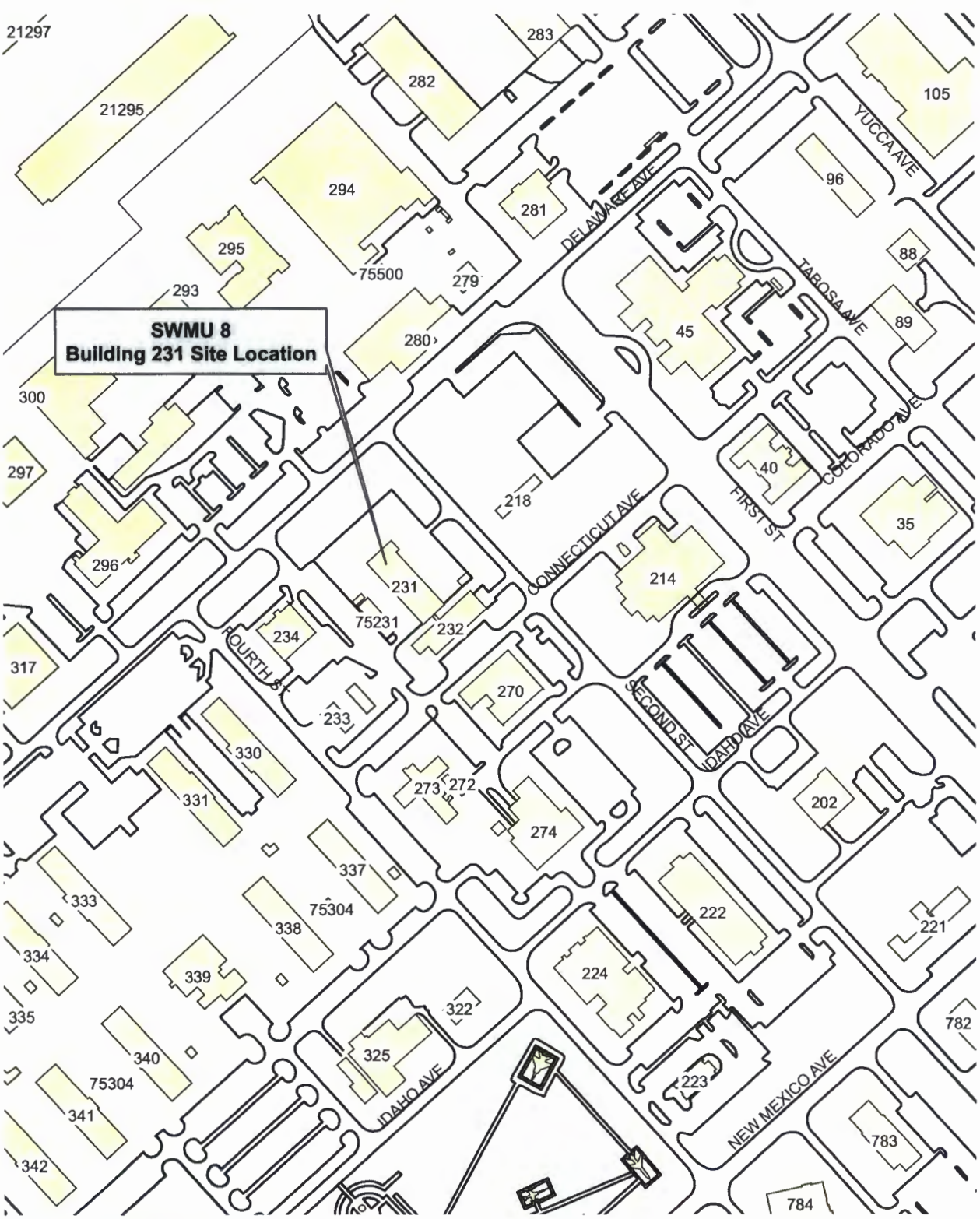
Site Vicinity and Location Map

PROJECT NO.	SCALE	DATE	DRAWN BY:
9050291	Shown	11/30/05	cm
			DRAWING NO: fig1

SWMU 8 Soil Remediation
Voluntary Corrective Measures Work Plan
Holloman Air Force Base, New Mexico

Figure 1



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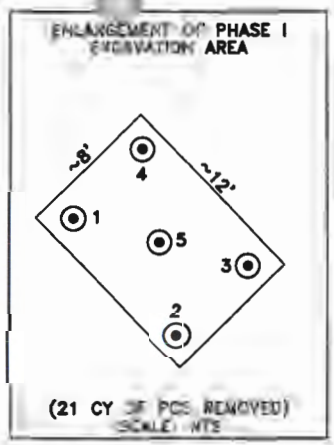
Site Map

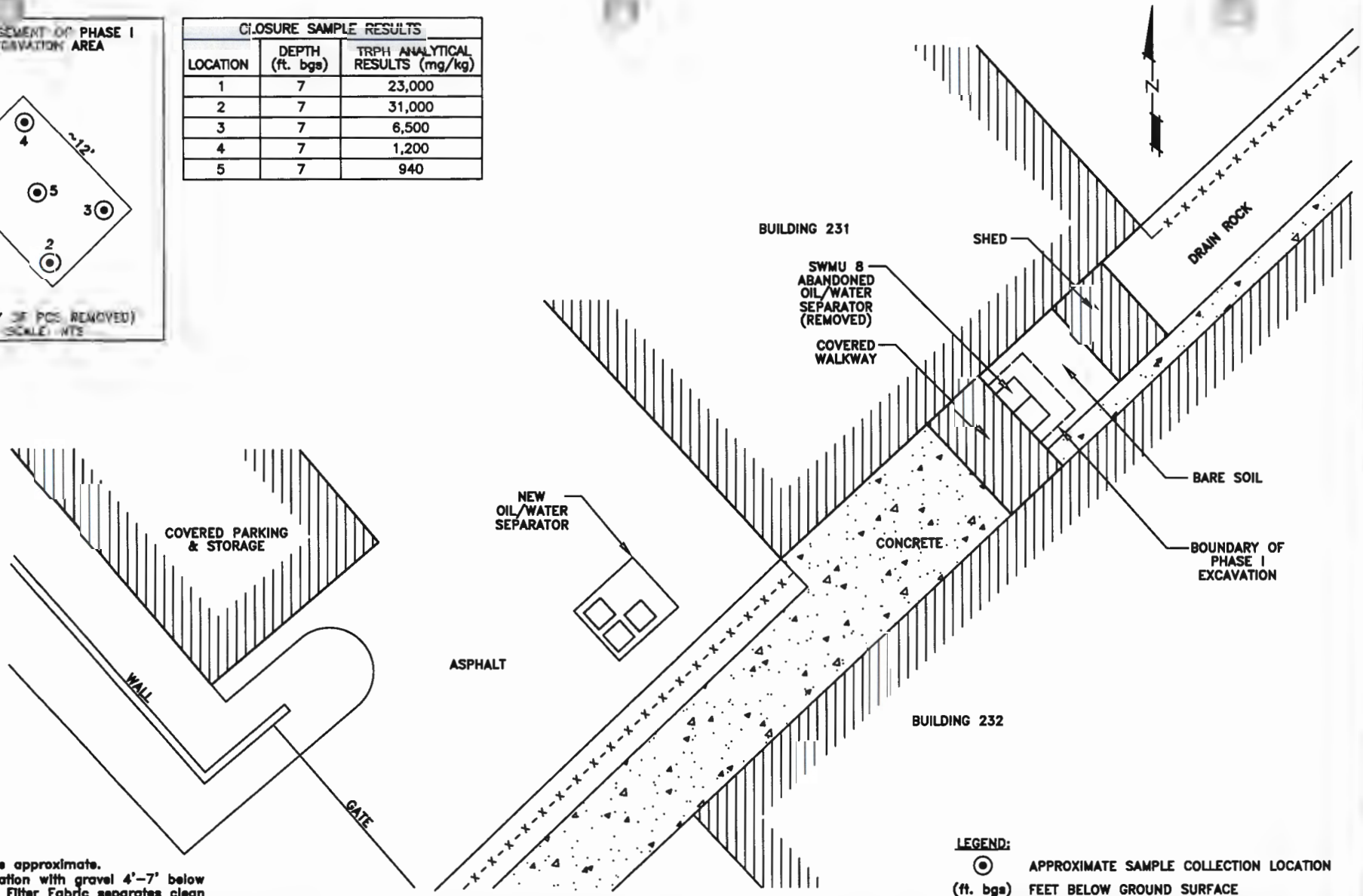
PROJECT NO.	SCALE	DATE	DRAWN BY:
9050291	1"=300'	11/30/05	cm
			DRAWING NO: fig2

SWMU 8 Soil Remediation
Voluntary Corrective Measures Work Plan
Holloman Air Force Base, New Mexico

Figure 2



CLOSURE SAMPLE RESULTS		
LOCATION	DEPTH (ft. bgs)	TRPH ANALYTICAL RESULTS (mg/kg)
1	7	23,000
2	7	31,000
3	7	6,500
4	7	1,200
5	7	940



Notes:
Site features are approximate.
Backfilled excavation with gravel 4'–7' below ground surface. Filter Fabric separates clean native soil backfill 0'–4' below ground surface.
Source: Remediation of POL – Contaminated Sites and Oil/Water Separator Removals (November, 1995)

LEGEND:

⊙	APPROXIMATE SAMPLE COLLECTION LOCATION
(ft. bgs)	FEET BELOW GROUND SURFACE
mg/kg	MILLIGRAMS PER KILOGRAM
TRPH	TOTAL RECOVERABLE PETROLEUM HYDROCARBONS

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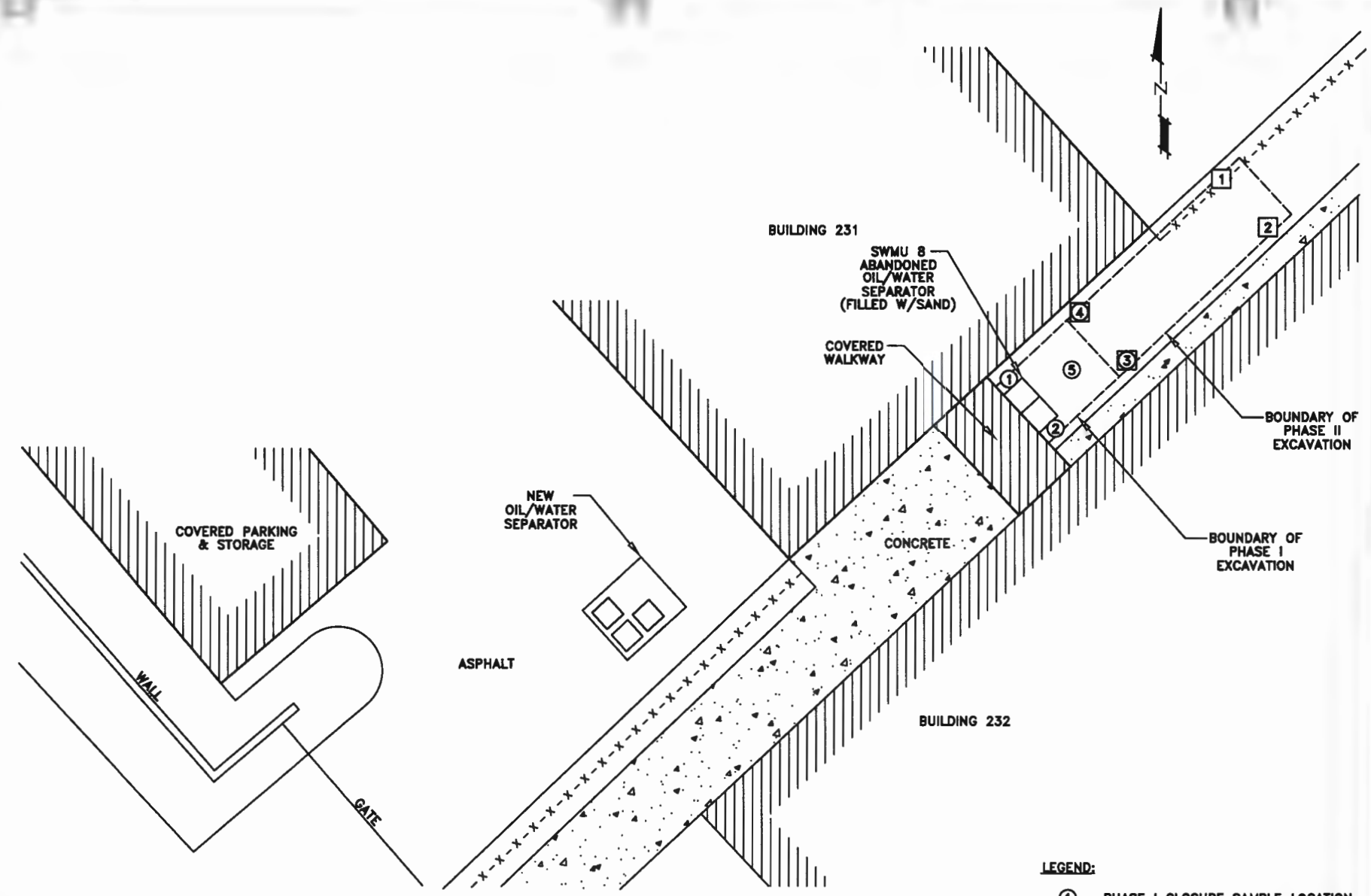
PHASE I
SWMU 8 OIL/WATER SEPARATOR

PROJECT NO:	SCALE	DATE	DRAWN BY:
9050291	1"=20'	12/07/05	MRM
			DRAWING NO: Figure 3

Remedial Action
Holloman Air Force Base
New Mexico

Figure 3



Notes:
Site features are approximate.
Source: Final Closure Report Addendum Phase II
Remediation of POL – Contaminated Sites (December, 1997)

LEGEND:

① PHASE I CLOSURE SAMPLE LOCATION

[1] PHASE II CLOSURE SAMPLE LOCATION

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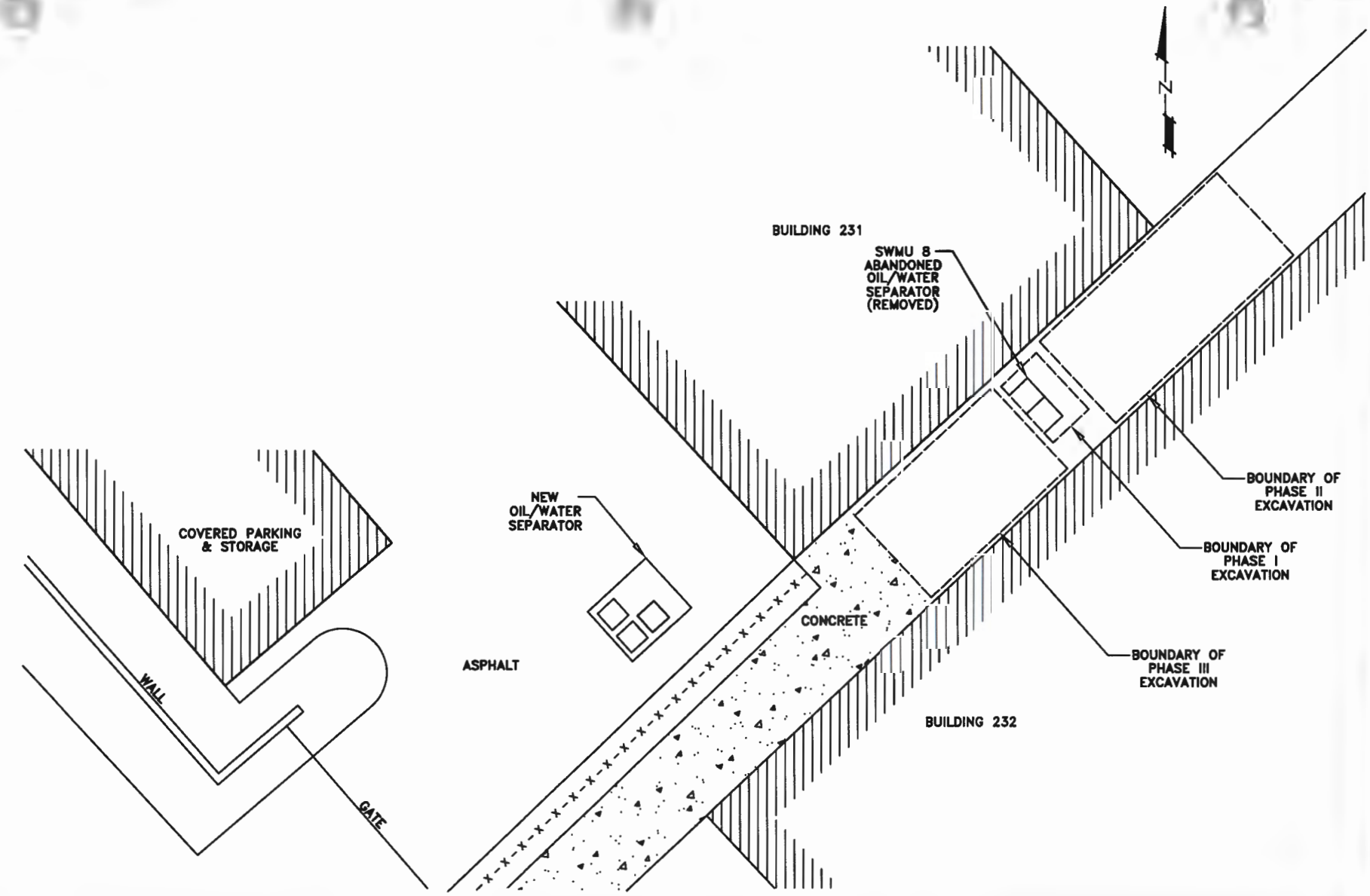
PHASE II
SWMU 8 PETROLEUM CONTAMINATED SOIL

PROJECT NO.	SCALE	DATE	DRAWN BY:
9050291	1"=20'	12/07/05	MRM

DRAWING NO: Figure 4

Remedial Action
Holloman Air Force Base
New Mexico

Figure 4



Notes:
Site features are approximate.

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PHASE III
SWMU 8 SOIL REMEDIATION &
EXCAVATION BOUNDARIES

PROJECT NO.	SCALE	DATE	DRAWN BY:
9050291	1"=20'	12/07/05	MRM
			DRAWING NO. Figure 5

Remedial Action
Holloman Air Force Base
New Mexico

Figure 5

APPENDIX A1

SECTION 10.0 OIL/WATER SEPARATOR REMOVAL AND RECLAMATION AT SWMU 8 – BUILDING 231

EBASCO, NOVEMBER 1995

10.0 OIL/WATER SEPARATOR REMOVAL AND RECLAMATION AT SWMU 8 - BUILDING 231

SWMU 8 (OWS at Building 231) is a Table 3 RFI site located south of Building 231. The OWS was approximately 4 feet wide, 8 feet long and 4 feet deep. The OWS accepted wash water from a heavy equipment washrack located adjacent to the unit. The separator received rinsate containing water, oils, detergents and fuels. Soil sampling was to be conducted during the Table 3 RFI (Radian, February 1994). However, samples were not collected as presented in the RFI Work Plan because the unit was inactive and scheduled for removal. Therefore, no data for VOCs, SVOCs and metals were available prior to OWS removal. However, native soil samples from the completed excavation were analyzed for these constituents to characterize their presence.

OWS removal and site reclamation activities took place from August 8-10, 1995. Specific details regarding these activities are presented in subsections 10.1 though 10.5. Photographs of on-site activities are presented in Appendix D. Figure 10-1 is a site map illustrating the extent of excavation.

10.1 Field Activities

Headspace testing of soils with a PID was used to determine relative concentrations of VOCs in excavated soils. These PID readings were recorded on forms attached to the Daily Quality Control Reports presented in Appendix B. Excavation was stopped before the extent was determined at the USACE's direction. A summarized chronology of the field activities performed at SWMU 8 is presented in Table 10-1.

10.2 Sampling and Analysis

Representative samples of native soil, and stockpiled soil were collected during investigation activities. The soil samples were collected and analyzed in accordance with the FSAP as described in subsection 2.4. Laboratory analytical results are provided in Appendix C. Table 10-2 summarizes the analytical results for the native soil confirmation samples. Table 10-3 summarizes the analytical results for the contaminated stockpile soil samples.

10.2.1 Native Soil confirmation Samples

On August 8, 1995, five native soil confirmation samples were collected inside the excavation. Four were collected from the excavation corners (SWMU-8-01-7 through SWMU-8-04-7), and one from the center of the excavation (SWMU-8-05-7). The sample locations are illustrated on Figure 10-1. The analytical results represent soil conditions upon completion of the excavation. The analytical results are presented in Appendix C and are summarized in Table 10-2.

TRPH laboratory analytical results above 1,000 mg/kg were indicated in four of the five samples. Sample SWMU-8-05-7, collected from the center of the excavation, contained TRPH at 940 mg/kg. TRPH concentrations of 23,000, 31,000, 6,500, and 1,200 mg/kg were present in samples SWMU-8-01-7, SWMU-8-02-7, SWMU-8-03-7, and SWMU-8-04-7 respectively. Several volatile organic compound analytes in EPA Method 8240 were detected in samples SWMU-8-01-7 and SWMU-8-02-7. No VOC analytes in EPA Method 8240 were detected above the laboratory quantitation limits in samples SWMU-8-03-7 through SWMU-8-05-7. Naphthalene concentrations were present in SWMU-8-01-7, and SWMU-8-05-7. 2-methylnaphthalene concentrations were present in SWMU-8-02-7, through SWMU-8-03-7. None of the other semi-volatile organic compound analytes in EPA Method 8270 were detected above laboratory quantitation limits in any of the samples. EPA 6000/7000 Series analytical results indicated various metals in all five samples.

10.2.2 Stockpiled Soil Samples

Soil samples for TPH field screening were collected from the clean and contaminated soil stockpiles. Screened soil samples were analyzed for TPH by Method 4030 in the field using the rapid immunoassay screen for petroleum fuels in soil prepared by ENSYS Inc. The stockpile soil samples were collected on September 27, 1995. TPH by field screening was identified in the clean soil stockpile at a concentration greater than 250 ppm, but less than 1,000 ppm, and greater than 1,000 ppm in the contaminated soil pile. Since the field TPH analysis indicated TPH levels above 1,000 ppm, soil samples were collected for laboratory analysis in accordance with the FSAP. Analytical results are presented in Appendix C and are summarized in Table 10-3.

Laboratory analytical results indicated 1,500 mg/kg of TRPH, and 370 mg/kg of TPH as gasoline in the contaminated stockpile sample. No BTEX concentrations were detected in the soil sample above the laboratory quantitation limits. Soil was tested for total lead on September 27, 1995 and contained 24 mg/kg. TCLP analytical results indicated no VOC, semi-VOC, or metals analyte concentrations above the laboratory quantitation limits.

10.3 Site Restoration

The excavation was backfilled with gravel up to at least 5 feet below grade, and clean compacted native soil to grade. The excavated area was restored to approximately its original condition. Additional restoration activities were performed on October 27, 1995. A final inspection was conducted on November 13, 1995. All work passed the final inspection with no deficiencies.

10.4 Waste Handling and Disposal

The approximately 21 cubic yard contaminated soil stockpile was transported offsite by RHINO ENVIRONMENTAL as nonhazardous waste to the RHINO ENVIRONMENTAL facility north of Newman, New Mexico, for land-farming and subsequent disposal in early October 1995. Copies of waste manifests and weight certificates/receipts are included in Appendix A.

The demolished separator and other construction debris were transported offsite by RHINO ENVIRONMENTAL as nonhazardous construction debris to the Otero/Lincoln County Regional Landfill facility for disposal in early October 1995. Copies of waste manifests and weight receipts are included in Appendix A.

10.5 Health and Safety Issues

Ambient air monitoring of the breathing zone was conducted during soil excavation activities. During these activities, the breathing zone was monitored using an LEL/O_2 meter. These measurements were recorded in the field log book. LEL/O_2 concentrations in the breathing zone never exceeded the criteria set forth in the SSHP.

10.6 Conclusions and Recommendations

All wastes generated during field activities have been removed and properly disposed. The site has been restored to approximately its original condition. However, native soil confirmation sample laboratory analytical results indicate TRPH levels (up to 31,000 mg/kg) well above the Base's action threshold of 1,000 mg/kg. Therefore, further action is required to delineate and then remediate the remaining PCS at SWMU 8. Additional investigation and *in-situ* remediation activities are planned for the site in 1996.

TABLE 10-1
CHRONOLOGY OF ACTIVITIES DURING OIL/WATER SEPARATOR REMOVAL AND RECLAMATION AT SWMU 8 - BUILDING 231 HOLLOMAN AFB, NEW MEXICO

DATE	ACTIVITY	NOTES
8 AUG 95	- Mobilized equipment and personnel. - Built bermed soil storage cell, lined with 40 mil plastic tarp. - Removed separator. - Excavated approx. 21 CY of PCS. - Screened soils; range 43-1,094 ppm. - Collected 4 sidewall and 1 bottom verification soil samples from the excavation.	
9 AUG 95	- Repaired 6-inch PVC sewer line. - Plugged other lines with grout. - Backfilled excavation with gravel, filter fabric, and clean native soil.	
10 AUG 95	- Finished fine grading. - Reinstalled fence. - Pressure washed adjacent parking lot. - Mobilized to SWMU 107	

TABLE 10-2
SUMMARY OF NATIVE SOIL CONFIRMATION ANALYTICAL RESULTS AT SWMU 8 - BUILDING 231 HOLLOMAN AFB, NEW MEXICO AUGUST 1995

Sample No. SWMU-8	-01-7	-02-7	-03-7	-04-7	-05-7
Sample Location	West Corner	S. Corner	East Corner	N. Corner	Center
Date Sampled	8/8/95	8/8/95	8/8/95	8/8/95	8/8/95
TRPH by 418.1 (mg/kg)	23,000	31,000	6,500	1,200	940
VOCS by 8240 (µg/kg)					
Acetone	<100	<100	<2,000	<2,000	<2,000
Carbon disulfide	37	<25	<500	<500	<500
Benzene	<25	<25	<500	<500	<500
Tetrachloroethene	480	190	<500	<500	<500
Toluene	170	<25	<500	<500	<500
Ethylbenzene	460	84	<500	<500	<500
Xylenes	6,200	32	<500	<500	<500
1,2-Dichlorobenzene	710	3,500	<1,000	<1,000	<1,000
1,3-Dichlorobenzene	1,100	4,800	<1,000	<1,000	<1,000
1,4-Dichlorobenzene	750	3,300	<1,000	<1,000	<1,000
SEMI VOCS by 8270 (ug/kg)					
Naphthalene	27,000	<6,600	<1,300	<990	3,500
2-Methylnaphthalene	7,900	8,900	1,400	<990	<1,300
TAL METALS by 6000/7000 series (mg/kg)					
Aluminum	3,200	2,600	2,100	1,600	2,400
Arsenic	1.1	1.2	1.3	<1.0	<1.0
Barium	95	<40	<40	<40	<40
Calcium	140,000	150,000	140,000	150,000	170,000
Chromium	<6.0	<6.0	<6.0	<6.0	<6.0
Copper	11	<5.0	5.3	<5.0	<5.0

TABLE 10-2 (continued)
SUMMARY OF NATIVE SOIL CONFIRMATION ANALYTICAL RESULTS
AT SWMU 8 - BUILDING 231
HOLLOMAN AFB, NEW MEXICO
AUGUST 1995

Sample No. SWMU-8	-01-7	-02-7	-03-7	-04-7	-05-7
Sample Location	West Corner	S. Corner	East Corner	N. Corner	Center
Date Sampled	8/8/95	8/8/95	8/8/95	8/8/95	8/8/95
Iron	3,800	2,700	3,500	1,700	2,700
Lead	47	26	17	8.4	34
Magnesium	3,100	2,900	1,600	1,100	1,700
Manganese	61	38	49	34	48
Potassium	1,100	<1,000	<1,000	<1,000	<1,000
Zinc	35	11	18	8.8	11

Notes: < = Constituent not detected above laboratory quantitation limit

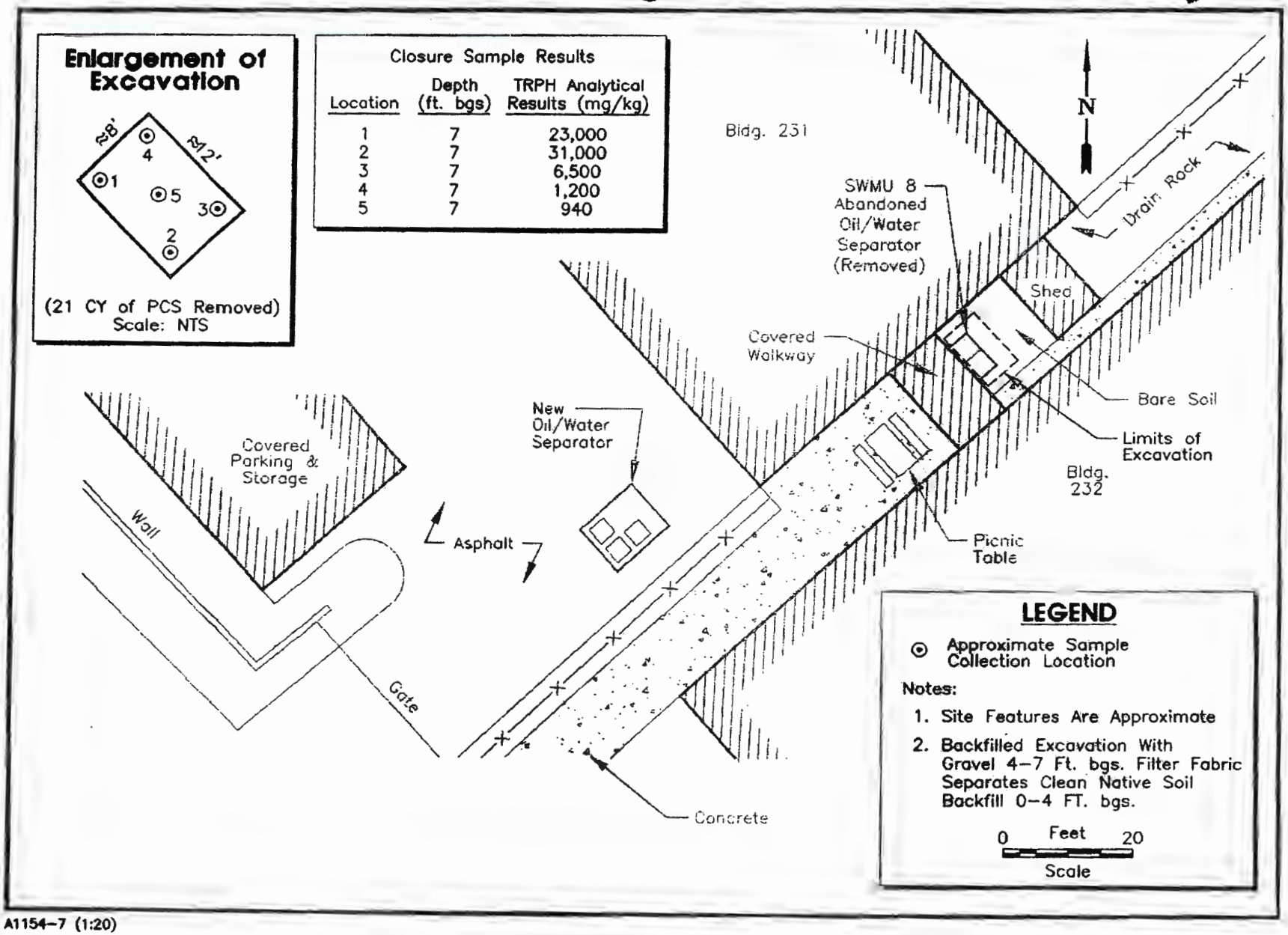
TABLE 10-3
SUMMARY OF STOCKPILE SOIL ANALYTICAL RESULTS
AT SWMU 8 - BUILDING 231
HOLLOMAN AFB, NEW MEXICO
SEPTEMBER 1995

Sample No. SWMU-8	-SP
Sample Type	Composite
Date Sampled	9/27/95
TRPH by 418.1 (mg/kg)	1,500
Aromatic Volatiles by 8021A (mg/kg)	Results
Benzene	<0.05
Toluene	<0.10
Ethylbenzene	<0.10
Xylenes	<0.20
BTEX Total	--
TPH as Gasoline	370
Lead by 7421 (mg/kg)	24
TCLP Volatiles by 1311/8240 (mg/l)	
Benzene	<0.05
Carbon tetrachloride	<0.05
Chlorobenzene	<0.05
Chloroform	<0.05
1,4-Dichlorobenzene	<0.05
1,2-Dichloroethane	<0.05
1,1-Dichloroethene	<0.05
2-Butanone	<0.02
Tetrachloroethene	<0.05
Trichloroethene	<0.05
Vinyl Chloride	<0.1
Miscellaneous Waste Characterization Analysis	
Closed Cup Flashpoint by ASTM D-93 (°F)	>220
Paint Filter by EPA 9095	No Liquids

TABLE 10-3 (continued)
SUMMARY OF STOCKPILE SOIL ANALYTICAL RESULTS
AT SWMU 8 - BUILDING 231
HOLLOMAN AFB, NEW MEXICO
SEPTEMBER 1995

Sample No. SWMU-8	SP
Sample Type	Composite
Date Sampled	9/27/95
pH by EPA 9045A	7.1
Total Cyanide by EPA 9010A (mg/kg)	<2.0
Reactivity Sulfide by SW 846 7.3.4.2 (mg/kg)	<25
TCLP Semivolatiles by 8270A (mg/l)	
o-Cresol	<0.033
m+p-Cresol	<0.033
1,4-Dichlorobenzene	<0.033
2,4-Dinitrotoluene	<0.033
Hexachloro-1,3-butadiene	<0.033
Hexachlorobenzene	<0.033
Hexachloroethane	<0.033
Nitrobenzene	<0.033
Pentachlorophenol	<0.17
Pyridine	<0.033
2,4,5-Trichlorophenol	<0.033
2,4,6-Trichlorophenol	<0.033
TCLP Metals by 6000/7000 Series (mg/l)	
Arsenic	<0.40
Barium	<4.0
Cadmium	<0.080
Chromium	<0.080
Lead	<0.040
Mercury	<0.0080
Selenium	<0.16
Silver	<0.080

Notes: < = Constituents not detected above laboratory quantitiation limit
NA = Not Analyzed



A1154–7 (1:20)

Figure 10-1: Site Map
SWMU 8, Building 231 OWS

APPENDIX A2

SECTION 4.0 SITE RESTORATION AT SWMU 8, BUILDING 231 O/WS

FOSTER WHEELER, DECEMBER 1997

4.0 SITE RESTORATION AT SWMU 8, BUILDING 231 O/WS

SWMU 8, Building 231 O/WS, is located southeast of Building 231 (Figure 4-1). The O/WS was abandoned and filled with sand. The O/WS was approximately 4 ft wide, 8 ft long, and 4 ft deep and accepted wash water containing oils, detergents, and fuels from a heavy equipment washrack located adjacent to the unit. Activities planned for this site included the removal and disposal of the O/WS and the excavation of TRPH-contaminated soil with concentrations greater than 1,000 mg/kg.

To fulfill the requirements of Holloman AFB's HSWA portion of the RCRA Part B permit, SWMU 8 was to be investigated and characterized concurrently with the separator removal in 1995 (GTI 1995).

4.1 FIELD ACTIVITIES

Initial removal and investigation/characterization activities began in August 1995; the O/WS and 21 cu yds (28 tons) of PCS were removed. It was then discovered that contaminated soil extended beyond what had been anticipated for the first phase of remediation. Field activities were postponed in order to determine the most efficient method of closure. Subsequently, NMED approved leaving intact TRPH-contaminated soil that extended under in-place structures as long as it posed no risk. Due to this agreement, excavation was determined to be the best closure method. Excavation activities were continued in April 1997, and the original excavation was extended eastward from the eastern edge of the original excavation. An additional 31.8 cu yds (43 tons) of TRPH-contaminated soil were excavated.

4.2 SAMPLING AND ANALYSIS

Representative samples of in-place soil and one sample of stockpiled soil were collected during restoration activities. The soil samples were collected and analyzed in accordance with Section 2.4 (Sampling and Analysis), the FSAP (Ebasco 1995a), and the Closure Report for Phase II Remediation of POL-Contaminated Sites (FWENC 1997). Laboratory analytical reports from

GTEL are provided in Appendix B. Table 4-1 summarizes the analytical results for the site closure and soil stockpile samples.

4.2.1 Site Closure Samples

As part of the first phase of the project, five closure samples were collected from the initial excavation and analyzed for TRPH. The closure samples were collected from each of the side walls and the bottom of the excavation. Four of the five samples had TRPH concentrations greater than the Base cleanup criteria of 1,000 mg/kg (Ebasco and GTI 1996).

During the second phase of the project, samples were taken outside the original excavation to the east. Four samples were taken from the walls of the new excavation and analyzed for TRPH, VOCs, SVOCs, BTEX, and metals. The second-phase analytical results, which represent in-place soil conditions upon completion of excavation activities, did not exceed the Base cleanup criteria of 1,000 mg/kg TRPH, 25 mg/kg benzene, or RBCs for detected metals (Table 4-1). TRPH concentrations ranged from not-detected to 78 mg/kg. Only two closure samples (sample 1 – 23,000 mg/kg and sample 2 – 31,000 mg/kg) taken adjacent to the building during the first phase of excavation had concentrations above the Base TRPH cleanup criteria of 1,000 mg/kg (Figure 4-1 and Table 4-1). No further excavation of contaminated soil is possible at this site. Because 80-90 percent of TRPH-contaminated soil has been excavated and no further excavation is possible, NFA is recommended per the Base Agreement with NMED.

4.2.2 Soil Stockpile Samples

One soil stockpile sample was collected and analyzed for TRPH, TCLP constituents (VOCs, SVOCs, and metals), BTEX, lead, and RCRA characteristics. As shown on Table 4-1, the analytical result for TRPH was below 1,000 mg/kg (36 mg/kg). All detections of metal analysis were below EPA Region VI RBCs (Table 4-1).

4.3 SITE RESTORATION

Site restoration activities for the first part of the project included backfilling and the replacement of landscaping rock. The second phase of the operation included backfilling, spreading of landscape rock, and replacing the fence. Following site restoration, a USACE representative performed a completion inspection. A copy of this report is included in Appendix C.

4.4 WASTE HANDLING AND DISPOSAL

The O/WS and excavated volume of PCS (21 cu yds or approximately 28 tons) was removed from the site during the first phase of construction, and approximately 31.8 cu yds or 43 tons of soil were removed and transported off site during the second phase. The soil removed during the second phase was taken to the Rhino Environmental facility for disposal. The O/WS was decontaminated and disposed as a solid waste at the Lincoln/Otero County landfill.

4.5 CONCLUSIONS AND RECOMMENDATIONS

A total of 71 tons (approximately 53 cu yds) of soil was excavated and removed from the site. Closure samples adjacent to the western structure contained more than 1,000 mg/kg of TRPH. All other sample analyses indicated TRPH concentrations were below 1,000 mg/kg. Because NMED approved leaving in place PCS extending beneath in-place structures, NFA is recommended for this site.

Table 4-1
Summary of Site Closure and Stockpile Sample Analytical Results for Soil at SWMU 8, Building 231 O/WS
Page 1 of 2

Sample I.D.				SWMU08-01-06	SWMU08-02-06	SWMU08-03-06	SWMU08-04-06	SWMU8-SPI*
Figure I.D.	1	2	5	1	2	3	4	—
Date Sampled	8/8/95	8/8/95	8/8/95	4/9/97	4/9/97	4/9/97	4/9/97	4/9/97
TRPH by Method 418.1 (mg/kg)	23,000	31,000	940	78	<20	58	25	36
VOCs by Method 1311/8240 (mg/L)	NA	NA	NA	NA	NA	NA	NA	ND
SVOCs by Method 1311/8270B (mg/L)	NA	NA	NA	NA	NA	NA	NA	ND
VOCs by Method 8240B (µg/kg)	NA	NA	NA	ND	ND	ND	ND	NA
SVOCs by Method 8270B (µg/kg)	NA	NA	NA	ND	ND	ND	ND	NA
VOCs by Method 8021A Benzene (mg/kg)	NA	NA	NA	<0.05	<0.05	<0.05	<0.05	<0.05
Toluene (mg/kg)	NA	NA	NA	<0.10	<0.10	<0.10	<0.10	<0.10
Ethylbenzene (mg/kg)	NA	NA	NA	<0.10	<0.10	<0.10	<0.10	<0.10
Xylenes (total) (mg/kg)	NA	NA	NA	<0.20	<0.20	<0.20	<0.20	<0.20
Metals by Method 7421 Lead (2,000 mg/kg)	NA	NA	NA	NA	NA	NA	NA	2.1
Metals by Method 9010A Total Cyanide (mg/kg)	NA	NA	NA	NA	NA	NA	NA	<2.0
Metals by Method 6010A (mg/kg)								
Aluminum[1] (77,000)	NA	NA	NA	2,200	1,800	3,600	3,400	NA
Barium[1] (5,300)	NA	NA	NA	29	20	71	62	27
Chromium[2] (230)	NA	NA	NA	<3.0	<3.0	4.1	4.0	<3.0
Copper (63,000)	NA	NA	NA	<2.5	<2.5	3.1	5.2	NA
Manganese (8,300)	NA	NA	NA	26	30	74	65	NA
Vanadium (12,000)	NA	NA	NA	6.2	6.6	9.2	11	NA
Zinc[1] (23,000)	NA	NA	NA	8.2	5.9	12	17	NA
Lead (2,000)	NA	NA	NA	5.4	<0.40	4.6	4.6	NA
Paint Filter by Method 9095	NA	NA	NA	NA	NA	NA	NA	NP

Table 4-1
Summary of Site Closure and Stockpile Sample Analytical Results for Soil at SWMU 8, Building 231 O/W
Page 2 of 2

Sample I.D.				SWMU08-01-06	SWMU08-02-06	SWMU08-03-06	SWMU08-04-06	SWMU8-SPI*
Figure I.D.	1	2	5	1	2	3	4	—
Date Sampled	8/8/95	8/8/95	8/8/95	4/9/97	4/9/97	4/9/97	4/9/97	4/9/97
Flash Point by Method ASTM D93 (°F)	NA	NA	NA	NA	NA	NA	NA	>200
pH by Method 9045A	NA	NA	NA	NA	NA	NA	NA	7.5
Reactive Sulfide by SW846 Ch#7 (mg/kg)	NA	NA	NA	NA	NA	NA	NA	<2.5

Notes:
Shading denotes site closure samples
* = Soil stockpile sample
< = Constituent not detected above laboratory quantitation limit
() = EPA Region VI risk-based criteria for industrial land use
ND = Not detected
NA = Not analyzed
NP = Not present
1 = Risk-based value above expected saturation point; value shown is residential land use risk-based concentration
2 = Represents risk-based concentration for chromium VI

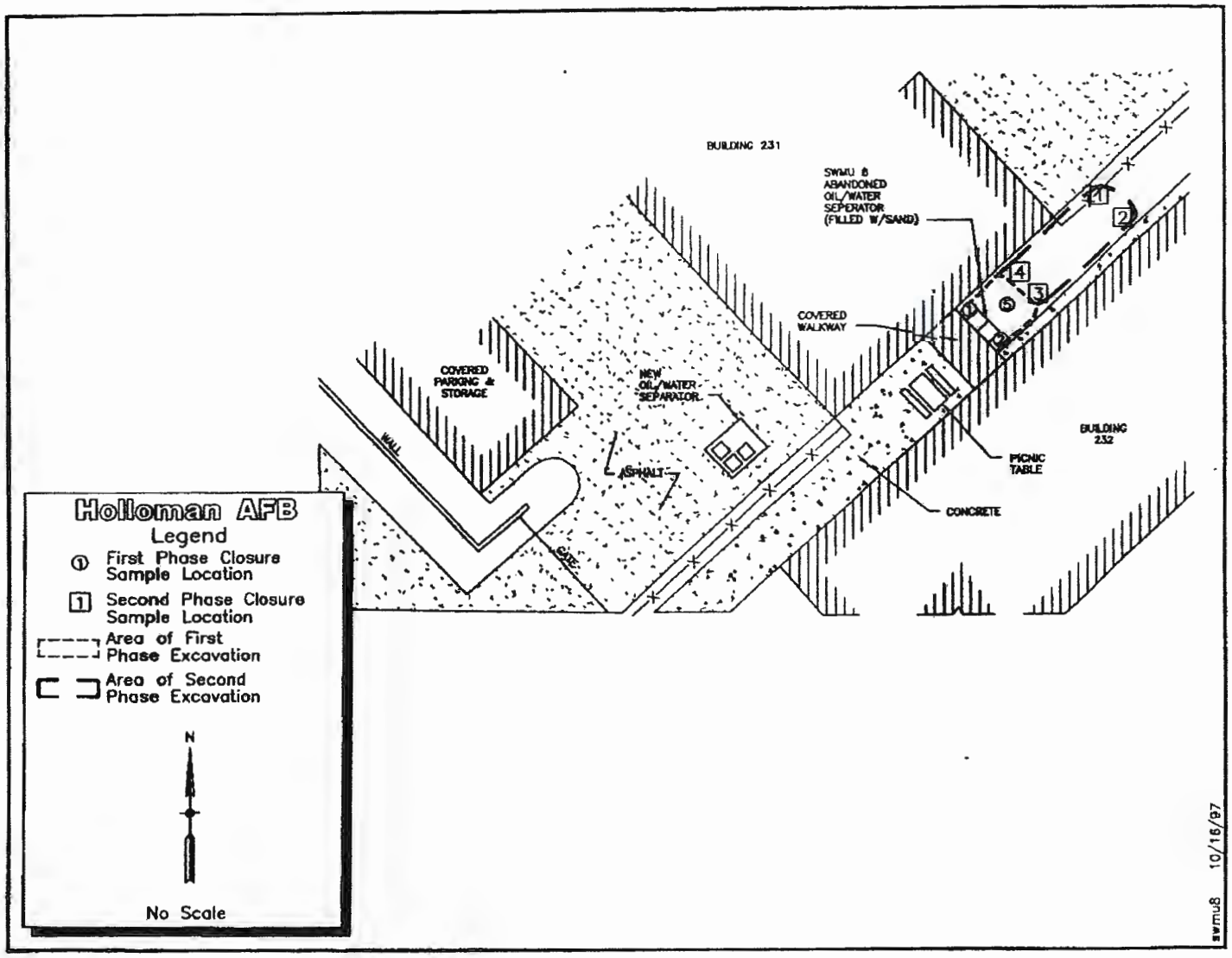


Figure 4–1. SWMU 8, Building 231 O/WS Site Map

APPENDIX B

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

EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL

09/03

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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 C

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 I - 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

AF FORM 332, JAN 92 *(Computer Generated)* *PREVIOUS EDITION IS OBSOLETE*

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 D

EPA INNOVATIVE TECHNOLOGY VERIFICATION REPORT: *FIELD MEASUREMENT TECHNOLOGIES FOR TOTAL PETROLEUM HYDROCARBONS IN SOIL*

SEPTEMBER 2001

United States
Environmental Protection
Agency

Office of Research and
Development
Washington, DC 20460

EPA/600/R-01/080
September 2001

PB2002-101512

EPA

Innovative Technology Verification Report

Field Measurement Technologies for Total Petroleum Hydrocarbons in Soil

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

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

SITE

REPRODUCED BY: NTIS
U.S. Department of Commerce
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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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September 2001

Innovative Technology Verification Report

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

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National Exposure Research Laboratory
Office of Research and Development
U.S. Environmental Protection Agency

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

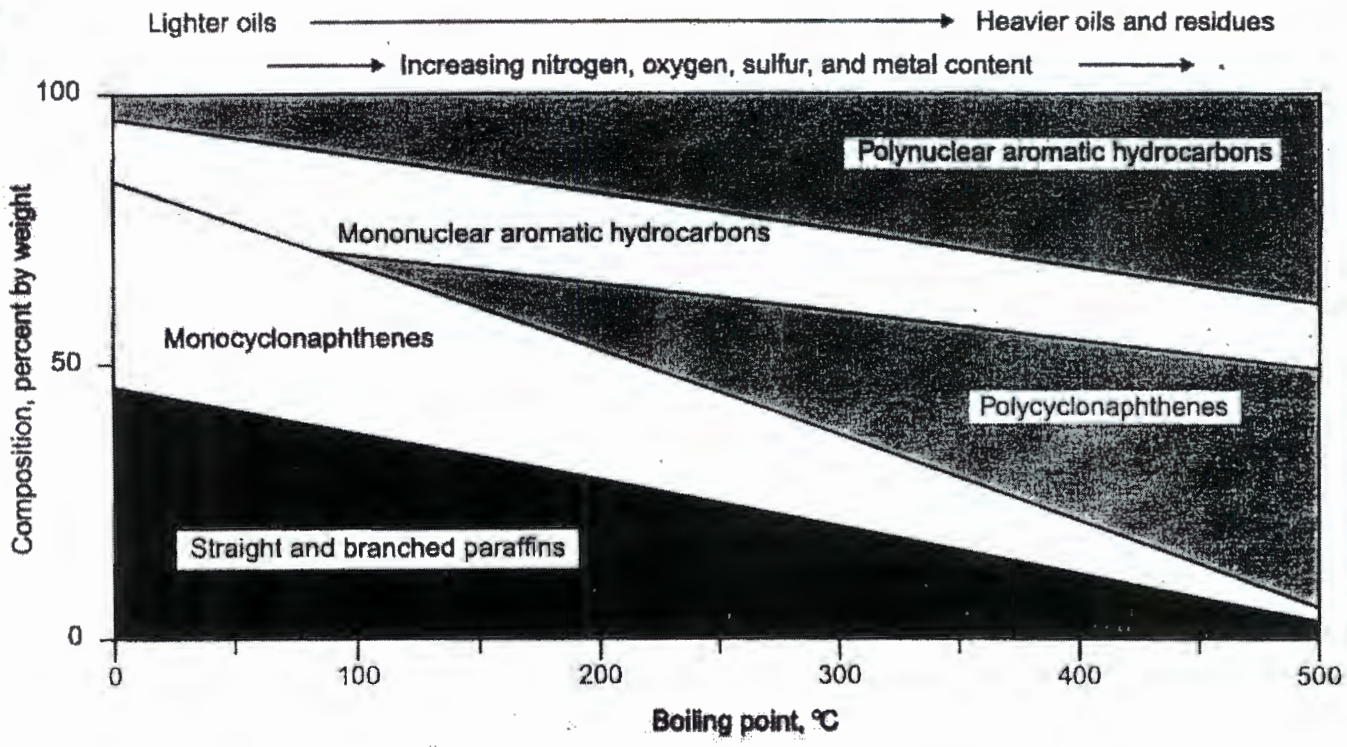
Petroleum is essentially a mixture of gaseous, liquid, and solid hydrocarbons that occur in sedimentary rock deposits. On the molecular level, petroleum is a complex mixture of hydrocarbons; organic compounds of sulfur, nitrogen, and oxygen; and compounds containing metallic constituents, particularly 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 includ

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

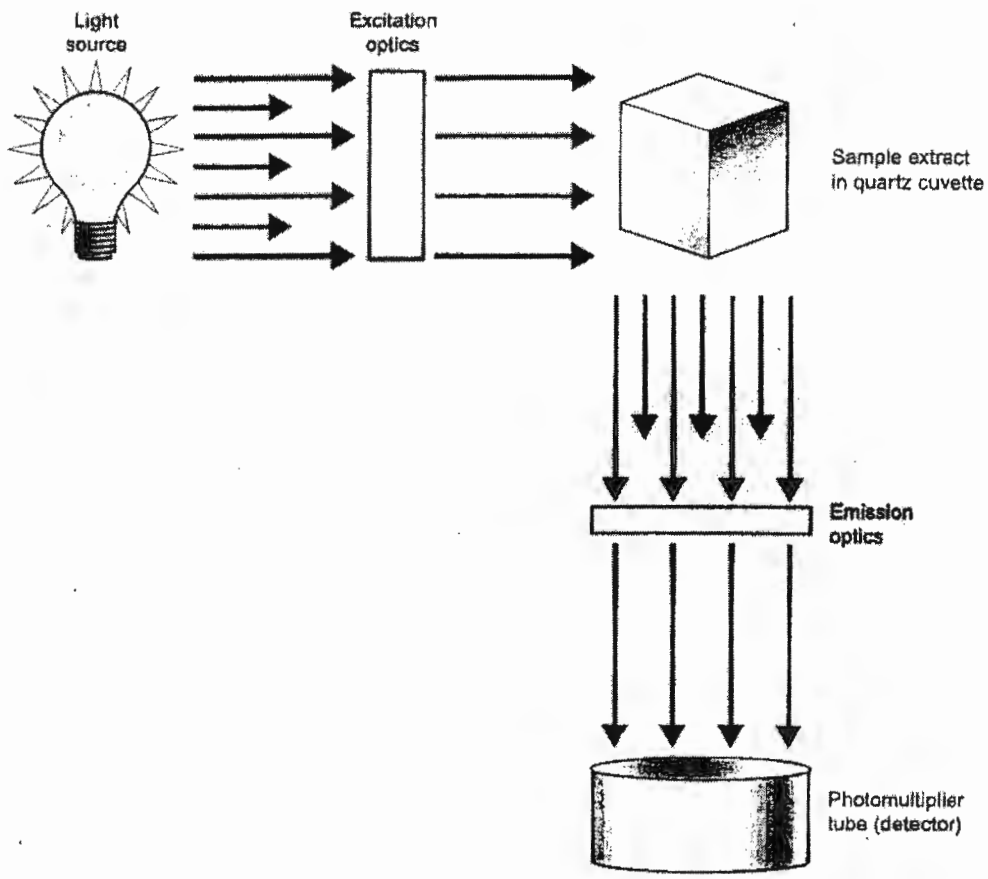


Figure 2-1. Schematic of ultraviolet fluorescence spectroscopy.

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:

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Fax: (603) 643-7900
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Internet: www.site-lab.com

APPENDIX E

NMED 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 and 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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APPENDIX F

KOMATSU HYDRAULIC PLATE COMPACTOR SPECIFICATIONS

HYDRAULIC PLATE COMPACTOR

Hydraulic Excavator Attachment

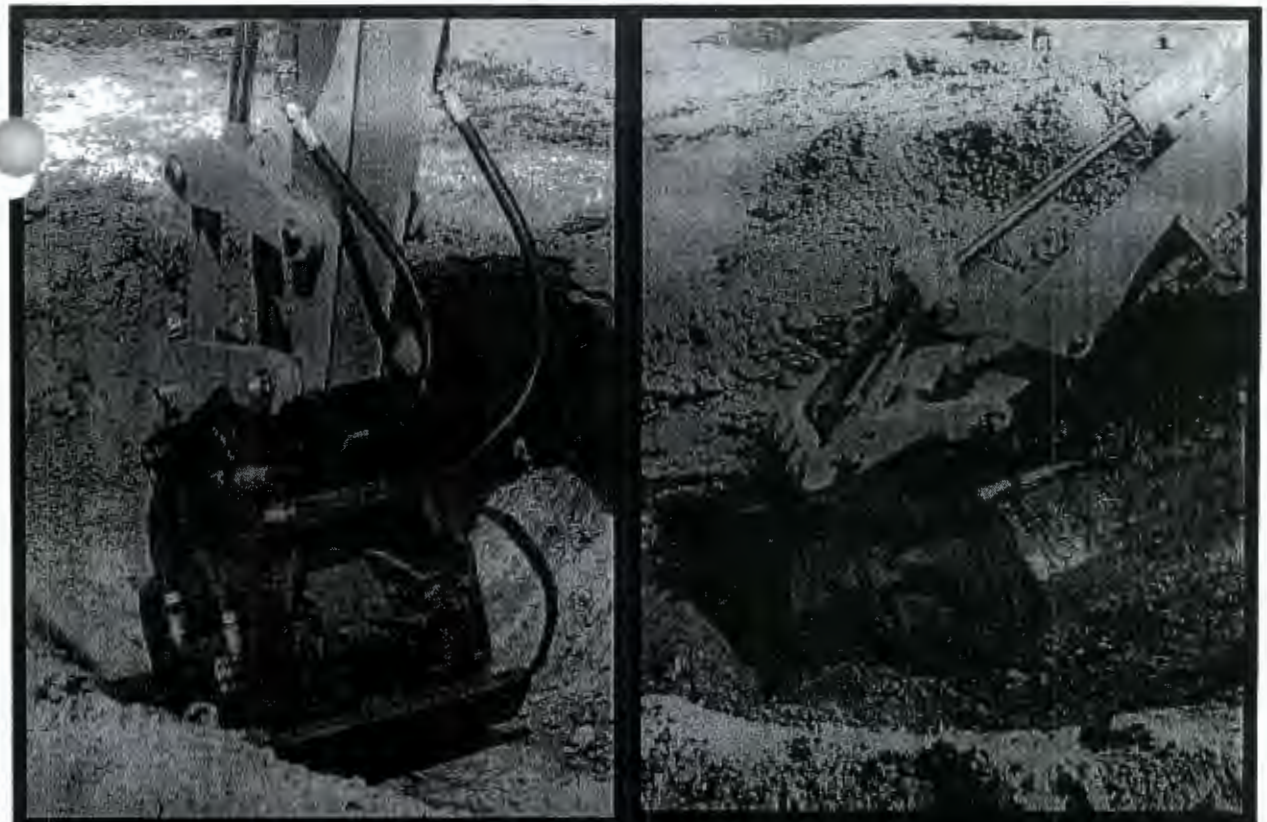
KOMATSU®

• MAXIMUM PRODUCTION
The compactor's ovesized eccentric, driven by its hydraulic motor, transmits powerful vibration waves through the baseplate to the soil.

• MINIMUM MAINTENANCE
Bearings run in oil bath; no greasing is required. Baseplate and eccentric housing are integrally mounted; no bolts to tighten. Heavy rubber isolators prevent vibrations from reaching the boom of the excavator.

•VIBRATORY PILE DRIVING
Where soils are suitably granular, the plate compactor can readily double as a pile driver. When placed atop a steel pile, a fencepost or similar object, the compactor's powerful vibrating forces exite the soil particles; then, with only slight down pressure from the boom, the pile quickly slides into the earth.

Capable of handling even your toughest compaction tasks, these quality hydraulic compactors are designed for rapid mounting and simple operation.

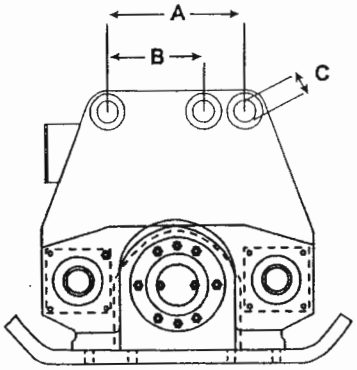


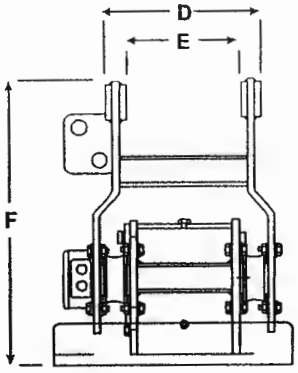
PC95 – PC400

HYDRAULIC EXCAVATOR
Working Gear

KOMATSU HYDRAULIC EXCAVATOR ATTACHMENT

HYDRAULIC PLATE COMPACTOR





Applications
Operating system combines maximum eccentric weight with the exact proportions of amplitude and vibration frequency necessary to generate the most effective centrifugal force. Capable of producing a Mod Proctor Density of 95% or better, the hydraulic plate compactor is outstanding for compacting granular and moderately cohesive soils.

KOMATSU COMPACTOR SPECIFICATIONS

Komatsu Models		PC95 PC100	PC120 PC128US PC150 PW170 PC200 PC228US	PC220 PC270 PC300 PC400
Compactor Models		JHPC145	JHPC215	JHPC400
Centrifugal Force	lbs kg	7000-14500 3175-6575	15000-21500 6800-9750	21000-40000 9525-18140
Cycles Per Minute	RPM	1800-2600	2000-2300	1500-2100
Flow Range	gpm lpm	12-30 45-115	30-44 115-165	44-55 170-210
Working Weight	lbs kg	850 385	1500 680	2500 1135
Baseplate Dimensions	inches mm	23x35 584x889	23.5x41 597x1041	35x41 889x1041
Estimated Lift	inches mm	24-48 610-1220	36-60 915-1525	48-72 1220-1830
←A→	inches mm	14 356	These units are supplied with a custom bolt-on mounting bracket built to Komatsu specifications. Bucket pins may be used.	
←B→	inches mm	n/a n/a		
←C→	inches mm	2.2 56		
←D→	inches mm	15 381		
←E→	inches mm	10.5 267		
←F→	inches mm	28.25 718		

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APPENDIX G

ASTM STANDARD TEST METHODS FOR DENSITY OF SOIL AND SOIL-AGGREGATE IN PLACE BY NUCLEAR METHODS (SHALLOW DEPTH)

Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)[1]

This standard is issued under the fixed designation D 2922; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

These test methods have been approved for use by agencies of the Department of Defense. Consult the DoD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.

[ε1] NOTE—Table 1 was corrected editorially in December 1997.

1. Scope

1.1 These test methods cover the determination of the total or wet density of soil and soil-rock mixtures by the attenuation of gamma radiation where the source and detector(s) remain on the surface (Backscatter Method) or the source or detector is placed at a known depth up to 300 mm (12 in.) while the detector(s) or source remains on the surface (Direct Transmission Method).

1.2 The density in mass per unit volume of the material under test is determined by comparing the detected rate of gamma radiation with previously established calibration data.

1.3 The values tested in SI units are to be regarded as the standard. The inch-pound equivalents may be approximate.

1.4 It is common practice in the engineering profession to concurrently use pounds to represent both a unit of mass (lbm) and a unit of force (lbf). This implicitly combines two separate systems of units: that is, the absolute system and the gravitational system. It is scientifically undesirable to combine the use of two separate sets of inch-pound units within a single standard. This standard has been written using the gravitational system of units when dealing with the inch-pound system. In this system the pound (lbf) represents a unit of force (weight). However, the use of balances or scales recording pounds of mass (lbm), or the recording of density in lbm/ft^3 should not be regarded as nonconformance with this standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific Hazard statements, see Section 6.

2. Referenced Documents

2.1 *ASTM Standards:*

D 698 Test Method for Moisture-Density Relations of Soil and Soil-Aggregate Mixtures Using 5.5-lb (2.49-kg) Rammer and 12-in. (305-mm) Drop[2]

D 1557 Test Method for Moisture-Density Relations of Soil and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in. (457-mm) Drop[2]

D 3216 Test Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures[3]

D 3017 Test Method for Water Content of Soil and Rock In-Place by Nuclear Methods (Shallow Depth)[2]

D4253 Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table[2]

D4643 Test Method for Determination of Water Content by the Microwave Oven Method[2]

D 4718 Practice for Correction of Unit Weight and Water Content for Soils Containing Oversize Particles[2]

D4944 Test Method for Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester Method[3]

D4959 Test Method for Determination of Water (Moisture) Content by Direct Heating Method[3]

3. Significance and Use

3.1 The test methods described are useful as rapid, nondestructive techniques for the in-place determination of density of soil and rock.

3.2 The test methods are suitable for quality control and acceptance testing for construction and for research and development applications.

3.3 The nondestructive nature of the tests allow repetitive measurements to be made at a single test location.

4. Interferences

4.1 The chemical composition of the sample may affect the measurement, and adjustments may be necessary.

4.2 The test methods exhibit spatial bias in that the instrument is more sensitive to the density of the material in close proximity to the surface (Backscatter Method only).

NOTE 1—The nuclear gauge density measurements are somewhat biased to the surface layers of the soil being tested. This bias has largely

[1] These test methods are under the jurisdiction of ASTM Committee D-18 on Soil and Rock and are the direct responsibility of Subcommittee D18.08 on Special and Construction Control Tests.

Current edition approved Oct. 10, 1996. Published February 1997. Originally published as D 2922 – 71. Last previous edition D 2922 – 91.

[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] *Annual Book of ASTM Standards*, Vol 04.09.

been corrected out of the direct transmission method and any remaining bias is insignificant. The backscatter method is still more sensitive to the material within the first several inches from the surface.

4.3 Oversize rocks or large voids in the source-detector path may cause higher or lower density determination. Where lack of uniformity in the soil due to layering, rock or voids is suspected, the test volume site should be dug up and visually examined to determine if the test material is representative of the full material in general and if rock correction (see 9.6) is required.

4.4 The sample volume is approximately 0.0028 m^3 (0.10 ft^3) for the Backscatter Method and 0.0057 m^3 (0.20 ft^3) for the Direct Transmission Method when the test depth is 15 cm (6 in.). The actual sample volume is indeterminate and varies with the apparatus and the density of the material. In general, the higher the density the smaller the volume.

5. Apparatus

5.1 *Nuclear Gage*—An electronic counting instrument, capable of being seated on the surface of the material under test, and which contains:

5.1.1 A sealed source of high energy gamma radiation such as cesium or radium.

5.1.2 *Gamma* Detector-Any type of gamma detector such as a Geiger-Mueller tube(s).

5.2 *Reference Standard-A* block of material used for checking instrument operation and to establish conditions for a reproducible reference count rate.

5.3 *Site Preparation* Device-A plate, straightedge, or other suitable leveling tool which may be used for planning the test site to the required smoothness, and in the Direct Transmission Method, guiding the drive pin to prepare a perpendicular hole.

5.4 *Drive Pin-A* pin of slightly larger diameter than the rod in the Direct Transmission Instrument, used to prepare a hole in the material under test for inserting the rod.

5.5 *Drive Pin Extractor-A* tool that may be used to remove the drive pin in a vertical direction so that the pin will not distort the hole in the extraction process.

5.5.1 A slide hammer, with a drive pin attached, may also be used both to prepare a hole in the material to be tested and to extract the pin without distortion to the hole.

6. Hazards

6.1 This equipment utilizes radioactive materials that may be hazardous to the health of the users unless proper precautions are taken. Users of this equipment must become familiar with applicable safety procedures and government regulations.

6.2 Effective user instructions together with routine safety procedures, such as source leak tests, recording and evaluation of film badge data, etc., are a recommended part of the operation and storage of this instrument.

7. Calibration

7.1 Calibration of the instrument will be in accordance with Annex A I.

8. Standardization and Reference Check

8.1 Nuclear gages are subject to long-term aging of the radioactive source, detectors, and electronic systems, which may change the relationship between count rate and material density. To offset this aging, the gage may be calibrated as the ratio of the measured count rate to a count rate made on a reference standard or to an air-gap count (for the backscatter air-gap technique, see 9.5.1.3). The reference count rate should be of the same order of magnitude as the measured count rate over the useful density range of the instrument.

8.2 Standardization of the gage shall be performed at the start of each day's work, and a permanent record of these data shall be retained. Perform the standardization with the gage located at least 8 m (25 ft) away from other sources of radioactive material, and clear of large masses or other items which may affect the reference count rate.

8.2.1 If recommended by the instrument manufacturer to provide more stable and consistent results: (*1*) turn on the gauge prior to use to allow it to stabilize, (2) leave the power on during the use of the gage for that day.

8.2.2 Using the reference standard, take at least four repetitive readings at the normal measurement period and determine the mean. If available on the gage, one measurement period of four or more times the normal period is acceptable. This constitutes one standardization check.

8.2.3 If the value obtained above is within the limits stated below, the gage is considered to be in satisfactory condition, and the value may be used to determine the count ratios for the day of use. If the value is outside these limits, allow additional time for the gage to stabilize, make sure the area is clear of sources of interference, and then conduct another standardization check. If the second standardization check is within the limits, the gage may be used, but if it also fails the test, the gage shall be adjusted or repaired as recommended by the manufacturer. The limits are as follows:

$$|N_s - N_o| \leq 2.0 \sqrt{N_o/F} \quad (1)$$

where:

N_s = value of current standardization count,

N_o = average of the past four values of N_s taken for prior usage, and

F = value of prescale. [The prescale value (F) is a divisor which reduces the actual value for the purpose of display. The manufactor will supply this value if other than 1.0.] Some instruments may have provisions to compute and display these values.

8.2.3.1 If the instrument standardization has not been checked within the previous three months, perform at least four new standardization checks, and use the mean as the value for N_o.

8.3 Use the value of N_s to determine the count ratios for the current day's use of the instrument. If for any reason the measured density becomes suspect during the day's use, perform another standardization check.

9. Procedure for Field Use

9.1 Standardize the gage. (See Section 8.)

9.2 Select a test location. If the gage will be closer than 250 mm (10 in.) to any vertical mass that might influence the result, such as in a trench or alongside a pipe, follow the manufacturer's correction procedure.

9.3 Remove all loose and disturbed material. Remove

additional material as necessary to reach the material that represents a valid sample of the zone or stratum to be tested. Surface drying and spatial bias should be considered in determining the depth of material to be removed.

9.4 Plane or scrape a smooth horizontal surface so as to obtain maximum contact between the gage and the material being tested. The placement of the gage on the surface of the material to be tested is always important, but is especially critical to the successful determination of density when using the *backscatter* method. The optimum condition in all cases, is total contact between the bottom surface of the gauge and the surface of the material being tested. To correct for surface irregularities, use of native fines or fine sand as a filler may be necessary. The depth of the filler should not exceed approximately 3 mm (⅛ in.) and the total area filled should not exceed 10 % of the bottom area of the instrument. The maximum depth of any void beneath the gage that can be tolerated without filling shall not exceed approximately 3 mm (⅛ in.). Several trial seatings may be required to achieve these conditions.

9.5 Proceed with the test in the following manner:

9.5.1 Backscatter Procedure:

9.5.1.1 Seat the gage firmly on the prepared test site.

9.5.1.3 Keep all other radioactive sources away from the gauge to avoid affecting the measurement so as not to affect the readings.

9.5.1.3 Secure and record one or more readings for the normal measurement period in the backscatter position.

NOTE 2—When using the backscatter air-gap procedure, follow the instrument manufacturers instructions regarding apparatus set up. Take the same number of readings for the normal measurement period in the air-gap position as in the standard backscatter position. Determine the air-gap ratio by dividing counts per minute obtained in the air-gap position by counts per minute obtained in standard backscatter position.

9.5.1.4 Determine the ratio of the reading to the standard count or to the air gap count. From this count ratio and the appropriate calibration and adjustment data, determine the in-place wet density.

9.5.2 *Direct Transmission Procedure:*

9.5.2.1 Make a hole perpendicular to the prepared surface using the guide and the hole-forming device 5.4, or by drilling if necessary. The hole shall be of such depth and alignment that insertion of the probe will not cause the gage to tilt from the plane of the prepared area. The depth of the hole must be deeper than the depth to which the probe will be placed. The guide shall be the same size as the base of the gauge, with the hole in the same location on the guide as the probe on the gauge. The corners of the guide are marked by scoring the surface of the soil. The guide plate is then removed and any necessary repairs are made to the prepared surface.

9.5.2.2 Proceed with testing in the following manner:

9.5.2.3 Set the gage on the soil surface, carefully aligning it with the marks on the soil so that the probe will be directly over the pre-formed hole.

9.5.2.4 Insert the probe in the hole.

9.5.2.5 Seat the gage firmly by rotating it about the probe with a back and forth motion.

9.5.2.6 Pull gently on the gage in the direction that will bring the side of the probe against the side of the hole that is closest to the detector (or source) location in the gauge housing.

9.5.2.7 Keep all other radioactive sources away from the gage to avoid affecting the measurement.

9.5.2.8 Secure and record one or more readings for the normal measurement period.

9.5.2.9 Determine the ratio of the reading to the standard count. From this count ratio and the appropriate calibration and adjustment data, determine the in-place wet density.

NOTE 3—Some instruments have built-in provisions to compute the ratio, wet density, and to enter an adjustment bias. Additionally some instruments may have provisions to measure and compute moisture content, and dry density.

9.6 If the volume tested as defined in 4.4 has excess oversize material with respect to the limitations in the appropriate Test Methods D 698, D 1557 or D 4253, then a correction for wet density (unit weight) and water content must be applied. This correction will be done in accordance with Practice D 4718. This test method requires sampling from the actual test volume.

9.6.1 If samples of the measure material are to be taken for purposes of correlation with other test methods or rock correction, the volume measured can be approximated by a 200 mm (8 in.) diameter cylinder located directly under the center line of the radioactive source and detector(s). The height of the cylinder to be excavated will be the depth setting of the source rod when using the Direct Transmission method or approximately 75 mm (3 in.) when using the Backscatter Method.

9.6.2 An alternative to the correction for oversize particles, that can be used with mass density methods or minimal oversize situations, involves multiple tests. Tests may be taken at adjacent locations and the results averaged to get a representative value. Comparisons need to be made to evaluate whether the presence of a single large rock or void in the soil is producing unrepresentative values of density. Whenever values obtained are questionable, the test volume site should be dug up and visually examined.

10. Calculation of Results

10.1 The in-place wet density is determined as outlined in 9.5. If dry density is required, the in-place water content shall be determined using either gravimetric samples and laboratory determination of water content (Test Methods D 2216, D 4643, D 4959, D 4944), or an instrument which determines water content by neutron thermalization (Test Method D 3017).

10.1.1 If the water content is determined by nuclear methods, Test Method D 3017, subtract the kg/m³ (lbf/ft³) of moisture from the kg/m³ (lbf/ft³) of wet density, and obtain dry density in kg/m³ (lbf/ft³).

10.1.2 If the water content is determined by other methods, and is in the form of percent, proceed as follows:

$$\rho_d = \frac{100\rho_m}{100 + w} \quad (2)$$

where:

ρ_d = dry density in kg/m³ (lbf/ft³),
ρ_m = wet density in kg/m³ (lbf/ft³), and
W = water as a percent of the dry mass.

11. Report

11.1 Report the following information:

11.1.1 Standardization and adjustment data for the date of the tests.

11.1.2 Make, model and serial number of the test instrument.

11.1.3 Name of the operator(s).

11.1.4 Test site identification.

11.1.5 Visual description of material tested.

11.1.6 Test mode (backscatter or direct transmission) and test depth (if applicable).

11.1.7 Wet and dry densities in kg/m^3 or unit weights in lb/ft^3.

11.1.8 Water content in percent of dry mass or dry unit weight.

12. Precision and Bias

12.1 *Precision:*

12.1.1 Precision-Criteria for judging the acceptability of wet density test results obtained by this test method are given in Table 1. The figure in column three represents the standard deviations that have been found to be appropriate for the materials tested in column one. The figures given in column four are the limits that should not be exceeded by the difference between the results of two properly conducted tests. The figures given are based upon an interlaboratory study in which five test sites containing soils, with wet densities as shown in column two were tested by eight different devices and operators. The wet density of each test site was determined three times by each device.[4]

12.1.2 An instrument count precision of 8 kg/m^3 (0.5 lbf/ft^3) for the Backscatter Method and 4 kg/m^3 (0.25 lbf/ft^3) Direct Transmission Method are typical on a material of approximately 2000 kg/m^3 (125 lbf/ft^3) density, with a measurement time of one minute.

[4] The data used to establish this precision statement is contained in a Research Report available from ASTM Headquarters. Request RR:D 18-1004.

TABLE 1 Results of Statistical Analysis

Precision and Soil Type	Average kg/m^3 (lb/ft^3)	Standard Deviation, kg/m^3 (lb/ft^3)	Acceptable Range of Two Results kg/m^3 (lb/ft^3)
Single Operator Precision:			
Direct Transmission:			
CL	1637 (114.7)	5.4 (0.34)	15.1 (0.94)
SP	1937 (120.9)	4.3 (0.27)	11.9 (0.74)
ML	2064 (130.1)	7.4 (0.46)	20.5 (1.28)
Backscatter:			
ML	1996 (124.6)	19.4 (1.21)	54.3 (3.39)
Multilaboratory Precision:			
Direct Transmission:			
a	1637 (114.7)	10.6 (0.66)	29.8 (1.66)
SP	1937 (120.9)	10.9 (0.66)	30.6 (1.91)
ML	2084 (130.1)	12.3 (0.77)	34.4 (2.15)
Backscatter:			
ML	1996 (124.6)	36.1 (2.36)	107 (6.67)

12.1.2.1 Instrument count precision is defined as the change in density that occurs corresponding to a one standard deviation change in the count due to the random decay of the radioactive source. The density of the material and the time period of the count must be stated. It may be determined from a series of 20 or more counts taken without moving the instrument, or alternately from the calibration data using the assumption that σ is equal to the $\sqrt{\text{count}}$ at that density. The count must be the true instrument count corrected for any pre-scaling (see 8.2.3).

$$P = \frac{\sigma}{S} \tag{3}$$

where:

P = instrument precision in density (kg/m^3 or lbf/ft^3)

σ = one standard deviation of the count

S = the slope of the calibration curve at the defined density value.

12.2 *Bias:*

12.2.1 There is no accepted reference value for this test method, therefore, bias cannot be determined.

13. Keywords

13.1 density; field density; nuclear methods

ANNEX

(Mandatory Information)

A1. CALIBRATION

A1.1 Verify or reestablish calibration curves, tables, or equation coefficients at least once every 12 to 18 months and after all major repairs which may affect the instrument geometry.

A1.2 The instrument shall be calibrated in such a way as to produce a calibration response within ± 16 kg/m^3 (± 1.0 lbf/ft^3) on blocks of materials (standards) of established densities. (This calibration may be done by the manufacturer, the user, or an independent vendor.) Nuclear instrument response is influenced by the chemical composition of measured material. This response must be taken into account in establishing the assigned standard block density. The densities of materials used to establish or verify the calibration should extend through a range representative of the density of the materials to be tested. The density of these material standards shall be determined to an accuracy of ± 0.2 %.

A1.3 Sufficient data shall be taken on each density standard to ensure an instrument count precision of at least one-half the instrument count precision required for field use. The data may be presented in the form of a graph, table, equation coefficients, or stored in the gauge, to allow covering the count rate data to material density.

A1.4 The method and test procedures used in establishing

the calibration count rate data shah be the same as those used for obtaining the field count rate data.

A1 .5 The material type, actual density and assigned standard block density of each calibration standard used to establish or verify the instrument calibration shall be stated as part of the calibration data.

A1 .6 The standards shah be of sufficient size to not change the count rate if enlarged in any dimension. Minimum surface dimensions of approximately 6 10 mm long by 430 mm wide (24 by 17 in.) have proven satisfactory. For the Backscatter Method a minimum depth of 230 mm (9 in.) is adequate; for the Direct Transmission Method the depth shah be at least 50 mm (2 in.) deeper than the deepest rod depth. A larger surface area may be required for the Backscatter Air-Gap technique. Minimum surface dimensions may be reduced slightly if the standards are adjacent to a dense material.

A1 .7 The most successful standards that have been established for accurate calibration have been made of aluminum, magnesium, aluminum/magnesium, granite and limestone. These standards have been used in combination with each other and with historical curve information to produce accurate and reliable calibration.

A1 .7.1 Standards of soil, rock, and concrete that have the characteristics of reproducible uniformity are difficult to prepare. These standards may be of use for some special calibration or field calibration where local site material chemistry or background situation require special adaptation.

The American Society for Testing and Materials takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, 100 Barr Harbor Drive, West Conshohocken, PA 19428.

APPENDIX H

UFGS SECTION 02770A
CONCRETE SIDEWALKS AND CURBS AND GUTTERS

MARCH 2004

UNIFIED FACILITIES GUIDE SPECIFICATIONS

Latest change indicated by CHG tags

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SECTION 02770A

CONCRETE SIDEWALKS AND CURBS AND GUTTERS
03/04

NOTE: This guide specification covers the requirements for concrete sidewalks and curbs and gutters.

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: This specification may be adjusted to cover separate curbs and gutters or combination curbs and gutters. This guide specification will not be used for integral or monolithic curbs of concrete pavement or for curbs and gutters for bridges.

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.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(1991; R 2000) Burlap Cloth Made from Jute or Kenaf

ASTM INTERNATIONAL (ASTM)

ASTM A 185	(2002) Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A 615/A 615M	(2003a) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM C 143/C 143M	(2003) Slump of Hydraulic Cement Concrete
ASTM C 171	(2003) Sheet Materials for Curing Concrete
ASTM C 172	(1999) Sampling Freshly Mixed Concrete
ASTM C 173	(1994ael) Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 231	(2003) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 309	(2003) Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 31/C 31M	(2003a) Making and Curing Concrete Test Specimens in the Field
ASTM C 920	(2002) Elastomeric Joint Sealants
ASTM D 1751	(1999) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(1984; R 1996e1) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D 5893	(1996) Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements

1.2 MEASUREMENT FOR PAYMENT

****

NOTE: The MEASUREMENT FOR PAYMENT and BASIS FOR PAYMENT paragraphs will be deleted if the work covered by this section of the specifications is included in one lump-sum contract price for the

entire work covered by the invitation for bids.

****

1.2.1 Sidewalks

The quantities of sidewalks to be paid for will be the number of square meters yards of each depth of sidewalk constructed as indicated.

1.2.2 Curbs and Gutters

The quantities of curbs and gutters to be paid for will be the number of linear meters feet of each cross section constructed as indicated, measured along the face of the curb at the gutter line.

1.3 BASIS FOR PAYMENT

1.3.1 Sidewalks

Payment of the quantities of sidewalks measured as specified will be at the contract unit price per square meter yard of the thickness specified.

1.3.2 Curbs and Gutters

Payment of the quantities of curbs and gutters measured as specified will be at the contract unit price per linear meter foot of each cross section.

1.4 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-03 Product Data

Concrete

Copies of certified delivery tickets for all concrete used in the construction.

SD-06 Test Reports

Field Quality Control

Copies of all test reports within 24 hours of completion of the test.

1.5 WEATHER LIMITATIONS

1.5.1 Placing During Cold Weather

Concrete placement shall not take place when the air temperature reaches 5 degrees C 40 degrees F and is falling, or is already below that point. Placement may begin when the air temperature reaches 2 degrees C 35 degrees F and is rising, or is already above 5 degrees C 40 degrees F. Provisions shall be made to protect the concrete from freezing during the specified curing period. If necessary to place concrete when the temperature of the air, aggregates, or water is below 2 degrees C 35 degrees F, placement and protection shall be approved in writing. Approval will be contingent upon full conformance with the following provisions. The underlying material shall be prepared and protected so that it is entirely free of frost when the concrete is deposited. [Mixing water and aggregates] [Mixing water] [Aggregates] shall be heated as necessary to result in the temperature of the in-place concrete being between 10 and 30 degrees C 50 and 85 degrees F. Methods and equipment for heating shall be approved. The aggregates shall be free of ice, snow, and frozen lumps before entering the mixer. Covering and other means shall be provided for maintaining the concrete at a temperature of at least 10 degrees C 50 degrees F for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period.

1.5.2 Placing During Warm Weather

The temperature of the concrete as placed shall not exceed 30 degrees C 85 degrees F except where an approved retarder is used. The mixing water and/or aggregates shall be cooled, if necessary, to maintain a satisfactory placing temperature. **The placing temperature shall not exceed 35 degrees C 95 degrees F at any time.**

1.6 PLANT, EQUIPMENT, MACHINES, AND TOOLS

1.6.1 General Requirements

Plant, equipment, machines, and tools used in the work shall be subject to approval and shall be maintained in a satisfactory working condition at all times. The equipment shall have the capability of producing the required product, meeting grade controls, thickness control and smoothness requirements as specified. Use of the equipment shall be discontinued if it produces unsatisfactory results. The Contracting Officer shall have access at all times to the plant and equipment to ensure proper operation and compliance with specifications.

1.6.2 Slip Form Equipment

Slip form paver or curb forming machine, will be approved based on trial use on the job and shall be self-propelled, automatically controlled, crawler mounted, and capable of spreading, consolidating, and shaping the plastic concrete to the desired cross section in 1 pass.

PART 2 PRODUCTS

2.1 CONCRETE

Concrete shall conform to the applicable requirements of [Section 03300A CAST-IN-PLACE STRUCTURAL CONCRETE] [Section 02753A CONCRETE PAVEMENT FOR AIRFIELDS AND OTHER HEAVY-DUTY PAVEMENTS] [Section 02754A CONCRETE PAVEMENTS FOR SMALL PROJECT] except as otherwise specified. Concrete shall have a minimum compressive strength of 24 MPa 3500 psi at 28 days. Maximum size of aggregate shall be 37.5 mm 1-1/2 inches.

2.1.1 Air Content

****

NOTE: The air content specified is for concrete that will be subjected to freezing weather and the possible action of deicing chemicals. In climates where freezing is not a factor but where air entrainment is used in local commercial practice to improve the workability and placeability of concrete, concrete having air content percent of 4.5 plus or minus 1.5 percent may be specified as Contractor's option to non air-entrained concrete.

****

Mixtures shall have air content by volume of concrete of 5 to 7 percent, based on measurements made immediately after discharge from the mixer.

2.1.2 Slump

****

NOTE: The desired slump will be inserted. Suggested limits are 75 mm (3 inches) plus or minus 25 mm (1 inch) for hand placed concrete or 25 mm (1 inch) plus or minus 10 mm (1/2 inch) for slipformed concrete.

****

The concrete slump shall be 50 mm plus or minus 25 mm 2 inches plus or

minus 1 inch where determined in accordance with ASTM C 143/C 143M.

2.1.3 Reinforcement Steel

****
NOTE: Reinforcement steel normally will not be required for curb and gutter construction. Where conditions exist that make it advantageous to use reinforcement steel, the reinforcing steel details will be indicated, and the following paragraphs will be included in the contract specification.
****

Reinforcement bars shall conform to ASTM A 615/A 615M. Wire mesh reinforcement shall conform to ASTM A 185.

2.2 CONCRETE CURING MATERIALS

2.2.1 Impervious Sheet Materials

Impervious sheet materials shall conform to ASTM C 171, type optional, except that polyethylene film, if used, shall be white opaque.

2.2.2 Burlap

Burlap shall conform to AASHTO M 182.

2.2.3 White Pigmented Membrane-Forming Curing Compound

White pigmented membrane-forming curing compound shall conform to ASTM C 309, Type 2.

2.3 CONCRETE PROTECTION MATERIALS

Concrete protection materials shall be a linseed oil mixture of equal parts, by volume, of linseed oil and either mineral spirits, naphtha, or turpentine. At the option of the contractor, commercially prepared linseed oil mixtures, formulated specifically for application to concrete to provide protection against the action of deicing chemicals may be used, except that emulsified mixtures are not acceptable.

2.4 JOINT FILLER STRIPS

2.4.1 Contraction Joint Filler for Curb and Gutter

Contraction joint filler for curb and gutter shall consist of hard-pressed fiberboard.

2.4.2 Expansion Joint Filler, Premolded

****
NOTE: Either type of joint sealer may be specified if determined necessary by the Contracting Officer and the inapplicable publication removed. Joint sealing material may be omitted where sealing of expansion joints is not deemed essential or advisable.
****

Expansion joint filler, premolded, shall conform to ASTM D 1751 or ASTM D 1752, 13 mm 1/2 inch thick, unless otherwise indicated.

2.5 JOINT SEALANTS

Joint sealant, cold-applied shall conform to ASTM C 920 or ASTM D 5893.

2.6 FORM WORK

Form work shall be designed and constructed to ensure that the finished concrete will conform accurately to the indicated dimensions, lines, and elevations, and within the tolerances specified. Forms shall be of wood or steel, straight, of sufficient strength to resist springing during depositing and consolidating concrete. Wood forms shall be surfaced plank, 50 mm 2 inches nominal thickness, straight and free from warp, twist, loose knots, splits or other defects. Wood forms shall have a nominal length of 3 m 10 feet. Radius bends may be formed with 19 mm 3/4 inch boards, laminated to the required thickness. Steel forms shall be channel-formed sections with a flat top surface and with welded braces at each end and at not less than two intermediate points. Ends of steel forms shall be interlocking and self-aligning. Steel forms shall include flexible forms for radius forming, corner forms, form spreaders, and fillers. Steel forms shall have a nominal length of 3 m 10 feet with a minimum of 3 welded stake pockets per form. Stake pins shall be solid steel rods with chamfered heads and pointed tips designed for use with steel forms.

2.6.1 Sidewalk Forms

Sidewalk forms shall be of a height equal to the full depth of the finished sidewalk.

2.6.2 Curb and Gutter Forms

Curb and gutter outside forms shall have a height equal to the full depth of the curb or gutter. The inside form of curb shall have batter as indicated and shall be securely fastened to and supported by the outside form. Rigid forms shall be provided for curb returns, except that benders or thin plank forms may be used for curb or curb returns with a radius of 3 m 10 feet or more, where grade changes occur in the return, or where the central angle is such that a rigid form with a central angle of 90 degrees cannot be used. Back forms for curb returns may be made of 38 mm 1-1/2 inch benders, for the full height of the curb, cleated together. In lieu of inside forms for curbs, a curb "mule" may be used for forming and finishing this surface, provided the results are approved.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

****

NOTE: On most projects, major grading operations involving excavation and construction of embankments will be performed and paid for under other sections of the specifications and, therefore, are not included in this guide specification. Where such work, including the construction of any required subbase, must be done under this section, paragraphs FORM SETTING, SIDEWALK CONCRETE PLACEMENT AND FINISHING, and CURB AND GUTTER CONCRETE PLACEMENT

AND FINISHING will be revised to cover necessary additional requirements. The subgrade will be indicated as extending at least 600 mm (2 feet) in width back of curb, gutter, entrance, and combination curb and gutters.

****

The subgrade shall be constructed to the specified grade and cross section prior to concrete placement. Subgrade shall be placed and compacted [as directed] [in conformance with Section [_____]].

3.1.1 Sidewalk Subgrade

The subgrade shall be tested for grade and cross section with a template extending the full width of the sidewalk and supported between side forms.

3.1.2 Curb and Gutter Subgrade

The subgrade shall be tested for grade and cross section by means of a template extending the full width of the curb and gutter. The subgrade shall be of materials equal in bearing quality to the subgrade under the adjacent pavement.

3.1.3 Maintenance of Subgrade

The subgrade shall be maintained in a smooth, compacted condition in conformity with the required section and established grade until the concrete is placed. The subgrade shall be in a moist condition when concrete is placed. The subgrade shall be prepared and protected to produce a subgrade free from frost when the concrete is deposited.

3.2 FORM SETTING

Forms shall be set to the indicated alignment, grade and dimensions. Forms shall be held rigidly in place by a minimum of 3 stakes per form placed at intervals not to exceed 1.2 m 4 feet. Corners, deep sections, and radius bends shall have additional stakes and braces, as required. Clamps, spreaders, and braces shall be used where required to ensure rigidity in the forms. Forms shall be removed without injuring the concrete. Bars or heavy tools shall not be used against the concrete in removing the forms. Any concrete found defective after form removal shall be promptly and satisfactorily repaired. Forms shall be cleaned and coated with form oil each time before concrete is placed. Wood forms may, instead, be thoroughly wetted with water before concrete is placed, except that with probable freezing temperatures, oiling is mandatory.

3.2.1 Sidewalks

Forms for sidewalks shall be set with the upper edge true to line and grade with an allowable tolerance of 3 mm 1/8 inch in any 3 m 10 foot long section. After forms are set, grade and alignment shall be checked with a 3 m 10 foot straightedge. Forms shall have a transverse slope [as indicated] [of 20 mm per meter 1/4 inch per foot] with the low side adjacent to the roadway. Side forms shall not be removed for 12 hours after finishing has been completed.

3.2.2 Curbs and Gutters

The forms of the front of the curb shall be removed not less than 2 hours

nor more than 6 hours after the concrete has been placed. Forms back of curb shall remain in place until the face and top of the curb have been finished, as specified for concrete finishing. Gutter forms shall not be removed while the concrete is sufficiently plastic to slump in any direction.

3.3 SIDEWALK CONCRETE PLACEMENT AND FINISHING

3.3.1 Formed Sidewalks

Concrete shall be placed in the forms in one layer. When consolidated and finished, the sidewalks shall be of the thickness indicated. After concrete has been placed in the forms, a strike-off guided by side forms shall be used to bring the surface to proper section to be compacted. The concrete shall be consolidated with an approved vibrator, and the surface shall be finished to grade with a strike off.

3.3.2 Concrete Finishing

After straightedging, when most of the water sheen has disappeared, and just before the concrete hardens, the surface shall be finished with a wood float or darby to a smooth and uniformly fine granular or sandy texture free of waves, irregularities, or tool marks. A scored surface shall be produced by brooming with a fiber-bristle brush in a direction transverse to that of the traffic, followed by edging.

3.3.3 Edge and Joint Finishing

All slab edges, including those at formed joints, shall be finished with an edger having a radius of 3 mm 1/8 inch. Transverse joint shall be edged before brooming, and the brooming shall eliminate the flat surface left by the surface face of the edger. Corners and edges which have crumbled and areas which lack sufficient mortar for proper finishing shall be cleaned and filled solidly with a properly proportioned mortar mixture and then finished.

3.3.4 Surface and Thickness Tolerances

Finished surfaces shall not vary more than 8 mm 5/16 inch from the testing edge of a 3 m 10-foot straightedge. Permissible deficiency in section thickness will be up to 6 mm 1/4 inch.

3.4 CURB AND GUTTER CONCRETE PLACEMENT AND FINISHING

3.4.1 Formed Curb and Gutter

Concrete shall be placed to the section required in a single lift. Consolidation shall be achieved by using approved mechanical vibrators. Curve shaped gutters shall be finished with a standard curb "mule".

3.4.2 Curb and Gutter Finishing

Approved slipformed curb and gutter machines may be used in lieu of hand placement.

3.4.3 Concrete Finishing

Exposed surfaces shall be floated and finished with a smooth wood float until true to grade and section and uniform in texture. Floated surfaces

shall then be brushed with a fine-hair brush with longitudinal strokes. The edges of the gutter and top of the curb shall be rounded with an edging tool to a radius of 13 mm 1/2 inch. Immediately after removing the front curb form, the face of the curb shall be rubbed with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. The front curb surface, while still wet, shall be brushed in the same manner as the gutter and curb top. The top surface of gutter and entrance shall be finished to grade with a wood float.

3.4.4 Joint Finishing

Curb edges at formed joints shall be finished as indicated.

3.4.5 Surface and Thickness Tolerances

Finished surfaces shall not vary more than 6 mm 1/4 inch from the testing edge of a 3 m 10-foot straightedge. Permissible deficiency in section thickness will be up to 6 mm 1/4 inch.

3.5 SIDEWALK JOINTS

Sidewalk joints shall be constructed to divide the surface into rectangular areas. Transverse contraction joints shall be spaced at a distance equal to the sidewalk width or 1.5 m 5 feet on centers, whichever is less, and shall be continuous across the slab. Longitudinal contraction joints shall be constructed along the centerline of all sidewalks 3 m 10 feet or more in width. Transverse expansion joints shall be installed at sidewalk returns and opposite expansion joints in adjoining curbs. Where the sidewalk is not in contact with the curb, transverse expansion joints shall be installed as indicated. Expansion joints shall be formed about structures and features which project through or into the sidewalk pavement, using joint filler of the type, thickness, and width indicated. Expansion joints are not required between sidewalks and curb that abut the sidewalk longitudinally.

3.5.1 Sidewalk Contraction Joints

The contraction joints shall be formed in the fresh concrete by cutting a groove in the top portion of the slab to a depth of at least one-fourth of the sidewalk slab thickness, using a jointer to cut the groove, or by sawing a groove in the hardened concrete with a power-driven saw, unless otherwise approved. Sawed joints shall be constructed by sawing a groove in the concrete with a 3 mm 1/8 inch blade to the depth indicated. An ample supply of saw blades shall be available on the job before concrete placement is started, and at least one standby sawing unit in good working order shall be available at the jobsite at all times during the sawing operations.

3.5.2 Sidewalk Expansion Joints

****

NOTE: For projects which do not reference Section 02760A FIELD MOLDED SEALANTS FOR SEALING JOINTS IN RIGID PAVEMENTS, the last paragraph will replace the reference to Section 02760A.

****

Expansion joints shall be formed with 13 mm 1/2 inch joint filler strips. Joint filler in expansion joints surrounding structures and features within the sidewalk may consist of preformed filler material conforming to ASTM D 1752 or building paper. Joint filler shall be held in place with steel pins or other devices to prevent warping of the filler during floating and finishing. Immediately after finishing operations are completed, joint edges shall be rounded with an edging tool having a radius of 3 mm 1/8 inch, and concrete over the joint filler shall be removed. At the end of the curing period, expansion joints shall be cleaned and filled with cold-applied joint sealant. Joint sealant shall be gray or stone in color. [Joints shall be sealed as specified in Section 02760A FIELD MOLDED SEALANTS FOR SEALING JOINTS IN RIGID PAVEMENTS.] [The joint opening shall be thoroughly cleaned before the sealing material is placed. Sealing material shall not be spilled on exposed surfaces of the concrete. Concrete at the joint shall be surface dry and atmospheric and concrete temperatures shall be above 10 degrees C 50 degrees F at the time of application of joint sealing material. Excess material on exposed surfaces of the concrete shall be removed immediately and concrete surfaces cleaned.]

3.5.3 Reinforcement Steel Placement

****

NOTE: Reinforcement steel normally will not be required for curb and gutter construction. Where conditions exist that make it advantageous to use reinforcement steel, the reinforcing steel details will be indicated, and the following paragraphs will be included in the contract specification.

****

Reinforcement steel shall be accurately and securely fastened in place with suitable supports and ties before the concrete is placed.

3.6 CURB AND GUTTER JOINTS

Curb and gutter joints shall be constructed at right angles to the line of curb and gutter.

3.6.1 Contraction Joints

Contraction joints shall be constructed directly opposite contraction joints in abutting portland cement concrete pavements and spaced so that monolithic sections between curb returns will not be less than 1.5 m 5 feet nor greater than 4.5 m 15 feet in length. Contraction joints shall be constructed by means of 3 mm 1/8 inch thick separators and of a section conforming to the cross section of the curb and gutter. Separators shall be removed as soon as practicable after concrete has set sufficiently to preserve the width and shape of the joint and prior to finishing.

3.6.2 Expansion Joints

****

NOTE: For projects which do not reference Section 02760A FIELD MOLDED SEALANTS FOR SEALING JOINTS IN RIGID PAVEMENTS, the last paragraph will replace the reference to Section 02760A.

****

Expansion joints shall be formed by means of preformed expansion joint filler material cut and shaped to the cross section of curb and gutter. Expansion joints shall be provided in curb and gutter directly opposite expansion joints of abutting portland cement concrete pavement, and shall be of the same type and thickness as joints in the pavement. Where curb and gutter do not abut portland cement concrete pavement, expansion joints at least 13 mm 1/2 inch in width shall be provided at intervals not less than 10 meters (30 feet) nor greater than 35 meters (120 feet). Expansion joints shall be provided in nonreinforced concrete gutter at locations indicated. Expansion joints shall be sealed immediately following curing of the concrete or as soon thereafter as weather conditions permit. [Joints shall be sealed as specified in Section 02760A FIELD MOLDED SEALANTS FOR SEALING JOINTS IN RIGID PAVEMENTS.] [Expansion joints and the top 25 mm 1 inch depth of curb and gutter contraction-joints shall be sealed with joint sealant. The joint opening shall be thoroughly cleaned before the sealing material is placed. Sealing material shall not be spilled on exposed surfaces of the concrete. Concrete at the joint shall be surface dry and atmospheric and concrete temperatures shall be above 10 degrees C 50 degrees F at the time of application of joint sealing material. Excess material on exposed surfaces of the concrete shall be removed immediately and concrete surfaces cleaned.]

3.7 CURING AND PROTECTION

****

NOTE: Only the methods of curing appropriate to local weather conditions and construction practices will be retained, but Contractor's option of at least 2 curing methods will be retained to promote competition in bidding.

****

3.7.1 General Requirements

Concrete shall be protected against loss of moisture and rapid temperature changes for at least 7 days from the beginning of the curing operation. Unhardened concrete shall be protected from rain and flowing water. All equipment needed for adequate curing and protection of the concrete shall be on hand and ready for use before actual concrete placement begins. Protection shall be provided as necessary to prevent cracking of the pavement due to temperature changes during the curing period.

3.7.1.1 Mat Method

The entire exposed surface shall be covered with 2 or more layers of burlap. Mats shall overlap each other at least 150 mm 6 inches. The mat shall be thoroughly wetted with water prior to placing on concrete surface and shall be kept continuously in a saturated condition and in intimate contact with concrete for not less than 7 days.

3.7.1.2 Impervious Sheeting Method

The entire exposed surface shall be wetted with a fine spray of water and then covered with impervious sheeting material. Sheets shall be laid directly on the concrete surface with the light-colored side up and overlapped 300 mm 12 inches when a continuous sheet is not used. The curing medium shall not be less than 450 mm 18-inches wider than the concrete surface to be cured, and shall be securely weighted down by heavy

wood planks, or a bank of moist earth placed along edges and laps in the sheets. Sheets shall be satisfactorily repaired or replaced if torn or otherwise damaged during curing. The curing medium shall remain on the concrete surface to be cured for not less than 7 days.

3.7.1.3 Membrane Curing Method

A uniform coating of white-pigmented membrane-curing compound shall be applied to the entire exposed surface of the concrete as soon after finishing as the free water has disappeared from the finished surface. Formed surfaces shall be coated immediately after the forms are removed and in no case longer than 1 hour after the removal of forms. Concrete shall not be allowed to dry before the application of the membrane. If any drying has occurred, the surface of the concrete shall be moistened with a fine spray of water and the curing compound applied as soon as the free water disappears. Curing compound shall be applied in two coats by hand-operated pressure sprayers at a coverage of approximately 5 square meters/L 200 square feet per gallon for the total of both coats. The second coat shall be applied in a direction approximately at right angles to the direction of application of the first coat. The compound shall form a uniform, continuous, coherent film that will not check, crack, or peel and shall be free from pinholes or other imperfections. If pinholes, abrasion, or other discontinuities exist, an additional coat shall be applied to the affected areas within 30 minutes. Concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied shall be resprayed by the method and at the coverage specified above. Areas where the curing compound is damaged by subsequent construction operations within the curing period shall be resprayed. Necessary precautions shall be taken to insure that the concrete is properly cured at sawed joints, and that no curing compound enters the joints. The top of the joint opening and the joint groove at exposed edges shall be tightly sealed before the concrete in the region of the joint is resprayed with curing compound. The method used for sealing the joint groove shall prevent loss of moisture from the joint during the entire specified curing period. Approved standby facilities for curing concrete pavement shall be provided at a location accessible to the jobsite for use in the event of mechanical failure of the spraying equipment or other conditions that might prevent correct application of the membrane-curing compound at the proper time. Concrete surfaces to which membrane-curing compounds have been applied shall be adequately protected during the entire curing period from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests, and from any other possible damage to the continuity of the membrane.

3.7.2 Backfilling

After curing, debris shall be removed and the area adjoining the concrete shall be backfilled, graded, and compacted to conform to the surrounding area in accordance with lines and grades indicated.

3.7.3 Protection

Completed concrete shall be protected from damage until accepted. The Contractor shall repair damaged concrete and clean concrete discolored during construction. Concrete that is damaged shall be removed and reconstructed for the entire length between regularly scheduled joints. Refinishing the damaged portion will not be acceptable. Removed damaged portions shall be disposed of as directed.

3.7.4 Protective Coating

****

NOTE: Concrete may require protection against the action of urea, sodium chloride, and calcium chloride used for de-icing purposes. Protection against these chemicals is not required for concrete of the specified air content that will be in place for a cumulative time of 6 weeks at a continuous minimum temperature of 5 degrees C (40 degrees F), excluding the curing time. Concrete which is to receive protective coating should be moist cured to eliminate the need for removing a curing membrane prior to application of the protective coating. ACI Committee Report 515 provides a detailed discussion of protective coating for concrete. The following paragraphs will be inserted if protective coating is required.

****

Protective coating, of linseed oil mixture, shall be applied to the exposed-to-view concrete surface after the curing period, if concrete will be exposed to de-icing chemicals within 6 weeks after placement. Concrete to receive a protective coating shall be moist cured.

3.7.4.1 Application

Curing and backfilling operation shall be completed prior to applying two coats of protective coating. Concrete shall be surface dry and clean before each application. Coverage shall be by spray application at not more than 11 square meters/L 50 square yards per gallon for first application and not more than 15.5 square meters/L 70 square yards per gallon for second application, except that the number of applications and coverage for each application for commercially prepared mixture shall be in accordance with the manufacturer's instructions. Coated surfaces shall be protected from vehicular and pedestrian traffic until dry.

3.7.4.2 Precautions

Protective coating shall not be heated by direct application of flame or electrical heaters and shall be protected from exposure to open flame, sparks, and fire adjacent to open containers or applicators. Material shall not be applied at ambient or material temperatures lower than 10 degrees C 50 degrees F.

3.8 FIELD QUALITY CONTROL

3.8.1 General Requirements

The Contractor shall perform the inspection and tests described and meet the specified requirements for inspection details and frequency of testing. Based upon the results of these inspections and tests, the Contractor shall take the action and submit reports as required below, and any additional tests to insure that the requirements of these specifications are met.

3.8.2 Concrete Testing

3.8.2.1 Strength Testing

The Contractor shall provide molded concrete specimens for strength tests. Samples of concrete placed each day shall be taken not less than once a day nor less than once for every 190 cubic meters 250 cubic yards of concrete. The samples for strength tests shall be taken in accordance with ASTM C 172. Cylinders for acceptance shall be molded in conformance with ASTM C 31/C 31M by an approved testing laboratory. Each strength test result shall be the average of 2 test cylinders from the same concrete sample tested at 28 days, unless otherwise specified or approved. Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength, and no individual strength test result falls below the specified strength by more than 4 MPa 500 psi.

3.8.2.2 Air Content

Air content shall be determined in accordance with ASTM C 173 or ASTM C 231. ASTM C 231 shall be used with concretes and mortars made with relatively dense natural aggregates. Two tests for air content shall be made on randomly selected batches of each class of concrete placed during each shift. Additional tests shall be made when excessive variation in concrete workability is reported by the placing foreman or the Government inspector. If results are out of tolerance, the placing foreman shall be notified and he shall take appropriate action to have the air content corrected at the plant. Additional tests for air content will be performed on each truckload of material until such time as the air content is within the tolerance specified.

3.8.2.3 Slump Test

Two slump tests shall be made on randomly selected batches of each class of concrete for every 190 cubic meters 250 cubic yards, or fraction thereof, of concrete placed during each shift. Additional tests shall be performed when excessive variation in the workability of the concrete is noted or when excessive crumbling or slumping is noted along the edges of slip-formed concrete.

3.8.3 Thickness Evaluation

The anticipated thickness of the concrete shall be determined prior to placement by passing a template through the formed section or by measuring the depth of opening of the extrusion template of the curb forming machine. If a slip form paver is used for sidewalk placement, the subgrade shall be true to grade prior to concrete placement and the thickness will be determined by measuring each edge of the completed slab.

3.8.4 Surface Evaluation

The finished surface of each category of the completed work shall be uniform in color and free of blemishes and form or tool marks.

3.9 SURFACE DEFICIENCIES AND CORRECTIONS

3.9.1 Thickness Deficiency

When measurements indicate that the completed concrete section is deficient

in thickness by more than 6 mm 1/4 inch the deficient section will be removed, between regularly scheduled joints, and replaced.

3.9.2 High Areas

In areas not meeting surface smoothness and plan grade requirements, high areas shall be reduced either by rubbing the freshly finished concrete with carborundum brick and water when the concrete is less than 36 hours old or by grinding the hardened concrete with an approved surface grinding machine after the concrete is 36 hours old or more. The area corrected by grinding the surface of the hardened concrete shall not exceed 5 percent of the area of any integral slab, and the depth of grinding shall not exceed 6 mm 1/4 inch. Pavement areas requiring grade or surface smoothness corrections in excess of the limits specified above shall be removed and replaced.

3.9.3 Appearance

Exposed surfaces of the finished work will be inspected by the Government and any deficiencies in appearance will be identified. Areas which exhibit excessive cracking, discoloration, form marks, or tool marks or which are otherwise inconsistent with the overall appearances of the work shall be removed and replaced.

-- End of Section --

APPENDIX I

ACCUTEST LABORAORIES USACE LABORATORY VALIDATION APPROVAL US DEPARTMENT OF ARMY

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)

Printed on Recycled Paper

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 J

NMED SOIL SCREENING LEVELS REVISION 2.0

AUGUST 2004

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 206 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 206 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.

Columns 9 and 10: 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)	Endpoint	Industrial/ Occupational Soil (mg/kg)	Endpoint	Construction Worker Soil (mg/kg)	Endpoint	VOC	DAF 1 (mg/kg)	DAF 20 (mg/kg)
Acenaphthene	4.69E+03	nc	3.48E+04	nc	1.44E+04	nc	X	3.99E+00	7.98E+01
Acetaldehyde	9.43E+01	nc	3.42E+02	nc	3.08E+02	nc	X	3.32E-04	6.63E-03
Acetone	7.04E+04	nc	1.00E+05	sat	1.00E+05	sat	X	1.03E-01	2.06E+00
Acrylonitrile	3.96E+00	ca	1.15E+01	ca	5.22E+01	nc	X	6.61E-06	1.32E-04
Acetophenone	1.31E+03	sat	1.31E+03	sat	1.31E+03	sat	X		
Acrolein	1.84E-01	nc	6.70E-01	nc	6.01E-01	nc	X	8.39E-06	1.68E-04
Aldrin	2.84E-01	ca	1.12E+00	ca	6.99E+00	nc		1.47E-02	2.94E-01
Aluminum	7.78E+04	nc	1.00E+05	max	1.44E+04	nc		7.50E+03	1.50E+05
Anthracene	2.35E+04	nc	2.64E+05	nc	8.53E+04	nc	X	8.00E+01	1.60E+03
Antimony	3.13E+01	nc	4.54E+02	nc	1.24E+02	nc		2.71E-01	5.42E+00
Arsenic	3.90E+00	ca	1.77E+01	ca	8.52E+01	nc		2.92E+00	5.83E+01
Barium	5.45E+03	nc	7.83E+04	nc	1.44E+03	nc		4.12E+01	8.23E+02
Benzene	2.70E+01	ca	7.36E+01	ca	1.57E+02	nc	X	1.41E-03	2.83E-02
Benzidine	2.11E-02	ca	8.33E-02	ca	7.09E-01	ca			
Benzo(a)anthracene	6.21E+00	ca	2.34E+01	ca	2.14E+02	ca		5.49E-02	1.10E+00
Benzo(a)pyrene	6.21E-01	ca	2.34E+00	ca	2.14E+01	ca		3.06E-01	6.12E+00
Benzo(b)fluoranthene	6.21E+00	ca	2.34E+01	ca	2.14E+02	ca		1.70E-01	3.40E+00
Benzo(k)fluoranthene	6.21E+01	ca	2.34E+02	ca	2.14E+03	ca		1.70E+00	3.40E+01
Beryllium	1.56E+02	nc	2.25E+03	nc	5.62E+01	nc		3.16E+00	6.32E+01
α-BHC	9.02E-01	ca	3.99E+00	ca	3.00E+01	ca		2.21E-05	4.43E-04
β-BHC	3.16E+00	ca	1.40E+01	ca	5.39E+01	nc		7.61E-05	1.52E-03
γ-BHC	4.37E+00	ca	1.93E+01	ca	8.09E+01	nc		3.55E-04	7.09E-03
1,1-Biphenyl	8.90E+01	sat	8.90E+01	sat	8.90E+01	sat	X	3.56E+00	7.12E+01
Bis(2-chloroethyl) ether	2.04E+00	ca	5.95E+00	ca	9.09E+01	ca	X	1.87E-06	3.75E-05
Bis(2-chloroisopropyl) ether	3.13E+03	nc	6.19E+03	nc	4.24E+03	nc	X	7.04E-05	1.41E-03
Bis(2-ethylhexyl) phthalate	3.47E+02	ca	1.37E+03	ca	4.66E+03	nc		1.09E+02	2.17E+03
Bis(chloromethyl) ether	4.26E-03	ca	1.10E-02	ca	2.11E-01	ca	X	8.87E-09	1.77E-07
Boron	5.50E+03	nc	6.16E+04	nc	2.14E+04	nc			

Chemical	Residential Soil (mg/kg)	Endpoint	Industrial/ Occupational Soil (mg/kg)	Endpoint	Construction Worker Soil (mg/kg)	Endpoint	VOC	DAF 1 (mg/kg)	DAF 20 (mg/kg)
Bromobenzene	3.32E+01	nc	1.22E+02	nc	1.09E+02	nc	X	1.03E-02	2.06E-01
Bromodichloromethane	1.03E+02	ca	5.13E+02	ca	1.05E+03	nc	X	4.64E-05	9.28E-04
Bromomethane	7.62E+00	nc	2.92E+01	nc	2.52E+01	nc	X	1.84E-03	3.67E-02
1,3-Butadiene	8.91E-01	ca	2.13E+00	ca	4.11E+00	nc	X	1.32E-05	2.63E-04
2-Butanone (MEK)	5.73E+02	nc	2.10E+03	nc	1.88E+03	nc	X	3.32E-01	6.63E+00
tert-Butyl methyl ether (MTBE)	9.80E+02	ca	3.18E+03	ca	4.07E+04	ca	X	2.33E-03	4.67E-02
n-Butylbenzene	6.20E+01	sat	6.20E+01	sat	6.20E+01	sat	X	1.06E+00	2.13E+01
sec-Butylbenzene	6.05E+01	sat	6.05E+01	sat	6.05E+01	sat	X	8.54E-01	1.71E+01
tert-Butylbenzene	1.06E+02	sat	1.06E+02	sat	1.06E+02	sat	X	8.47E-01	1.69E+01
Cadmium[a]	7.41E+01	nc	8.60E+03	nc	4.74E-03	nc		3.76E-01	7.52E+00
Carbon disulfide	3.76E+03	nc	2.14E+04	nc	1.34E+04	nc	X	3.76E-01	7.52E+00
Carbon tetrachloride	3.13E+00	ca	7.75E+00	ca	9.06E+00	nc	X	2.87E-03	5.74E-02
Chlordane	1.62E+01	ca	7.19E+01	ca	1.30E+02	nc		3.61E-01	7.21E+00
2-Chloroacetophenone	4.07E-02	nc	1.48E-01	nc	1.33E-01	nc	X	4.35E-05	8.70E-04
2-Chloro-1,3-butadiene	5.64E+00	nc	2.05E+01	nc	1.84E+01	nc	X	5.51E-03	1.10E-01
1-Chloro-1,1-difluoroethane	2.05E+02	sat	1.00E+05	sat	1.00E+05	sat	X	6.36E+01	1.27E+03
Chlorobenzene	1.76E+02	nc	2.42E+02	sat	2.42E+02	sat	X	5.14E-02	1.03E+00
1-Chlorobutane	2.91E+02	sat	2.91E+02	sat	2.91E+02	sat	X	9.45E-01	1.89E+01
Chlorodifluoromethane	2.05E+02	sat	1.00E+05	sat	1.00E+05	sat	X	6.21E+01	1.24E+03
Chloroethane	1.38E+03	sat	1.38E+03	sat	1.38E+03	sat	X	1.12E-03	2.23E-02
Chloroform	3.56E+00	ca	8.52E+00	ca	1.88E+01	nc	X	2.45E-02	4.90E-01
Chloromethane	1.95E+01	ca	4.77E+01	ca	2.53E+02	nc	X	5.01E-04	1.00E-02
β-Chloronaphthalene	6.26E+03	nc	2.58E+04	nc	1.40E+04	nc	X	1.26E+00	2.52E+01
o-Chloronitrobenzene	1.69E+00	nc	6.23E+00	nc	5.54E+00	nc	X	3.98E-05	7.96E-04
p-Chloronitrobenzene	1.24E+01	nc	5.09E+01	nc	4.15E+01	nc	X	3.18E-04	6.37E-03
2-Chlorophenol	3.91E+02	nc	8.07E+02	nc	5.47E+02	nc	X	2.31E-02	4.62E-01
2-Chloropropane	2.87E+02	nc	6.89E+02	sat	6.89E+02	sat	X	4.34E-02	8.68E-01
o-Chlorotoluene	1.56E+03	nc	7.74E+02	nc	6.46E+02	nc	X	5.09E-02	1.02E+00
Chromium III	1.00E+05	max	1.00E+05	max	1.00E+05	max		9.90E+06	1.98E+08
Chromium VI	2.34E+02	nc	3.40E+03	nc	1.80E+02	ca		9.58E-01	1.92E+01
Chrysene	6.21E+02	ca	2.34E+03	ca	2.14E+04	ca	X	5.49E+00	1.10E+02

Chemical	Residential Soil (mg/kg)	Endpoint	Industrial/ Occupational Soil (mg/kg)	Endpoint	Construction Worker Soil (mg/kg)	Endpoint	VOC	DAF 1 (mg/kg)	DAF 20 (mg/kg)
Cobalt	1.52E+03	nc	2.05E+04	nc	6.10E+01	nc		2.26E+00	4.52E+01
Copper	3.13E+03	nc	4.54E+04	nc	1.24E+04	nc		3.52E+01	7.03E+02
Crotonaldehyde	3.37E+00	ca	1.67E+01	ca	5.18E+01	sat	X	1.53E-05	3.06E-04
Cumene (isopropylbenzene)	7.00E+02	nc	2.73E+03	nc	2.32E+03	nc	X	3.65E-01	7.29E+00
Cyanide	1.56E+03	nc	2.27E+04	nc	6.19E+03	nc		3.88E-02	7.75E-01
Cyanogen	3.13E+03	nc	8.22E+02	nc	7.11E+02	nc	X	5.55E-02	1.11E+00
Cyanogen bromide	7.04E+03	nc	1.85E+03	nc	1.60E+03	nc	X	1.27E-01	2.54E+00
Cyanogen chloride	3.91E+03	nc	1.03E+03	nc	8.88E+02	nc	X	6.93E-02	1.39E+00
DDD	2.44E+01	ca	1.11E+02	ca	8.29E+02	ca		4.20E-01	8.40E+00
DDE	1.72E+01	ca	7.81E+01	ca	5.85E+02	ca		1.34E+00	2.68E+01
DDT	1.72E+01	ca	7.81E+01	ca	1.38E+02	nc		7.89E-01	1.58E+01
Dibenz(a,h)anthracene	6.21E-01	ca	2.34E+00	ca	2.14E+01	ca		5.24E-02	1.05E+00
Dibenzofuran	3.13E+02	nc	3.17E+03	nc	1.09E+03	nc	X	2.85E-01	5.70E+00
1,2-Dibromo-3-chloropropane	3.64E+00	nc	1.32E+01	nc	1.19E+01	nc	X	1.01E-05	2.02E-04
Dibromochloromethane	7.62E+01	ca	3.79E+02	ca	1.39E+03	nc	X	1.14E-04	2.28E-03
1,2-Dibromoethane	7.14E-02	ca	3.36E-01	ca	2.47E+00	ca	X	2.11E-05	4.23E-04
1,4-Dichloro-2-butene	1.33E-01	ca	3.17E-01	ca	7.14E+00	ca	X	2.89E-07	5.78E-06
1,2-Dichlorobenzene	1.16E+02	sat	1.16E+02	sat	1.16E+02	sat	X	4.46E-01	8.93E+00
1,3-Dichlorobenzene	7.04E+01	nc	7.39E+01	nc	5.70E+01	nc	X	6.09E-03	1.22E-01
1,4-Dichlorobenzene	3.60E+01	ca	8.14E+01	sat	8.14E+01	sat	X	8.27E-02	1.65E+00
3,3-Dichlorobenzidine	1.08E+01	ca	4.26E+01	ca	3.71E+02	ca		1.88E-04	3.76E-03
Dichlorodifluoromethane	1.44E+02	nc	2.05E+02	sat	2.05E+02	sat	X	2.85E-01	5.70E+00
1,1-Dichloroethane	8.20E+02	nc	1.22E+03	sat	1.22E+03	sat	X	6.05E-03	1.21E-01
1,2-Dichloroethane	5.07E+00	ca	1.26E+01	ca	5.33E+01	nc	X	9.92E-04	1.98E-02
cis-1,2-Dichloroethene	7.82E+02	nc	2.67E+02	nc	2.28E+02	nc	X	1.68E-02	3.37E-01
trans-1,2-Dichloroethene	1.56E+03	nc	3.98E+02	nc	3.44E+02	nc	X	2.91E-02	5.82E-01
1,1-Dichloroethene	1.82E+02	nc	6.86E+02	nc	6.01E+02	nc	X	1.92E-03	3.84E-02
2,4-Dichlorophenol	1.80E+02	nc	2.05E+03	nc	6.99E+02	nc		1.22E-02	2.45E-01
1,2-Dichloropropane	1.00E+01	nc	3.64E+01	nc	3.28E+01	nc	X	3.94E-05	7.89E-04
1,3-Dichloropropene	1.13E+01	ca	2.98E+01	ca	8.38E+01	nc	X	1.28E-04	2.56E-03
Dicyclopentadiene	2.35E+03	nc	2.13E+00	nc	1.92E+00	nc	X	4.51E-04	9.02E-03

Chemical	Residential Soil (mg/kg)	Endpoint	Industrial/ Occupational Soil (mg/kg)	Endpoint	Construction Worker Soil (mg/kg)	Endpoint	VOC	DAF 1 (mg/kg)	DAF 20 (mg/kg)
Dieldrin	3.04E-01	ca	1.20E+00	ca	1.02E+01	ca		1.36E-04	2.71E-03
Diethyl phthalate	4.80E+04	nc	1.00E+05	max	1.00E+05	max		1.74E+01	3.48E+02
Dimethyl phthalate	1.00E+05	max	1.00E+05	max	1.00E+05	max		1.66E+02	3.31E+03
Di-n-butyl phthalate	6.00E+03	nc	6.84E+04	nc	2.33E+04	nc		1.84E+02	3.67E+03
2,4-Dimethylphenol	1.20E+03	nc	1.37E+04	nc	4.66E+03	nc		4.27E-02	8.54E-01
2,4-Dinitrotoluene	1.20E+02	nc	1.37E+03	nc	4.66E+02	nc		2.27E-02	4.54E-01
1,2-Diphenylhydrazine	6.08E+00	ca	2.39E+01	ca	2.04E+02	ca		9.73E-05	1.95E-03
Endosulfan	3.60E+02	nc	4.10E+03	nc	1.40E+03	nc		7.43E-01	1.49E+01
Endrin	1.80E+01	nc	2.05E+02	nc	6.99E+01	nc		3.72E-02	7.45E-01
Epichlorohydrin	1.51E+01	nc	5.90E+01	nc	5.01E+01	nc	X	3.46E-04	6.93E-03
Ethyl acetate	7.04E+04	nc	1.00E+05	sat	2.06E+04	sat	X	1.41E+00	2.83E+01
Ethyl acrylate	5.13E+01	sat	6.62E+02	ca	4.52E+03	ca	X	5.90E-04	1.18E-02
Ethyl chloride	1.38E+03	sat	1.38E+03	sat	7.48E+04	ca	X	1.12E-03	2.23E-02
Ethyl ether	1.89E+03	sat	1.89E+03	sat	1.89E+03	sat	X	2.27E-01	4.53E+00
Ethyl methacrylate	5.18E+01	sat	5.18E+01	sat	5.18E+01	sat	X	1.42E+00	2.85E+01
Ethylbenzene	1.06E+04	ca	2.54E+04	ca	5.71E+05	ca	X	5.25E-01	1.05E+01
Ethylene oxide	2.47E+00	ca	7.39E+00	ca	1.08E+02	ca	X	4.11E-06	8.23E-05
Fluoranthene	2.25E+03	nc	2.44E+04	nc	8.73E+03	nc		2.41E+02	4.82E+03
Fluorene	3.13E+03	nc	2.94E+04	nc	1.06E+04	nc	X	5.01E+00	1.00E+02
Furan	7.82E+01	nc	1.88E+01	nc	1.63E+01	nc	X	1.29E-03	2.58E-02
Heptachlor	1.08E+00	ca	4.26E+00	ca	3.63E+01	ca			
Hexachlorobenzene	3.04E+00	ca	1.20E+01	ca	1.02E+02	ca		8.27E-02	1.65E+00
Hexachloro-1,3-butadiene	1.20E+01	nc	1.37E+02	nc	4.66E+01	nc		8.08E-02	1.62E+00
Hexachlorocyclopentadiene	1.25E+02	nc	4.10E+03	nc	4.31E+02	nc		1.50E+01	3.00E+02
Hexachloroethane	6.00E+01	nc	6.84E+02	nc	2.33E+02	nc		1.37E-02	2.74E-01
n-Hexane	3.80E+01	sat	3.80E+01	sat	3.80E+01	sat	X	7.29E-01	1.46E+01
HMX	3.00E+03	nc	3.42E+04	nc	1.17E+04	nc			
Hydrogen cyanide	1.99E+01	nc	7.31E+01	nc	6.53E+01	nc	X	1.20E-03	2.40E-02
Indeno(1,2,3-c,d)pyrene	6.21E+00	ca	2.34E+01	ca	2.14E+02	ca		4.79E-01	9.58E+00
Iron	2.35E+04	nc	1.00E+05	max	9.29E+04	nc		3.27E+00	6.54E+01
Isobutanol	2.22E+04	sat	2.22E+04	sat	2.22E+04	sat	X	4.69E-01	9.39E+00

Chemical	Residential Soil (mg/kg)	Endpoint	Industrial/ Occupational Soil (mg/kg)	Endpoint	Construction Worker Soil (mg/kg)	Endpoint	VOC	DAF 1 (mg/kg)	DAF 20 (mg/kg)
Isophorone	5.12E+03	ca	2.02E+04	ca	4.66E+04	nc		1.69E-02	3.38E-01
Lead	4.00E+02		7.50E+02	nc	7.50E+02	nc		4.58E-01	9.17E+00
Lead (tetraethyl-)	6.11E-03	nc	6.84E-02	nc	2.38E-02	nc			
Maleic hydrazide	1.57E+03	sat	1.57E+03	sat	1.57E+03	sat	X	7.86E-01	1.57E+01
Manganese	1.55E+03	nc	2.18E+04	nc	1.48E+02	nc		5.24E-02	1.05E+00
Mercury (elemental)	1.00E+05	max	3.41E+02	nc	8.44E+01	nc			
Mercury (methyl)	6.11E+00	nc	6.84E+01	nc	2.38E+01	nc			
Methacrylonitrile	3.61E+00	nc	2.00E+01	nc	1.28E+01	nc	X	1.69E-04	3.39E-03
Methomyl	1.96E+03	nc	2.83E+02	nc	2.49E+02	nc	X	5.64E-02	1.13E+00
Methyl acetate	7.82E+04	nc	1.00E+05	sat	1.00E+05	nc	X	1.03E+02	2.06E+03
Methyl acrylate	2.35E+03	nc	3.12E+02	nc	2.75E+02	nc	X	4.62E-01	9.24E+00
Methyl isobutyl ketone	5.43E+03	nc	6.90E+03	sat	6.90E+03	sat	X	5.81E-02	1.16E+00
Methyl methacrylate	2.83E+03	sat	2.83E+03	sat	2.83E+03	sat	X	2.64E-01	5.29E+00
Methyl styrene (alpha)	2.16E+02	sat	2.16E+02	sat	2.16E+02	sat	X	3.09E-01	6.18E+00
Methyl styrene (mixture)	1.28E+02	nc	2.16E+02	sat	2.16E+02	sat	X	4.31E-02	8.62E-01
Methylcyclohexane	2.10E+03	nc	7.63E+03	nc	6.87E+03	nc	X	1.35E+01	2.69E+02
Methylene bromide	1.12E+02	nc	4.54E+02	nc	3.74E+02	nc	X	1.28E-02	2.56E-01
Methylene chloride	1.65E+02	ca	4.40E+02	ca	2.55E+03	sat	X	8.44E-04	1.69E-02
Molybdenum	3.91E+02	nc	5.68E+03	nc	1.55E+03	nc		2.02E+01	4.03E+02
Naphthalene	7.19E+01	nc	9.83E+01	sat	9.83E+01	sat	X	1.97E-02	3.93E-01
Nickel	1.56E+03	nc	2.25E+04	nc	5.61E+02	nc		1.30E+01	2.61E+02
Nitrate	1.00E+05	max	1.00E+05	max	1.00E+05	max			
Nitrite	7.82E+03	nc	1.00E+05	max	3.10E+04	nc			
Nitrobenzene	2.18E+01	nc	1.36E+02	nc	7.89E+01	nc	X	9.00E-04	1.80E-02
Nitroglycerin	3.47E+02	ca	1.37E+03	ca	1.19E+04	ca			
N-Nitrosodiethylamine	3.24E-02	ca	1.28E-01	ca	1.09E+00	ca			
N-Nitrosodimethylamine	9.54E-02	ca	3.76E-01	ca	3.20E+00	ca		1.15E-06	2.31E-05
N-Nitrosodi-*n*-butylamine	2.48E-01	ca	6.67E-01	ca	1.16E+01	ca	X	1.12E-06	2.24E-05
N-Nitrosodiphenylamine	9.93E+02	ca	3.91E+03	ca	3.40E+04	ca		2.94E-02	5.89E-01
N-Nitrosopyrrolidine	2.32E+00	ca	9.12E+00	ca	7.77E+01	ca			
m-Nitrotoluene	4.10E+02	nc	5.57E+02	sat	5.57E+02	sat	X	1.62E-02	3.24E-01

Chemical	Residential Soil (mg/kg)	Endpoint	Industrial/ Occupational Soil (mg/kg)	Endpoint	Construction Worker Soil (mg/kg)	Endpoint	VOC	DAF 1 (mg/kg)	DAF 20 (mg/kg)
o-Nitrotoluene	4.10E+02	nc	5.57E+02	sat	5.57E+02	sat	X	1.62E-02	3.24E-01
p-Nitrotoluene	4.10E+02	nc	5.57E+02	sat	5.57E+02	sat	X	1.62E-02	3.24E-01
Pentachlorobenzene	4.80E+01	nc	5.47E+02	nc	1.86E+02	nc		1.00E+00	2.00E+01
Pentachlorophenol	2.98E+01	ca	1.00E+02	ca	1.03E+03	ca		1.06E-03	2.11E-02
Phenanthrene	1.80E+03	nc	2.05E+04	nc	6.99E+03	nc		3.81E+00	7.62E+01
Phenol	1.80E+04	nc	1.00E+05	max	6.99E+04	nc		1.05E-03	2.11E-02
Polychlorinatedbiphenyls		ca		ca		ca			
Aroclor 1016	2.22E+00	ca	8.26E+00	ca	1.50E+01	nc			
Aroclor 1221	2.22E+00	ca	8.26E+00	ca	7.61E+01	ca			
Aroclor 1232	2.22E+00	ca	8.26E+00	ca	7.61E+01	ca			
Aroclor 1242	2.22E+00	ca	8.26E+00	ca	7.61E+01	ca			
Aroclor 1248	2.22E+00	ca	8.26E+00	ca	7.61E+01	ca			
Aroclor 1254	1.11E+00	nc	8.26E+00	ca	4.28E+00	nc			
Aroclor 1260	2.22E+00	ca	8.26E+00	ca	7.61E+01	ca			
n-Propylbenzene	5.32E+01	sat	5.32E+01	sat	5.32E+01	sat	X	1.06E+00	2.13E+01
Propylene oxide	2.17E+01	ca	9.01E+01	ca	7.91E+02	ca	X	4.52E-05	9.05E-04
Pyrene	2.30E+03	nc	3.13E+04	nc	9.05E+03	nc	X	2.84E+01	5.68E+02
RDX	4.42E+01	ca	1.74E+02	ca	6.99E+02	nc			
Selenium	3.91E+02	nc	5.68E+03	nc	1.55E+03	nc		2.58E-01	5.17E+00
Silver	3.91E+02	nc	5.68E+03	nc	1.55E+03	nc		4.23E-01	8.47E+00
Strontium	4.69E+04	nc	1.00E+05	max	1.00E+05	max		2.03E+02	4.06E+03
Styrene	4.19E+02	sat	4.19E+02	sat	4.19E+02	sat	X	1.35E-01	2.70E+00
1,2,4,5-Tetrachlorobenzene	1.80E+01	nc	2.05E+02	nc	6.99E+01	nc			
1,1,1,2-Tetrachloroethane	3.93E+01	ca	1.03E+02	ca	8.55E+02	sat	X	1.33E-04	2.66E-03
1,1,2,2-Tetrachloroethane	5.20E+00	ca	1.36E+01	ca	2.56E+02	ca	X	1.70E-05	3.40E-04
Tetrachloroethene	9.83E+00	ca	2.46E+01	ca	9.76E+01	sat	X	3.22E-04	6.44E-03
Thallium	5.16E+00	nc	7.49E+01	nc	2.04E+01	nc		1.42E-01	2.85E+00
Toluene	2.48E+02	sat	2.48E+02	sat	2.48E+02	sat	X	3.40E-01	6.80E+00
Toxaphene	4.42E+00	ca	1.74E+01	ca	1.48E+02	ca		2.35E-02	4.71E-01
Tribromomethane	8.11E+02	ca	4.02E+03	ca	6.02E+03	nc		3.01E-02	6.02E-01
1,1,2-Trichloro-1,2,2-trifluoroethane	3.18E+03	max	1.00E+05	max	1.00E+05	max	X		

Chemical	Residential Soil (mg/kg)	Endpoint	Industrial/ Occupational Soil (mg/kg)	Endpoint	Construction Worker Soil (mg/kg)	Endpoint	VOC	DAF 1 (mg/kg)	DAF 20 (mg/kg)
1,2,4-Trichlorobenzene	6.51E+02	nc	8.53E+02	sat	8.53E+02	sat	X	1.99E-01	3.98E+00
1,1,1-Trichloroethane	5.51E+02	sat	5.51E+02	sat	5.51E+02	sat	X	2.49E-02	4.98E-01
1,1,2-Trichloroethane	1.07E+01	ca	2.70E+01	ca	1.75E+02	nc	X	1.24E-03	2.47E-02
Trichloroethene	6.48E-01	ca	1.59E+00	ca	3.41E+01	ca	X	2.33E-03	4.66E-02
Trichlorofluoromethane	5.28E+02	nc	9.59E+02	sat	9.59E+02	sat	X	1.13E+00	2.27E+01
2,4,5-Trichlorophenol	6.00E+03	nc	6.84E+04	nc	2.33E+04	nc		9.24E+00	1.85E+02
2,4,6-Trichlorophenol	6.00E+00	nc	6.84E+01	nc	2.33E+01	nc		2.66E-03	5.32E-02
1,1,2-Trichloropropane	2.27E+01	nc	8.61E+01	nc	7.49E+01	nc	X	1.15E-02	2.30E-01
1,2,3-Trichloropropane	3.20E+00	ca	1.59E+01	ca	1.69E+01	nc	X	2.08E-06	4.17E-05
1,2,3-Trichloropropene	1.78E+01	nc	6.67E+01	nc	5.85E+01	nc	X	1.12E-02	2.23E-01
Triethylamine	6.36E+01	nc	2.31E+02	nc	2.08E+02	nc	X	2.06E-03	4.12E-02
1,2,4-Trimethylbenzene	5.22E+01	nc	1.91E+02	nc	1.71E+02	nc	X	6.89E-02	1.38E+00
1,3,5-Trimethylbenzene	2.23E+01	nc	6.89E+01	sat	6.89E+01	sat	X	1.72E-02	3.44E-01
2,4,6-Trinitrotoluene	3.00E+01	nc	3.42E+02	nc	1.17E+02	nc			
Vanadium	5.48E+02	nc	7.95E+03	nc	2.17E+03	nc		4.03E+01	8.07E+02
Vinyl acetate	9.53E+02	nc	3.49E+03	nc	3.12E+03	nc	X	7.30E-02	1.46E+00
Vinyl bromide	5.67E+00	nc	2.06E+01	nc	1.85E+01	nc	X	3.93E-05	7.86E-04
Vinyl chloride (Child)	3.49E-01	ca							
Vinyl chloride (adult)			1.30E+01	ca	1.74E+02	ca	X	3.25E-04	6.49E-03
m-Xylene	8.00E+01	sat	8.00E+01	sat	8.00E+01	sat	X	8.13E+00	1.63E+02
o-Xylene	9.86E+01	sat	9.86E+01	sat	9.86E+01	sat	X	7.37E+00	1.47E+02
p-Xylene	1.24E+02	sat	1.24E+02	sat	1.24E+02	sat	X	7.88E+00	1.58E+02
Xylenes	1.32E+02	sat	1.32E+02	sat	1.32E+02	sat	X	5.07E-01	1.01E+01
Zinc	2.35E+04	nc	1.00E+05	max	9.29E+04	nc		6.22E+02	1.24E+04

Notes: [a] - An oral absorption efficiency of 5% was assumed for the dermal route.
ca – carcinogenic effect basis
nc – noncarcinogenic effect basis
sat – soil saturation limit basis
max – low toxicity maximum, health based SSL exceeds 10^5 mg/kg
Compounds solid at ambient temperature will present a risk-based level over the soil saturation level (USEPA 2001a)

APPENDIX K

SITE-SPECIFIC ADDENDUM TO THE BASEWIDE HEALTH AND SAFETY PLAN

SITE-SPECIFIC ADDENDUM TO THE BASEWIDE HEALTH AND SAFETY PLAN

SWMU 8 SOIL REMEDIATION SITE HOLLOMAN AIR FORCE BASE ALAMOGORDO, NEW MEXICO

Prepared for:

49 CES/CEV
Holloman Air Force Base, New Mexico
and
U.S. Army Corps of Engineers
Omaha District
Omaha, Nebraska

CONTRACT NO. DACA45-03-D-0023
TASK ORDER NO. 017
Bhate Project Number: 9050291.01.01

Prepared by

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December 2005

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SITE-SPECIFIC ADDENDUM
SWMU 8 SOIL REMEDIATION SITE
HOLLOMAN AFB, NEW MEXICO

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A - Activity Hazards Analyses

ACRONYMS AND ABBREVIATIONS

AHA	Activity Hazard Analysis
ANSI	American National Standards Institute
Bhate	Bhate Environmental Associates, Inc.
CIH	Certified Industrial Hygienist
cu yds	Cubic yards
CFR	Code of Federal Regulations
CPR	Cardiopulmonary Resuscitation
dBA	Decibels
HAFB	Holloman Air Force Base
HASP	Health and Safety Plan
HSM	Health and Safety Manager
MSDS	Material Safety Data Sheet
mg/M^3	Milligrams per cubic meter of air
NFPA	National Fire Protection Agency
OWS	Oil/Water Separator
PCS	Petroleum Contaminated Soils
PID	Photo Ionization Detector
PELs	Permissible Exposure Limits
PPE	Personal protective equipment
ppm	Parts per million
SPF	Sun protection factor
SPM	Senior Project Manager
SSA	Site-Specific Addendum
SSHO	Site Safety and Health Officer
SWMU	Solid Waste Management Unit
VOCs	Volatile Organic Compounds

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1 PROJECT SAFETY COORDINATION

The Bhate personnel who are responsible for safety and health issues at the Solid Waste Management Unit (SWMU) 8 Soil Remediation, Holloman Air Force Base (HAFB), New Mexico project site are identified below. Their 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 Environmental Associates, Inc., (Bhate) for implementation on this scope of work. The requirements of this site-specific addendum are applicable to Bhate employees, their subcontractors, and site visitors.

This Health and Safety Plan has been reviewed and approved by:

John Hymer Site Manager/Site Safety and Health Officer (SSHO)	Signature	Date
Jim Moore, P.G. Project Manager	Signature	Date
Judith McBride, Certified Industrial Hygienist (CIH)	Signature	Date

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2 PROJECT BACKGROUND AND SCOPE

The objective of this remedial action is to remove, through excavation, and properly dispose of the remaining petroleum contaminated soils (PCS) located at SWMU 8 (former Oil/Water Separator) on the south side of Building 231. The Oil/Water Separator (OWS) was 4 feet wide, 8 feet long, and 4 feet deep. Based on interviews with HAFB personnel the OWS released wash water rinsate containing oils, detergents, and fuels into the surrounding soil. The OWS removal and initial site remediation activities were conducted by Ebasco Services in August 1995. Approximately 21 cubic yards (cu yds) of PCS were removed during the original excavation. Remediation activities were continued by Foster Wheeler in April 1997, and the original excavation was extended eastward from the eastern edge of the original excavation. An additional 32 cu yds of PCS were excavated. Activities planned for this remedial action include the excavation and disposal of PCS extending westward from the western edge of the original excavation. The anticipated activities for the project include:

- Mobilization and demobilization of equipment;
- Soil excavation and loading;
- Confirmation soil sampling and screening
- Excavated soils placement and land-farm maintenance, as applicable; and,
- Backfill excavation with clean soil.

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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
_v_ **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 surfaces • Heavy equipment and vehicular traffic • Materials handling • Slips, trips, and falls • Excavation
_v_ **Utilities**	• Low	• 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.
_v_ **Chemical**	• Moderate	• Potential for exposure to neat products should be limited to equipment fluids (fuel, lubricants, coolant, etc.) • Petroleum Hydrocarbons
_v_ **Physical**	• Moderate	• Thermal stressors • Equipment noise
_v_ **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 Activity Hazard Analysis (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	Soils Placement/Land-farm Maintenance and Backfilling Excavation with Clean Soil
Soil Excavation and Loading	Soil Confirmation Sampling and Screening

3.3 Written Safety Procedures and Programs

Table 3-3 provides a summary of the existing safety procedures and programs that will be used for this site. Copies of applicable procedures and programs are included in the *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

The following personal protective equipment (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
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
Equipment Operation	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
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 Tyvek coveralls may be worn as recommended by the SSHO.
Soil Sampling	Hard Hat[2] (for overhead hazards), Safety Glasses[1] with rigid side shields.	Steel toed boots	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 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	None[3, 4]	Minimum of long pants and shirts with a minimum 4-inch sleeve

Notes:

[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 40 hours of use with no continuous exposures over the established Permissible Exposure Limits (PELs)
- Changes that may be otherwise identified in 29 Code of Federal Regulations (CFR) §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:**
Judith McBride, CIH, **Bhate Health and Safety Manager**		

5 SITE MONITORING

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 Site Safety and Health Officer (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)	Compound / Instrument	Action Level(s) and Frequency	Actions
Excavation Soil Placement at and Maintenance of Land-farm Confirmation Soil Sampling and Screening	Total Volatile Organic Compounds (VOCs) / Photoionization Detector (PID)	0 - 9 parts per million (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 benzene.** Ensure personnel are upwind, notify the Site Manager. SSHO may upgrade PPE to Level C respiratory protection with organic vapor cartridge, as necessary. If benzene is detected follow response actions outlined for benzene.
	Benzene / 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.
	Particulates / Personal DataRam or similar particulate monitor	=1.5 milligrams per cubic meter of air (mg/M^3) particulates (average) not to exceed 5.0 mg/M^3 5 minute monitoring periods as necessary if visible dust is present.	Stop work, increase dust suppression

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6 SITE CONTROL

6.1 Control Measures

Site-specific site control measures will be used to control access to the work area. Tables 6-1 and 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	The work area will be clearly demarcated with signage and/or caution tape, as needed, or where necessary to restrict foot or vehicle traffic, temporary construction fencing will be erected. Entry into the work area will require authorization by the Site Manager.

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.

6.2 Decontamination

Required decontamination procedures are described below in Table 6-3.

Table 6-3. Decontamination Procedures

Type of decontamination	Decontamination Methods
Personnel decontamination	Personnel will be required to thoroughly wash hands and face 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	Efforts will be made to minimize equipment contact with contaminated materials. Prior to leaving the work area 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.

7 COMMUNICATIONS

Cellular telephones will be available to summon emergency services as required. Refer to Sections 10, 11, and 12 of this Site-Specific Addendum (SSA) for site specific guidance on emergency situations and appropriate actions. Site communication amongst workers shall be a combination of verbal and 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 personnel working on the SWMU 8 Soil Remediation project will follow the requirements outlined in the *Basewide HASP* Sections 7.4 and 5, respectively.

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9 HAZARDOUS CHEMICALS

Hazardous chemicals (as defined in 29 CFR §1910.1200) to be brought or used on-site are identified below. This chemical inventory and the Material Safety Data Sheets (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

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10 EMERGENCY ACTION AND RESPONSE

Personnel responsible for coordinating emergency response actions during the SWMU 8 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	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 Basewide Health and Safety Plan Incident Reporting and Investigation Procedure

Table 10-3 summarizes potential emergency situations and response actions that are applicable for the SWMU 8 Soil Remediation 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 (including 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 and 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 Health and Safety Manager (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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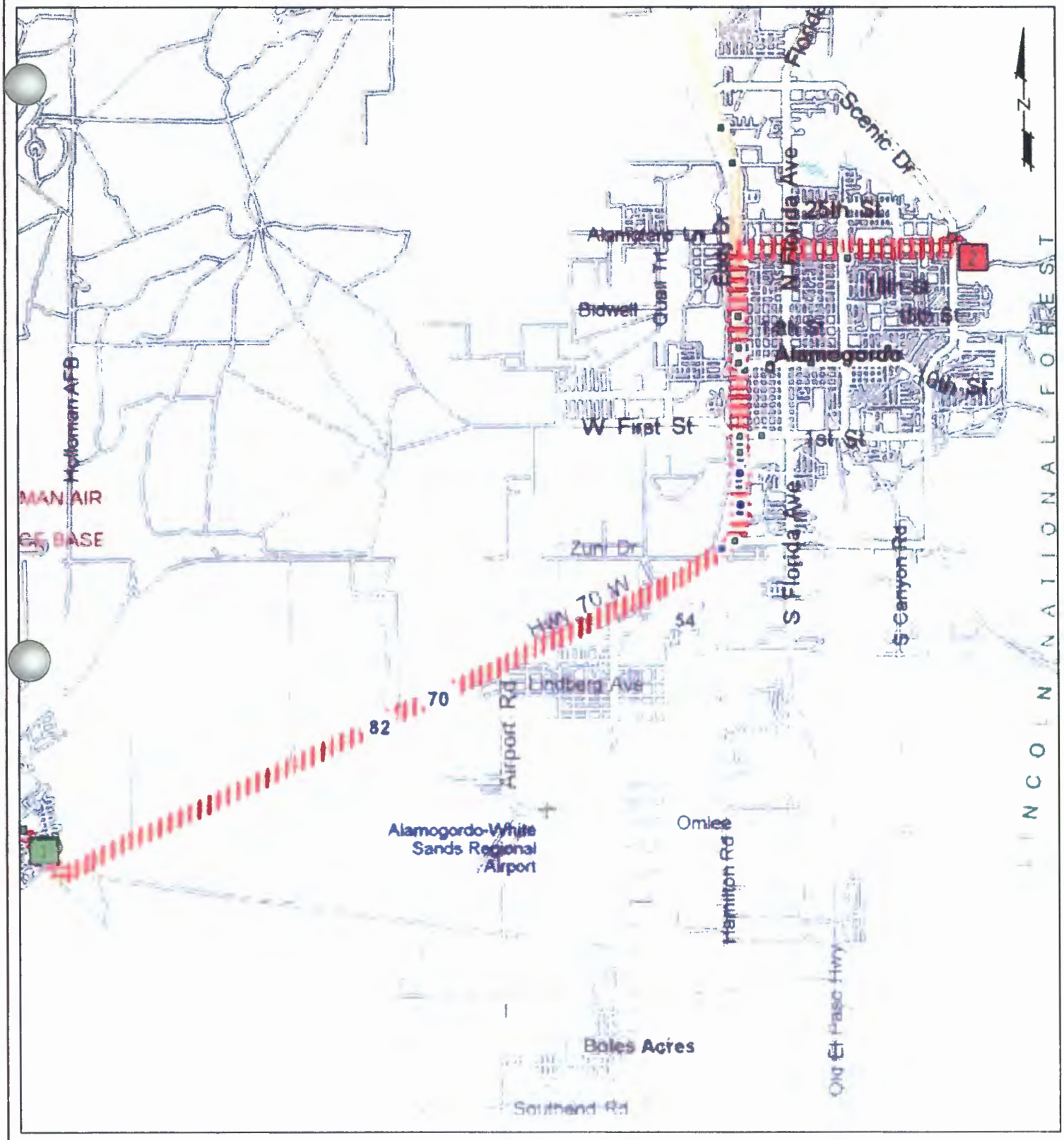
FIGURES



bhate

HOSPITAL ROUTE MAP

GERALD CHAMPION REGIONAL HOSPITAL

Source: Microsoft Expedia Street Maps

PROJECT NO.	SCALE	DATE	DRAWN BY: MRM
9050291	NTS	12/27/05	DRAWING NO: Figure 12–1

Holloman Air Force Base
Health and Safety Plan

Figure 12–1

ATTACHMENTS

ATTACHMENT A

ACTIVITY HAZARD ANALYSES (AHAS)

AHA No.	AHA Title
AHA - 1	General Site Activities, Mobilization, and Demobilization
AHA - 2	Soil Excavation/Loading and Confirmation Sampling
AHA - 3	Soils Placement/Land-farm Maintenance and Backfilling Excavation with Clean Soil

Activity Hazard Analysis (AHA) – 1

Task: General Site Activities; Site Mobilization and Demobilization		**Project:** SWMU 8 Soil Remediation
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	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 decibels (dBA) (ear muffs or plugs) • SSHO will determine the need for hearing protection • 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 skin 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 Agency (NFPA) approved and used with pouring spout or funnel • Equipment operation 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 an 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, 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

AHA – 1 (continued)

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 Cardiopulmonary Resuscitation (CPR) and First aid training

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Activity Hazard Analysis (AHA) – 2

Task: Excavation and Soil Loading		**Project:** SWMU 8 Soil Remediation
Minimum Personal Protective Equipment (PPE): Level D PPE		**Location:** Holloman Air Force Base, New Mexico
Activity	**Potential Hazard(s)**	**Control Measures**
Excavation and Confirmation Soil Sampling 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	• 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
	Exposure to soil contaminants	• Utilize appropriate PPE and decontamination procedures • Conduct work activities in a manner that minimizes potential contact with excavated materials

AHA – 2 (continued)

Activity	Potential Hazard(s)	Control Measures
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	• Only experienced personnel will operate equipment • 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)	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) – 3

Task: Soils Placement/Land-farm Maintenance and Backfilling Excavation with Clean Soil		**Project:** SWMU 8 Soil Remediation
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 Backfilling Excavation with Clean Soil	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
Hazards and recommended controls from AHA – 1 and AHA-2 apply	Heavy equipment operation	• Haul truck drivers should wait for signal from equipment operator to enter the land-farm soil placement area • Only experienced personnel will operate equipment • Ground personnel are not permitted to approach equipment in motion or while materials being handled • Maintain clear radius of machine • 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 • Only necessary personnel will be permitted in the delineated land-farm area
Equipment Used	**Inspection Requirements**	**Training Requirements**
Level D PPE First Aid Kits Portable Eyewash Fire Extinguishers Heavy Equipment (Tractor, Haul Trucks)	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

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